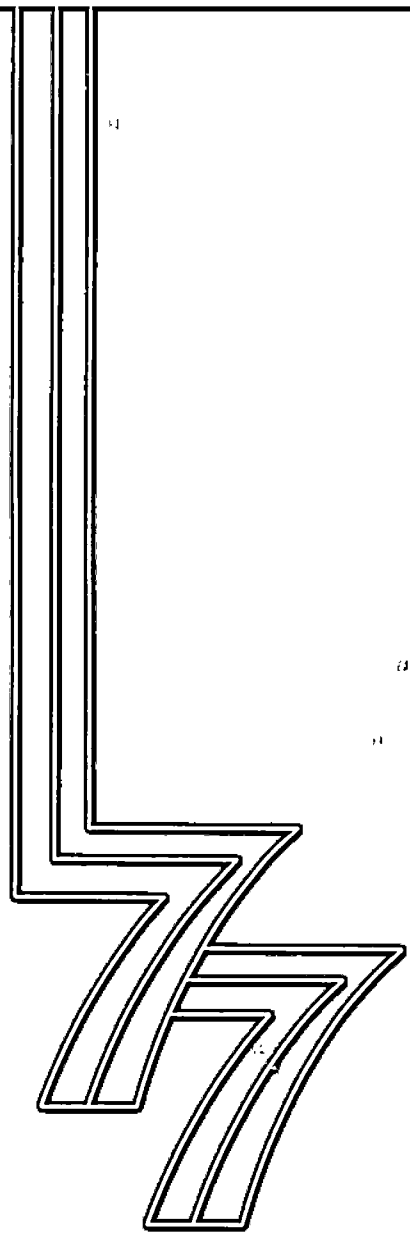
U. S. Nuclear Regulatory Commission
Annual Report 1977



April 28, 1978

The President
The White House
Washington, D.C. 20500

Dear Mr. President:

We have the honor to submit herewith the third Annual Report of the United States Nuclear Regulatory Commission for your transmittal to the Congress, as required by Section 307(c) of the Energy Reorganization Act of 1974. This report covers the major activities of the NRC from October 1, 1976, through September 30, 1977, and briefly describes some additional actions through December 31, 1977.

Respectfully,

Joseph M. Hendrie
Chairman

Table of Contents

Chapter 1—OVERVIEW AND SUMMARY

Chapter 2—REACTOR REGULATION

Chapter 3—MATERIALS REGULATION

Chapter 4—DOMESTIC SAFEGUARDS

Chapter 5—WASTE MANAGEMENT

Chapter 6—INSPECTION AND ENFORCEMENT

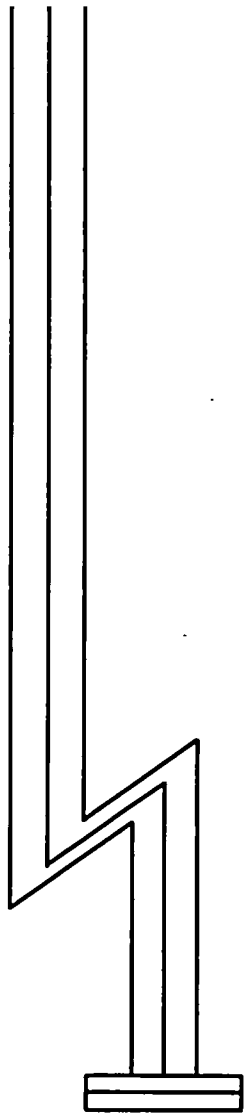
Chapter 9—INTERNATIONAL ACTIVITIES

Chapter 10—REGULATORY STANDARDS

Chapter 11—REGULATORY RESEARCH

Appendices

Overview and Summary



This third Annual Report of the Nuclear Regulatory Commission describes the major events and challenges affecting nuclear regulation during fiscal year 1977 and key actions taken, underway and planned on behalf of the public.

Section 307(c) of the Energy Reorganization Act of 1974 specifies a number of areas of NRC activity that must be discussed in the Annual Report, including those pertaining to nuclear power plant safety, safeguards and waste disposal. In addition to responding to the statutory mandate, the report treats several matters that gave rise to public concern during the year, and seeks to clarify for the general public the status of licensed nuclear operations and their regulation. The Commission hopes that the presentation in one publication, with index, of a comprehensive description and discussion of its programs will make the Annual Report useful as a reference document. Chapters 2 through 14, and appendices, describe NRC activities in each major program area during the fiscal year ended September 30, 1977, and Chapter 1 presents a brief overview and summary of these activities. This report also provides brief accounts of some of the more important actions taken during the balance of the calendar year 1977, which will be discussed more extensively in the 1978 Annual Report.

In 1977 the Commission continued to carry out its responsibilities in an environment of widespread public debate over issues associated with the use of nuclear technology. The issues being debated were focused mainly on various safety aspects of nuclear activities, the need for timely resolution of the problem of radioactive waste management, reforming the licensing process, safeguarding nuclear facilities and materials against malevolent actions, and efforts to deter the worldwide spread of nuclear weapons capability. A national policy against nuclear proliferation, enunciated in Presidential statements, intersected directly with domestic fuel cycle deliberations. It led to a Commission decision in December to terminate a three-year NRC proceeding on whether plutonium should be recovered from spent uranium reactor fuel and recycled into fresh mixed oxide fuel on a wide scale.

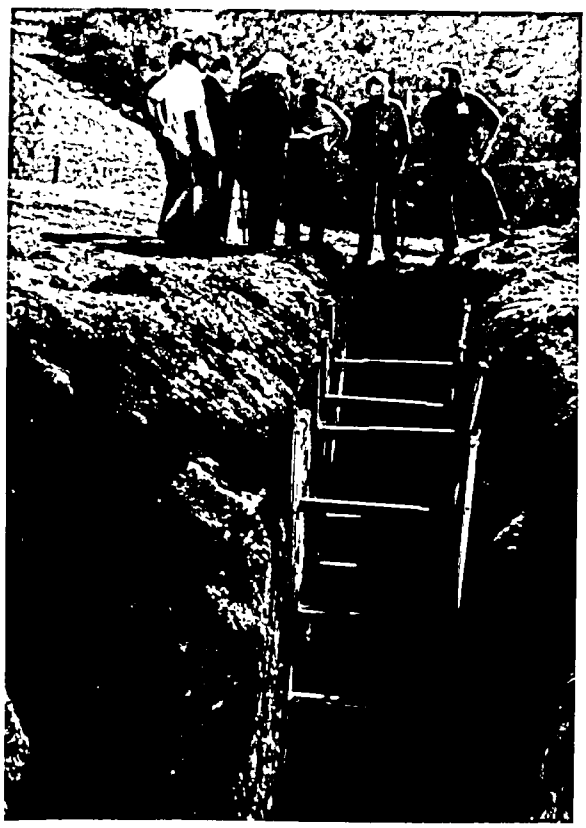
Although some 1977 developments prompted the Commission to reexamine priorities given certain of its programs, the NRC's statutory responsibility remains unchanged: to regulate civilian nuclear activities so that the public health and safety, national security and environmental quality are protected and the antitrust laws obeyed.

SAFETY

There are two aspects to the question of safety in nuclear activities: the risks posed by nuclear accidents, on the one hand, and by routine releases of low levels of radioactivity on the other. Since uncertainties and risks cannot be reduced to zero in any human endeavor, the NRC's safety goal in nuclear power regulation is to require licensees and applicants for licenses to take those actions considered necessary to assure that the risks from normal operation and from accidents are extremely low.

With respect to normal facility operations, control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk. For example, NRC regulations require that the low-level releases of radioactive materials in effluents from light water-cooled power reactors and resultant doses to the public be kept "as low as reasonably achievable." The Commission's numerical guidelines for implementing this requirement, if met, will keep radiation doses to persons living near nuclear plants at levels which are small fractions of doses occurring from natural background radiation, and of existing radiation protection standards followed by all Federal agencies. Uncertainties at the present state of knowledge as to the risk of harmful effects from low-level exposures have been the subject of continuing debate. The NRC staff has been evaluating specific radiation epidemiology research findings concerning effects of both occupational and nonoccupational exposures with the goal of ensuring that radiological exposure limits reflect results of the latest research in this field.

The NRC's inspections of licensees and examination of personnel radiation exposure records during 1977 indicate that NRC licensees continued to achieve a generally good overall radiation safety record. There were 19 abnormal occurrences in licensed operations during fiscal year 1977—seven involving power reactors and 12 involving materials licensees. These occurrences—events considered to be significant from the standpoint of safety but which do not always imply a direct, imminent threat to persons—were reported to Congress on a quarterly basis, and are summarized in this report.



Geological and seismological experts from NRC's Office of Nuclear Reactor Regulation, the U.S. Geological Survey, the California Division of Mines and Geology, and Earth Sciences Associates examine trenches at the General Electric Company's Vallecitos Nuclear Center near Pleasanton, California, for evidence of geologic faulting. This investigation in October 1977 led the NRC staff to order the General Electric Test Reactor shut down on October 27, 1977.

Licensed Reactors

During 1977 there was no nuclear accident causing detectable injury to any person at any licensed power reactor in the United States. As of December 31, 1977, licensed nuclear electric generating plants had accumulated approximately 366 reactor-years of operation without experiencing such an accident.

The seven abnormal occurrences at power reactors during 1977 involved technical problems, failures of materials, design defects, personnel error and laxity in safeguards. The fact that technical problems and malfunctions encountered in operations have not escalated into serious accidents has served to demonstrate the effectiveness of requiring defense-in-depth protection in reactor design. At the same time, however, such occurrences demonstrate the need for continual regulatory vigilance in following nuclear operations to assure prompt corrective action where indicated and to apply lessons of experience. This continues to be a prime function

An NRC inspector looks over a reactor flow chart—a document showing water flow paths inside the reactor vessel—with the Control Center Operator in the control room of a Florida nuclear power plant.

of the NRC, utilizing not only findings from its inspections, investigations, technical studies, research, and operational reports from licensees, but also information concerning safety from all available sources.

During 1977, the NRC took a number of actions to correct deficiencies at operating reactors, some of which involved temporary shutdowns for modifications of design or procedures, or replacement of components. Safety-related events with potential significance are routinely examined to determine whether they apply to other facilities. In November, for example, the NRC staff undertook two surveys of electrical components in all operating nuclear power plants—one resulting from a petition from the Union of Concerned Scientists which was based on certain tests performed for the NRC, and the other arising from the detection of electrical grounds during reactor operation. By year-end the NRC staff had ordered the shutdown of one plant until qualified electric cable connectors could be installed, and was continuing to investigate conditions at other potentially affected facilities. Actions on the principal technical problems with reactors considered during fiscal year 1977 are discussed later in this Annual Report.

In other actions, the NRC staff announced in August 1977 that it would recommend denial of permission to resume operation of the Humboldt Bay Nuclear Power Plant near Eureka, Calif., based on a year-long review of potential earthquake effects which had not been taken into account in the reactor design. And, in October, the staff ordered the shutdown of General Electric Company's test reactor near Pleasanton, Calif., on the basis of new information on geologic faulting near the site.

Recognizing that NRC regulations have evolved over a period of years, the Commission approved, in November 1977, a staff plan to systematically evaluate 11 nuclear power plants licensed for operation before 1972 to determine to what extent they meet current licensing requirements for new plants. While substantial improvements have already been made in response to safety issues or in specific systems of these older reactors, each plant will be reviewed as a whole to determine whether additional changes will be required. Examples of matters to be considered are seismic design, accident reevaluation, and systems to monitor for primary coolant leakage.

The NRC staff in November recommended discontinuance of an early site review of Baltimore Gas & Electric Company's proposed nuclear station location at Perryman, Md., concluding that there are clearly superior alternative sites from the standpoint of population density and other factors.

In enforcement actions during the 12-month period ended September 30, the NRC fined licensees of six operating reactors and suspended the license of a senior reactor operator for violations of NRC regulations.

Occupational Exposures

Data collected from the four categories of licensed operations having the greatest potential for significant personnel radiation exposures—power reactors, industrial radiographers, fuel fabricators and processors, and certain processors and distributors of radioisotopes—indicate that exposures to individuals generally continue to be well below allowable limits.

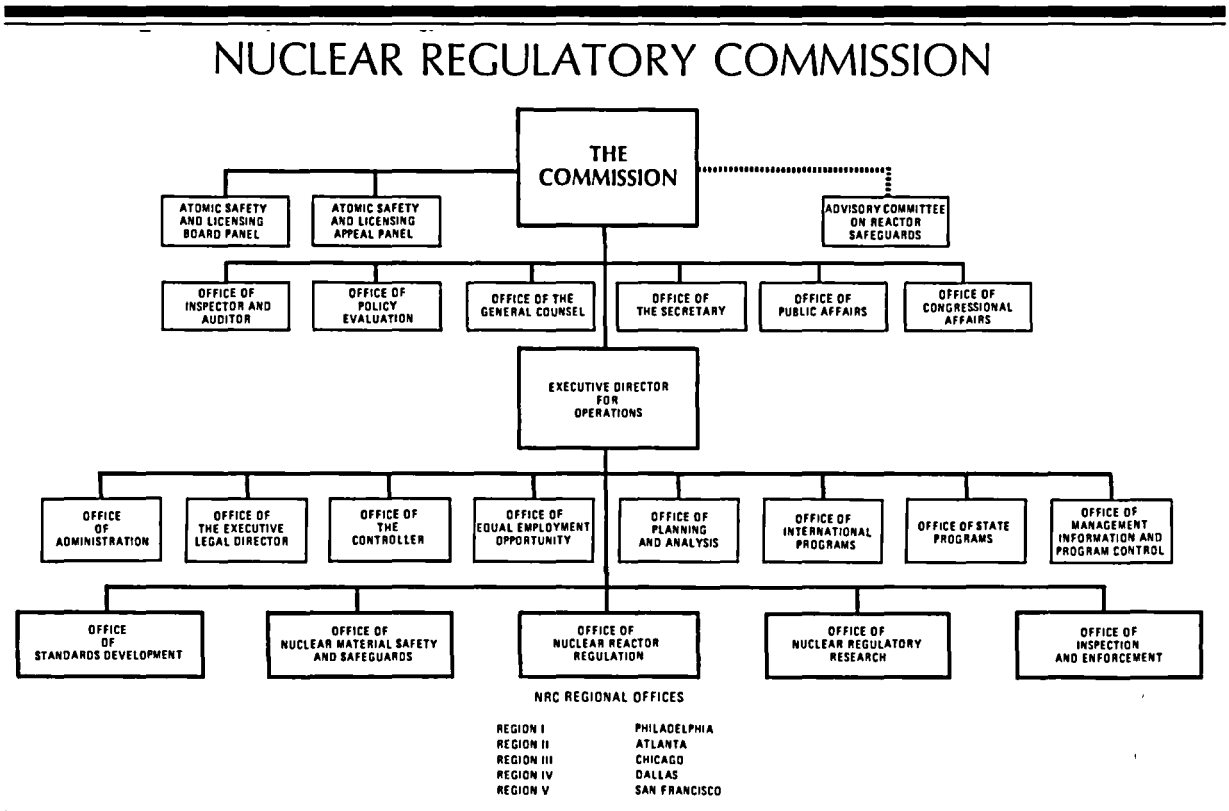
The reports for 1976 on some 92,800 persons monitored in these operations showed that exposures of nearly half of these individuals were too small to be detected by personnel radiation dosimeters. Three exposures were recorded that exceeded the maximum annual limit of 12 rems established by Federal regulations. The average exposure was 0.36 rem per person, the same as in 1975. Most of these exposures occurred at the 62 nuclear power plants authorized to operate during 1976, and involved many short-term employees engaged in plant maintenance.

Of the 12 abnormal occurrences among nuclear materials licensees during the fiscal year, nine involved overexposures of personnel in industrial radiographic operations. The number of overexposed individuals is small in light of the thousands of employees of hundreds of licensed firms who use radioactive sources to make millions of x-ray-like pictures each year to detect flaws in dense materials such as structural steel. Nevertheless, these sources of highly penetrating radiation have a high potential for personnel overexposures, and the Commission is concerned with reducing the number of such occurrences. Accordingly, an action plan was set in motion in 1977. It includes a rulemaking proceeding, possible revision of design criteria for radiographic devices, and seminars on radiation safety and NRC requirements to be conducted by the NRC staff expressly for industrial radiographers.

Transportation

About 2.2 million packages of radioactive materials are shipped annually in the United States. About 40 percent are shipped by air, and of these more than 60 percent contain small amounts of radioisotopes for medical uses. NRC, the Department of Transportation, the U.S. Postal Service and the States all have a part in regulating the safety of commercial shipments of nuclear material. NRC regulations apply to its licensees and generally specify procedures and standards for packages and shipments to protect the public.

Since formation of the NRC in 1975, the staff has been reviewing existing transportation regulations. As part of a Commission rulemaking proceeding announced in 1975, the staff issued in December 1977 its Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes. The statement concludes that present regulations governing the transporta-



tion of radioactive materials are adequate; however, studies are continuing on certain aspects to determine whether changes should be made. In this regard, the NRC staff is preparing an environmental statement on transportation of radioactive materials through urban areas, and conducting a joint study with DOT of the adequacy of existing requirements for shipment of low-level radioactive materials. The results of these studies will be useful to the Commission in considering a petition from two Congressmen and several consumer-interest and environmental organizations asking that regulations on shipments of radioactive materials be amended.

Public concern over increasing shipments of highly enriched uranium through Chicago's O'Hare Airport led to a decision in December 1977 that such shipments would be moved through other airports until completion of a joint study by the NRC and the Office of the Mayor of Chicago. An NRC task force was participating in the study at the end of the year. A New York City ordinance, passed in 1975, which virtually bans the transport of significant amounts of radioactive material within the city, continued in litigation. A hearing was held on the matter in November 1977 by DOT, which is considering the compatibility of the ordinance with Federal regulations.

The NRC expects to be able to certify to the Congress early in 1978, in response to P.L. 94-79, that it has developed and tested a container for air transport of plutonium that can withstand virtually any type of aircraft accident.

RESEARCH

The third year of NRC's research program produced substantial results, particularly in the area of light water reactor safety research where the principal effort is concentrated.

Results of the NRC's confirmatory research add to the understanding of the margins of safety which NRC licensing requirements are intended to provide in nuclear power plants. Important advances were made in the loss-of-fluid test (LOFT) program, in measuring the oxidation of nuclear fuel cladding, in computer code development, in fracture mechanics, and in the area of fire protection research. Experimental data from LOFT tests are showing good agreement with predictions. The nonnuclear tests in LOFT—NRC's largest experimental facility—were completed, and preparations are underway for tests with a nuclear core, anticipated to begin in the spring of 1979.

Significant progress also was made in research programs supporting advanced reactor safety, safeguards, and the fuel cycle and the environment.

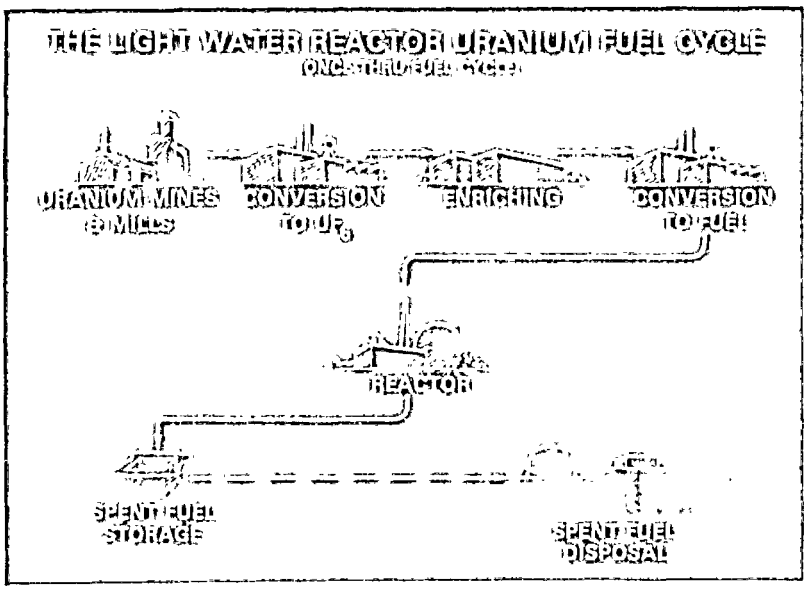
NRC efforts in risk assessment were concentrated on the use of techniques developed in the *Reactor Safety Study* (also known as the Rasmussen Report) and further development of probabilistic analysis and risk assessment and their application in the licensing and other regulatory functions. A seven-member group of scientists from outside the NRC was appointed by the Commission in mid-1977 to review the *Reactor Safety Study* and comments received on it. The panel conducted several public meetings during the year. The report of this independent group, expected in mid-1978, will clarify the achievements and limitations of the *Reactor Safety Study* and present recommendations to the Commission on the further development and use of risk assessment methodology.

During 1977 the NRC investigated the pros and cons of constructing a facility in the range of one-third to one-half the actual size of pressurized water reactor vessels to conduct tests concerning emergency core coolant bypass and steam-water mixing phenomena. In December, after considering the staff's proposal and comments of the Advisory Committee on Reactor Safeguards, the Commission decided to defer a request for funding in the fiscal year 1979 budget pending further study and the consideration of possible alternatives.

At year-end the Commission established a research review group to implement an amendment (P.L. 95-209) of the Energy Reorganization Act of 1974 which directs NRC to "develop a long-term plan for projects for the development of new or improved systems for nuclear power plants." The Congressional intent behind this effort is "the improvement of reactor safety and not the enhancement of the economic attractiveness of nuclear power versus alternative energy sources."

THE NUCLEAR FUEL CYCLE

The relationship between United States foreign policy interests and domestic decisions concerning the future course of civilian nuclear power was redefined during 1977. Salient developments regarding the fuel cycle included (*1*) President Carter's nuclear policy statement in April in which he said that commercial reprocessing and recycling of plutonium produced in U.S. reactors would be deferred indefinitely, (*2*) establishment in October of an



International Nuclear Fuel Cycle Evaluation (INFCE) project to conduct technical and analytical studies on how to minimize the danger of nuclear weapons proliferation without jeopardizing energy supplies, (*3*) Administration and Congressional initiatives to enact nonproliferation legislation, and (*4*) an acceleration of efforts to resolve the problems of interim storage of spent reactor fuel and final disposal of high-level wastes.

Recycle Proceeding Ended

In December the Commission terminated proceedings on the issue of whether and under what conditions uranium and plutonium might be recovered from spent light water reactor fuel and recycled in fresh mixed oxide fuel. Public consideration of this question began in 1974 with publication of a draft Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors, referred to as GESMO. Hearings on the health, safety and environmental issues of the question began in November 1976 and ended in February 1977. The GESMO board postponed the next phase (safeguards) of the hearings after the President's April nuclear power policy statement, and the Commission invited comments from the public, the GESMO participants and the Executive Branch. In addition to other comments, the President told the Commission that his nonproliferation initiatives would be assisted if the proceedings were terminated.

After soliciting and receiving public comments on the President's views and several specified alternative courses of action, the Commission decided in public meetings in December to end the GESMO proceeding as well as proceedings on certain pending or further major plutonium recycle-related license applications. These matters will be reexamined after completion of ongoing alternative fuel cycle studies. The Commission also decided to publish the draft safeguards supplement to the GESMO statement as a staff technical report and to reserve for decision, if it arises, the question of whether a facility such as the Barnwell (South Carolina) reprocessing plant may be licensed for experimental and feasibility purposes on a noncommercial basis in support of the nation's nonproliferation objectives.

NRC staff members are participating actively in the U.S. support effort for various working groups of the INFCE project, which is expected to be concluded in about two years.

With no spent reactor fuel reprocessing services available, the problem of storing irradiated fuel elements has escalated in importance. The NRC has been processing many applications for the expansion of storage pools at reactor sites. In September, the Commission approved the first transfer of spent fuel from one reactor site to another reactor site with spare capacity. A draft environmental statement prepared by the staff concludes that the spent fuel expected to be generated through the year 2000 can be handled by modifying storage space at each reactor site, supplemented by additional off-site storage. A proposed rule and guide for independent spent fuel storage installations will be issued in 1978 for public comment.

Exports and International Safeguards

Concern over nuclear proliferation has brought about a reassessment of U.S. nuclear export policy. During the year NRC reviewed export licensing procedures and issued a proposed new section of the Code of Federal Regulations to cover export-import activities. This will be supplemented with criteria for nuclear exports once nonproliferation legislation is enacted. The NRC has been assisting in the development of draft nonproliferation legislation.

In 1977 the NRC also participated in forming a new Federal interagency committee to coordinate nuclear export activities, issued several major export licenses, and continued to work with the Department of State and other agencies to implement the U.S.-IAEA Safeguards Agreement and to strengthen the IAEA safeguards program.

Domestic Safeguards

In 1977, the NRC staff began to amend licenses to ensure industry-wide compliance with upgraded requirements for monitoring and controlling the quality of measurements of special nuclear material in the commercial fuel cycle.

The NRC issued a report in August of strategic special nuclear material (SSNM) inventory differences covering licensed facilities after January 1, 1968. Further reports will be published periodically. The NRC staff concluded that there had been no evidence of any diversion of significant quantities of special nuclear material from licensed facilities during the time period covered (January 1, 1968 through September 30, 1976). Subsequent Congressional hearings and inquiries have focused on the possibility of an earlier diversion from the Nuclear Materials and Equipment Corporation facility at Apollo, Pa. Those inquiries were still in process at the end of 1977.

During the year, as a result of special NRC reviews conducted in 1976, specified actions were taken to strengthen physical security measures at facilities handling significant quantities of highly enriched uranium or plutonium. NRC teams are continuing to conduct field evaluations of safeguards at fuel processing plants.

In 1977 NRC issued a proposed new rule to further strengthen safeguards of SSNM in fuel cycle facilities and in transit, as well as in certain research reactors. It also issued two proposed regulations (to be applied to both fuel cycle activities and reactors) concerning security clearances of licensee personnel and qualification of guards and other security people.

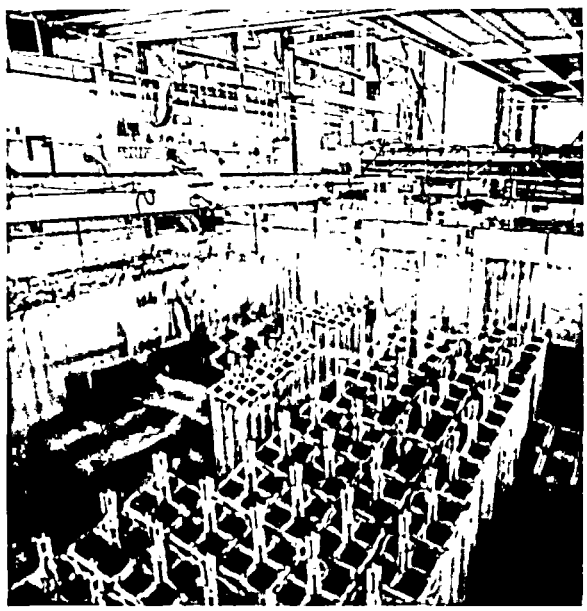
Stringent new regulations on protection of nuclear power reactors from sabotage, under development since 1974, were adopted in February 1977. Certain interim actions to upgrade safeguards capability were required by May 15, 1977, and full implementation will be required by August 1978.

Other safeguards actions included development of proposed rule changes concerning contingency plans of licensees for dealing with threats, thefts and sabotage. The draft rule changes were discussed in regional meetings with fuel cycle licensees who handle significant quantities of SSNM and with power reactor operators.

Waste Management

The NRC has restructured and substantially expanded its organization for regulating the management of nuclear wastes. Resources are being developed for contractual support independent of the national laboratories managed by the Department of Energy (DOE).

Regulations governing high-level waste repositories to be proposed by DOE for licensing continue to be developed and are scheduled to be published for public comment in late 1978. These will include



This spent reactor fuel storage basin at General Electric Company's Morris, Illinois, facility holds both 4-bundle PWR fuel assemblies (foreground) and 9-bundle BWR assemblies (center). GE has applied to NRC for a license amendment which would more than double the capacity of the facility through construction of an additional pool.

criteria for waste form and for the design and siting of repositories. The NRC conducted three regional workshops in September 1977 to facilitate State review of preliminary drafts of site suitability criteria for high-level waste disposal.

A public rulemaking hearing is scheduled early in 1978 on revisions of 10 CFR § 5.20, Table S-3. This table specifies the environmental effects of balance of the fuel cycle (uranium milling, production of enriched uranium fuel, reprocessing, spent fuel storage, transportation, and management of radioactive wastes) which must be considered in assessing the impact of an individual power reactor. The "Environmental Survey of the Uranium Fuel Cycle," published in 1974 by the Atomic Energy Commission, established the technical basis for Table S-3. A supplement to the survey was published by the NRC in October 1976 in response to a court decision remanding the reprocessing and waste management portions of the rule. In addition, significant questions have been raised about the S-3 Table's values for radioactive releases from uranium mill tailings. These questions are not part of the aforementioned rulemaking proceeding, but are the subject of petitions and reviews within the Commission.

In response to Congressional concerns, an NRC task force reviewed the Federal-State program for regulating commercial low-level radioactive waste burial grounds and published its findings in March 1977. Based on recommendations in this report and public comments, the Commission in December announced plans for improving this program. The staff will accelerate standards development for low-level waste disposal and will examine alternatives to shallow land burial in concert with other Federal and State agencies. Any new land sites must be justified on the basis of demonstrated needs. The Commission held in abeyance the task force recommendation to seek increased Federal control in this area.

Among matters of public concern in low-level waste management during 1977 was the NRC's delay in acting on an application for renewal of the license for a disposal site at Sheffield, Ill. (NRC regulations permit continued operation of facilities during pendency of timely filed license renewal applications.) The State filed suit against NRC and the site operator for failure to act on the application and to prepare an environmental impact statement in a timely manner. (The site was originally licensed prior to enactment of the National Environmental Policy Act, which requires such statements.) The NRC expects to issue an environmental statement and complete action on the license application during 1978, assuming resolution of zoning and land ownership questions.

Congressional concern also was expressed over technical and economic considerations associated with the decommissioning of nuclear facilities and sites after the end of their useful lives. Recognizing that the current generation of large commercial reactors and supporting nuclear facilities would substantially increase future decommissioning needs, the Commission began a review and reevaluation of the regulatory approach to decommissioning in 1975. Technical studies on decommissioning were initiated to provide a data base for engineering methodology, radiation risks, and estimated costs of decommissioning light water reactors and their associated fuel cycle facilities. These studies will form the basis for new decommissioning regulations applicable to all licensed facilities.

IMPROVING LICENSING PROCEDURES

An improved process for licensing nuclear power plants continues to be an important goal of the Commission.

In mid-1977 a group of senior NRC staff members concluded a study of recent licensing actions and recommended several actions that could (1) shorten some phases of the licensing process without compromising quality of reviews, (2) strengthen the technical review, and (3) increase opportunities for public participation. The staff report analyzed difficulties experienced by the staff, applicants, and other parties in licensing proceedings. It also evaluated the effects of changes in the process in recent years such as standardization, early site reviews, standard staff review plans and coordination efforts with other Federal and State agencies.

The Commission has directed the staff to proceed with most of the study group's recommendations. Some will be implemented on a trial basis for the next few construction permit applications. In these cases, the staff will provide earlier guidance and coordination with prospective applicants, issue an early Safety Evaluation Report, and arrange for public participation in meetings with the applicant near the proposed site before and after the application is formally docketed for review.

At mid-year the Commission issued a policy statement reaffirming its support of the program for standardizing nuclear power plant designs. It also adopted rules establishing procedures for early reviews of site suitability separate from and prior to a construction permit application. A review of NRC reactor siting policies is underway, and the Commission expects to make decisions in 1978 on procedures for reviewing alternative sites and on emergency planning policy and regulations.

Cooperative efforts with the States to avoid duplication and minimize cost and delay in nuclear facility licensing have increased markedly. Both the States and NRC have appointed liaison officers to coordinate licensing matters. NRC has adopted some recommendations made by State regional organizations as a result of NRC-sponsored Power Plant Siting Conferences. In June 1977 an NRC staff task force distributed a draft report on improving regulatory effectiveness in Federal/State siting actions. The culmination of nine months of study by the task force in cooperation with State representatives and other groups, the report provides insight into deficiencies in the environmental decision-making process and makes a number of recommendations. In other coordinating actions, decisions are being made on joint NRC-State regulatory hearings on a case-by-case basis, and the NRC is seeking cooperative agreements with those States having water quality permit authority with respect to proposed nuclear plants.

As part of NRC's review of Agreement States' regulatory programs, NRC reviewers periodically observe routine Agreement State inspections. Here, a State inspector (left), accompanied by an NRC reviewer (right), examines a State licensee's soil density gaging device during an inspection in Texas.

DOE Licensing Bill

During July, August and September 1977, the Commission provided comments to the Department of Energy on preliminary drafts of proposed nuclear siting and licensing legislation. On September 26, 1977, the Commission provided DOE with a draft bill in order to focus consideration on some of the questions which the Commission believes should be addressed in drafting nuclear licensing reform legislation. In October, the Commission made further detailed comments in a letter to the Office of Management and Budget. The Commission's activities in commenting on subsequent DOE drafts leading to an Administration proposed nuclear siting and licensing bill are expected to continue in the coming months.

NEW LEGISLATION

Legislation affecting nuclear regulation enacted during the year included the 1977 Clean Air Act Amendments (Public Law 95-95, signed August 7) and the NRC appropriation authorization for fiscal year 1978 (Public Law 95-209, signed December 13), which mandated several new NRC tasks.

Clean Air Act

The Clean Air Act Amendments brought, for the first time, radioactive substances within the framework of the Act. The Administrator of the Environmental Protection Agency (EPA) must determine within two years whether emissions of radioactive pollutants "will cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health." If an affirmative determination is made, he must list each pollutant under one of three sections of the Act and promulgate national primary and secondary ambient air quality standards, new source performance standards or hazardous air pollutant emission standards, depending on where the pollutant is listed. While the Administrator must implement and enforce the standards, he is required to enter into an interagency agreement with the NRC to minimize duplication of effort in exercising jurisdiction under the Act.

EPA and the NRC are engaging in discussions on how to implement the provisions of the Amendments.

The Clean Air Act Amendments also give the States broad authority to set air quality standards for radioactive materials. States may not only establish standards more stringent than Federal

standards, but also may promulgate State standards in the absence of Federal standards.

Authorization Act Requirements

The NRC Appropriations Authorization Act imposed several reporting and other requirements, both by new mandates and by amendments to the Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974. These provisions include requirements that:

- The Commission publish a statement detailing the need for research and contractual support of domestic safeguards functions before funds can be allocated for this purpose.
- Expenditures for research contracts related to advanced reactor safety be authorized by the Commission after consideration of any recommendations of the Advisory Committee on Reactor Safeguards (ACRS) regarding the proposed research.
- The Commission submit to Congress quarterly reports on steps taken to meet provisions of the Equal Employment Opportunity Act.
- The Commission submit to Congress by January 1, 1978, "a plan providing for the specification and analysis of unresolved safety issues relating to nuclear reactors," and include progress reports in its Annual Report thereafter concerning corrective actions on such issues.
- The Commission develop a long-term research plan for projects to develop new or improved safety systems for nuclear power plants.
- The ACRS undertake a study of reactor safety research, submitting reports annually to Congress, the first such report due by December 31, 1977.
- The ACRS establish a program of two-year fellowships to assist in carrying out its functions.
- The Commission promulgate, by December 31, 1977, guidelines for determining whether a potential NRC contractor has a conflict of interest which might impair the contractor's judgment or confer an unfair competitive advantage.

As this Annual Report went to press, the Commission and the ACRS had taken, or were taking appropriate steps to comply with provisions of the Authorization Act.

For fiscal year 1978, the Act specifies a personnel level of 2,723 (a 9 percent increase over fiscal year 1977) and funding at $295 million (a 16 percent increase over fiscal year 1977). The increase in personnel will provide for increased inspection effort in the safeguards and the fuel cycle and materials programs and for the initial phase of the resident inspection program. The increase in funding is required mainly to support regulatory research projects.

Reactor Regulation

The primary goal of the NRC in its licensing and regulating of nuclear reactors is to assure the health and safety of the public and the protection of the environment. The licensing process is centered in the NRC's Office of Nuclear Reactor Regulation (NRR) where each proposed nuclear power plant is reviewed by a staff drawn from a broad spectrum of professional disciplines and organized into four divisions, plus an antitrust and indemnification group. (See Appendix 1 for a description of NRR organization.)

This chapter discusses major aspects of the reactor licensing process and develops the relationship between licensing actions and the primary objective: the safe operation of nuclear power plants. The chapter covers specific licensing actions during fiscal year 1977; steps to ensure safe design under the "defense-in-depth" concept; highlights of special technical reviews; action to improve the licensing process through standardization and early site review; environmental protection; antitrust reviews; indemnity and insurance matters; and other subjects relating to safety in reactor operations. (Safeguards against sabotage of reactors are discussed in Chapter 4.)

Status of Nuclear Power Generation

As of September 30, 1977, there were 230 nuclear power units either in operation, being built or being planned, representing a total capacity of 230,000 net megawatts electric (MWe). Of these 230 units, 202 had entered the NRC licensing process, as follows:

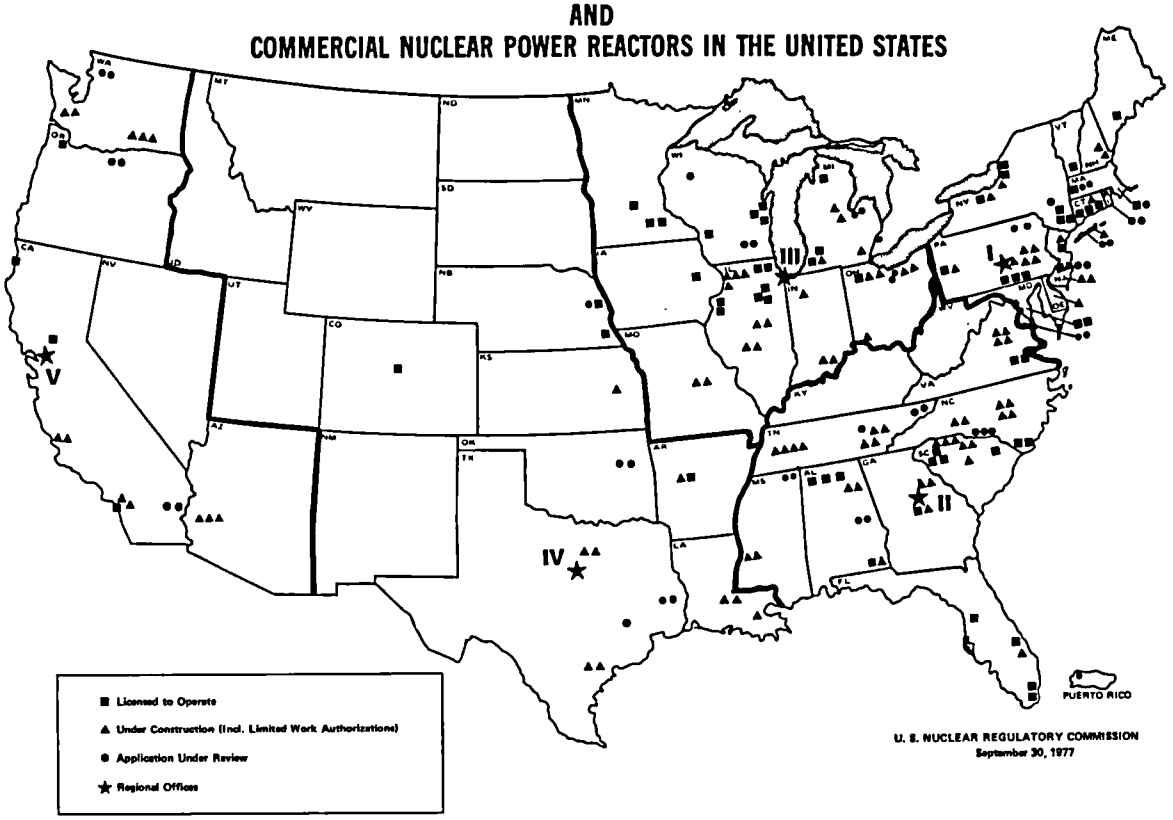
- 65 licensed to operate, with a total capacity of 47,000 MWe.
- 78 with construction permits, representing 83,000 MWe capacity.
- 59 under review for construction permits, representing 66,000 MWe capacity. (Initial construction work was proceeding on 15 of these under limited work authorizations.)

Of the remaining 28 units—those which had not entered the NRC licensing process—13 had been ordered and 15 publicly announced.

Licensing Reactor Operators

The safety of a nuclear facility depends not only on its design but on the qualifications of the people who operate it. To assure

NRC REGIONAL OFFICES
AND
COMMERCIAL NUCLEAR POWER REACTORS IN THE UNITED STATES



that the people in charge of each nuclear power plant are capable of directing and performing the activities necessary to reactor operation, the NRC requires each individual who handles the controls of the reactor to be licensed. The requirements for issuance of operators' licenses are set forth in 10 CFR Part 55. (See also the 1976 NRC Annual Report, pp. 21 and 23.) Two types of licenses are issued by the NRC: one for "operators" and one for "senior operators." During fiscal year 1977, the NRC issued 364 new operator licenses, 249 renewals, and 23 amendments, bringing the number of operator licenses in effect on September 30, 1977 to 1,000. During the same period 284 new licenses, 463 renewals and 18 amendments were issued for senior operators, bringing the total to 1,417 in effect.

ADVANCED NUCLEAR POWER PLANTS

In October of 1976, then President Ford stated that the United States and other nations "...should increase their use of nuclear power...," but that "...reprocessing and recycling of plutonium should not proceed unless...the world community can effectively overcome the associated risks of proliferation of nuclear weapons capabilities."

Shortly after taking office, President Carter expressed similar views and, on April 7, 1977, issued a statement on Nuclear Power Policy which reconfirmed the share that nuclear energy was to have in the total energy prospects of the country. The President's program would also defer indefinitely the commercial reprocessing and recycling of plutonium produced in nuclear power reactors, restructure the U.S. breeder reactor program to give high priority to alternative designs, and defer the time when breeder reactors were to be commercialized.

During the report period, the NRC prepared, in response to a request of the General Accounting Office, an assessment of a variety of reactor types and fuel cycles which have been identified as potential alternatives to the LMFBR and its attendant plutonium fuel cycle. NRC staff presented its views on the potential licensability of these reactor types and associated fuel cycles, with respect to safety and safeguards concerns and environmental acceptability. More detailed evaluations will be prepared in connection with the Department of Energy's study of alternate reactor and fuel cycle concepts to meet the President's goals.

Clinch River Breeder Reactor

The Clinch River facility near Oak Ridge, Tenn. was proposed as a demonstration plant with a liquid metal fast breeder reactor (LMFBR), fueled with a mixture of plutonium and uranium oxides. Although designed to generate 380 megawatts for an existing electrical power grid, the generation of electricity was considered a secondary benefit. The primary purpose of the Clinch River project was to provide design, construction and operating data and experience which would be considered in deciding whether the LMFBR should be developed as a commercially feasible generator of electricity. The former Energy Research and Development Administration (ERDA—now part of the Department of Energy) has had direct management responsibilities for the project and has been the primary contact with the NRC staff during the licensing process. (See the 1976 NRC Annual Report, pages 32 and 33, for a description of NRC's earlier licensing review.)

On April 22, 1977, following the President's energy policy message, ERDA requested an indefinite suspension of the public hearing schedule associated with the licensing of the Clinch River facility. This request was granted by the Atomic Safety and Licensing Board. Prior to this request, the NRC staff had completed its review of the Environmental Report for the facility and on February 7, 1977 had issued the Final Environmental Statement (NUREG-0139). In addition, in response to a request by ERDA for a limited work authorization (LWA), the NRC staff had prepared a Site Suitability Report which was issued on March 7, 1977. The Site Suitability Report was based on the staff review of the information then available in the Preliminary Safety Analysis Report and was intended to form a principal part of staff testimony with respect to a decision on an LWA at the environmental hearing.

The staff review of the safety-related features of the proposed plant had been continuing while the environmental and site suitability issues were being resolved. The Commission, having considered the President's energy policy message and the testimony of ERDA's Acting Administrator regarding construction of the Clinch River facility, determined that the staff should not continue to review the plant on an indefinite schedule. The staff redirected its activities to bring the safety review to a point where the effort to date would be adequately documented and any nearly complete efforts would be completed, thus allowing an orderly resumption of the licensing process if warranted by future Congressional and Administration actions.

Fast Flux Test Facility

The Fast Flux Test Facility (FFTF) is a major test facility in the LMFBR program which, with a power of 400 megawatts (thermal), will provide an intense beam of fast neutrons for irradiating fuels and materials in advanced reactor research and development. A Final Safety Analysis Report was received on April 2, 1976 and a safety review was initiated by NRC. The safety review—which is being performed in accordance with existing interagency agreements with the former ERDA—is approximately 85 percent complete and the Safety Evaluation Report will be issued early in 1978. Sodium filling is expected to take place in June 1978 and fuel loading one year later. Full power operation is not expected until February 1980.

During the construction permit review of FFTF, the possibility of a "core disruptive accident" was examined in detail. It was concluded that such an accident was extremely unlikely and that, even if it occurred, the estimated energy releases could be accommodated with the existing design. The energetics of a core disruptive accident are being evaluated in the light of recent advances in technology. Although the possibility of a meltdown is considered remote, the consequences of such an event remain under study in the evaluation of the containment design margins. Hazards related to tornado missiles and seismic motion are also being investigated in the safety review.

The Advisory Committee on Reactor Safeguards has been extensively involved in the review of FFTF and related LMFBR technology, and it is anticipated that the Committee will continue to devote substantial effort to the FFTF safety review.

Gas-Cooled Reactors

As a consequence of the withdrawal of the General Atomic Company from the commercial nuclear power market in late 1975, regulatory activities related to gas-cooled reactors have been confined primarily to the Fort St. Vrain reactor, now undergoing power ascension testing. A limited licensing review related to a standardized, large, high-temperature gas-cooled reactor and to a gas-cooled fast breeder reactor has also been undertaken. Standards development by NRC for gas-cooled reactors was terminated in 1975, but the staff continues to encourage development of industry-sponsored standards pertaining to gas reactor safety. Staff members also have met with General Electric, General Atomic, and ERDA

representatives to discuss the "pebble bed" reactor concept, including consideration of its potential use for process heat generation and as a thermal breeder of uranium-233 from thorium.

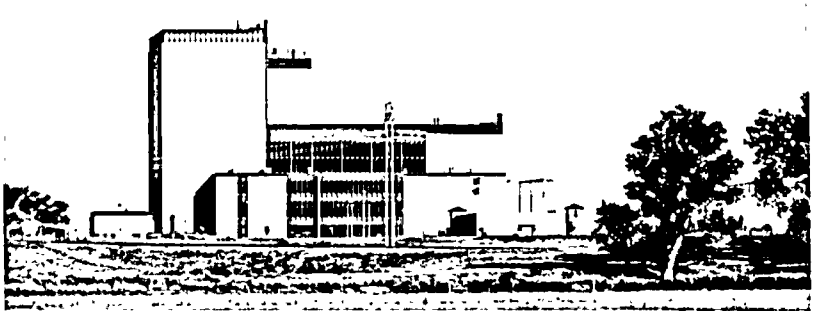
Fort St. Vrain. Fort St. Vrain, a 330-MWe high-temperature gas cooled reactor (HTGR), was designed by the General Atomic Company and is being operated by the Public Service Company of Colorado near Platteville, Colo. It delivers steam to a conventional turbine generator at a temperature of 1,000°F and a pressure of 2,500 pounds-per-square-inch, with a net efficiency of 39.2 percent, which is appreciably higher than conventional light water reactors achieve. The fuel (containing enriched uranium and thorium) is in the form of ceramically coated particles encased in a graphite matrix. The reactor is helium-cooled, with the primary coolant system, including the steam generators and helium circulators, enclosed within a prestressed concrete vessel. In December 1976, Fort St. Vrain was synchronized with the utility grid. Until October 28, 1977, the reactor was undergoing power ascension testing at a power level restricted to no greater than 40 percent of its rated thermal power level of 842 megawatts. On October 28, 1977, a license amendment was issued authorizing power operation up to the 70 percent level. Additional licensing review is in progress in the consideration of an authorized power level greater than 70 percent.

Large High-Temperature Gas-Cooled Reactor. A preliminary Safety Evaluation Report for General Atomic's design of a large, standardized HTGR was prepared by NRC staff and discussed with the ACRS Subcommittee on HTGRs in July 1977. This report updated the safety evaluation of the Summit and Fulton HTGRs which had been made prior to the withdrawal of their construction permit applications. The preliminary SER emphasized the status of the graphite structural design, the seismic design and the thermal and fluid mechanical design. The classification of HTGR accidents according to risk levels was reviewed by the staff. General Atomic will be asked to provide additional confirmation of the low risk estimates associated with certain postulated events as plans for a "lead plant" HTGR develop.

Gas-Cooled Fast Breeder Reactor. In late 1976, an organization of utilities, Helium Breeder Associates, was formed to work with both General Atomic and ERDA toward the development and demonstration of the Gas-Cooled Fast Breeder Reactor (GCFR). The GCFR demonstration unit would produce 330 MWe and its design would be similar to one for which a licensing feasibility review was conducted by the NRC staff in 1974. In mid-1977, the staff met with the ACRS Subcommittee on the GCFR, representatives of Helium Breeder Associates (HBA), General Atomic, and the Southwestern Public Service Company to review the planned program. As a member of HBA, Southwestern Public Service Company would plan to operate the GCFR demonstration plant on a site near Amarillo, Tex.

Floating Nuclear Power Plants

Proposed floating nuclear power plants are electrical generating stations of standardized design which would be constructed at a shipyard facility, using assembly line techniques, and ultimately be sited at coastal or riverine sites. They are planned



The Fort St. Vrain Nuclear Generating Station includes the only gas-cooled reactor licensed for operation in the United States. The reactor is housed in the tall building at the left.

Table 1. Nuclear Power Plant Licensing Actions—Fiscal Year 1977

LIMITED WORK AUTHORIZATIONS

Applicant	*Facility*	*Date Issued*	*Location*
1. Tennessee Valley Authority	Hartsville A1, A2, B1 & B2	12-27-76	Hartsville, Tenn.
2. Kansas City Gas & Electric Co.	Wolf Creek 1	1-24-77	Coffey County, Kans.
3. Washington Public Power Supply System	WPPSS 3 & 5	4-8-77	Satsop, Wash.
4. Duke Power Co.	Cherokee 1, 2 & 3	7-28-77	Cherokee County, S.C.
5. Public Service Co. of Indiana	Marble Hill 1 & 2	8-24-77	Jefferson County, Ind.

CONSTRUCTION PERMITS

Applicant	*Facility*	*Date Issued*	*Location*
1. Gulf States Utilities Co.	River Bend 1 & 2	3-25-77	West Feliciana Parish, La.
2. Florida Power & Light Co.	St. Lucie 2	5-2-77	St. Lucie County, Fla.
3. Cleveland Electric Ill. Co.	Perry 1 & 2	5-3-77	Lake County, Ohio
4. Tennessee Valley Authority	Hartsville A1, A2, B1, B2	5-9-77	Hartsville, Tenn.
5. Kansas City Gas & Electric Co.	Wolf Creek 1	5-17-77	Coffey County, Kans.
6. Rochester Gas Electric Corp.	Sterling 1	9-1-77	Cayuga County, N.Y.

OPERATING LICENSES

Applicant	*Facility*	*Date Issued*	*Location*
1. Florida Power Corp.	Crystal River 3	12-3-76	Citrus County, Fla.
2. Toledo Edison Co.	Davis-Besse 1	4-22-77	Ottawa County, Ohio
3. Alabama Power Co.	Farley 1	6-25-77	Houston County, Ala.

to be of conventional design (using pressurized water reactors) mounted on floating platforms similar to the hull of a barge. Offshore Power Systems, a subsidiary of Westinghouse Electric Corporation, filed an application with the NRC in 1973 for a license to manufacture eight identical floating nuclear power plants.

An NRC staff Safety Evaluation Report (NUREG-75/100) was issued in September 1975; Supplement No. 1 (NUREG-0054) was issued in March 1976 and Supplement No. 2 in October 1976. The staff's Final Environmental Statement (Part I), issued in October 1975, relates to the construction and non-nuclear testing of the floating plants at the manufacturing site in Jacksonville, Florida; the Final Environmental Statement (Part II), issued in September 1976, relates to the generic aspects of the siting and operation of eight floating plants. A separate Draft Environmental Statement (Part III), issued in October 1976, discussed the consequences of radiological releases through liquid pathways on a generic and comparative basis and considered a wide spectrum of hypothetical accidents, including a core melt, for both offshore and landbased sites. At the end of 1977, a revised DES-Part III was being prepared which will compare the total risk of a spectrum of accidents (including core-melt) at a FNP with a land-based plant. This revised DES will consider, based upon the staff's revised Liquid Pathway Generic Study and a cost-benefit balancing, whether the total risk of a core-melt event would be of such a magnitude that mitigation would be required.

During 1977 the staff continued its analyses of floating plants sited in estuarine and riverine environments and plans to issue an addendum to the FES-Part II specifically addressing these matters. Public hearings on safety and environmental issues were started in March 1975 and continued during 1976 and 1977.

The first application for a permit to construct and operate an offshore floating nuclear power station was filed in 1973 by the Public Service Electric & Gas Company of New Jersey. The proposed Atlantic Generating Station, consisting of two floating units (1150 MWe each) would be located approximately three miles off the coast of New Jersey, some 11 miles northeast of Atlantic City. The staff's Draft Environmental Statement (NUREG-0058) was issued in October 1976 and the Safety Evaluation Report (NUREG-0293) was issued in July 1977. Issuance of a Final Environmental Statement and hearings to consider the issuance of a construction permit have not yet been scheduled.

Liquid Pathway Generic Study. In connection with proposed floating nuclear power plants, the staff has prepared a report on the consequences of the accidental release of radioactivity to the liquid pathway at representative land and water-based sites. The report, "Liquid Pathway Generic Study" (draft issued in September 1976 as NUREG-0140), will provide information important not only to the floating nuclear plant licensing process, but also to the evaluation of accident consequences via the liquid pathways at land-based plants. During fiscal year 1977, many public comments were received and discussions were held with various public agencies, organizations, and individuals on the draft study. The NRC staff has made major revisions to the report in response to the comments, specifically in the areas of accident analysis and radionuclide source terms, hydrologic dispersion models, dosimetric models, ecological considerations, and interdiction procedures. The Final Liquid Pathway Generic Study Report is expected to be completed and available for public distribution in fiscal year 1978.

Light Water Breeder Reactor

The Light Water Breeder Reactor (LWBR) utilizes the uranium-thorium fuel cycle and light water reactor technology to produce fissionable uranium 233 from fertile thorium. In order to determine whether or not this kind of breeder reactor could produce more fissionable material than it consumed, a uranium 233-thorium core was installed in the existing reactor vessel at the Shippingport Atomic Power Station at Shippingport, Pa. The reactor plant (formerly owned by ERDA) is owned by the Department of Energy (DOE) and is operated for DOE by the Duquesne Light Company, which owns the associated steam-electric portion of the plant.

As a government-owned facility, the Shippingport reactor plant is not subject to NRC licensing. However, as a result of ERDA's request that the NRC provide comments on ERDA's Safety Analysis Report for the LWBR, the NRC staff performed a safety review of the installation and of significant changes to the Shippingport plant that have been made since the plant was last operated. This review was carried out between July 1975 and October 1976. The results were published in the staff's Safety Evaluation Report, issued in July 1976, and in a Supplement to the SER issued in November 1976. The project was also reviewed by the Advisory Committee on Reactor Safeguards in August 1976. The Committee reported the results

THE LICENSING PROCESS

Obtaining an NRC construction permit—or a limited work authorization pending a decision on issuance of a construction permit—is the first objective of a utility or other company seeking to operate a nuclear power reactor or other nuclear facility under NRC license. The process is set in motion with the filing and acceptance of the application, generally comprising ten or more large volumes of material covering both safety and envimental factors, in accordance with NRC requirements and guidance. The second phase consists of safety, environmental, safeguards and antitrust reviews undertaken by the NRC staff. Third, a safety review is conducted by the independent Advisory Committee on Reactor Safeguards (ACRS); this review is required by law. Fourth, a mandatory public hearing is conducted by a three-man Atomic Safety and Licensing Board (ASLB), which then makes an initial decision as to whether the permit should be granted. This decision is subject to appeal to an Atomic Safety and Licensing Appeal Board (ASLAB), and could ultimately go to the Commissioners for final NRC decision. The law provides for appeal beyond the Commission in the Federal courts.

As soon as an initial application is accepted, or "docketed," by the NRC, a notice of that fact is published in the *Federal Register*, and copies of the application are furnished to appropriate State and local authorities and to a public document room (PDR) established in the vicinity of the proposed site, as well as to the PDR in Washington, D.C. At the same time, a notice of a public hearing is published in the *Federal Register* (and local newspapers) which provides 30 days for affected members of the public to petition to intervene in the proceeding. Such petitions are entertained and adjudicated by the ASLB appointed to the case, with rights of appeal by the petitioner to the ASLAB.

The NRC staff's safety, safeguards, environmental and antitrust reviews proceed in parallel. With the guidance of the Standard Format (Regulatory Guide 1.70), the applicant for a construction permit lays out the proposed nuclear plant design in a Preliminary Safety Analysis Report (PSAR). If and when this report has been made sufficiently complete to warrant review, the application is docketed and NRC staff evaluations begin. Even prior to submission of the report, NRC staff conducts a substantive review and inspection of the applicant's quality assurance program covering design and procurement. The safety review is performed by NRC staff in accordance with the Standing Review Plan for light-water-cooled reactors published in September 1975. This plan states the acceptance criteria used in evaluating the various systems, components and structures important to safety and in assessing the proposed site, and it describes the procedures used in performing the safety review.

The NRC staff examines the applicant's PSAR to determine whether the plant design is safe and consistent with NRC rules and regulations; whether valid methods of calculation were employed and accurately carried out; whether the applicant has conducted his analysis and evaluation in sufficient depth and breadth to support staff approval with respect to safety. When NRC staff is satisfied that the acceptance criteria of the Standard Review Plan have been met by the applicant's preliminary report, a Safety Evaluation Report is prepared by the staff summarizing the results of their review regarding the anticipated effect of the proposed facility on the public health and safety.

When the ACRS has completed its review, the NRC staff issues a supplement to the Safety Evaluation Report incorporating any changes or actions adopted as a result of ACRS recommendations. A public hearing can then be held, generally taking place in a community near the proposed site, on safety aspects of the licensing decision.

The environmental review begins with preparation by NRC staff of a Draft Environmental Statement, assessing the consequences to the environment of the operation of the proposed facility at the proposed site. The statement is published and distributed with specific requests for review by Federal, State and local agencies and other interested parties. Their comments are then taken into account in the preparation of a Final Environmental Statement. Both the draft and the final statement are made available to the public at the time of respective publication. A public hearing, with the appointed ASLB presiding, can then be conducted on environmental aspects of the proposed licensing action (or a hearing on both safety and environmental matters may be held, if that is indicated).

The antitrust reviews of license applications are carried out by the NRC and the Attorney General in advance of, or concurrently with, other licensing reviews. If an antitrust hearing is required, it is held separately from those on safety and environmental aspects.

In appropriate cases, NRC may grant a Limited Work Authorization to an applicant in advance of the final decision on the construction permit in order to allow certain work to begin at the site, saving as much as seven months' time. The authorization will not be given, however, until NRC staff have completed environmental impact and site suitability reviews and the appointed ASLB has conducted a public hearing on environmental impact and site suitability with a favorable finding. To enable the staff and licensing board to make these safety determinations, the applicant must submit the environmental portion of the application early.

When a plant is nearing completion, the applicant must go through virtually the same process to obtain an operating license as to obtain a construction permit. The application is filed, NRC staff and the ACRS review it, a Safety Evaluation Report and an updated Environmental Statement are issued. A public hearing is not mandatory at this stage, but one may be held if requested by affected members of the public or at the initiative of the Commission. Each license for operation of a nuclear reactor contains technical specifications which set forth the particular safety and environmental protection measures to be imposed upon the facility and the conditions that must be met for the facility to operate. Once licensed, a nuclear facility remains under NRC surveillance and undergoes periodic inspections throughout its operating life. In cases where the NRC finds that substantial, additional protection is necessary for the public health and safety or the common defense and security, the NRC may require "backfitting" of a licensed plant, that is, the addition, elimination or modification of structures, systems or components of the plant.

of its review in a letter to the Commission on August 19, 1976.

The staff recommended, in its Safety Evaluation, that certain additions to the facility be made to enhance the margins of safety already designed into the plant. The staff concluded that, subject to implementation of these recommendations, the LWBR could be operated as proposed without undue risk to the health and safety of the public. The ACRS also concluded in its report that it would be acceptable for the Shippingport Atomic Power Station to operate with the LWBR core as proposed.

ERDA subsequently confirmed that the staff's recommendations have been implemented and the plant is now in operation.

ACTION ON TECHNICAL PROBLEMS

Not all the latent vulnerabilities in a complex technology can be anticipated and eliminated by design. For that reason, the "defense-in-depth" concept is applied to contain and neutralize the effects of abnormal events in nuclear facilities through backup safety systems. Equally important, design changes or backfitting are required when any safety-related deficiencies are revealed through such occurrences or through confirmatory research into potential problem areas. The following are the principal phenomena which have posed technical problems within nuclear power plants during the report period.

Steam Generator Tube Integrity

Steam generator tubes in a pressurized water reactor (PWR) are an integral part of the pressure boundary of the primary coolant system. They serve as the heat exchangers that pass heat generated in the reactor core to the secondary system where steam is produced and piped to the turbine generators. Any loss of integrity of steam generator tubes would constitute a breach of the boundary between the primary and secondary systems and would permit the radioactive reactor coolant to leave the closed primary system. During 1977, a number of significant developments involving leakage and deterioration of these tubes took place. See "Abnormal Occurrences—1977," in Chapter 7 for a discussion of these phenomena and of actions taken or planned in response to them by the various utilities and vendors affected.

Overpressurization

Over the last five years, there have been approximately 30 "pressure transients" at various PWR facilities where the pressure-temperature limits included in the technical specifications for the respective facilities have been exceeded. Because the frequency of these events has increased in the past few years, the NRC in August 1976 advised licensees that interim measures were to be taken to reduce it. In addition, licensees were requested to submit analyses of the need for long-term modifications to assure an acceptably low probability of overpressure transients.

The NRC formed a task group to address this issue and establish a basis for a comprehensive analysis of the problem. The group concluded that pressure transients have neither damaged reactor vessels in operating plants nor increased the likelihood of vessel failure in the future. However, the task group emphasized that reactor vessel safety margins would be reduced during the vessel lifetime because the cumulative neutron exposure would reduce material toughness at the temperatures at which the transients had occurred. This conclusion confirmed the earlier staff decision to take appropriate regulatory actions (1) to reduce the pressure transient frequency, and (2) to provide equipment that would restrict future transients to the levels specified by the Technical Specification pressure-temperature limits. The NRC's intent is to require each operating plant by January 1978 to implement either long-term or interim modifications that would significantly reduce the likelihood of pressure transients. Those facilities employing interim modifications would be required to implement final modifications at the next cold shutdown outage after January 1, 1978. The NRC is also requiring the licensees of operating reactors to provide upgraded administrative procedures to reduce the likelihood of pressure transients. Proposed PWR operating procedures and system design changes are presently being evaluated.

Reliability of Power Supplies

For safety reasons, the direct current power supplies at nuclear power stations must be reliable. For example, if there were a sudden massive failure

of the redundant DC power supplies during normal operation, an insufficient capacity for shutdown cooling of the reactor core might result. A consultant to the NRC has stated that such an occurrence is probable enough to warrant prompt remedial action.

The specific scenario postulated by the consultant is as follows:

While a nuclear power plant is operating, one of two redundant DC power supply systems fails, causing a reactor scram and a subsequent loss of all offsite power. At this point, "safe shutdown" of the plant requires that the residual heat from the decay of radioactivity be removed from the reactor. Since the control of valve position and of the pumps needed to remove the residual heat depends on the availability of DC power, continued cooling of the reactor core can only be assured through the availability of the redundant DC power supply.

The NRC staff's view is that the simultaneous and independent failure of redundant DC power supplies is so unlikely as to be incredible and that their failure because of some single event is judged to be so unlikely that the public health is not presently threatened. The staff view is based on the following considerations: (1) the postulated scenario is highly unlikely; (2) the period of vulnerability to the above cited single failure of the redundant DC power supply is limited, i.e., both the DC power supply failure which would initiate the scenario and the second failure of the remaining source of DC power must occur within 30 seconds to defeat starting of the redundant diesel power supply; and (3) the degree of vulnerability is mitigated substantially by the availability of alternative measures for restoration of power or for removal of decay heat, and of sufficient time (at least an hour) for operator implementation of these alternative measures.

The NRC staff believes that the issue is important and warrants further generic studies of the reliability of the DC power supplies, particularly with respect to common mode failures.

Feedwater Nozzle Cracking

Recent operational experience has revealed significant cracking on the inner surface of boiling water reactor (BWR) feedwater nozzles. See discussion in Chapter 7 under "Abnormal Occurrences—1977."

Fire Protection

Following the fire at the Browns Ferry plant in March 1975, the NRC reviewed the fire protection programs of all operating plants, sending teams of specialists in various areas to each facility. For plants that are not yet operational, fire protection reviews by NRC staff specialists and consultants have become part of the ongoing reviews of applications for licenses and permits. In this way, the applicant's proposed fire protection program is reviewed by the staff in the normal course of the licensing procedure. Improved guidelines have been issued for: fire protection programs in both new and existing nuclear power stations, fire hazards analysis, technical specifications, and criteria for evaluating alternative methods of fire protection. Revised procedures have also been developed within NRC, calling for implementation of the new guidelines, use of multidiscipline teams to review the interrelationship of fire protection programs and nuclear safety, use of specialized review teams for evaluating revised fire protection programs for operating reactors, and reduction of the time and correspondence required to complete the evaluations.

For their part, licensees have been requested to: (1) reevaluate the fire protection program at each existing facility in accordance with the new guidelines; (2) perform a fire hazards analysis to provide a basis for the fire protection program; (3) propose modifications to improve fire protection procedures and to provide improved portable and fixed fire suppression systems; (4) propose technical specifications for fire protection systems; and (5) propose a schedule for implementation. Applicants have been requested to perform similar tasks for each proposed new facility.

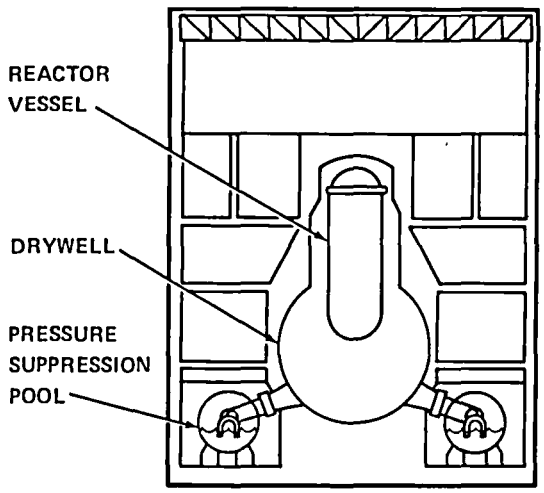
Each staff review includes assessment of the evaluations and proposals cited above; visits to each site to establish the extent of the fire hazard, and adequacy of safety-related equipment and fire protection systems; preparation of recommendations for modifications; issuance of safety evaluations summarizing the staff findings; and amendments of licenses and technical specifications.

Pressure Suppression Containments

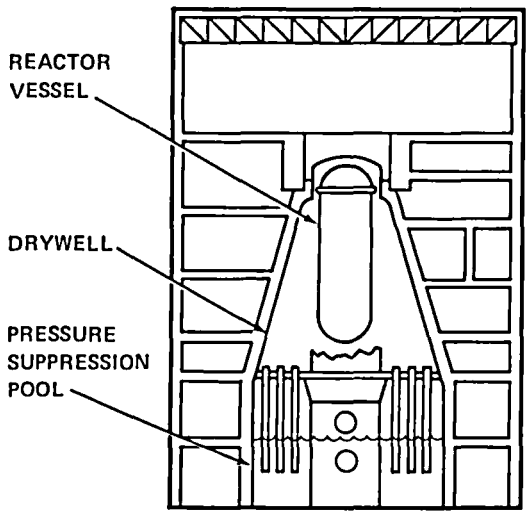
During certain postulated accidents, the containment for a boiling water reactor may be subjected to "transient short-term hydraulic loading." The loading, which is most likely to occur in the early stages of reactor depressurization during a loss-of-coolant accident, is caused by the gases (air or steam) that are ejected into the pressure-suppression pool of water. (A more detailed description of the phenomenon is presented in the 1976 Annual Report, page 27.)

Changes have been made to some Mark I BWR containments to increase their capability to with-

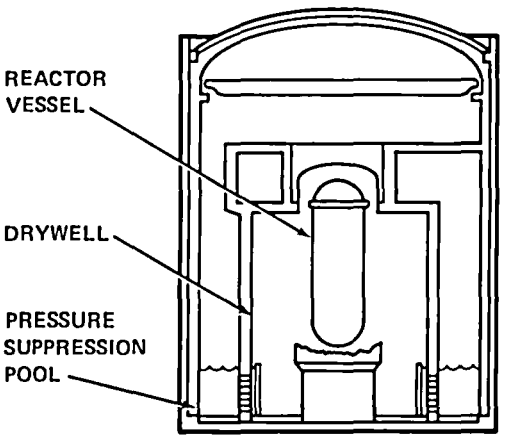
BWR PRESSURE SUPPRESSION CONTAINMENTS



MARK I



MARK II



MARK III

stand the transient loading, and changes are being made in some Mark II designs (no plant with a Mark II or Mark III containment is as yet operational). The first series of full-scale tests to obtain quantitative data on the loading have been performed for the owners of the Mark II containments now under construction or licensing review. Additional tests are planned. Tests made under contract with the NRC to confirm the applicability of the Mark I reduced-scale tests have been completed, and the results were being evaluated at the close of the report period. Changes will be made in all containments—whether of the Mark I, II, or III type—if tests and analyses indicate their structural capability is deficient.

Anticipated Transients Without Scram

Nuclear plants have safety and control systems to limit the consequences of temporary abnormal operating conditions or "anticipated transients." Some deviations from normal operating conditions may be quite trivial; others, occurring less frequently, may impose significant demands on plant equipment. In some anticipated transients, rapidly shutting down the nuclear reaction (initiating a "scram"), and thus rapidly reducing the generation of heat in the reactor core, is an important safety measure. If there were a potentially severe "anticipated transient" and the reactor shutdown system did not "scram" as desired, then an "anticipated-transient-without-scram," or ATWS, would have occurred.

Although an ATWS which could affect the public health and safety is considered unlikely, the potential consequences are sufficiently serious to warrant careful consideration. In September 1973, the then-AEC staff published WASH-1270, "Technical Report on Anticipated Transients Without Scram for Water Cooled Power Reactors," which set forth staff "acceptance criteria" to protect against ATWS events. During the two-year period following publication of the staff report, each of the four reactor manufacturers submitted analyses and supporting information on ATWS which was reviewed by the NRC staff and addressed in four status reports published in December 1975. The staff reports evaluated the information for conformance to the WASH-1270 criteria and noted where design changes and additional analyses were required.

The vendors and owners have questioned whether the NRC staff's requirements are necessary and justified. The industry contends that the probability of an ATWS event is significantly less than estimated by the NRC staff and so low as to make ATWS events minor safety concerns in light water

reactor operations. The Electric Power Research Institute and the vendors have submitted a number of reports on the probability of and the risk to the public from ATWS events. These reports and the relevant findings of the Reactor Safety Study (WASH-1400) are being reviewed to determine whether any change in the staff position is warranted.

A number of boiling water reactor licensees have made modifications to the recirculation pump control circuits that partially fulfill the NRC staff requirements. All BWR licensees were asked to make the same modifications, and all but one are committed to making them. Specific licensee proposals are being reviewed by the staff; additional changes may be required in all reactors after reappraisal of the staff position is completed early in 1978.

Water Hammer

In recent years a number of incidents involving "water hammers" in power reactors have been cited in Licensee Event Reports. The water hammers have primarily involved steam generator feedrings, although other plant systems have also been affected. The incidents have been attributed to such causes as rapid condensation of steam pockets, steam-driven slugs of water, pump startup with partially empty lines, and rapid valve motion. Most of the incidents resulted in relatively minor damage involving pipe hangers and restraints. However, there have been several incidents which have resulted in piping and valve damage.

No water-hammer incident has resulted in the release of radioactivity outside of the plant. However, because of the continuing incidence of water-hammer events and the safety significance of the systems involved, it was decided that systematic review procedures should be developed to make certain that water hammer is given adequate consideration in licensing reviews and in reviews of operating reactors. The work includes revising the reporting and review processes to ensure that potential water-hammer problems are addressed and that design features and procedures to prevent damaging water-hammer incidents are provided and verified, as required, in preoperational tests. In addition, NRC is sponsoring independent studies of water hammer, including evaluation of potential problems and corrective measures, review of pertinent experimental and analytical work, and water-hammer calculations. Licensees have been requested to provide information on water-hammer incidents in steam generators, including modifications to prevent water-hammer and schedules for implementing them.

PROTECTING THE ENVIRONMENT

Under the National Environmental Policy Act of 1969 (NEPA) and Executive Order 11514 of 1970, the NRC is required to ascertain and evaluate the potential effect on the environment of any major activity proposed for licensing. The analysis of environmental impact and consideration of measures to eliminate or mitigate any anticipated adverse effects on environmental quality are essential elements in NRC licensing, rulemaking, enforcement and similar decisions.

In order to develop the methods and data needed to conduct the environmental phase of the regulatory process, NRC supports substantial NEPA-related research (see Chapter 11). For their part, all applicants proposing to construct a nuclear facility must submit a comprehensive environmental report, which is generally based on two or more years of work in accumulating and analyzing environmental and other data required by the NRC. The report must demonstrate through a cost-benefit analysis showing why, in the applicant's judgment, the aggregate benefit to society of the proposed facility will outweigh the aggregate costs.

The NRC staff's independent review of the applicant's proposal and cost-benefit analysis are set forth in a draft environmental impact statement which is circulated for comment to Federal, State and local agencies, and the public. Comments are taken into account in a final environmental statement which, in each construction permit proceeding, must be considered at a public hearing by an Atomic Safety and Licensing Board. The same procedure is followed in updating the environmental statement at the operating license stage, and another hearing is held if warranted by the public interest. Table 2 lists the draft and final environmental statements issued during the fiscal year 1977.

Various aspects of regulating the environmental impact of nuclear power plants that received special attention in 1977 are discussed below. These include activities aimed at resolving specific site-related problems, improving analytic techniques, monitoring operations and mitigating adverse events, controlling effluents, and improving Federal/State cooperation.

Use of Limited Work Authorization

NRC regulations provide that the Office of Nuclear Reactor Regulation may authorize, in

Table 2. Nuclear Power Plant Environmental Impact Statements Issued From October 1, 1976 through September 30, 1977

DRAFT STATEMENTS		FINAL ENVIRONMENTAL STATEMENTS	
Plant	*Date Issued*	*Plant*	*Date Issued*
1. William H. Zimmer (operating license)	10-22-76	1. Indian Point Unit No. 2 (once-through cooling)	11-19-76
2. Floating Nuclear Power Plants (Part III)	10-18-76	2. North Anna Units 1 and 2 (addendum, operating license)	11-26-76
3. Atlantic, Units 1 and 2 (Revised DES)	10-28-76	3. Three Mile Island (supplement, operating license)	12-17-76
4. Palisades (addendum, operating license)	11-18-76	4. Black Fox Units 1 and 2	2-8-77
5. Midland (supplement)	1-13-77	5. Clinch River Breeder Reactor	2-7-77
6. Shoreham (operating license)	3-24-77	6. Montague	2-14-77
7. Ft. Calhoun Unit 2 (site suitability)	4-13-77	7. Phipps Bend	2-22-77
8. Edwin I. Hatch, Unit 2 (operating license)	4-28-77	8. Skagit Units 1 and 2 (supplement)	4-20-77
9. Blue Hills Units 1 and 2 (site suitability)	6-10-77	9. Tyrone Energy Park	4-20-77
10. Yellow Creek Units 1 and 2	6-24-77	10. North Coast Unit No. 1	4-26-77
11. Indian Point Unit 3 (closed-cycle cooling)	8-9-77	11. William H. Zimmer (operating license)	6-10-77
		12. Arkansas Nuclear One Unit 2 (operating license)	6-16-77

appropriate cases, limited amounts of work to be carried out prior to issuance of the construction permit.

This authorization is known as a Limited Work Authorization (LWA), of which there are two types. One type (LWA-1) authorizes certain site preparation work, such as installation of temporary support facilities, excavation, construction of service facilities and certain other work not subject to the quality assurance requirements for safety-related facilities. Under the second type of LWA (LWA-2), structural foundation work may be authorized.

An LWA-1 may be granted only after completion of the environmental review required by NEPA, as well as a site suitability review, a hearing on environmental matters by the licensing board, and a determination by the board that there is reasonable assurance that the proposed site is suitable for a nuclear power reactor of the general size and type proposed. An LWA-2 may be granted if the board determines that there are no unresolved safety issues related to the work to be authorized.

An average of 10 months advance in scheduled initiation of construction activities has been realized for the 24 projects (47 units) receiving LWAs since this procedure was adopted in April 1974.

Health Effects of Coal and Nuclear Cycles

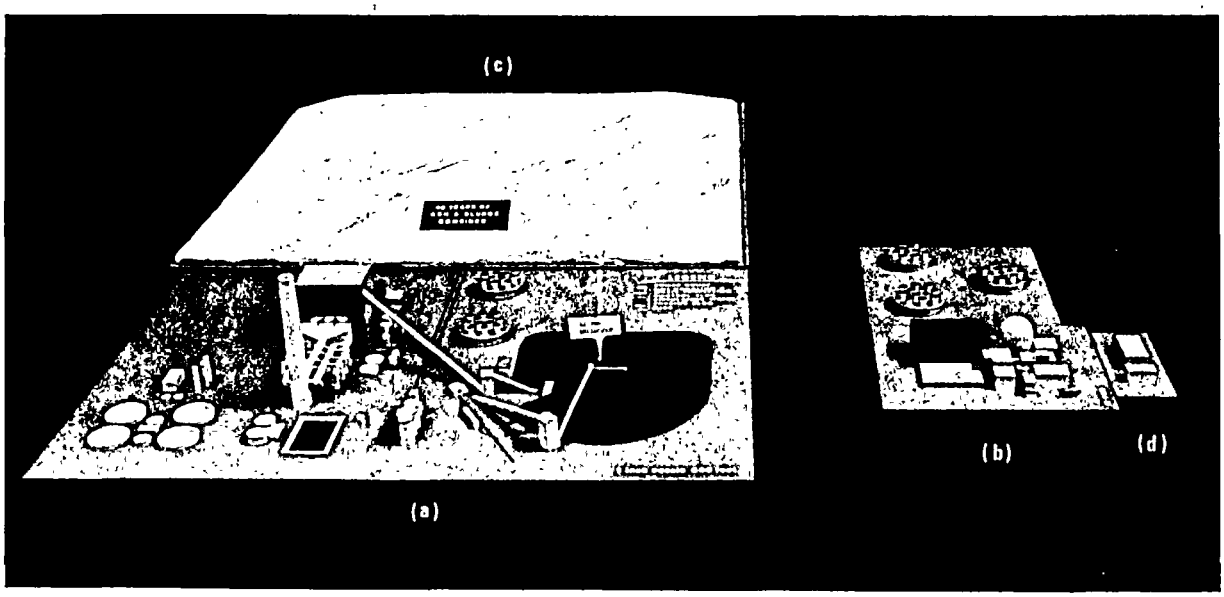
The NRC is required not only to evaluate the environmental effects of the proposed action that it is considering for licensing, but must also compare those effects with the environmental conse-

quences of available alternatives to the proposed action. In the past the environmental statements prepared by the NRC have discussed the impacts of the coal fuel cycle, currently the most important alternative source of electrical power, in terms of economics, and particularly as related to land and water use.

On January 25, 1977, an Atomic Safety and Licensing Appeal Board rendered a decision (Hartsville Nuclear Plant) which essentially directed that the staff examine environmental effects, including health effects on human and animal life, of the emissions from coal plants, and do so to the same degree that they have for nuclear plants. It also recommended that the staff accord more nearly equal treatment to all environmental considerations, rather than focusing mainly on economic factors. Although identical treatment in every aspect of the environmental comparison may not be required, this kind of critical comparison goes to the heart of NRC's duty under NEPA, since coal and nuclear power plants are currently the major feasible alternatives to oil as sources of electrical power.

As a result of the ASLAB decision cited above, the NRC staff prepared testimony comparing the health effects of coal and nuclear plants for both hearings then under way and as part of the environmental statements being prepared. In the testimony—and in the draft of NUREG-0332, "Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives"—mortality and morbidity rates were estimated according to current knowledge of the health effects of contemporary component designs and current operation of fuel cycle facilities, and in anticipation of emission rates and occupational exposures for facilities expected to go into operation between the present and 1985. Although it was shown that the coal fuel cycle alternative has a greater adverse effect on human health than the uranium fuel cycle, the increased risk of adverse health effects for either fuel cycle option represents a very small increase in risk to the health of the average individual in the public sector.

In order to evaluate such effects for the future, the NRC supported a study at Argonne National Laboratory. The results of the study have been published in "The Environmental Effects of Using Coal for Generating Electricity" (NUREG-0252). The NRC also initiated several other studies during fiscal year 1977 to provide further details and greater accuracy in the analytical evaluation of the adverse health effects associated with various fuel cycle alternatives. Among these are the study entitled "Impacts of the Coal Fuel Cycle," and a study initiated at the Argonne National Laboratory on "Projection Models for Health Effects Assessment." Completion of these tasks may provide a basis for further improvement in the health effects comparisons for both fuel cycles.



These scale models compare the land area needed for (a) a 1,000 MWe coal-fueled power plant with 60 days fuel supply and (b) a 1,000 MWe nuclear plant with 30-year fuel supply. Behind the coal plant is (c) a pile representing the amount of ash and sludge produced by the plant during 40 years of operation. To the right of the nuclear plant are (d) blocks representing the amount of waste fuel from 30 years of nuclear plant operation (an additional 10 years of spent fuel would be stored on the reactor site).

Site-Related Problems

Endangered Species Act. The purpose of the Endangered Species Act is to conserve endangered and threatened species of fish, wildlife, and plants, as well as their habitat. If the NRC staff believes a project may affect an endangered species, then the staff contacts the Department of Interior, Fish and Wildlife Service and requests review and comments. These are considered in any final decision regarding the project.

An example is the Hartsville Nuclear Project in Tennessee where an endangered mussel species was identified near the proposed location for the plant discharge. After consultation with the applicant and the Fish and Wildlife Service, the staff has concluded that the mussel bed may be avoided safely by moving the discharge to a point downstream of the mussel bed.

Socioeconomic Assessments. The construction and operation of a nuclear power plant has a considerable impact on the social and economic life of communities near the plant site. The influx of construction workers and their dependents is typically the major source of socioeconomic impact during construction of a nuclear power plant, resulting in an increased demand on local public and private facilities and services—such as classrooms, highways and traffic controls, housing, water and sewage, recreation, and retail stores.

The degree of stress and disruption a community will experience is partially dependent on the ability of the community to anticipate and plan for the impact of plant construction. When the taxable base of an affected community increases because of the plant, tax revenues over the life of the plant may greatly exceed the cost of meeting the increased demand for public facilities and services. The flow of tax benefits to local communities varies considerably among the States, however, and tax benefits do not always flow to those communities receiving the greatest impact.

In order to promote effective planning and preparation by affected communities through a more timely disclosure of potential socioeconomic impacts to local officials, NRC is developing a procedure whereby NRC staff will be in communication with State and local officials and with the utility to help forecast such impacts prior to submittal of the utility's Environmental Report and plan accordingly. This procedure will provide information by which local officials can develop plans to mitigate potentially severe impacts and will encourage the utility to participate more fully in that process.

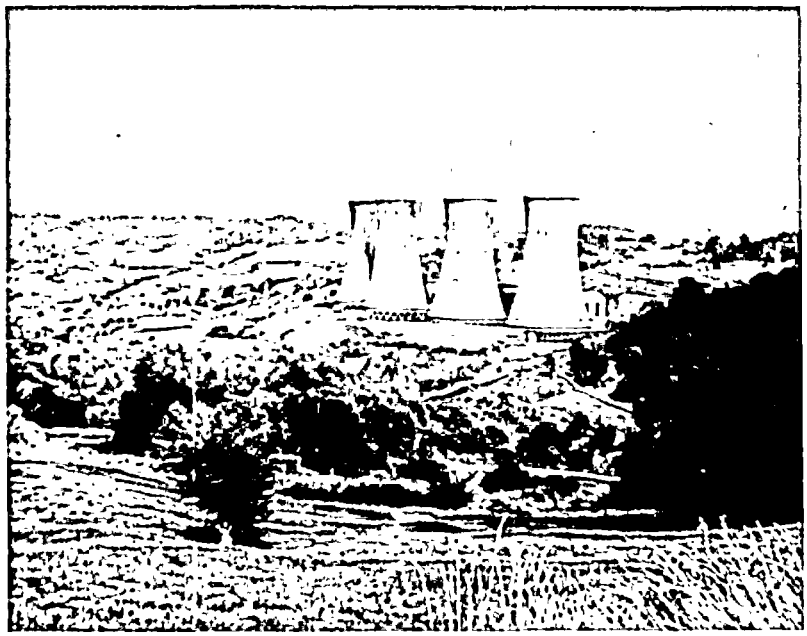
NRC is also sponsoring a study to improve its ability to forecast the number of construction workers coming into an area, their family characteristics, and probable residential location within the community.

In addition, the NRC is studying the full spectrum of social and economic impact experienced in the locales around 12 of the plants currently licensed to operate. This study will provide a reference for the type and magnitude of impacts which can be expected under a range of local conditions, including the extent to which impacts were in fact mitigated. The information generated by this study will improve NRC capabilities for forecasting social and economic impacts in future licensing applications. The information will also be made available for the use of officials in communities surrounding proposed nuclear plants.

Need for Facility. NEPA requires that the NRC prepare an analysis of the need for any proposed nuclear facility. The performance of this task was greatly facilitated with the development during 1977 of a model for forecasting electricity demand in the various States. The modelling effort is being carried out at Oak Ridge National Laboratory under NRC support. To date, forecasts for approximately one-half the States have been completed, and as environmental statements have been issued and hearings held, the appropriate State forecast has been included in the staff analysis. Results of a separate NRC study on the effects of electricity demand, energy conservation, rate restructure and other factors will be incorporated into the forecasting model.

Improved Meteorological Assessments. The transport and diffusion characteristics of the atmosphere around a nuclear power plant site are important in estimating the potential radiological exposure of the public from either an accidental or routine release of gaseous radioactive effluents. During recent years, field experiments have been conducted at various locations across the country to improve understanding of atmospheric diffusion processes. Several of these experiments have been sponsored by the NRC, and others have been conducted by utilities in support of their licensing applications.

Experiments at the Three Mile Island, River Bend, Idaho Falls and Clinch River sites were conducted during light wind and stable atmospheric conditions, which are not conducive to a wide dispersion of gaseous effluents. Experiments were performed at the Rancho Seco and Millstone sites to assess the effects of plant structures on atmospheric mixing. Results of field experiments such as these have been used to improve the transport and diffusion models used in the licensing review to assess the potential for radiological exposure of the



The plume from natural draft cooling towers is mainly steam, but often includes some residue from "antifouling" chemicals used in the cooling system.

offsite population. Computer codes have been developed or revised to reflect the new atmospheric transport and diffusion models. The new models increase the accuracy of the assessments of the consequences of accidental and routine releases of gaseous radioactive effluents.

In evaluating the environmental suitability of a nuclear power plant site, it is also necessary to consider atmospheric effects resulting from the operation of the heat dissipation system, that is, cooling towers or cooling ponds. Such effects include increased fogging or icing in the environs and the creation of a visible plume of vapor from the cooling systems. To improve models used to assess atmospheric effects, NRC is comparing actual observations of such effects with the predictions of a number of available models. The validity of the predictive models is being critically evaluated by the Argonne National Laboratory (ANL), under contract with the NRC. The emphasis of the ANL study has been on developing more precise means of predicting the lengths of visible plumes and the amount of material deposited in drift from natural draft cooling towers. (Natural draft cooling towers were selected as the principal cooling system for the purpose of this study because they offer better opportunity for obtaining observational data.)

Atmospheric dispersion conditions at approximately 100 nuclear power plant sites have been examined in order to determine whether a "climatology" of atmospheric dispersion conditions can be established and used to facilitate early site reviews and to evaluate alternative sites. By standardizing plant and site parameters—such as site boundary distances—atmospheric dispersion conditions may be categorized and used to develop reliable estimates of a site's dispersion characteristics early in a licensing review, or when onsite meteorological data or representative data from offsite locations are not available.

Severe Weather Phenomena. The design criteria for safety-related structures, systems, and components at a nuclear power plant must take into account all important severe weather phenomena and extreme meteorological conditions to which the plant may be exposed. The NRC has established a working group, with members from various offices, to examine the meteorological conditions used in developing current standard (industry-wide) engineering criteria and codes, to identify important meteorological conditions that may not be directly considered in NRC Regulatory Guides, and to provide guidance on the establishment of acceptable limits to be included in design and operating criteria for safety-related structures, systems, and components.

NRC has contracted with the National Oceanic and Atmospheric Administration's National Climatic Center and Office of Hydrology to develop "extreme value" analysis and estimated "return periods for fastest mile" wind speeds for locations along the Atlantic and Gulf coastlines, extreme maximum and minimum temperatures, weight of snowpacks for the Great Lakes and New England areas, and revised estimates of "probable maximum winter precipitation." Results of these studies will be used to establish new guidelines or to revise

existing guidelines for consideration of severe weather and extreme meteorological conditions in the design of nuclear power plants. Work has also been initiated to provide improved data on the frequency of lightning strikes on the ground and the energy associated with these strikes. The National Weather Service's Severe Weather Warning Dissemination Group has been requested to explore the types of severe weather warnings available; these may be referenced in the operating and emergency procedures of nuclear power plants.

Licensing Action on Seismic Issues

North Anna Power Station. A geologic fault was identified in 1973 which transects the excavation for four nuclear power reactors planned for installation at the North Anna Power Station in Louisa County, Va., by the Virginia Electric & Power Company. The company received construction permits for Units 1 and 2 in early 1971. (See Chapter 12 for discussion of events following the discovery of the fault with respect to notification of the proper authorities.) Investigations by the licensee, the NRC (then AEC Regulatory staff) and the U.S. Geological Survey led to the conclusion by NRC staff that the fault was "not capable" (as defined in Appendix A, 10 CFR Part 100) and, therefore, that the North Anna site was acceptable in that regard.

At the close of the report period, the NRC staff's operating license review was essentially complete; fuel-loading for Unit 1 was authorized on November 26, 1977.

Diablo Canyon Nuclear Plant. Construction permits for Units 1 and 2 of the Diablo Canyon Nuclear Plant, located on the California coast about 12 miles from San Luis Obispo, were issued in 1968 and 1970 respectively. In addition to the AEC review of the proposed site, independent reviews were performed for the AEC by the U.S. Geological Survey and the U.S. Coast and Geodetic Survey. Based on these investigations, the units were designed and constructed to withstand the maximum earthquake potential identified for the site at that time (0.4g horizontal alleceration).

In 1971, the existence of a fault—now known as the Hosgri Fault—passing about 3.5 miles offshore from the plant site came to light. When application to the AEC (now NRC) for an operating license was made in 1973, detailed investigation of the Hosgri Fault began, leading to a conclusion by the NRC and the U.S. Geological Survey that the maximum potential earthquake ground motion at the proposed site "may be more severe than that for which the plant had been originally designed." Thus, in April of 1976, the applicant for an operating license—the Pacific Gas and Electric Company—was advised that the plant's seismic capabilities should be reanalyzed "to determine what modifications would be necessary to withstand the more severe ground motion (0.75g)" predicated on the existence of the offshore fault. The applicant had not submitted complete results of this reanalysis at the close of the report period, nor did it appear that it would do so in time to allow a decision on the operating license prior to the fall of 1978.

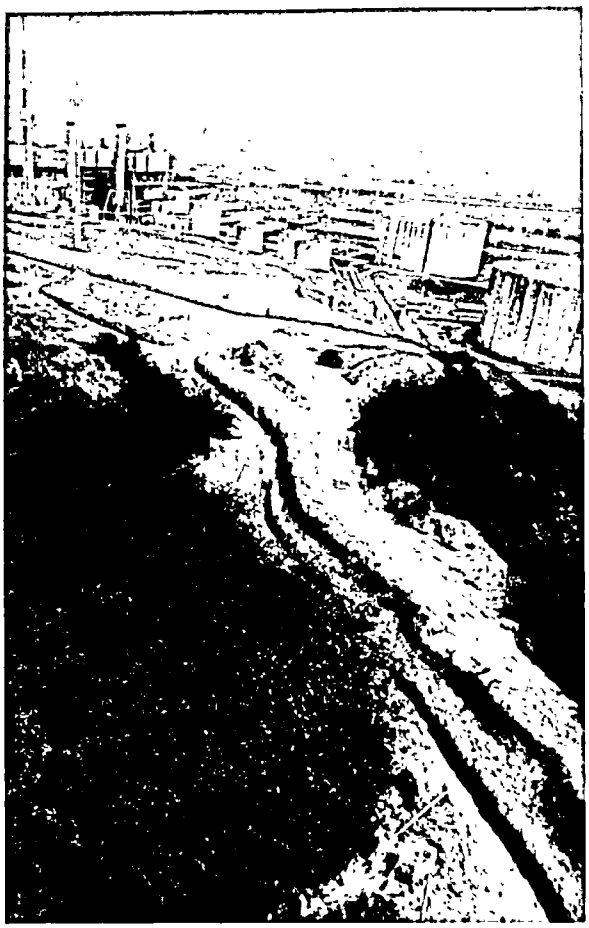
NRC staff review of this case was the subject of hearings by the House Subcommittee on Energy and Environment on June 30, 1977; the House Subcommittee on Oversight and Investigations is also being kept apprised of developments in this operating license review.

Humboldt Bay Nuclear Plant. A provisional operating license was issued to the Pacific Gas and Electric Company for Unit 3 of the Humboldt Bay Power Plant in August of 1962. The plant is located in northern California, near Eureka. Prior to issuance of a full-term operating license, the AEC Regulatory staff continued its review and called into question the adequacy of the plant design to accommodate potential seismic acceleration proper to the plant site.

From 1969 to 1973, the licensee performed studies and submitted reports to the AEC on geology, seismology, liquefaction potential and seismic design upgrading at the facility. In June 1973, the AEC (now NRC) informed the licensee of the need to provide more precise definition of previously identified faults in the area in question and to assess the potential for surface faulting at the site. Additional work was carried out and, on August 25, 1975, the licensee submitted its report. Based on its assessment of all information provided up to May 1976, the NRC staff concluded that its concerns about the need for seismic reevaluation had not been satisfied. On May 21, 1976, NRC issued an Order requiring that its concerns be resolved prior to restart of the power plant following the 1976 refueling outage which was to begin on July 2. The staff noted that "as the regional geologic picture was developed in greater detail, the confidence that the original plant design could withstand all postulated seismic events declined."

The licensee has performed extensive geologic investigation and plant modification since June 1976 and, by letter of March 25, 1977, has submitted a draft report in partial fulfillment of requirements specified in the NRC Order. In May

1977, the licensee proposed a license amendment which would allow restart of the unit based on satisfactory completion of the Order's requirement. In July 1977, a request for a hearing on this proposed amendment was submitted by citizens in the Humboldt Bay area. In August 1977, the NRC staff informed the licensee that, having examined the latter's most recent draft report, it could not conclude with reasonable certainty that surface faulting would not occur at the Humboldt Bay site. The staff also stated its intention to recommend denial by the licensing board of the application for amendment permitting restart of the unit. The licensee has been given the NRC staff's and the U.S. Geological Survey's evaluations regarding the potential for surface faulting at the site and was, at the close of the report period, considering its position.



Geologic trenching dug as part of Pacific Gas & Electric Company's investigation of faulting near the Humboldt Bay power plant south of Eureka, Calif.

Transmission Systems

Recent license applications have shown a general tendency within the nuclear industry toward the design of transmission systems with higher load capacities than in the past. The staff has undertaken a review of data concerning the environmental impacts associated with these extra-high voltage AC systems (EHVAC). The review mainly entailed a study of the operational characteristics of 765 kV systems and their potential impact on human health and safety. A brief summary of the staff's initial findings is presented below.

Electrostatic and Electromagnetic Field Effects. Construction permit license applications involving EHVAC systems show that transmission systems are now being designed to meet or exceed line clearance being considered as the maximum "let go" level in the proposed revision of Part 2 of the National Electrical Safety Code. Applications of these standards ensure that no serious injuries (e.g., shocks resulting in involuntary muscle contractions) will occur from induced steady state currents resulting from operation of proposed EHVAC systems.

With regard to ground level magnetic field strengths, the maximum strengths predicted for presently designed EHVAC systems are well below the level at which harmful effects may be expected.

Conflicting data exist, however, on the *long term* biological effects of electrical fields. As an active member on the Interagency Advisory Committee on Electric Field Effects promoting research in this area, the NRC has not to date received any report documenting health effects on humans resulting from electric fields associated with transmission lines. Some data (primarily from the U.S.S.R.) point to potential biological effects of electric fields in laboratory animal experiments and electrical substation environments.

Control of Effluents

Implementation of 10 CFR Part 50, Appendix I. On September 4, 1975, the Commission amended Appendix I to 10 CFR Part 50 to provide that applicants whose applications for construction permits for light-water-cooled nuclear power reactors were docketed on or after January 2, 1971, and prior to June 4, 1976, would have the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I. Under the option an applicant may choose to design the radwaste management systems to satisfy the "Guides on Design

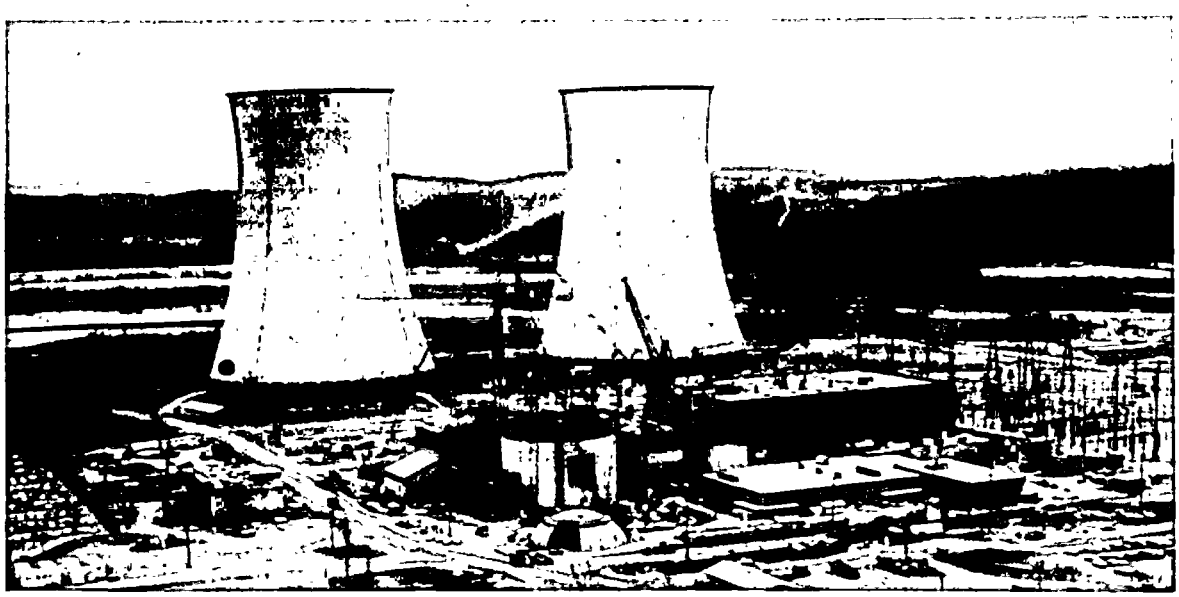
Objectives for Light-Water-Cooled Nuclear Power Reactors," proposed in the "Concluding Statement of Position of the Regulatory Staff," in Docket RM-50-2, dated February 20, 1974. In amending Appendix I, the Commission noted that it is unlikely that further reductions in releases of radioactive material in effluents would be warranted on a cost-benefit basis for light-water-cooled nuclear power reactors having radwaste systems and equipment determined to be acceptable under the RM-50-2 option.

Evaluation of plants to assess conformance with Appendix I is in progress. To date, 71 plants have been evaluated for conformance with the option described above and 14 have been evaluated for conformance with the cost-benefit analysis required by Paragraph II.D of Appendix I.

Implementation of Technical Specifications. Since the adoption of Appendix I, the staff has been developing radiological effluent Standard Technical Specifications to meet the requirements of the rule. These specifications provide monitoring, sampling, analytical and reporting requirements and are being prepared in the format of Appendix A (radiological safety), Standard Technical Specifications. Following approval by the Regulatory Requirements Review Committee, these specifications will be forwarded to all applicants for operating licenses for inclusion in the Final Safety Analysis Reports and to all licensees with operating licenses. Licensees will be requested to submit site-specific technical specifications as amendments to their operating licenses on a schedule to be determined by the NRC staff.

Implementation of The EPA Uranium Fuel Cycle Standard. On December 28, 1976, Federal Regulation 40 CFR Part 190 was promulgated by the Environmental Protection Agency. This standard, entitled "Environmental Radiation Protection Standards for Nuclear Power Operations," requires that operations covered by the standard be conducted so that there is reasonable assurance that the annual dose equivalent to a member of the public exposed to planned discharges of radioactive materials and to radiation from the operation does not exceed a value of 25 millirems to the whole body. The standard also sets a thyroid and organ dose limit and provide curie-release limits for several specific radioisotopes. The standard is to be effective by December 1, 1979, except for two of the isotope release limits.

The NRC is responsible for implementing the EPA standard, which is somewhat less restrictive for a single reactor plant than the annual dose equivalents corresponding to the design objectives of Appendix I to 10 CFR Part 50. NRC has established a task force to work out the details of implementation, and it is considering such matters as the



Construction of TVA's two-unit Watts Bar nuclear plant near Spring City, Tennessee, was over 50 percent complete at the end of 1977. The top of the reactor containment building in the foreground still rests on the ground. The natural draft cooling towers behind the plant are 450 feet tall, with a 400-foot diameter base.

technical issues for implementation in licensing actions for all types of anticipated nuclear fuel cycle facilities, including sites having more than one reactor and sites having more than one type of facility. Need for amending existing NRC regulations is also being considered by the task force, as is the need to modify regulatory guides, standard review plans, technical specifications, and inspection procedures.

Workshop on Radioactive Waste Treatment Systems. In January 1977, a workshop on Reactor Radwaste Management, organized and conducted by the Oak Ridge National Laboratory (ORNL) and NRC, was held in New Orleans, La. The workshop was intended to provide information needed to update four generic reports (under preparation by ORNL for the NRC) and to provide an opportunity for those in the field of radioactive waste management to assess process equipment performance under actual operating conditions. The workshop was attended by 190 persons, including representatives from various Federal and State agencies, utilities, nuclear steam supply vendors, architect-engineers, and radwaste equipment vendors.

INTERAGENCY COORDINATION

Duplication of effort by NRC and other Federal agencies—such as the Environmental Protection Agency (EPA), the Department of the Interior, the Department of Commerce, the Army Corps of Engineers, the Advisory Council on Historic Preservation, and the like—has been substantially reduced or avoided through the establishment of close working relationships and formal agreements.

NRC-EPA Memorandum of Understanding

A vital interagency arrangement is embodied in the January 30, 1976 Memorandum of Understanding between NRC and EPA "Regarding Implementation of Certain Responsibilities under the Federal Water Pollution Control Act (FWPCA)." This Memorandum is intended to (1) consolidate the demands for water quality data placed on applicants for nuclear facilities licenses by assuring that applicants' environmental reports contain sufficient information to meet NRC's needs under the National Environmental Policy Act (NEPA) and EPA's needs under the FWPCA; and (2) to minimize any duplication of effort between NRC and EPA in meeting their respective responsibilities under NEPA and FWPCA, as noted in the 1976 NRC Annual Report (page 70).

EPA and NRC water quality assessments still involve some duplication of effort. This is due primarily to the fact that the NRC-EPA Memorandum of Understanding can be fully effective only when the applicant can provide an 18-to-24-months record of basic aquatic data at the time of submission of the environmental report to NRC. For the applications already filed, the Memorandum is being implemented to the maximum extent practicable.

Cooperation on Specific Cases

Brunswick Units 1 and 2 (North Carolina). In the Final Environmental Statement (FES) the NRC staff recommended that a closed-cycle cooling system be constructed by the end of three years. Although the utility signed a stipulation to this effect, a request for relief from this requirement was filed with the EPA under section 316 of the FWPCA. A hearing was held in the spring of 1976; NRC participated in the EPA hearing process by supplying a witness who testified on the aquatic impact of the present once-through cooling system and supported the position that cooling towers should be required.

Indian Point Units 2 and 3 (New York). The Indian Point site is located on the Hudson River in an area of the river where striped bass spawn and spend the early part of their lives. The concern is that continued operation of the once-through cooling system will cause irreversible damage to the population of striped bass and other species. Accordingly, the staff recommended that a closed-cycle cooling system be installed for each unit. The preferred system is one employing natural draft cooling towers. Conversion to cooling towers and cessation of once-through cooling has been set for May 1, 1982. NRC staff has maintained close contact with the EPA in anticipation of hearings to be held in response to the utility's request for an exemption, under section 316 of the FWPCA, from the need for cooling towers. The hearings are to consider not only Indian Point but other plants (fossil-fueled) on the Hudson River as well. NRC staff are working closely with the EPA in preparing testimony, questions and analyses pertinent to the fish populations and the environmental impact of once-through cooling systems and cooling towers at Indian Point. When the hearings commence, the NRC will provide witnesses as appropriate.

Table 3. Agencies and Groups Which Are Consulted or Contacted During NRC's Environmental Review Process

FEDERAL AGENCIES

Advisory Council on Historic Preservation
Department of Agriculture
Department of Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Power Commission
Federal Energy Agency

STATE AND LOCAL AGENCIES

Office of the Governor
State Public Service Commission
State Siting Commission (if one exists)
State Energy Commission (if one exists)
State Environmental Conservation Commission (if one exists)
State Historic Preservation Officer
Other state and local agencies, commissions, boards, etc. (determined on a case-by-case basis)

OTHERS (IF THEIR INTEREST IS KNOWN TO NRC)

Environmental Groups
Conservation Groups
Members of the General Public

Seabrook Station Units 1 and 2 (New Hampshire). The Seabrook Station, currently under construction by the Public Service Company of New Hampshire in Seabrook, will use once-through cooling with sea water. The NRC staff has had frequent contacts with the EPA during the NRC hearings, as well as during the EPA hearings held in response to a request for an exemption under section 316 of the FWPCA. The EPA ultimately approved the use of once-through cooling with the provision that the intake be located farther from the shore than originally approved by the NRC staff and licensing boards. The new intake location was evaluated by the NRC and approved. (See discussion in Chapter 13.)

Other Interagency Agreements

Other formal interagency agreements exist between NRC and the Department of Energy, the Army Corps of Engineers, the U.S. Coast Guard, the Department of Interior, the Department of Transportation, and the Advisory Council on Historic Preservation.

COOPERATION WITH STATES

Although NRC and the States cooperate extensively in the environmental review process, there remains some duplication of effort, particularly in assessing the need for power and in evaluating water quality impacts. Additionally, in States which have NEPA-type laws requiring an independent assessment of environmental impact, duplicative environmental reviews may be conducted. (See chapter 8 for detailed report on NRC-State cooperation in fiscal year 1977.)

Agreements for Cooperation

Beginning in March 1977, NRC increased its efforts to cooperate closely with States to which EPA has granted authority to issue National Pollutant Discharge Elimination System Permits (402 permits), required for every nuclear power plant licensed by NRC. The purpose is to enter into agreements for cooperation that embody principles similar to those set forth in the Second NRC-EPA Memorandum of Understanding under the FWPCA. In some instances agreements with States may be broader than the NRC-EPA Memorandum. For instance, an agreement might include provisions whereby the State would prepare for NRC (under specific NRC guidelines) portions of environmental impact statements in areas such as water quality, need for power, socioeconomic impact, etc. To date, 14 States have been contacted and all either indicated a strong interest in such agreements or have expressed their willingness to pursue the matter further. It is anticipated that through the agreements mutual concerns of the NRC and the States will be better understood and needless duplication of effort avoided. It is expected that two or more formal agreements will be consummated by early 1978.

In the absence of any formal agreement between them, NRC and New York State issued a "Joint Working Paper for the Preparation of Environmental Reports for Generating Facilities in New York State." This document is intended for use by any New York State utility for the preparation of a single environmental report which will satisfy the environmental requirements of both the State and NRC.

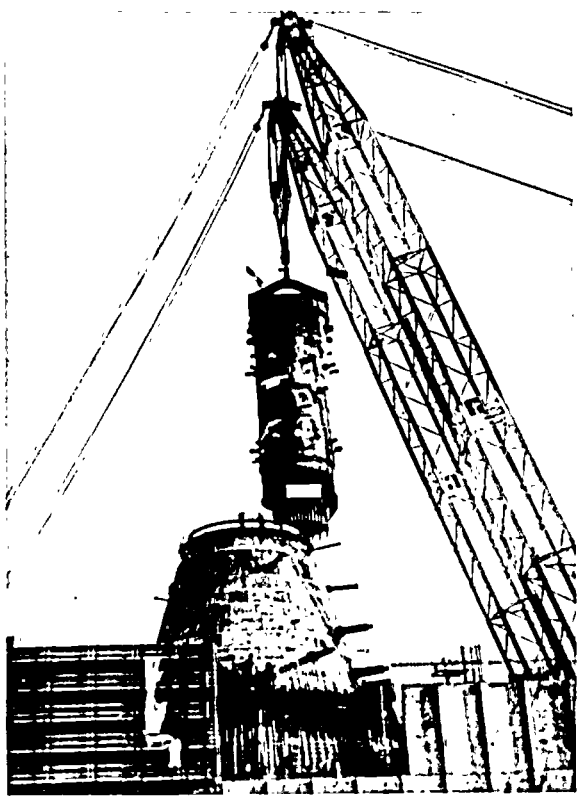
Joint Hearings

Decisions to hold joint NRC-State hearings are being made on a case-by-case basis, depending upon the compatibility of NRC and State environmental review schedules and other considerations. The status of these ongoing efforts is summarized below.

Douglas Point. Joint environmental hearings between the State of Maryland and NRC were held in July and August of 1976 for the proposed Douglas Point Nuclear Power Plant to be located adjacent to the Potomac River about 30 miles below Washington, D.C., in Charles County, Maryland.

The joint hearing involved close coordination between the State and NRC in technical review and development of the joint hearing protocol. The hearing was a success, as attested by both the NRC and State agencies, in terms of function, Federal-State relations, and avoidance of duplicative effort.

Greene County. The NRC and the New York State Board on Electric Generation Siting and the Environment have substantial common areas of jurisdiction in the licensing of proposed nuclear generating facilities in New York State. Although a reading of the National Environmental Policy Act of 1969 and Article VIII of the New York State Public Service Law clearly shows these areas of common interest, the practice had been for both



The pressure vessel for WNP-2 at Richland, Washington, was lowered into place in April 1977.

Federal and State agencies to conduct separate public hearings on the full range of issues within the scope of their respective jurisdictions.

On November 9, 1976, the NRC and State of New York agreed by protocol to hold a joint hearing on matters of common interest and concurrent jurisdiction on the proposed Greene County Nuclear Power Plant. The evidentiary hearing on environmental matters has been in progress since January 4, 1977 before a joint hearing board made up of the NRC's Atomic Safety and Licensing Board and two hearing officials from the New York State Board of Electric Generation Siting and the Environment, with participation by the parties admitted in both proceedings. Joint hearings should be beneficial to both the Federal and State regulatory processes. Not only will costly duplicative efforts be avoided, but the more complete records developed in joint hearings should provide a better basis for regulatory decision-making. Joint hearings should also enhance the opportunity for effective public participation in the decisional processes of both agencies.

IMPROVING THE LICENSING PROCESS

Improving Effectiveness and Efficiency

On April 20, 1977, the Commission directed that recently completed licensing actions be reviewed by the staff for the purpose of identifying ways to improve the effectiveness and efficiency of NRC nuclear power plant licensing activities. A report (NUREG-0292) issued in June 1977 summarizes the results of the study by an internal ad hoc Study Group established in response to that directive.

A prime assumption of this study was that any envisioned improvement in efficiency should not be permitted to reduce the quality now achieved in the licensing process.

In examining recent experience with safety and environmental licensing reviews, the Study Group focused exclusively on construction permit (CP) reviews, for two reasons: the review of operating license applications generally does not affect the schedule (i.e., it is not on "the critical path") for design and construction of nuclear power plants, and the lessons learned from experience in CP reviews would generally apply to operating license activities as well.

Ten applications for which construction permits have been issued since the formation of the NRC and four applications currently in the review process were selected for analysis. The more recent applications were examined to determine whether trends which appeared in the completed cases persist. Data on the time and manpower expended in the selected proceedings were also examined, and the Study Group considered the effects of some recent events affecting the licensing process, e.g., the revision of the Standard Format guidance, the establishment of the Regulatory Requirements Review Committee, the implementation of Standard Review Plans, and the use of Limited Work Authorizations.

The Group concluded that (1) substantial time will be needed to provide sufficient experience to be able to measure the effects of changes in a meaningful way, and (2) outside influences, such as the downturn of the economy in mid-1974, have had a significant effect on utilities' plans and have largely masked the time-saving effects of NRC changes made during that time.

The Study Group presented for Commission consideration eleven recommendations, each of which was believed to have the potential for improving the licensing process without compromising the quality of review. The recommendations, not in order of importance, are as follows:

(1) Improve the quality of applications by providing better guidance to applicants and strengthening acceptance criteria.

(2) Improve the quality of applications by eliminating obsolete and unnecessary information.

(3) Increase preterndering coordination with applicants.

(4) Expand and restructure the acceptance review process.

(5) Modify the current review process by developing and issuing an early Safety Evaluation Report based on the application as docketed.

(6) Increase public participation during staff review of applications.

(7) Improve the hearing process in the interest of increased efficiency and effectiveness.

(8) Study long-range standardization policy to assure orderly development and implementation of standardization policy and procedures to deal with anticipated future needs.

(9) Modify Limited Work Authorization (LWA) rules to provide clearer guidance on specific site preparation and construction activities which may be permitted under LWAs.

(10) Increase use of rulemaking to resolve, or to assist in the resolution of, major issues that are routinely litigated in individual licensing proceedings.

(11) Amend the Atomic Energy Act to eliminate mandatory ACRS review of every construction permit and operating license application and provide for ACRS review of applications only when desired by either the NRC or the ACRS.

Progress in Standardization

Continued progress was made during 1977 toward standardization of nuclear power plants. The NRC regards standardization of plant designs —complemented by the early review of sites proposed for the location of nuclear plants—as one of the most important means for improving the efficiency and effectiveness of the regulatory process.

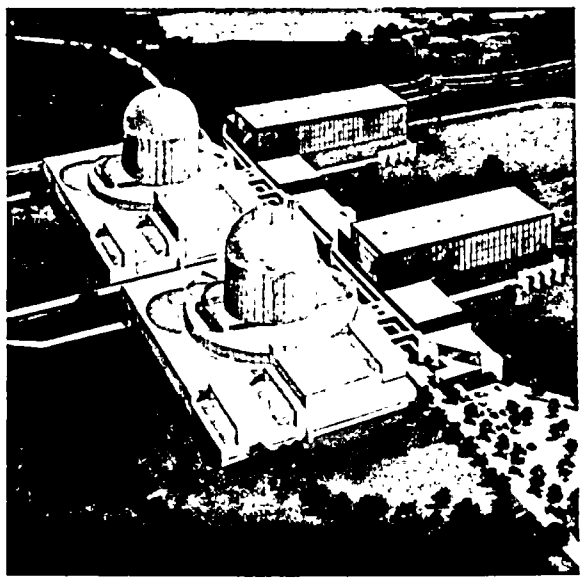
The standardization approaches accepted by NRC are based on the multiple use of previously approved plant designs. As described in the 1976 NRC Annual Report (page 36), four procedural options are available to applicants for standardization of nuclear power plants: "Reference System" (approved design used repeatedly by reference), "Duplicate Plants" (approved design for several identical plants), "License to Manufacture" (approved design for manufacture of identical units at a central location), and "Replication" (reuse of recently approved custom design).

Since the standardization policy was announced by the Atomic Energy Commission in 1972, the following has been accomplished:

(1) Seventeen applications for preliminary design approvals under the reference system concept have been received. Eleven preliminary design approvals for reference system designs had been issued as of the end of the report period. Ten construction permit applications (for a total of 25 units) referencing five of the reference system designs had been received. Construction permits for nine of the units had been issued. Decisions on the others are expected to be reached within the next year.

(2) One application for a manufacturing license for eight floating nuclear plants has been received. A decision on issuance of the manufacturing license is expected during 1978.

(3) Eight applications for construction permits, for a total of 15 units, have been received under the duplicate plant concept. Construction permits for eight of the units have been issued and the decisions on the remaining seven units are expected early in 1978.



Above is an artist's conception of Stone & Webster Corporation's standardized balance of plant design which could be matched to a standardized nuclear steam supply system.

(4) Three applications for construction permits, for a total of six units, have been received under the replication concept. Decisions on construction permits for four of the units are expected to be reached prior to January 1978 and for the remaining two units in 1978.

The Commission issued a policy statement on June 29, 1977, reaffirming its support of standardization, and requesting public comments on proposed practices. The public comments are to be considered by the staff in developing recommendations, for Commission consideration, concerning the administrative steps that can be taken to encourage continued and expanded industry participation in the standardization program for nuclear power plants, including possible changes in NRC regulations. The staff recommendations are expected to be submitted to the Commission within the next few months.

Table 4 lists the applications for preliminary design approvals of reference standard designs, and for construction permits for plants utilizing one or more of the available standardization options. Since the standardization policy was implemented in 1973, more than one-half the construction permit applications have utilized one or more of the standardization options and that fraction has increased to about two-thirds during the last two years.

Table 4. Standardization Applications
(as of September 30, 1977)

PROJECT	APPLICANT	DOCKET DATE	COMMENTS
Reference Systems			
GESSAR-238 (NI)	General Electric	7/30/73	Nuclear island. PDA-1 (Preliminary Design Approval) issued 12/22/75
CESSAR	Combustion Engineering	12/19/73	Nuclear Steam Supply System (NSSS). PDA-2 issued 12/31/75
RESAR-41	Westinghouse	3/11/74	NSSS. PDA-3 issued 12/31/75
B-SAR-241	Babcock & Wilcox	5/14/74	NSSS (Withdrawn)
SWESSAR RESAR-41	Stone & Webster	6/28/74	Standard Balance-of-plant (BOP) matched to RESAR 41. PDA-4 issued 5/5/76
CESSAR		10/21/74	BOP matched to CESSAR. PDA-6 issued 8/16/76
RESAR-3S		10/2/75	BOP matched to RESAR-3S PDA-8 issued 3/31/77
B-SAR-205		12/22/75	BOP matched to B-SAR-205
C F Braun SSAR	C F Braun	12/21/74	Turbine Island matched to GESSAR-238 (NI) PDA-5 issued 5/7/76
B-SAR-205	Babcock & Wilcox	3/1/76	NSSS.
GASSAR	General Atomic	2/5/75	NSSS.
GESSAR-251	General Electric	2/14/75	NSSS. PDA-9 issued 3/31/77
RESAR-3S	Westinghouse	7/31/75	NSSS. PDA-7 issued 12/30/76
GESSAR-238	General Electric	10/16/75	NSSS. PDA-10 issued 3/10/77
BOPSSAR	Fluor Pioneer	1/27/76	BOP. PDA-11 issued 8/17/77
GIBBSAR	Gibbs & Hill	5/10/77	BOP matched to RESAR-41
RESAR-414	Westinghouse	12/30/76	NSSS.
Utility Applications Using Reference Systems			
Cherokee 1, 2 & 3	Duke Power	5/24/74	References CESSAR
Perkins 1, 2 & 3	Duke Power	5/24/74	References CESSAR
South Texas 1 & 2	Houston Light & Power	7/5/74	References RESAR-41. CPs issued 12/22/75
WPPSS 3 & 5	Washington Public Power Supply System	8/2/74	References CESSAR
Palo Verde 1, 2 & 3	Arizona Public Service	10/7/74	References CESSAR. CPs issued 5/25/76
Hartsville 1, 2, 3 & 4	Tennessee Valley Authority	11/22/74	References GESSAR-238 (NI). CPs issued 5/9/77

PROJECT	APPLICANT	DOCKET DATE	COMMENTS
Utility Applications Using Reference Systems (*Continued*)			
Black Fox 1 & 2	Public Service of Oklahoma	12/23/75	References GESSAR-238 (NSSS)
Phipps Bend 1 & 2	Tennessee Valley Authority	11/7/75	References GESSAR-238 (NI
Yellow Creek 1 & 2	Tennessee Valley Authority	7/16/76	References CESSAR
Erie 1 & 2	Ohio Edison Company	3/1/77	References B-SAR-205
Duplicate Plants			
Byron 1 & 2 Braidwood 1 & 2	Commonwealth Edison	9/20/73	Two units at each of two sites. CPs issued 12/31/75
Cherokee 1, 2 & 3 Perkins 1, 2 & 3	Duke Power	5/24/74	Three units at each of two sites. Also references CESSAR
SNUPPS			Five units at four sites
Wolf Creek	Kansas Gas & Electric Kansas City Power & Light	5/17/74	CP issued 5/17/77
Callaway 1 & 2	Union Electric	6/21/74	CPs issued 4/14/76
Tyrone 1	Northern States Power	6/21/74	Under review
Sterling	Rochester Gas & Electric	6/21/74	CP issued 9/77
WNP Koshkonong 1 & 2	Wisconsin Electric Power Madison Gas & Electric Wisconsin Power & Light Wisconsin Public Service	8/9/74	Initially submitted under duplicate plant option with intent for as many as six total units at three sites. Utility's change in plans led to removal from standardization program by staff.
License to Manufacture			
Floating Nuclear Plant (FNP) 1-8	Offshore Power Systems	7/5/73	Entire plant design
Utility Applications Using License to Manufacture			
Atlantic 1 & 2	Public Service Electric & Gas	3/1/74	References FNP
Replication			
Jamesport 1 & 2	Long Island Lighting	9/6/74	Replicates Millstone 3
Marble Hill 1 & 2	Public Service of Indiana	9/17/75	Replicates Byron
New England 1 & 2	New England Power & Light	9/9/76	Replicates Seabrook

Early Site Reviews

As part of the NRC's continuing efforts to improve the effectiveness and efficiency of the licensing process, the Commission, on June 6, 1977, adopted rules establishing procedures for the early review of safety and/or environmental site suitability issues for nuclear power reactor facilities. This review would be conducted prior to and separate from the detailed review of the design features of the facility. These Early Site Review (ESR) procedures can provide early resolution of one or more issues relating to site acceptability and can assist in identifying those site characteristics which must be subsequently considered in designing a nuclear facility for that site.

In recognition of the increasing involvement of non-utility organizations, primarily States, in the siting of power generation facilities, the new rules in Appendix Q to 10 CFR 50, specifically allow review of site suitability issues separate from and prior to a construction permit application.

Reviews of site suitability issues performed in connection with a construction permit application will normally culminate in a public hearing before an Atomic Safety and Licensing Board (ASLB), a partial decision on the site suitability issues under review, and administrative review of that decision by the Atomic Safety and Licensing Appeal Board and/or the Commission. Except as affected by the subsequent identification of significant new information, the partial decision would normally remain in effect for a period of five years or, where the applicant has made timely submittal of the remainder of the information required for the CP application, until the conclusion of the construction permit proceeding.

Reviews of site suitability issues performed in accordance with the Appendix Q procedures, which may be requested by any person, do not require a public hearing or culminate in a partial decision by an ASLB. These reviews will terminate with the issuance of a Staff Site Report (SSR), which will include a summary of the staff's conclusions regarding the site suitability issues under review and also any conditions that might be placed on use of the site which should be considered in the subsequent design of the facility. SSRs may be incorporated by reference in CP applications at any time. However, the conclusions of the SSR will be reexamined by the staff if five years or more have elapsed between issuance of the SSR and its incorporation by reference in a CP application. During that five-year period, the SSR will be reexamined by the staff only when there is reason to believe that there may be grounds for substantially altering the earlier staff positions.

Under Early Site Review procedures, the nature of technical review in any specific review area may vary, depending on the issues submitted for review and the proposed findings or conclusions requested. The finding to be made on a particular issue could vary from (1) a finding similar to that arrived at in present-day CP applications to (2) a more general finding of "reasonable assurance" regarding site suitability. The findings of "reasonable assurance" would imply that, for the site suitability issues considered, the site is representative of other sites that have been licensed in the past, alternatives have been adequately treated and, therefore, it is reasonable to determine that a nuclear power plant could subsequently be designed that would be acceptable for that site with respect to those site suitability issues considered.

In (1) above, the technical finding would be based on analyses similar to those performed for present-day CP applications, except that detailed impact analyses would normally be based on "envelope" assumptions regarding plant design and operating characteristics. These assumptions would be necessary, since actual plant design would not usually be known. In this case, the actual detailed impacts would be evaluated based on the envelope assumptions and judgments made as to their acceptability. If the site is judged suitable in those areas under review and there is no new information affecting the earlier conclusions, all that would be required in those areas at the subsequent facility review stage would be a determination of whether the actual plant design and operating characteristics are within the scope of those assumed in the "envelope" at the Early Site Review stage.

In (2) above, the finding would be based on knowledge of regional and site resources and physical characteristics, current technology of nuclear reactors and associated systems, and NRC siting practices. Such a review could conclude that with respect to those topics under review a nuclear reactor of current technology, located on the proposed site, could be constructed and safely operated with satisfactory protection of the environment. In this case the actual detailed calculations of impact would be deferred to the facility review stage, when it would be determined whether the particular location at the site and the design of the structures and systems are satisfactory, or whether alternative locations or designs are necessary to adequately mitigate impacts. This means that for the topics submitted, the Early Site Review under option (2) would be aimed solely at general site suitability (and perhaps alternative site) determinations, whereas detailed questions regarding mitigation of impacts by alternative design or onsite location of structures and systems would be deferred

to the facility review stage. (A more detailed description of technical review options under the Early Site Review procedures is provided in NUREG-0180; additional guidance will be furnished in 1978.)

Following is a brief summary of applications which are under review or which will be tendered utilizing the ESR concept.

- The Puerto Rico Water Resources Authority, in November 1975, indefinitely delayed construction of the North Coast Nuclear Station. The applicant requested that the review of environmental and site safety issues continue as an ESR. The Final Environmental Statement pertaining to site suitability was issued in April 1977. It is expected that the Site Safety Evaluation Report will be issued by mid-1978.
- The Omaha Public Power District, one of the co-owners of the Ft. Calhoun Station, unilaterally canceled Unit 2 of the station in February 1977, but requested that the environmental review continue as an ESR. The applicant has not yet decided if they will request a hearing or a Staff Site Report (Appendix Q). The DES was issued in April 1977. The FES is scheduled for issuance in late 1977. There is a significant possibility that the applicant will revive the CP application.
- Pacific Gas and Electric Company is expected to apply for an ESR on issues limited to geology and seismology in early 1978. This application will require significant coordination with various California agencies.
- Gulf State Utilities Company applied for construction permits for Blue Hills, Units 1 and 2, in 1974. In early 1976, the applicant postponed the project several years and requested an early site review that would salvage the effort already expended by the applicant by resolving all site-related issues that can be resolved at this time.

Standard Review Plans

Environmental standard review plans are being prepared to guide and direct the staff's environmental review of nuclear power plant applications. The plans are intended to give guidance to both applicants and staff as to the information and criteria that are considered essential to the environmental review process. The plans will specify NRC internal procedures and positions, document the content and bases for each environmental review, and frame the extent of the review to assure that only essential items are considered. Upon their completion, the review plans will be used as the basis for a revision of Regulatory Guide 4.2.

The preparation of environmental standard review plans was begun in 1976, and at the end of 1977 the 91 plans needed to direct the environmental review process had been issued in draft form for review and comment. The initial group of plans was issued in February 1977, and the others in May and December 1977, as NUREG-0158, Parts I, II and III. Final comments on the environmental standard review plans were due in January 1978. After staff consideration of those comments, the final plans will be issued for staff use.

Standard Technical Specifications—Safety

The NRC (then AEC) initiated the Standard Technical Specification (STS) Program in the spring of 1972 as part of its overall licensing standardization effort. This program has resulted in the development of uniform and consistent STSs for each of the vendors of nuclear steam supply systems and associated balance-of-plant equipment. The STSs are currently being used as the basis for all technical specifications issued with facility operating licenses and have contributed to the promotion of uniform application and interpretation of NRC requirements by the nuclear industry.

Certain utilities have sites with one unit operational and a similar unit scheduled for operation with STS in the future. In these situations, a conversion of the older unit's specifications to STS has been found to be beneficial in ensuring uniform operational practices. This conversion effort, undertaken in close cooperation with the utilities, will involve facilities at five sites during the next several years.

Fifteen facilities using STSs were scheduled to be in operation by December 31, 1977.

Standard Technical Specifications—Environment

The NRC environmental review process under NEPA provides for the establishment of operating limitations and monitoring requirements for each nuclear plant. Their purpose is to assure that the plant meets design specifications and to verify anticipated environmental impacts. Control measures are incorporated into operating licenses by means of Environmental Technical Specifications

NRR site visit team members investigate barranca (sea cliff) near the San Onofre nuclear generating station units 2 and 3. The San Onofre plant will be required to help divert nearby highway water run-off to protect the barranca formation, which is endangered because of erosion of unconsolidated sandstone.

(ETS), which specify appropriate limiting conditions for operation and provide detailed procedural requirements for conducting the monitoring programs. Significant progress has been made in our understanding of the environmental issues involving power plants since the program was initiated in 1971. A frequent practice in early monitoring programs was to place general requirements on licensees, which resulted in the generation of large amounts of data, much of which proved to be extraneous. Recently ETS have become more streamlined, focusing directly on those issues of environmental concern that are identified in environmental impact statements.

Another improvement in the licensing process is a recently initiated program to establish conformity in the ETS process. This is being accomplished by selecting representative power plants at the operating license stage and developing ETS for them in a format readily applicable to other plants. Details will vary from plant to plant, but the underlying principles and objectives will be consistent for all. Standardization of ETS will be further enhanced by developing uniform definitions of technical terms used in the ETS and by providing for administrative procedures that apply to every plant with little need for case-specific requirements.

An important aspect of the staff effort to normalize the format and content of Environmental Technical Specifications is the need to minimize the inclusion, as a result of the NEPA reviews, of license conditions related to water quality issues which are the responsibility of the Environmental Protection Agency (EPA) or of designated "permitting States" under the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). NRC's posture with regard to non-radiological ETS involving potential duplication of effort with EPA is as follows:

(1) Water quality parameters which are determined to be of NEPA concern and which also have numerical limits by way of Section 401(d) requirements or Section 402 permits under PL 92-500, will no longer be included in ETS as limiting conditions to an NRC operating license. However, NRC will require monitoring of the parameters and NRC notification if the permit limits are exceeded or if the limits are revised. Regarding the enforcement of these limits, it will normally be the policy of the NRC Office of Inspection and Enforcement to limit their inspection and enforcement activities to ensuring compliance with the monitoring or reporting requirements specified in Section 3.0 of the ETS. They will normally not inspect or enforce compliance with the actual limits of the certifications or permits. However, they may, at their own initiative or at the request of the State or EPA, investigate or assist in the investigation of any unusual occurrences involving water quality issues. The rationale for this policy is that, under law, the EPA or the

Federally approved permitting State is charged not only with the authority for setting effluent limitations, but also with the responsibility for appropriate inspection and enforcement of such requirements. This approach is intended, therefore, to eliminate duplicative enforcement responsibilities between NRC and EPA or a designated permitting State without compromising NRC responsibilities under NEPA. While a certification provided under Section 401(d) could conceivably be worded in such a manner as to require NRC enforcement action, close coordination with the States on a case-by-case basis will alleviate this concern.

(2) Technical details of monitoring programs will no longer be included in the ETS. They will, instead, be specified in an environmental program description which will be initially approved by NRC and subsequently managed by the licensee. Changes to the program description can be made without prior NRC approval, subject to the licensee's evaluation that the change does not violate the original intent of the monitoring program. This provides a means by which technical aspects of programs can be modified without going through the formality of a license amendment.

The approach described above is being implemented on two licensing actions currently under OL-stage review (McGuire and Three Mile Island facilities). All future OLs will also use this approach. In addition, a staff paper is in preparation which will propose amendments to 10 CFR Parts 50 and 51 to incorporate specific requirements for environmental technical specifications into the regulations.

Quality Assurance

The application of disciplined engineering practices and thorough management and programmatic controls to the design, fabrication, construction and operation of nuclear power plants is essential to the protection of public health and safety and of the environment. Quality Assurance (QA) provides this necessary discipline and control. Through a QA program that meets NRC requirements, all organizations performing work that is important to safety are required to conduct work in a pre-planned and documented manner; to independently verify the adequacy of completed work; to provide records that will confirm the acceptability of work and manufactured items; and to assure that all individuals are properly trained and qualified to carry out their responsibilities.

Each NRC licensee is held responsible for assuring that his nuclear power plants are built and operated safely and in conformance with the NRC regulations. In addition, the NRC has several specific QA responsibilities. First, it has a responsibility for developing the criteria and guides for judging the acceptability of nuclear power plant QA programs. Second, it has a responsibility for reviewing the QA programs of each licensee and his principal contractors to assure that sufficient management and program controls exist. Finally, NRC inspects selected activities to determine that the QA programs are being implemented effectively.

Where inspections or events signal QA deficiencies, it usually indicates either that the QA program is deficient or that it is not being implemented properly. In the former case, the NRC requires appropriate program upgrading. In the latter case, NRC uses enforcement authority as necessary to achieve proper implementation. If a generic QA problem develops, improvements in QA programs are made industry-wide.

Through the NRC topical report program, the industry has widely adopted standardized QA programs which can be used on new projects without a new review. As of October 31, 1977, a total of 29 topical reports on quality assurance from manufacturers of nuclear steam supply systems, architect-engineering firms, constructors and utilities have been found acceptable by the NRC, and other reports are under review. In addition, NRC is reviewing a topical report from the Coordinating Agency for Supplier Evaluation, which, if and when accepted, should reduce the need for audits of potential suppliers.

In order to independently assess the adequacy of NRC's regulatory practices in the area of quality assurance, the NRC contracted with Sandia Laboratories to do a comprehensive study on this topic. The results of this study were published in August 1977, generally endorsing current practices, while suggesting additional measures and potential improvements for NRC consideration. Some of these recommendations are being implemented, and others are being evaluated.

Systematic Evaluation Program

During fiscal year 1977, the NRC developed a program for the systematic evaluation of certain nuclear power plants licensed for operation before 1972. Since these facilities first began operation, many new licensing criteria have come to be applied in the review process for construction permit and operating license applications. Modifications

of earlier licensed plants to assure their continued safe operation have taken place during the intervening years, but these improvements have been made generally on the basis of individual operating experience or particular isolated systems within the plants.

The systematic evaluation of these older plants was started in fiscal year 1978. The NRC is evaluating the safety of individual systems in the context of overall plant safety and will reassess the safety margins prevailing in selected facilities licensed before 1972 to determine the degree to which each one meets current licensing requirements. Areas in which a facility falls short of meeting the requirements for a contemporary plant will be appraised, taking into account the unit's operating history, the probability of potential accident, and the probable consequences thereof. Any changes required in a plant's equipment or operating procedures will be based on a balanced overall safety assessment.

Topical Reports/Generic Reviews

The major nuclear steam supply system manufacturers, architect-engineering firms, and major component manufacturers are encouraged to prepare and submit topical reports which describe proposed solutions to safety problems, results of research and development programs, and current analytical techniques. These reports generally have broad applicability to several plants or designs, and, if found acceptable by the NRC staff, they can be referenced in any number of applications, thus reducing repetitious review and accelerating the process. In the past year, the NRC staff has clarified the criteria utilized in determining the acceptability of a topical report. A related step has been the staff's effort to identify issues and problems which have applicability to a number of plants or review cases and resolve them generically, rather than on a case-by-case basis.

Impact of Changing Requirements

Changes in NRC licensing requirements have been frequently cited as a cause of onerous delays and additional costs in the licensing process. While many of these changes involve significant safety matters, and are viewed as a justifiable part of the licensing review process, the NRC staff has made increasing use of value/impact assessments by which to ensure that the expected benefit of a new requirement justifies its probable cost in time, money, and effort.

All significant proposed requirements, as well as new regulatory guides, which inform the industry of acceptable licensing positions, are critically reviewed by the Regulatory Requirements Review Committee, composed of senior NRC management, before approval. Additionally, guidance on staff review considerations and positions is written into the staff's Standard Review Plans. Finally, NRC management will meet with applicants, members of the staff or others, to try to resolve any disagreements with staff positions on an application. These procedures are clearly established, and information regarding them has been made public.

ANTITRUST ACTIVITIES

As required by law since December 1970, the NRC has conducted prelicensing antitrust reviews of all applications for nuclear power plants and certain other nuclear facilities for commercial use. These reviews assure that the issuance of a particular license will not create or maintain a situation inconsistent with the antitrust laws. The NRC will hold a hearing when it is recommended by the Attorney General and must also consider whether antitrust issues raised by the NRC staff or intervenors should be the subject of a hearing. (In addition to remedies resulting from antitrust hearings, remedies may also be achieved through negotiated license conditions.)

Antitrust hearings are held separately from those on environment, health, and radiological safety matters. So that antitrust reviews do not delay NRC licensing decisions, applicants are required to submit specified antitrust information to the NRC at least nine months, but not earlier than 36 months, before other parts of the construction permit applications are filed for acceptance review. Additionally, NRC performs antitrust reviews at the operating license stage if it is determined that significant changes in the licensee's activities have occurred since the previous antitrust review.

Since the inception of NRC's antitrust program, 91 initial reviews have been or are being performed. Of the 89 applications reviewed by the Department of Justice, 17 were recommended for hearing; 24 were recommended for "no hearing" because applicants agreed to antitrust license conditions; and 48 were recommended for "no hearing," without need for conditions. In addition to these initial reviews, NRC has reviewed and sought advice from the Department of Justice in 20 cases in which additional applicants are seeking part-ownership participation in nuclear plants for which applications had been tendered previously.

Significant developments have occurred during fiscal year 1977 in several antitrust proceedings, including two cases where intervenors have sought and been granted hearings. These developments are:

- The initial decision by the Atomic Safety and Licensing Board on the consolidated Davis-Besse/Perry antitrust hearings was rendered in January 1977. The decision generally supported the position of the NRC staff, the Department of Justice, and the intervenors in its finding of situations inconsistent with the antitrust laws and in its ordering of certain license conditions to remedy such situations. Exceptions to the decision have been filed by the applicants with the appeal board.

  The applicants also filed a motion to have these license conditions stayed, pending their appeal. In March 1977, the appeal board issued a decision affirming the licensing board's denial of a stay. The ordered antitrust license conditions have been attached to the David-Besse 1 operating license, as well as to the Perry 1 & 2 construction permits.
- Initial decisions have been rendered by the Atomic Safety and Licensing Board on the two-part hearing on Alabama Power Company's Farley Units 1 and 2. The initial decision dealing with the factual situation was rendered in April 1977, and the initial decision dealing with the remedy in June 1977. Exceptions have been filed with the ASLAB by all parties. The board determined that there was a situation inconsistent with the antitrust laws and asked that conditions pertaining to its antitrust findings be included in the licenses issued in June 1977, for the Farley units.
- The Florida Municipal Utilities Association and several Florida cities were granted intervention by the Atomic Safety and Licensing Board in April 1977, in the St. Lucie, Unit 2 proceeding. The construction permit for the facility was issued in May 1977, after all the parties in the proceeding agreed that the antitrust hearing, if held, could follow after issuance of the permit. After an appeal by the applicant, the appeal board upheld the licensing board's decision in July 1977. At year-end the matter was awaiting formal action before the Commission.
- Central Power & Light Company, a co-holder of a construction permit from the South Texas Project, sought an antitrust hearing via a "Petition to Intervene." A licensing board decision granting the requested relief was reversed by the appeal board. On appeal, the Commission subsequently determined, by Memorandum and Order, that a further antitrust review by the Attorney General related to the South Texas Project is advisable because "significant changes" have occurred since the prior antitrust review was completed at the construction permit stage.
- Several California public power entities and the California State Department of Water Resources requested leave to intervene, in October 1976, with respect to Pacific Gas and Electric Company's Stanislaus application. Intervention was granted to all of the parties and a hearing ordered. The Attorney General had not recommended a hearing in connection with its review of this application on the basis of the applicant's commitment to accept certain license conditions. In a prehearing conference in July 1977, the Atomic Safety and Licensing Board dismissed a motion for summary disposition by the applicant and initiated a prehearing schedule.

INDEMNITY AND INSURANCE

On January 3, 1977, the Commission published an effective rule in the Federal Register which implemented the provisions of legislation enacted on December 31, 1975, modifying and extending the Price-Anderson Act for 10 years. The provisions of this new rule became effective on August 1, 1977. The rule provides a three-layered system to pay public liability claims in the unlikely event of a nuclear incident involving personal injury or property damage.

The first layer of this system provides that all licensees of commercial nuclear power plants rated at 100 electrical megawatts or more must provide proof of financial protection in an amount equal to the maximum liability insurance available from private sources. This amount was increased by the nuclear energy liability insurance pools from $125 million to $140 million in January 1977.

The new second layer provides a mechanism—payment of a retrospective premium—whereby the utility industry shares collectively in any damages exceeding $140 million which might result from a nuclear incident. In the event of a nuclear incident causing damages exceeding $140 million, each licensee of a commercial reactor rated at 100 electrical megawatts or more would be assessed a prorated share of damages of up to $5 million per reactor per incident.

The third layer, Government indemnity, will gradually be phased out as more commercial reac-

tors are licensed and these new licensees participate in the retrospective premium system. Currently, the Government indemnity layer equals the difference between the $560 million limit of liability and the sum of the first and second layers. At the end of fiscal year 1977, there were 62 reactors with a rated capacity in excess of 100 electrical megawatts licensed to operate; the Government's indemnity obligation at the time was thus $110 million. Government indemnity for reactors will be phased out when the first and second layers by themselves provide liability coverage of $560 million. Under the current level of financial protection required by the Commission, this will occur when 84 commercial reactors have been licensed. After that point, the limit of liability for a single nuclear incident would increase without limit in increments of $5 million for each new reactor licensed.

Additionally, in the effective rule, the Commission exercised its discretionary authority under the Price-Anderson Act by requiring persons licensed to possess and use plutonium at certain plutonium processing and fuel fabrication plants to maintain financial protection at the maximum amount available from private sources (primary layer). These licensees are not required to participate in the retrospective premium system (secondary layer) but are indemnified up to the statutory maximum of $560 million.

Constitutionality of the Price-Anderson Act. On March 31, 1977, the U.S. District Court for the Western District of North Carolina issued a memorandum of decision declaring that the Price-Anderson Act's provision limiting liability to $560 million was unconstitutional. This decision generally supported the position of the plaintiffs, the Carolina Environmental Study Group, Inc. and its individual members. The NRC and Duke Power Company, who are co-defendants in this case, have both filed notices of appeal to the U.S. Supreme Court. In November 1977, the Supreme Court indicated it would review the decision.

Indemnity Operations

As of September 30, 1977, 132 indemnity agreements with NRC licensees were in effect. Indemnity fees assessed by the NRC from October 1, 1976, through September 30, 1977, totaled $2,804,713. Total fees collected since the inception of the program are $17,982,753.

Future collection of indemnity fees will decrease as the indemnity program is phased out for commercial reactor licensees. No payments have been made under the NRC's indemnity agreements with licensees during the 20 years of the program's existence.

Insurance Premium Refunds

The two private nuclear energy liability insurance pools—the Nuclear Energy Liability-Property Insurance Association and Mutual Atomic Energy Liability Underwriters—paid to policyholders the eleventh annual refund of premium reserves under their Industry Credit Rating Plan. Under the rating plan, a portion of the annual premiums is set aside as a reserve for either payment of losses or ultimate return to policyholders. The amount of the reserve available for refund is determined on the basis of loss experience of all policyholders over the preceding 10-year period. Refunds paid in 1977 totalled $1,951,511 which is approximately 71 percent of all premiums paid on the 378 nuclear liability insurance policies issued in 1967. The refunds represent 98.97 percent of the premiums placed in reserve in 1967.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards is a panel of independent advisors established by law to review and report to the NRC on safety studies and license applications for nuclear power reactors and other major nuclear facilities, such as spent fuel processing plants. The Committee also provides advice to the Commission on a wide range of safety-related matters, such as the adequacy of proposed reactor safety standards, reactor safety research, specific technical issues of a topical nature, and the safety of operating reactors.

In its review of proposed facilities during the report period, the Committee gave special emphasis to the following safety-related matters:

- Analysis of systems interactions in nuclear power plants, including the physical configuration of safety systems and interrelated functions and actions.
- Innovative safety features, such as the upper head injection system and ice condenser containment system.
- Methodology applied to the seismic evaluation of nuclear power plant sites and structures.
- Physical protection of nuclear facilities and safeguards for special nuclear material.

- Reliability of safety-related systems, such as the DC power supply in nuclear power plants.

The Committee has also given considerable attention to the following subjects at the specific request of the NRC:

- Packages for air shipment of plutonium and transportation of other radioactive materials.
- Long-term waste management for high-level and low-level wastes.
- Specific reactor safety issues which have been raised by members of the NRC technical staff.

The Committee's advice was also requested by the NRC on the environmental survey of the waste management portions of the light-water-reactor fuel cycle, and a report was provided to the Commission in early 1977. This action represented the first time the Committee had become involved in the review of environmental matters, though future efforts in this area are expected.

In fiscal year 1977, the Committee provided advisory reports to the NRC concerning construction permits for seven licensed nuclear power stations, comprising a total of 18 individual nuclear power plants. The continued effort toward standardization of nuclear power plant design was reflected in the Committee's review and approval of four standard safety analysis reports from reactor designers and architect-engineering firms. These consisted of the General Electric Standard Nuclear Steam Supply Systems (GESSAR-238 NSSS and GESSAR-251); Fluor Pioneer Balance of Plant Standard Safety Analysis Report, as applied to Westinghouse Electric Corporation Standard Plant (RESAR-41); and the Babcock & Wilcox Standard Safety Analysis Report (B-SAR-205). In addition, the Committee reviewed the standard plant design and the application for a manufacturing license for eight Floating Nuclear Power Plants. Operating license applications were reviewed for four nuclear power plants—Davis-Besse, Unit 1; Three Mile Island, Unit 2; North Anna, Units 1 and 2—and a partial review was conducted for the Diablo Canyor plant, Units 1 and 2. Special reviews were conducted by the Committee during the report period on the ECCS (emergency core cooling system) evaluation model for Exxon replacement fuel; the operation of Zion Station, Units 1 and 2; and the proposed operation of D. C. Cook station, Unit 1, at full power with replacement fuel.

Special reports were provided to the NRC by the Committee during the report period on the following matters:

- Proposed Qualification Criteria to Certify Packages for Air Transport of Plutonium.
- Proposed Revisions in 10 CFR 50 and 51 to Provide for Use of Mixed Oxide Fuels.

The Commission meets with the Advisory Committee on Reactor Safeguards in September 1977 in open session to discuss priorities for resolution of generic items, the annual report on reactor safety research, and other matters.

- Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors—Health, Safety and Environment.
- Reports (two) on Selected Safety Issues Related to Light Water Reactors.
- Report on the Management of High Level Radioactive Wastes.
- Report on the Midland Plant, Units 1 and 2.
- Status of Generic Items Related to Light Water Reactors.
- Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (NUREG-0116).
- The Advanced Reactor Safety Research Program.
- Response to the Midland Atomic Safety and Licensing Board Request for Additional Information.
- Security of Nuclear Power Plant Information.

The Committee provided reports to the Congress and to other Governmental agencies, as follows:

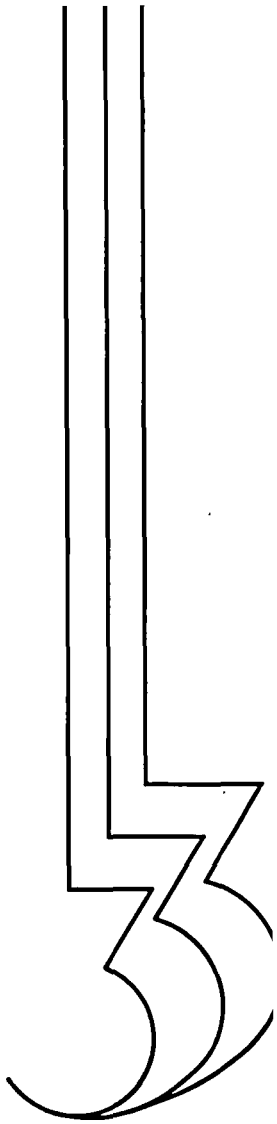
- Reports to Congressman Udall, Chairman, Subcommittee on Energy and the Environment on the Reactor Safety Study RSS, WASH 1400, NUREG 75-014.
- Report to Senate Government Operations Committee responding to Questions Arising from the Hearings on the Nuclear Regulatory Commission's Safety and Licensing Procedures, December 13, 1976.
- Report to the Director, Bureau of Radiological Health, Commonwealth of Pennsylvania re Shippingport Reactor.

The Committee also completed preliminary site reviews for the Blue Hills, Sundesert and San Joaquin Nuclear Power Plant sites during the fiscal year.

An increased emphasis was given to the resolution of generic items by the Committee during the report period, and a program to establish priorities for resolution was initiated. The Committee also implemented provisions of the Government in the Sunshine Act to provide further opportunity for public observation of and participation in Committee activities.

In performing the reviews and preparing the reports referenced above, the Committee met in full session 12 times. Ninety-five Subcommittee and Working Group meetings were held during the reporting period and 12 site-facility visits were made. All of the full Committee meetings were partly open to the public and 94 of the 95 Subcommittee meetings were either fully or partly open.

Materials Regulation



Except for uranium mining and the enrichment of uranium in Government-owned plants, NRC regulates all steps involved in supplying fuel to nuclear reactors. Thus, NRC reviews and licenses uranium mills, spent fuel storage facilities, uranium hexafluoride conversion facilities, fuel processing and fabrication facilities and fuel reprocessing plants. NRC is also responsible for regulating the use of reactor-produced radioisotopes in medicine and industry, and the transportation of nuclear materials. In all of these areas, NRC requires that licensees conform to standards established to protect public health and safety, national security and the environment.

THE REPROCESSING-RECYCLE ISSUE

During fiscal year 1977, the NRC continued to be concerned with whether and under what conditions uranium and plutonium might be recovered from spent light water nuclear reactor fuel and recycled in fresh mixed oxide fuel. The spent fuel is in storage at reactor sites or at inactive reprocessing plants.

Currently, all light-water-cooled power reactors (LWRs) are fueled entirely with uranium slightly enriched in the isotope uranium-235. Plutonium, which is produced within the fuel during reactor operation, contributes about one-third of the energy generated in a LWR. The plutonium and uranium remaining in the spent fuel can be recovered and used in making fresh fuel for recycle to LWRs. Although such recovery and recycle may conserve resources, objections have been raised on safety, environmental and national security grounds.

Under a November 1975 policy statement of the Commission (40 FR 53056), the NRC began public hearings to help resolve the issue, using as a basis the "Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light-Water Cooled Reactors—Health, Safety and Environment," publication number NUREG-0002, referred to as GESMO I (see 1976 NRC Annual Report, pages 47-50).

Under the same November 1975 policy statement, the NRC also continued to process license applications for the construction, operation, and modification of facilities to reprocess spent fuel, fabricate mixed oxide fuel, and perform related functions. The U.S. Court of Appeals for the Second Circuit held, however, that the Commission could not issue such licenses for commercial-scale activities until it had completed the GESMO proceedings.

Hearings on GESMO

The first phase of the GESMO I hearings was given over to questioning of the NRC staff. It was based, in part, upon questions and statements submitted by citizen groups, electric utility groups, representatives of other nuclear industries, and State and Federal agencies. In response to the hearing board's questions, the NRC staff provided oral testimony requiring about 4,500 pages in the printed record, as well as about 5,000 pages of written replies and supplemental testimony on the health, safety and environmental aspects of the recycle of plutonium as fuel in LWRs. Supplemental testimony broadened the scope of the hearing to cover other topics, including: alternative nuclear fuel cycles that might extend the burnup of uranium fuels and not require plutonium recycle; the use of thorium-uranium-233 fuels in LWRs; and comparisons of the environmental impacts of using fossil fuel, solar energy, geothermal energy and nuclear fuel for generation of electrical energy. The first phase of the hearing ended in February 1977.

Presidential Policy Statements

Prior to the next phase of the GESMO public hearings, wherein all parties to the proceeding other than the NRC staff were to provide testimony and respond to questions submitted to the hearing board, President Carter, on April 7, 1977, issued a statement on nuclear power policy. With respect to matters relevant to GESMO he said: "... we will defer indefinitely the commercial reprocessing and recycling of the plutonium produced in the U.S. nuclear power programs. From our experience we have concluded that a viable and economic nuclear power program can be sustained without such reprocessing and recycling." The President also announced a restructuring of the U.S. breeder reactor program to give greater priority to alternative designs, and a redirection of funding for the U.S. nuclear research and development programs in order to accelerate research into alternative nuclear fuel cycles which do not involve direct access to materials usable in nuclear weapons. In view of the President's statement, the GESMO hearing board, on April 12, 1977, postponed the resumption of the hearings until further notice.

On May 3, 1977, the NRC announced that it would assess the effect of the President's statement on the future course and scope of the GESMO proceeding, and that further notice regarding the hearing would be issued after the assessment was made. In this regard, the NRC invited comments from the public, from the GESMO parties and from the Executive Branch of the Government. Twenty-seven comments were received. On October 4, 1977, the Assistant to the President for Domestic Affairs and Policy advised the Commission that the President believed his nonproliferation initiatives would be assisted both domestically and internationally if the NRC were to terminate the GESMO proceedings. Specifically, the President was said to believe that the following actions would be helpful in achieving the Administration's goals:

- Publication of the NRC's assessment of safeguards issues involved in plutonium recycle.
- Termination of staff reviews and hearings relating to recycle activities. (Continuation of these activities could lead other nations to question the United States' commitment to defer commercial reprocessing and plutonium recycle.)
- Denial of interim licensing of recycle-related fuel cycle facilities.
- Denial of interim licensing for use of mixed oxide fuel in reactors, except in small quantities for experimental purposes.

Revised Commission Policy

The Commission sought public comment on the President's views and on several specified alternative courses of action. Comments were received in November.

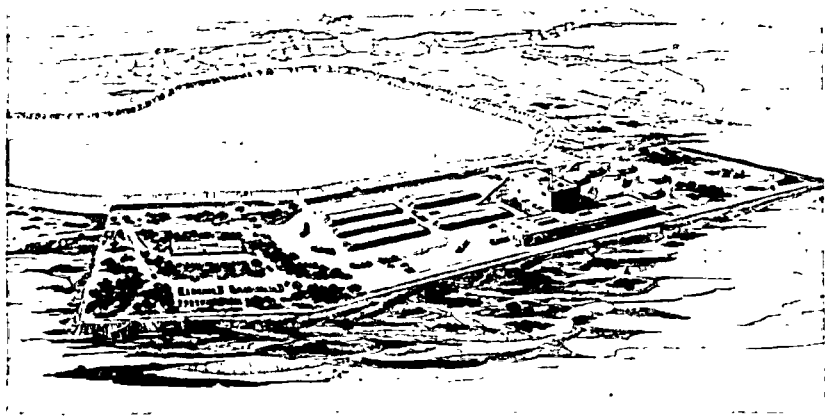
In light of the above events and after consideration of all the comments received, the Commission decided at public meetings in December 1977:

(1) To terminate the GESMO proceeding.

(2) To terminate the proceedings on pending or future plutonium recycle-related license applications, except for (a) proceedings on licenses for the fabrication or use of small quantities of mixed oxide fuel for experimental purposes, and (b) those portions of proceedings which involve only spent fuel storage, disposal of existing waste, or decontamination of existing plants.

(3) To re-examine the above matters after the completion of the ongoing alternative fuel cycle studies, now expected to take about two years.

(4) To publish the draft safeguards supplement to the GESMO document as a staff technical report.



Conceptual view of proposed United Nuclear Corporation's uranium mill to be built at Morton Ranch, Wyoming. This project is currently under review, and licensing action is expected in mid-1978.

(5) As a consequence of the above decisions, to withdraw the 1975 policy statement.

(6) To reserve for decision, if it arises, the question of whether a facility such as the Barnwell facility may be licensed for experimental and feasibility purposes on a noncommercial basis to investigate processes which support the nation's nonproliferation objectives.

URANIUM MILLING

After uranium ore is mined, it is concentrated in a series of mechanical crushing and grinding operations and in subsequent chemical processes. These steps result in the accumulation of large quantities of waste product material called "tailings." The tailings create radiological and environmental problems because they contain almost all of the radioactivity, e.g., radium and its daughters, that was originally present in the ore. Although the concentration of radioactive material in tailings is relatively low, they represent a waste management problem because of the large quantities involved and the long half-lives of the radionuclides present.

There are currently 19 uranium mills in operation, all located in western States. Nine of these mills are licensed by NRC. The remaining 10 are licensed by States under the State Agreements program (see Chapter 8). The various mill sites already contain about 100 million tons of accumulated tailings, and a number of new mills are presently under construction or are in the planning stage. It is estimated that, by the year 2000, approximately 90 uranium mills may be in operation and nearly one billion tons of uranium mill tailings will have been generated.

Environmental Impact Statement

Because of questions raised concerning the potential effects of expanding uranium milling operations on the environment, the NRC decided in 1976 to prepare a generic environmental impact statement (GEIS) covering uranium milling, with particular emphasis on mill tailings. In the GEIS, the local, regional and national environmental impacts of milling operations to the year 2000 will be assessed and, if warranted, regulatory changes to enhance environmental protection will be recommended.

Work on the GEIS went forward during fiscal year 1977. Its scope and outline were published in the *Federal Register* in March 1977 for public comment. Over 20 letters of comment were received from the public, industry and other Government agencies. The staff has taken these comments into account in developing the study.

A draft of the GEIS is expected to be issued for public comment in August 1978. NRC's intent is also to publish for public comment proposed rules or legislative changes related to uranium milling no later than the time of publication of the final GEIS.

Management of Mill Tailings

During preparation of the GEIS on uranium milling, the staff is requiring mill operators to commit themselves to a definite plan for tailings management and final disposal. As a prerequisite for receiving a license, each mill operator must also make financial arrangements which assure that sufficient funds will be available to complete disposal of the tailings according to the approved plan.

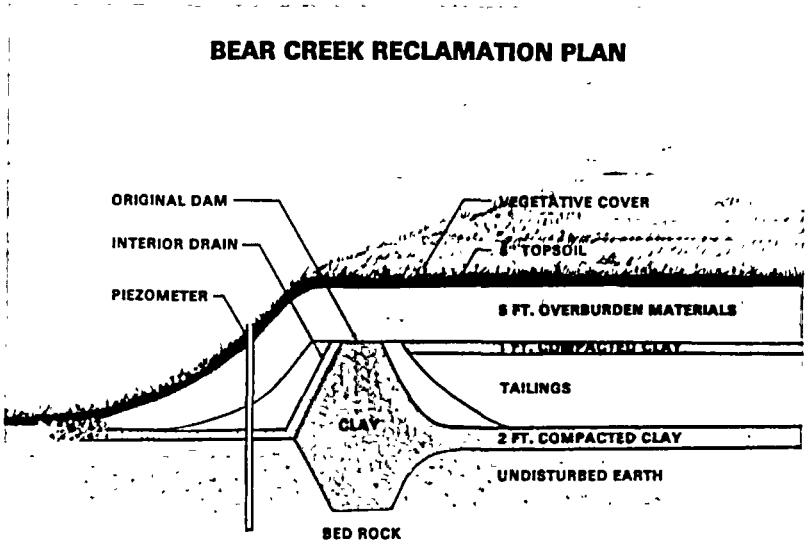
The plan and the financial arrangements are made license conditions. A set of performance objectives has been established by the NRC staff for an acceptable mill tailings waste management and disposal program. They are as follows:

1. Locate the tailings isolation area in a place remote from people, so that population exposures will be reduced to the maximum extent reasonably achievable.
2. Locate the isolation area in a place where the disruption and dispersion of tailings by natural forces is eliminated or reduced to the maximum extent reasonably achievable.
3. Design the isolation area in such a way that seepage of toxic materials into the groundwater system will be eliminated or reduced to the maximum extent reasonably achievable.
4. Eliminate the possibility of tailings being blown to unrestricted areas during normal operating conditions.
5. Reduce the direct gamma radiation from the impoundment area essentially to the level of the background radiation naturally present.
6. Reduce the radon emanation rate from the impoundment area to about twice that of the emanation rate in the surrounding environs.
7. Eliminate the need for an ongoing monitoring and maintenance program following successful reclamation.
8. Provide surety arrangements to assure that sufficient funds are available to complete the full reclamation plan.

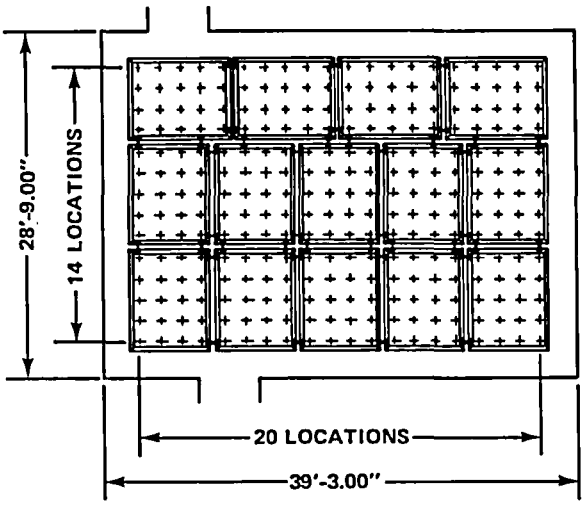
By the end of the fiscal year, all nine NRC-licensed milling operators had agreed to meet the performance objectives. Eight had submitted engineering plans in conformance with the goals; the ninth is expected to submit such plans in the coming year. Applications submitted for proposed new mills also included reclamation plans based on the performance objectives.

Licensing Reviews

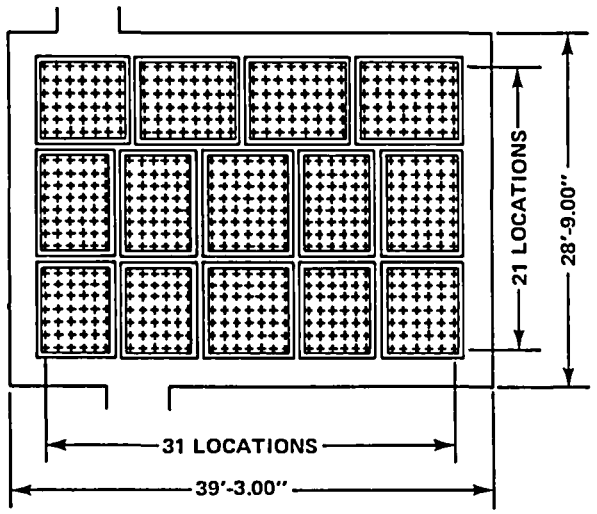
Four uranium mill licensing actions took place this year. Each license issued incorporated conditions for final tailings reclamation plans and performance bonds. A source material license was issued to the Rocky Mountain Energy Company authorizing operation of its new uranium mill in Converse County, Wyoming. Issuance of the license followed publication of a final environmental impact statement in June 1977. Other uranium mill licensing actions included renewal of the licenses for the Rio Algom uranium mill near La Sal, Utah, and the Utah International uranium mill in the Shirley Basin area of Wyoming. At year's end, environmental impact statements were being prepared and reviews were being conducted for renewal of NRC licenses for five other operating uranium mills and for the following proposed new mills: Minerals Exploration Company, Sweetwater County, Wyo.; United Nuclear Corporation, Converse County, Wyo.; and Kerr-McGee Nuclear Corporation, Converse County, Wyo.



Artist's conception of the final mill tailing reclamation plan for the Bear Creek Mill Project of Rocky Mountain Energy Company at Converse County, Wyoming. This plan was approved by the NRC licensing staff.



ORIGINAL SPENT FUEL
STORAGE RACK ARRANGEMENT



MODIFIED SPENT FUEL
POOL ARRANGEMENT

Spent fuel storage pools at some reactors can be "re-racked" to increase the storage capacity. These drawings represent the changes proposed by the Portland General Electric Company to increase the capacity of the storage pool at the Trojan nuclear power plant from 280 spent fuel assemblies to 651 assemblies.

At the request of the U.S. Forest Service and the State of Colorado, the staff agreed to provide technical assistance in the preparation of the environmental impact statement for a new mill in Colorado proposed by Homestake Mining Company. Colorado indicated that it would also request NRC assistance in the preparation of environmental assessments on other milling projects in the coming year.

Continued interest is being shown by the uranium industry in the "*in situ* solution mining" of uranium. In this process, uranium is leached from the ore in place and the mineral solution is pumped to the surface, where the uranium is extracted. License applications from two firms, Wold Nuclear Company and Kerr-McGee Nuclear Corporation, for research and development test operations in Wyoming were under staff review at the end of the year. Six other firms have received licenses in the past authorizing solution mining research and development operations at various sites in Wyoming. Environmental impact statements were being prepared in connection with applications for proposed commercial-scale solution mining operations in Wyoming by the Wyoming Mineral Corporation and by the Exxon Company.

A technical assistance contract was made in October 1976 with Oak Ridge National Laboratory to provide information on the environmental aspects of *in situ* solution mining of uranium.

Research Studies

In cooperation with the Environmental Protection Agency, NRC has initiated a program to measure release rates of effluents from operating uranium mills. The primary objective is to provide data which can be used in evaluating the environmental impacts of uranium milling operations and in developing regulatory guides on effluent and environmental monitoring programs for uranium mills. The studies involve the measurement of airborne particulates released from mill stacks and vents, and of particulates and radon-222 released from ore and tailings piles. Measurements of airborne particulates and of radon-222 and daughter-product concentrations in the offsite environment are also being carried out in order to validate the models used to assess the environmental impact of uranium mills during NRC's licensing reviews. Initial measurements are being made in the Grants, N.M., area.

STORAGE OF SPENT FUEL

From the early days of the nuclear power industry in the United States, electric utilities planning to construct and operate light water nuclear power reactors assumed that the used or spent fuel dis-

charged from the reactors would be chemically reprocessed to recover the residual fissile and fertile materials (uranium and plutonium), and that the materials so recovered would be recycled in fresh reactor fuel. To accomplish this, it was expected that some fuel discharged periodically from operating reactors would be stored in onsite fuel storage pools for a period of time (to cool and to permit decay of radioactive materials in the fuel) and then shipped elsewhere for reprocessing. Accordingly, space was typically provided in storage pools at reactor sites for about one and one-half nuclear reactor cores—based on the assumption that about one-fourth of the reactor core would be changed each year. Thus, onsite storage pools were planned to hold an average of one year's discharge, with sufficient remaining capacity to hold a complete core should operating difficulties make it necessary to unload all the fuel from the reactor. Without such exigencies, an average of about five years' discharge could be accommodated before the pools were filled.

The only commercial reprocessing plant to be licensed, the Nuclear Fuel Services plant at West Valley, N.Y., operated for a time. However, after a shutdown intended for extensive alterations and expansion, the company concluded that these changes were commercially impractical and, as a consequence, the facility is not being reopened. A second commercial reprocessing facility, the General Electric Company's Midwest Fuel Recovery Plant at Morris, Ill., was constructed but has never operated. A proposed third plant, the Allied General Nuclear Services plant at Barnwell, S.C., has been the subject of hearings before the NRC, and an Exxon plant proposed for construction in Tennessee came under license review in fiscal year 1977. However, significant policy developments (i.e., the President's statement that domestic plutonium recycle should be deferred, and the Commission's termination of GESMO proceedings) have eliminated for the foreseeable future the prospect of reprocessing as a means of reducing the annual and cumulative volume of spent fuel to be stored or otherwise disposed of.

Draft Environmental Statement

In a *Federal Register* notice on September 16, 1975, the Commission directed the staff to prepare a "Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel." During fiscal year 1977, a draft environmental statement was completed for internal review and was to be issued for public comment in March 1978. In the draft statement, the staff estimates that some 95,000 metric tons of spent fuel may be discharged from light water reactors through the year 2000. In order to arrive at an estimate of the maximum environmental effect, it is assumed that none of this spent fuel will have been reprocessed or permanently stored by the year 2000. The statement examines the ability of traditionally designed reactor pools to accommodate this discharge and the impacts of providing and not providing adequate storage.

The staff's analysis in the draft statement shows that the spent fuel which will be generated through the year 2000 can be accommodated by modification of present storage arrangements at each nuclear reactor and by providing storage space at locations away from the reactors. The staff found that this solution is both environmentally and economically less costly than its alternatives.

The draft statement reaches two conclusions based on these findings:

1. No modification of 10 CFR 51.20(e)—the summary of environmental considerations for the uranium fuel cycle—appears necessary.
2. The NRC should publish a rule and associated regulatory guides to regulate the anticipated growth in away-from-reactor storage.

In keeping with the second conclusion, a proposed rule for away-from-reactor storage, 10 CFR Part 72, and a revised Regulatory Guide 3.24, "Guidance on the License Application, Siting Design and Plant Protection for an Independent Spent Fuel Storage Installation," will be issued in 1978 for public comment.

Licensing Review

A topical report, "Independent Spent Fuel Storage Facility," for a standard facility to be located on the site of a parent facility, such as a nuclear power station, was reviewed by NRC staff during fiscal year 1977. The pool storage facility design, submitted by the Stone and Webster Engineering Corporation, could hold up to 1,300 metric tons of uranium dioxide—equivalent to the volume of spent fuel discharged during about 35 years of operation of a 1,000-MWe nuclear power plant. Review of a topical report for a similarly designed independent spent fuel storage facility to be submitted by NUS Corporation will be completed in fiscal year 1979. These reviews are expected to reduce the time required by the staff for licensing specific stor-

age facilities. The Stone & Webster and NUS designs take advantage of site data already acquired in connection with the construction of the parent facility; in addition, some logistical support supplied by the parent facility would be available to the storage facility.

The General Electric Company has applied for a permit to increase the capacity at its Morris, Ill., storage facility from 750 metric tons to 1,850 metric tons. The staff review of the application will be completed during fiscal year 1978. The proposed capacity increase would be accomplished by construction of an additional pool, using the same design as the existing pool.

Discussions were held with ERDA (now Department of Energy) staff to establish arrangements for an exchange of information regarding a proposed independent facility for the packaging and excess storage of spent fuel. Such a buffer facility is expected to be collocated with a geologic repository for permanent disposal of spent fuel or high-level radioactive waste. NRC will provide preliminary guidance during the period prior to receipt of a license application.

On October 18, 1977, DOE proposed that the Government accept and take title to spent nuclear fuel from utilities for one-time storage fees on a voluntary basis. NRC staff is providing guidance regarding a potential license application for a DOE interim spent fuel storage facility.

OTHER FUEL CYCLE ACTIVITIES

Conversion to UF_6

Following the milling operation, uranium ore concentrates are shipped to a facility for purification and conversion to uranium hexafluoride (UF_6). This compound is fed into the gaseous diffusion plants where the uranium is enriched (see below). Two commercial facilities in the United States produce UF_6 from ore concentrates—the Allied Chemical plant at Metropolis, Ill., and the Kerr-McGee facility in Sequoyah County, Okla. During fiscal year 1977, licenses for these facilities were renewed for a full five-year term. The Kerr-McGee license renewal provided for a capacity increase from 5,000 to 10,000 tons of uranium per year. The Allied plant has a rated capacity of 14,000 tons of uranium per year.

Uranium Enrichment

The enrichment of uranium to the degree needed to make it usable in reactor fuel continues to be the only major step in the nuclear fuel cycle not performed as a commercial enterprise. Three gaseous diffusion plants owned by the Department of Energy (DOE) constitute the entire U.S. enriching capacity. These plants are not regulated by NRC. Additional enrichment capacity is to be provided through the construction of a large addition to the existing diffusion plant at Portsmouth, Ohio. The addition will use the centrifuge enrichment technology developed by ERDA (now a part of DOE). The existing and planned enrichment capacity should be adequate to meet domestic and foreign needs until about 1990.

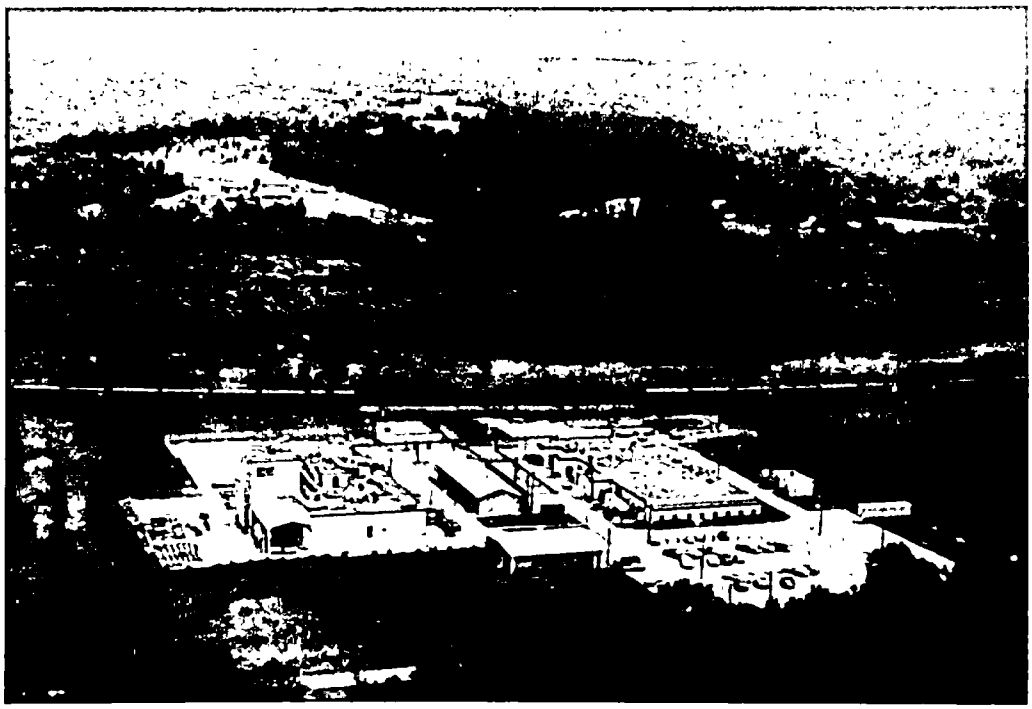
Fuel Fabrication

Uranium hexafluoride (UF_6) enriched to a maximum of five percent in the U-235 isotope is shipped from enrichment facilities to fuel fabrication plants where it is converted to ceramic uranium dioxide (UO_2) pellets for encapsulation in long pencil-like tubes made of "Zircaloy." These tubes are then sealed and assembled into fuel bundles for insertion into light water reactors. Currently, there are five such fuel fabrication plants.

In addition to having regulatory authority over the LWR fuel fabrication plants described above, the NRC is responsible for the licensing of facilities engaged in the fabrication and assembly of high-enriched fuel elements for naval reactors and of fuel plates for research and test reactors.

Licensing actions in 1977 included the issuance of license renewals for the following plants: the Atomics International test reactor and fuel research and development facility (Canoga Park, Calif.); the Babcock & Wilcox Company naval nuclear fuel plant (Lynchburg, Va.); the Combustion Engineering, Inc. uranium-dioxide fuel production facility (Hematite, Mo.); the United Nuclear Company naval nuclear fuel plant (Montville, Conn.); and the General Electric Company fuel research and development facility (San Jose, Calif.).

Applications were received for the addition of a UF_6 to UO_2 conversion facility to the Babcock & Wilcox commercial nuclear fuels plant at Lynchburg, Va., and for the addition of a second UF_6 to UO_2 conversion line to the Exxon Nuclear Company LWR fuel fabrication plant at Richland, Wash.



This is Combustion Engineering's Hematite, Missouri, uranium fuel fabrication plant. Operations include conversion of low enriched UF_6 to UO_2, fabrication of UO_2 pellets, and related processes. Finished pellets are shipped to Combustion's Windsor, Connecticut, facility to be used in the manufacture of fuel elements for power reactors.

Existing Plutonium Facilities

NRC regulations require that plutonium processing and fuel fabrication plants proposed for licensing must be evaluated to determine that there is reasonable assurance of protection against natural phenomena such as floods, hurricanes, earthquakes and tornadoes. At the time 10 CFR 70.23(b) was promulgated the Commission noted (36 FR 17573; Sept. 2, 1971) that existing licensed plutonium pilot plants and research and development plants would be examined with the objective of improving their ability to withstand natural phenomena without loss of capacity to protect the public. With respect to this capability, the staff is evaluating all fuel fabrication facilities that are licensed or expect to be licensed to possess and process 5 kg (11 lb.) or more of unencapsulated plutonium.

Experts in seismology and geology, surface hydrology, normal and severe weather phenomena, structural analysis, source term characterization, meteorological dispersion, demography, ecology, and radiological impact are participating in the program. They are assessing the likelihood that selected facilities might be subjected to adverse phenomena and the consequences that might result. The assessment will provide a basis for determining the extent of backfitting, if any, necessary to protect the public and for developing siting and general design criteria for future plants.

Fuel Reprocessing

While the future of commercial reprocessing in the United States remained in question, the staff continued to consider applications for licenses to construct and operate fuel reprocessing plants under the Commission's policy announced in November 1975. (See 1976 NRC Annual Report, page 48.)

Acceptance of Exxon Nuclear Company's Environmental Report in December 1976 completed the application for licenses to construct and operate a Nuclear Fuel Recovery and Recycling Center on the ERDA (now Department of Energy) Reservation at Oak Ridge, Tennessee. This facility would have the capability to store up to 7,000 metric tons of spent fuel and to reprocess up to 2,100 metric

tons per year. Although authorization was requested to construct and operate the entire facility, the fuel storage portion of the facility would be constructed first, for operation in the early 1980's, with construction and operation of the chemical separation portion to follow later in the decade. The safety review of the application continued and the environmental review began in 1977. After a prehearing conference, further hearings were suspended for three months until an appeal board ruled that they should be resumed. Public hearings had not been scheduled by the end of fiscal year 1977.

Licensing review of reprocessing facilities constructed by Allied-General Nuclear Services at Barnwell, S.C., was continued at a reduced level of effort during the year in light of Administration policy and uncertainty regarding ultimate use of the facilities. No hearings were held.

As a consequence of the Commission's December decision regarding reprocessing and recycle facilities, discussed earlier in this chapter, the NRC staff terminated reviews of the Exxon and Barnwell applications while assuring preservation of the results of the technical review effort expended.

Following the announcement by Nuclear Fuel Services, Inc. that it was withdrawing from the fuel reprocessing business, the staff began a special study on the adequacy of high-level waste storage at the company's West Valley, N.Y., site. While ultimate responsibility for the site remains an open question, the staff has continued to follow conditions at the site. Specifically, in June the staff issued an interim safety evaluation on the current reduced operations at West Valley. The staff concluded that these operations presented no undue risk to the health and safety of the public or of employees.

The staff has continued to conduct confirmatory studies of the effects of natural phenomena on the dormant plant. It also has requested support from the DOE in developing a scheme for the safe, practical disposal of the high-level waste stored there.

Fuel Cycle Costs

In keeping with its obligations to assess environmental impacts and to make benefit-cost analyses related to nuclear power plants and to the nuclear fuel cycle as a whole, NRC must maintain an awareness of nuclear fuel cycle costs. Accordingly, NRC has contracted with Battelle Pacific Northwest Laboratories (PNL) to develop a file of cost information on components in the LWR fuel cycle and a model that can be used to predict such costs.

ENVIRONMENTAL SURVEY OF THE URANIUM FUEL CYCLE

When assessing the environmental impact of a proposed nuclear power plant, the NRC considers the environmental effects of the activities that would be involved in mining the uranium and producing the nuclear fuel for the proposed plant and in safely disposing of its spent fuel and radioactive wastes. In 1974 the Atomic Energy Commission published a report, WASH-1248, entitled, "Environmental Survey of the Uranium Fuel Cycle," which summarized the environmental impacts of all fuel cycle activities and calculated the average impact resulting from the production and ultimate disposal of the nuclear fuel for one year's operation of a 1,000 MWe nuclear power plant. When the report was issued, the AEC stated that it would be revised periodically to reflect advances in technology and changes in the nuclear fuel cycle. A revision is now being considered which would reflect the following:

- A 1976 supplement to WASH-1248 was published (NUREG-0116) describing in more detail the environmental impacts of spent fuel reprocessing and waste management activities, referred to as the "back end" of the fuel cycle. (See Chapter 5; also 1976 NRC Annual Report, page 81.) The supplement was to be reviewed in a public hearing beginning in January 1978.
- NRC staff began a thorough review of the environmental impacts of mining, milling, enrichment and fuel fabrication—the "front end" of the fuel cycle.
- The NRC is sponsoring research by Battelle Pacific Northwest Laboratories on the releases of radioactive material (principally radon gas and other radioactive species found in the uranium decay chain) in mining activities.

  A new Generic Environmental Impact Statement on Uranium Milling is being prepared. (See discussion in this chapter.)
- The National Oceanic and Atmospheric Administration is providing a more refined computer code for calculating the dispersion of atmospheric releases of radioactive material from fuel cycle plants.
- The Oak Ridge National Laboratory is developing a computer code for making more accurate estimates of radiation doses to the population, taking into account the most recent demographic data for specific sites.

- The Argonne National Laboratory is developing a computer code which would apply the latest data on population age distributions and on relationships between radiation exposures and health effects to calculations of the health effects of radioactive effluents from fuel cycle activities.

A two-year period is estimated for completion of the various steps required to produce a revision of the Environmental Survey, which was scheduled to begin in March 1978.

TRANSPORTATION OF RADIOACTIVE MATERIALS

Coordination Among Federal Agencies

Transportation of radioactive materials is regulated at the Federal level principally by the NRC and the Department of Transportation (DOT). NRC is authorized by the Atomic Energy Act of 1954, as amended, to regulate the receipt, possession, use and transfer, including transportation, of source, byproduct and special nuclear materials. DOT is required by several Congressional acts, the latest of which is the Transportation Safety Act of 1974, to regulate safety in the transportation of all hazardous materials, including radioactive materials. In practice, these agencies partition their overlapping regulatory authorities through a Memorandum of Understanding so as to avoid duplication of effort and to develop a single consistent and comprehensive system for assuring safety in the transportation of radioactive materials. Under this Memorandum, the DOT functions as the competent authority with respect to international shipments. DOT also is the standards-writing body for packages containing quantities of radioactive materials so small that they would not pose a significant hazard if released (Type A), for package and vehicle labeling, and for safe conditions of carriage. The NRC functions as standards-writing body for packages containing quantities of radioactive material so large that they must be safely retained in their containers under normal and accident conditions (Type B) and for packages containing fissile material. NRC also makes independent evaluations of package designs submitted by applicants and serves as a technical advisor to DOT regarding packages used for the import and export of radioactive materials.

Others with regulatory authority in this field are the U.S. Postal Service, which regulates mail shipments of quantities of radioactive material so small as to be exempt from packaging and labeling requirements in 49 CFR Parts 170-189, and the individual States, which have jurisdiction over intrastate transportation of radioactive materials.

Package designs used by contractors for the Department of Energy are reviewed and approved by that agency. An informal transition program during which the NRC has been reviewing such package designs has been conducted during the past year. An agreement is being negotiated between NRC and the Department of Energy under which the latter will require its contractors to ship radioactive materials in packages built according to designs approved by NRC.

In June 1977, the NRC issued a topical report—"Regulatory and Other Responsibilities as Related to Transportation Accidents" (NUREG-0179)—to clarify the regulatory and other responsibilities of the different parties involved in dealing with those few transportation accidents involving radioactive materials that may be expected to occur each year. Any further changes in responsibilities will be covered in appropriate procedural documents, including the Memorandum of Understanding between NRC and DOT, or by rulemaking.

Shipping Low-Level Radioactive Material

NRC and the Department of Transportation have begun a study of the adequacy of existing requirements for the shipment of material containing a low level of radioactivity. The study was undertaken following a truck accident in September 1977 in which a shipment of uranium concentrate (yellow cake) was spilled onto a highway near Springfield, Colo. Key subjects in the study will include an analysis of current packaging requirements to seek ways to make packaging more accident resistant; emergency planning; routing of shipments; and State and Federal licensing requirements.

Safety of Transportation Workers

The NRC has devoted substantial effort to fostering better understanding by the public of the benefits and risks of transporting radioactive material. As part of this effort, the NRC issued a topical report (NR-DES-0001) in November 1976 on measurements of the radiation doses received by flight attendants from shipments of radioactive material on commercial airline flights in the United States. The study was sponsored jointly by two flight attendants' unions—the Association of Flight

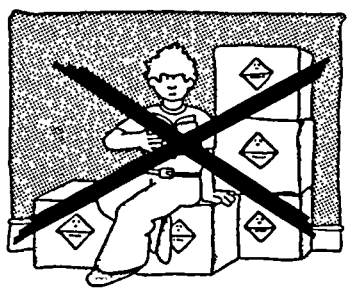
Attendants of the Airline Pilots Association and the Air Transport Division of the Transport Workers Union—and the NRC. The results indicated that the exposures were small, well below recommended limits for members of the public and less than the natural radiation dose received at 30,000 feet altitude.

The NRC also issued in March 1977 a report, "Exposure of Airport Workers to Radiation from Shipments of Radioactive Materials" (NUREG-0154), reviewing studies conducted at six major U.S. airports. These studies showed that most of the monitored cargo workers receive annual radiation doses of less than 0.1 rem from handling such shipments. (A dose of 0.1 rem is equal to the average amount of radiation that a person would receive in one year from natural background sources.) The studies showed further that none of the monitored cargo workers received an annual radiation dose in excess of 0.5 rem, the recommended dose limit for the general public. No evidence was found in the six studies to suggest that members of the public other than cargo workers receive any exposure of significance even though truck drivers, customers and others were occasionally observed in storage dock areas while radioactive packages were present.

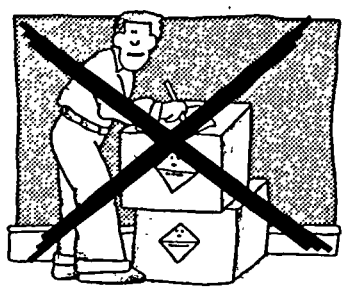
These studies also indicated that some of the exposures received by the cargo workers were attributable to unnecessary contact with the packages of radioactive material. Manuals and posters to instruct cargo workers on ways to avoid these unnecessary contacts were prepared during fiscal year 1977 and will be issued jointly by NRC and DOT in 1978.

HANDLING RADIOACTIVE MATERIALS PACKAGES

These illustrations are examples from the manuals and posters that will be issued jointly by NRC and DOT in 1978 to instruct cargo workers on the basic principles for avoiding unnecessary radiation exposures.



DON'T HANG AROUND
radioactive materials packages.



DON'T WRITE ON
radioactive materials packages.

International Standards

Safety regulations for transporting radioactive material in the United States are based on standards developed by the International Atomic Energy Agency (IAEA) with the active participation of its member states. The United States participated in this work through representatives from NRC, DOT and the nuclear industry. Adoption by member states of the IAEA standards contributes significantly to safe transportation throughout the world.

In keeping with U.S. policy to maintain standards consistent with international standards, the NRC and the DOT are jointly considering adoption into their regulations of recent revisions in the IAEA standards (which were generally supported by U.S. representatives at the IAEA panel meetings). The revisions include use of the IAEA system of classifying radionuclides to determine the limits on contents for Type A (smaller quantities) packages, the use of the IAEA classification system for Type B (larger quantities) packages based on whether the package design is multilaterally or unilaterally approved, and the use of IAEA specifications for limits on radioactivity released by Type B packages involved in severe accidents.

Adoption of the IAEA standards will be responsive to three petitions for rulemaking which requested deletion of the provisions in the NRC regulations (10 CFR Part 71) that impose packaging requirements on shipments of radioactive materials with low specific activity.

Environmental Statements

From its inception in January 1975, the NRC has carried on a review of the existing regulations and

procedures for transportation of radioactive materials. As part of this review, the NRC initiated in June 1975 a public rulemaking proceeding regarding the air transport of all nuclear materials, including plutonium and enriched uranium.

Also, with the technical assistance of Sandia Laboratories, an environmental impact statement was prepared to assess the impacts associated with the transportation of radioactive materials, including relative costs and benefits of alternative modes of transportation. Information derived from research into the accident-resistant properties of packages used for shipping plutonium and from the NRC's 1975 Radioactive Material Shipments Survey were used in preparing the statement. The draft statement (NUREG-0034) was made available for public comment in March 1976. About 30 letters of comment were received. The final statement (NUREG-0170) was released to the public in December 1977.

The study indicates that transportation of radioactive materials is being conducted under the present regulatory system in an adequately safe manner. For example, radioactive shipments may be expected to add only one latent cancer fatality per year from routine shipments and one case per 200 years from accidents, assuming 1975 accident and shipping rates. By 1985, it is expected that these estimates might increase three-fold as a result of an increased volume of shipments. These rates compare to a nationwide total of 300,000 cancer deaths per year from all causes.

The NRC continued a study, initiated in May 1976, which will lead to a generic environmental impact statement on transportation of radioactive materials in urban areas. Information produced by the study, being performed with the assistance of Sandia Laboratories, will be used to assess current regulations with respect to the special problems posed by urban environments. An interim report, describing progress to date in the modeling and data collection efforts on this study, was released to the public in April 1977.

Developing a Safe Plutonium Package

Public Law 94-79 requires that the NRC prohibit its licensees from transporting plutonium by air until it has certified to the Congress "that a safe container has been developed and tested which will not rupture under crash and blast testing equivalent to the crash and explosion of a high-flying aircraft." Except for plutonium contained in a medical device designed for individual human application—for example, a cardiac pacemaker—the restriction applies to air transport of plutonium in any form or quantity, whether for export, import or domestic shipment.

The NRC continued an intensive program to formulate requirements which will achieve a high degree of assurance that plutonium packages for air shipment can withstand virtually any type of aircraft accident. (See 1975 NRC Annual Report, page 66; 1976 NRC Annual Report, pages 58-59.) Qualification criteria have been developed and have been reviewed by the Advisory Committee on Reactor Safeguards and the Assembly of Engineering of the National Academy of Sciences. A package meeting the requirements has been designed and tested at Sandia Laboratories and the test data are being reviewed by these same organizations. The NRC consequently expects to be able to certify to Congress early in 1978 that a safe package has been developed and tested in conformity with Public Law 94-79.

Sabotage of Shipping Packages

Contentions regarding possible sabotage of packages of radioactive materials in transit to and from power plants have been raised before Atomic Safety and Licensing Boards conducting hearings on various nuclear power plants (Wolf Creek in Kansas, Sterling and Jamesport in New York, Pilgrim in Massachusetts, and Tyrone in Wisconsin). The NRC staff testified in these hearings on package vulnerability and possible health effects from sabotage. This testimony presented calculations indicating that, because of the low radioactivity and dense solid nature of the material, sabotage of new fuel and low level waste shipments would produce no early fatalities and that it would be very unlikely to produce even one latent cancer fatality. Further calculations indicated that sabotage of a spent fuel shipment resulting in a release of radioactive material would cause no early fatalities and could cause about ten latent cancer fatalities, if it is assumed that all of the gaseous fission products, one percent of the volatile solid fission products, and 0.1 percent of the nonvolatile solid fission products were released from the largest capacity cask currently authorized, and that the release took place under average weather conditions in an area with a population density of 100 people per square mile. A testing program conducted at Sandia Laboratories indicates that this is as large a release as should be expected and that an actual release would probably be much smaller, depending on saboteur capability.

Diversion of spent fuel shipments for the purpose of separating out fissile material from the other constituents is not considered credible because of the high level of radioactivity of the spent fuel, the massive construction of the shipping cask, and the unusual skills and resources required to accomplish such a task. (Transportation safeguards for special nuclear material are discussed in Chapter 4.)

Packaging Standards

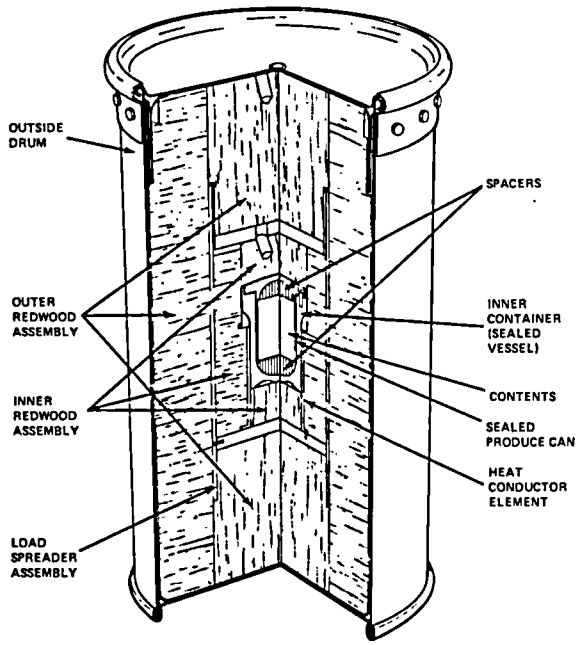
In August 1977, the NRC published amendments to 10 CFR Part 71 to upgrade requirements for quality assurance in the design, fabrication, assembly, testing, use and maintenance of packaging for transporting licensed radioactive material. The new regulations also revoked, subject to a timely application for reapproval, the authority granted under earlier regulations for licensees to use certain shipping casks for solid irradiated nuclear fuel.

Regulatory Guide 7.6, issued in February 1977, provides design criteria for the structural analysis of shipping cask containment vessels. Guide 7.8, issued in May 1977, provides guidance on load combinations for the structural analysis of shipping casks.

Transportation Litigation

New York State filed suit against the NRC and six other Federal agencies in the Federal District Court of New York City in May 1975 to ban transportation by air, and related connecting transportation, of plutonium and other special nuclear materials to, from, in and over the City and State of New York and the United States and its territories. In September 1975 the district court denied a motion for a preliminary injunction, which was sustained on appeal to the Second Circuit Court of Appeals. The disposition of the case awaits consideration of the NRC environmental statement (NUREG-0170) issued in December 1977. In the meanwhile, air transportation of plutonium is stayed by Public Law 94-79, as discussed earlier in this chapter.

New York City passed a health ordinance in September 1975 which requires city approval for the transportation of certain types and amounts of radioactive material within its borders. The NRC presented testimony at hearings on this matter in opposition to the ordinance and the Justice Department challenged the legality of the action in a suit against the City of New York. In January 1976, the district court denied a motion by the U.S. Attorney



Above is a cutaway drawing of the 500-pound Plutonium Air Transportable (PAT) package. This package, which is subject to final approval, is designed to carry up to 2 kilograms of plutonium for shipment by air. Certification tests to determine licensability of this design require that containers must survive a six-phase sequential test series including: (1) impact on an essentially unyielding concrete/steel target at 300 mph; (2) a 70,000-pound load applied through a 2-inch wide steel beam; (3) a 500-pound steel spike dropped onto the package from 10 feet; (4) a 100-pound steel structural angle beam dropped twice on the PAT from 150 feet; (5) engulfment in a jet-fuel fire of at least 1,850°F for one hour; and (6) submersion of the charred package in water for eight hours. The photograph below shows a PAT package following the tests and after the outer packaging materials have been cut away. The inner containment vessel maintains its structural integrity and remains leak-tight.

for a preliminary injunction against the virtual ban on transportation through the city. The Secretary of Transportation is considering the compatibility of the ordinance with Federal regulations. A public hearing on this matter was held by the Department of Transportation in New York during November 1977. (See also discussion under "Judicial Review" in Chapter 13.)

Several proceedings on rail transportation of spent fuel and radioactive wastes were initiated before the Interstate Commerce Commission (ICC) in which railroad organizations have proposed tariffs that would severely restrict such transportation. The NRC entered a contention that, insofar as the proceedings involve issues of radiological safety in the transportation of radioactive materials, those concerns should be addressed to the NRC and/or the DOT and not to the ICC. The ICC issued an environmental impact statement on these matters in August 1977. NRC provided some technical assistance to ICC in this task. The ICC Administrative Law Judge then ruled that the risks of transport were not great enough to justify certain railroads' refusal to carry spent nuclear fuel as common carriers. The ICC later decided in favor of the position that radioactive material transportation safety issues should be left to NRC and DOT. The railroad organizations have requested that the full ICC review the matter.

RADIOISOTOPES LICENSING

Outside the nuclear fuel cycle, there are approximately 19,000 nuclear material licenses in effect in the United States, principally for the use of reactor-generated radioisotopes in medicine, industry, and academic fields. Over half of these licenses are administered by 25 Agreement States under regulatory authority delegated by the NRC (see Chapter 8). Of the licenses administered directly by the NRC, over half are for industrial applications, about a third involve medical uses, and the remainder are for teaching and research.

Uses in Industry

Well Logging. Interest in logging of completed oil wells or wells no longer producing has increased since the onset of the energy crisis. In most situations, the only practical means for determining whether additional production can be realized is by using logging devices containing radioactive sources of gamma radiation or neutrons. These sources are subject to NRC licensing.

Industrial Radiography. Gamma radiation sources are used for non-destructive testing of welds in nuclear power plants, cross-country pipelines, ship and submarine construction, and other heavy construction. There are now over 800 firms in the United States licensed to use this technique. It is most useful when external power sources, such as those needed for x-ray machines, are not available or when use of x-ray would be cumbersome. In view of the number of incidents of unnecessary overexposure of radiographers (see Chapter 7), the NRC staff is reviewing the relevant regulations and guides to determine whether revisions should be made.

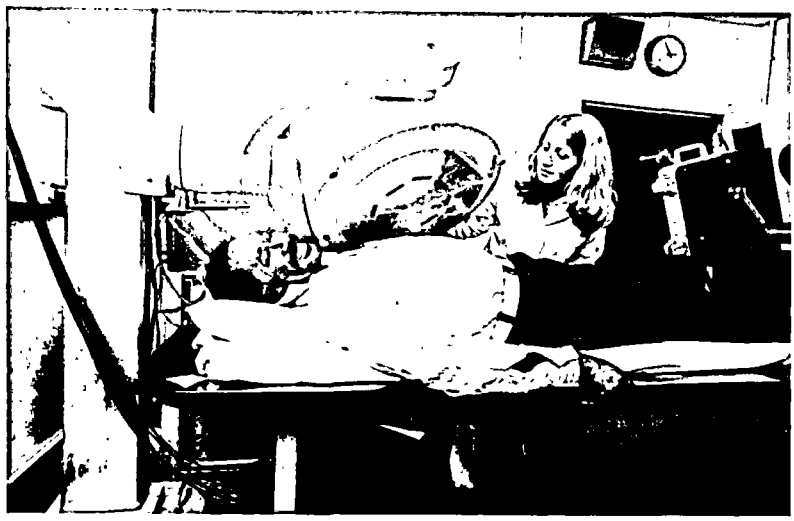
Uses in Medicine

Radioactive materials are widely used for medical diagnosis and therapy. Since 1946, the number of medical institutions in the United States licensed to use radioactive materials derived from nuclear chain reactions has grown from 38 to more than 12,000, including both NRC and Agreement State licensees. These licensees perform an estimated 30 million nuclear medicine procedures per year at an estimated cost of $1.6 billion.

Diagnostic Techniques. Diagnostic nuclear medicine includes such techniques as measuring the uptake of radioactive drugs by individual organs (for such purposes as assessing thyroid function), "imaging" the distribution of radioactive drugs among organs or within an organ (to detect the presence of tumors, for example), estimating the size of certain body pools (such as red blood cell and blood plasma volumes), and measuring the components in biological samples (such as protein binding sites and hormones in blood and urine).

Therapeutic Techniques. Therapeutic techniques include the use of radioactive drugs internally (for example, in the treatment of thyroid cancer), the use of radioactive devices both as implants and on the surface of the body (termed "brachytherapy," or "therapy from a short distance") and the use of radioactive devices external to the body (termed "teletherapy," or "therapy from a distance").

A proposed amendment to 10 CFR 35.13, issued May 19, 1977, establishes specific guidelines for the calibration of teletherapy machines. The NRC staff worked closely with the American Association of Physicists in Medicine in developing the technical



A technologist prepares a patient for a diagnostic procedure using a gamma camera at the nuclear medicine department of the National Institutes of Health in Bethesda, Maryland. The camera is used for organ imaging and cardiac flow studies.

requirements in the rule. It would require teletherapy licensees to:

- Have a qualified expert perform full calibration measurements on each teletherapy unit at least once each year.
- Perform spot-check measurements on the output of their units at least monthly.
- Report to the NRC any radiation doses that differ from prescribed doses by more than 10 percent.

The proposed amendment is designed to ensure that patients receive correct radiation doses.

Nuclear Powered Pacemakers. Since 1972, the NRC and its predecessor, the AEC, have licensed plutonium-238 powered pacemakers on a limited, investigational basis. They have been implanted in several hundred patients in the United States who suffer from certain forms of abnormal heart rhythm.

In March 1977, the NRC published proposed amendments to Part 70 of its regulations which would establish a general license for routine use of the pacemakers. Under the proposed amendments, NRC would simplify its licensing regulations for:

- Hospitals implanting the plutonium-238 powered pacemakers.
- Patients using such pacemakers.
- Possession of the pacemakers during activities related to recovery of the devices to assure controlled disposal.

Safety performance requirements for the pacemakers would be established in the regulations. The safety requirements, which would involve tests for resistance to impact, crush, fire, cremation and corrosion, would assure that the plutonium-238 will be contained in the pacemakers under adverse environmental conditions. A manufacturer would be required to satisfy those requirements before his pacemakers could be distributed for routine use under a general license.

Further, under a proposed amendment to Part 150 concerning the sharing of regulatory responsibilities with Agreement States, the NRC would be the single authority for regulating the distribution, implantation, and recovery of pacemakers used under the general license. This proposed change is based on the need for controlled disposal to assure proper protection of the public health and environment.

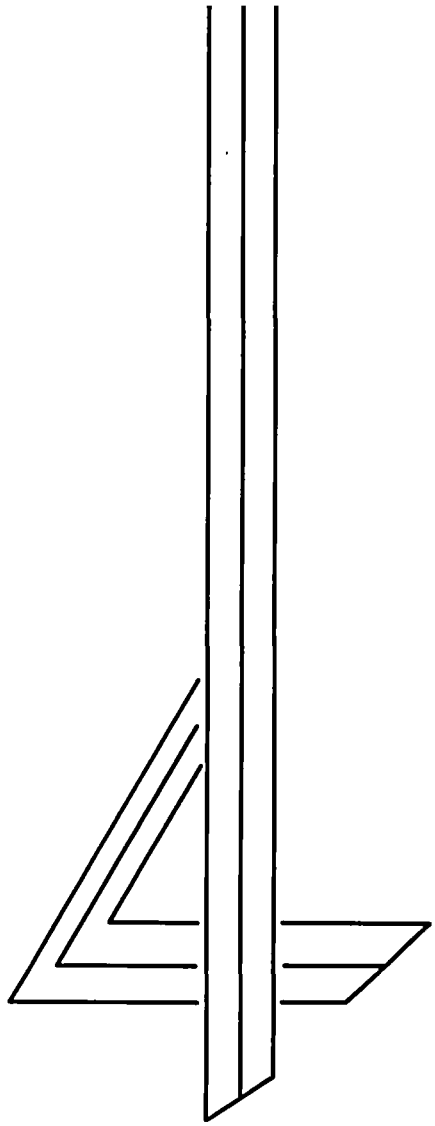
Licensing Matters. On August 15, 1977, 10 CFR 35.12 was amended to require that byproduct material licenses be issued to medical institutions rather than to the individual physicians using the material. This rule will clearly place the responsibility for radiation safety with the institution and eliminate the disruption of medical service which can occur when a physician holding a private practice license leaves an institution. It will also simplify NRC's regulatory efforts by confining responsibility to the hospital and eliminating the extra cost of maintaining multiple licenses at the same institution.

In May 1977, the NRC held a meeting with the public and a meeting of its Advisory Committee on the Medical Use of Isotopes (also open to the public) to consider the extent to which the NRC should be involved in regulating the medical uses of radioisotopes. Approximately 90 members of the public attended these two meetings. The 34 oral and written comments received will be considered by the NRC staff in the preparation of a comprehensive policy statement on this matter.

Uses in Consumer Products

A variety of articles containing small quantities of byproduct and source materials are distributed to the public. Recently, there has been a rapid growth in the distribution of ionization-type smoke detectors containing americium 241 and backlit digital watches containing tritium. Such products are distributed in accordance with criteria published in 1965. Because Federal statutory responsibilities (i.e., NEPA) have changed since these criteria were established, the NRC is initiating a two-year study to determine the environmental impact of the distribution of consumer products containing radioactive materials and whether changes are necessary in the criteria. A generic environmental impact statement will be issued at the conclusion of the study.

Domestic Safeguards



Safeguards measures are designed to deter, prevent, or respond to the unauthorized possession or use of significant quantities of nuclear material through theft or diversion; and the sabotage of nuclear facilities.

The NRC does not rely on any single protective system, but rather its objective is to achieve an integrated system of protection that includes appropriate elements of physical security and nuclear material control and accounting, as well as contingency plans in the event that safeguards systems fail.

Recent regulations for reactor protection against sabotage refer to a threat level. Although a threat level is not defined in current NRC safeguards regulations for fuel cycle facilities, recent facility reviews and licensing actions require safeguards systems that protect strategic special nuclear material (SSNM) against theft by at least one insider occupying any position, or by several well-armed, well-trained outsiders who might have inside knowledge or assistance. (SSNM is material that could be fabricated into a nuclear explosive device, viz., plutonium, uranium-233, or uranium enriched in the U-235 isotope to a specified degree.)

Other aspects of the NRC safeguards program are (1) analysis of historical data on the size and character of groups involved in incidents of terrorism and other antisocial behavior; (2) communications and work with other Federal agencies having special knowledge and expertise concerning terrorism and antisocial activity; and (3) review of NRC records on past threatened violence in the commercial nuclear industry. Prudence dictates that NRC provide continuing close attention to the safeguards effectiveness of the licensed nuclear industry.

FUEL CYCLE AND TRANSPORTATION

Material Control and Accounting

Detailed and specific material control and accounting requirements are applicable to licensees authorized to possess special nuclear material (SNM) in unsealed form in quantities exceeding one "effective kilogram" (one kilogram for plutonium or uranium-233; larger amounts of material enriched with uranium-235, depending on the degree of enrichment). The requirements contain provisions related to facility organization, accountability measurements, measurement and statistical controls, inventory

methods, shipping and receiving procedures, material storage practices, records and reports, and management controls.

Material Accounting Improvements. In fiscal year 1977, the NRC staff began its review of plans submitted by licensees for monitoring and controlling the quality of SNM measurements. These plans were responsive to regulations (10 CFR 70.57) issued in August 1975 and provided for the upgrading of measurement quality control. The plans are being used to amend individual licenses to ensure industry-wide compliance. Under the new requirements, licensees must:

- Assure independence between performance and control functions.
- Establish review and audit programs.
- Perform tests, analyses, and evaluations of measurement equipment.
- Improve the timeliness of data retrieval.
- Perform continuing data analyses.
- Provide for personnel training.
- Formalize measurement procedures.
- Calibrate measurement systems on a scheduled basis.
- Monitor and control measurement performance.

Material Inventory Differences

In August 1977, the NRC issued a report which made public, for the first time, inventory differences (often called "Material Unaccounted For—MUF") at licensed facilities possessing significant quantities of SSNM. These materials, if diverted, have the potential to be used to make explosives. The report, "Strategic Special Nuclear Material Inventory Differences" (NUREG-350), covered facilities licensed after January 1, 1968.

A similar report was issued by the Energy Research and Development Administration (now in the Department of Energy (DOE)), covering license-exempt facilities and those licensed by the former AEC before 1968. The two reports attracted wide public attention. NRC staff briefed the press and several Congressional oversight committees prior to releasing the NRC report.

For the entire period covered by the NRC report (January 1968 to September 1976) total inventory differences were 542.4 kilograms for high-enriched uranium (26 facilities), 32.8 kilograms for plutonium (18 facilities), and 2.6 kilograms for uranium-233 (3 facilities). Inventory differences may be caused by a variety of factors, including clerical error, material trapped in process lines or equipment, and inaccurate measurement of scrap and other hard-to-measure items. It should be noted that it may be impossible to state with certainty the exact cause of a specific inventory difference.

On a year-to-year basis, the report showed a downward trend in inventory differences, particularly for high-enriched uranium, in spite of the increasing amounts of material handled by the licensed facilities. This downward trend can be attributed to improved measurement techniques and a strengthening of NRC safeguards regulations.

Physical Security Requirements

The current regulation pertaining to physical security establishes requirements for the protection of fuel cycle facilities and transportation involving certain specified types and quantities of plutonium and high-enriched uranium. Licensees are required to submit security plans for protecting these materials during transportation and when in nuclear facilities. Security requirements for protecting fixed sites include the establishment and training of a security organization (including armed guards), provision of physical barriers, establishment of controls on access to facilities and material, use of intrusion alarms, arrangements for communication with response forces, and establishment of response plans. Requirements for the protection of nuclear shipments include preplanning to reduce risks in transit, making road shipments in either special or armored vehicles, providing armed escorts in a separate vehicle, arranging for frequent communication with a control point, and developing an automatic response in the event that scheduled communication reports are not received.

Physical Security Improvements in 1977. Safeguards at licensed nuclear fuel cycle facilities are intended to be capable of protecting with a high degree of assurance against a hypothetical threat of theft by one insider and by a determined violent assault involving several persons, with knowledge or assistance provided by an insider.

In 1976, the NRC conducted special reviews of safeguards at fuel cycle facilities possessing significant quantities of high-enriched uranium or plutonium (see 1976 Annual Report, page 88). Although these reviews established that the facilities had the capability to withstand a hypothetical threat, there still remained some variations in the relative capa-

bilities of different licensees in this regard. As a result, specified actions, which included such measures as increasing the numbers of guards, adding armament, and hardening or increasing patrols of storage areas, were completed in early 1977. As a result of these activities, all such facilities are now judged to have comparable safeguards effectiveness.

GAO Report

On May 4, 1977, the General Accounting Office (GAO) issued a report entitled "Commercial Nuclear Fuel Facilities Need Better Security" which recommended that:

(1) NRC further extend its monitoring of licensees' material control and accounting operations. (This question is presently under study.)

(2) NRC require licensees to upgrade their systems to protect against an increased threat. (A proposed rule to require protection against an increased threat was issued for public comment on July 5, 1977—See discussion below.)

(3) NRC periodically assess changes in threat levels and require security systems to meet such changes. (NRC is doing this on a continuing basis in close coordination with the U.S. intelligence community.)

(4) NRC require a personnel security program for certain SNM licensees. (A proposed rule to accomplish this was issued for public comment on March 17, 1977—See discussion below.)

(5) NRC seek legislative authority to allow guards to use deadly force to protect SNM. (This issue is presently under study.)

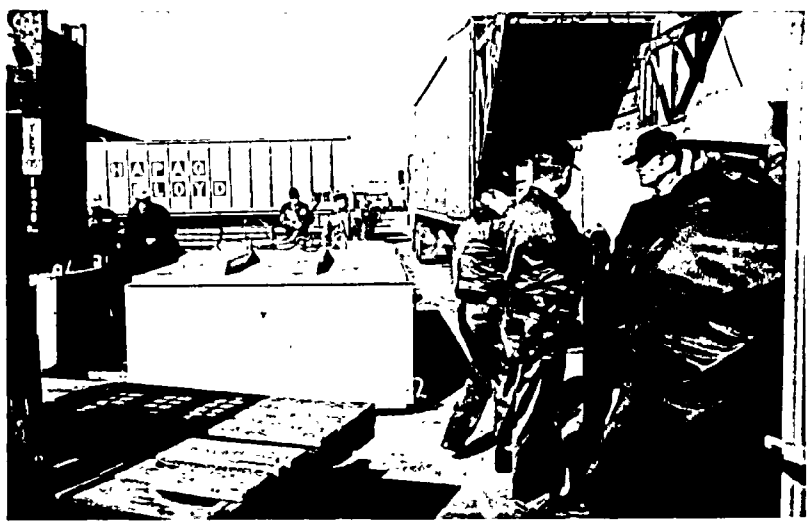
Evaluations and Tests

Fuel Processing Plants. During 1977, the NRC staff continued to conduct field evaluations of safeguards at fuel processing plants. The purpose of these reviews was to evaluate the adequacy of safeguards against a range of hypothetical threats, both internal and external. Both physical security and material accounting practices were assessed.

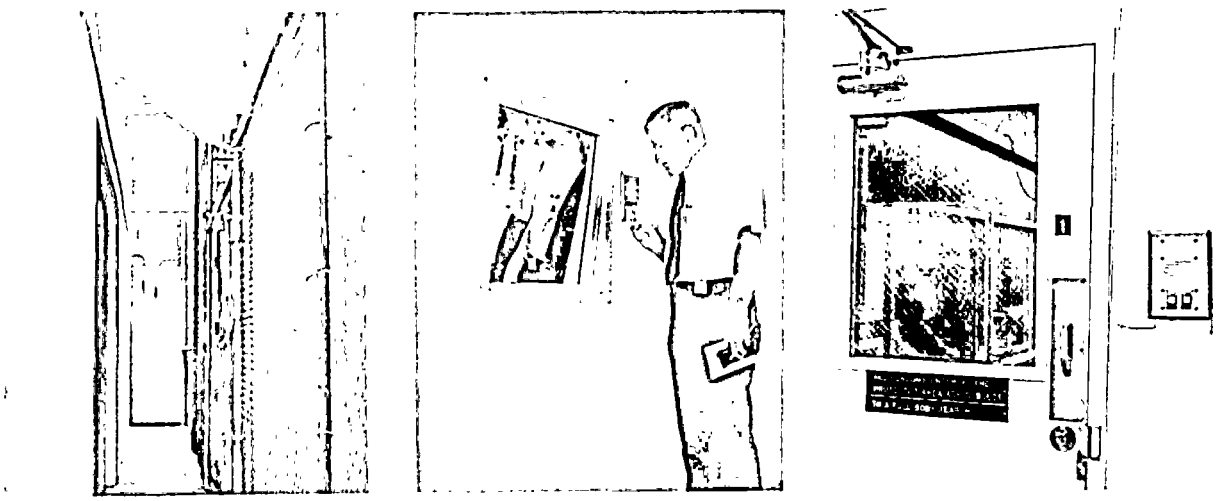
Four separate NRC field teams composed of three to five persons each took part in each site evaluation. Two teams evaluated plant capabilities in physical security and in material control and handling. The other teams assessed possible vulnerability to attack or sabotage. One of these—an external assault ("Black Hat") team—spent several days reviewing each site and its environs to detect specific weaknesses and then tried to devise assault plans which might exploit the weaknesses. These scenarios were not enacted, but were discussed with the licensees' security people to alert them to matters requiring special attention.

Each of the four field teams compiled reports for each facility evaluated. These were combined into a single overall report for a facility, which was then reviewed by the NRC licensing staff for appropriate action. These field evaluations will continue in 1978.

Intrusion Alarm Systems. With assistance from the Department of Defense, the NRC staff evaluated intrusion alarm systems at several fuel cycle facilities. The evaluation included an examination of physical measurement processes, operational and maintenance procedures, and the vulnerability



Armed guards attend the transloading of an import shipment of special nuclear material from a cargo airplane to a truck. NRC inspects each import and export at its point of entry or departure, and NRC regulations require that such shipments be under constant protection within the United States.



This licensee, a manufacturer of reactor fuel, meets some of NRC's safeguards requirements by enforcing strict limits on access to sensitive areas of the plant.

of the alarm systems to compromise by an insider. The findings in each case were discussed with licensee management. A classified report is being prepared which will summarize what was learned about the contribution of intrusion alarm systems to site security.

Road Transportation. During 1977, NRC and ERDA (now in DOE) worked out arrangements to conduct a joint test involving road transportation of special nuclear material. Tests will begin in 1978 and will continue for two years. The major purpose is to evaluate use of DOE's "SECOM" communications system by private carriers. Secondary evaluations will focus upon such matters as police coordination, escort tactics, human factors and armor. (See 1976 Annual Report, page 89.)

Performance-Oriented Physical Protection Rule

On July 5, 1977, NRC published for comment a proposed new rule (in 10 CFR Part 73) to further strengthen safeguards for significant quantities of SSNM in fuel cycle facilities, in certain research reactors and in transit.

The proposed rule describes the characteristics of a hypothetical external adversary group against which licensees would be required to design their safeguards systems. It also describes safeguards performance levels which nuclear facilities and transporters would be required to achieve, but allows flexibility for the design of systems to meet the desired objective.

This approach acknowledges that there is more than one way to build a safeguards system. The proposed amendments do, however, identify elements and components that, if included in a physical protection program, would achieve the required performance. Furthermore, the NRC staff plans, at the time the regulation is issued in effective form, to issue supplementary regulatory guides which further explain the intent of the regulation and provide design criteria for satisfying its requirements. The guides should help licensees in developing safeguards systems that satisfy the regulation.

REACTOR SAFEGUARDS

Revised Physical Security Plans

In November 1974, the former AEC proposed that the regulations set forth in 10 CFR Parts 50 and 73 be amended to prescribe detailed requirements for the protection of nuclear power reactors from sabotage. The proposed rule was reevaluated in the light of comments solicited and received from the public, and the Commission adopted certain revisions before promulgation of 10 CFR 73.55 on February 24, 1977. The revised rule required improved capabilities to be implemented by May 25, 1977, except for those involving construction and installation of equipment not already in place, which are to be accomplished by August 1978.

Early implementation was required for certain aspects of the total security program, such as: (1) organization, training, and supervision of the security force; (2) search of incoming persons, packages, material and vehicles; (3) use of security badges; (4) visitor control; (5) liaison with local

law enforcement authority; (6) requirements related to responding to security contingencies; and (7) provision of a minimum of five armed, trained guards on each shift supplemented by additional trained and armed personnel to respond to a security event. Other aspects of the security program, which involve procurement and installation of major items of equipment and construction of buildings, are required to be completed by August 24, 1978 or sooner, if possible. These include installation of security intrusion detection systems, redundant communications links with law enforcement authorities, personnel and package search equipment, incorporation of alarm stations, and installation of surveillance aids such as upgraded lighting systems and closed circuit television.

Implementation of new rule. As required by the new regulation, all licensees with operating power reactors, and those anticipating operating licenses by August 1978 submitted amended security plans describing upgraded security systems at the facilities. The NRC formed eight review teams to review and evaluate these amended security plans in two phases.

The first phase, completed in November 1977, consisted of a detailed review of the amended security plans, an on-site evaluation by the security team, and meetings with the licensees to formulate acceptable site-specific security systems. The second phase will include a final review of any necessary modifications of the amended security plans in response to the initial review, and the writing of a Security Plan Evaluation Report.

GAO Report on Reactor Security. A GAO report published on April 7, 1977 criticized security at nuclear power plants, concluded that failure to define a level of threat against which protection is needed or to establish specific requirements had resulted in inconsistencies in protection levels at different plants, and implied that no remedial action was being taken.

The amendments to 10 CFR Part 73, described above, were published in the *Federal Register* in February 1977, and show that the NRC was aware of the inconsistencies identified by the GAO, and had already acted to eliminate them and to upgrade protection at all nuclear power plants.

The GAO report recommended "immediate interim action" and that all plants be placed on "alert." The interim action had been taken with the publication of 10 CFR 73.55 requiring, as noted above, that improved capabilities be implemented by May 15, 1977. The NRC considers that effective implementation of this rule is providing an appropriate increase in the level of physical security at nuclear power plants.

The GAO cited apparent inconsistency in the scope of inspections performed in the past on security plans at nuclear power plants. The variations in approach observed by the GAO did exist and can be attributed to several causes. Each licensee's approved security plan, prior to implementation of the definitive requirements of 10 CFR 73.55, addressed different commitments and provided varying levels of detail to support those commitments. The site inspections thus tended to vary in accordance with each licensee's commitments and the specific details provided in the approved security plan. The amended security plans submitted under the new regulation and the program for their review and approval will tend to eliminate variations in the level of protection provided; however, adequate recognition must be given to variations in design resulting from differing types of reactors and site conditions. The human factor as a cause of non-uniformity should be minimized by continuing NRC review and revision of inspection programs and procedures to upgrade the consistency of site inspections as the new rules for physical protection are implemented.

PERSONNEL SECURITY FACTORS

During the year, the NRC published for public comment two proposed regulations concerned with security clearances of personnel involved in licensed

NRC assists in training licensees' guard forces in fulfilling their responsibilities under NRC regulations.

operations and qualifications of licensee guards and other security personnel which would be applicable to both nuclear fuel cycle activities and reactors.

Qualifications of Security Guards

A proposed new Appendix B of 10 CFR Part 73 describes upgraded qualifications and equipment for security personnel who protect licensed nuclear facilities and transportation activities. The proposed rule, published in July 1977, is an outgrowth of the Security Agency Study (see 1976 Annual Report, page 87), the findings of a joint ERDA-NRC task force on safeguards (NUREG-0095), and other deliberations.

The regulation would require security personnel to meet minimum specified criteria for physical fitness, training, and other qualifications, and to be requalified annually.

Personnel Clearances

On March 17, 1977, the NRC published for comment proposed regulations (10 CFR Parts 10 and 11) that would require certain individuals involved in licensed nuclear activities to receive authorization from the NRC before being granted access to or control over special nuclear material (SNM). The proposed rule covers both fuel cycle activities and reactors. The purpose would be to provide a measure of assurance that those individuals would not use their positions to commit theft or sabotage. Authorization would be granted on the basis of background investigations.

The NRC proposal involves two clearance levels. The higher level, NRC-U, involves a "full-field" background investigation by the FBI and would be required for (1) individuals who require unescorted access to SNM and to "vital area" (areas that contain equipment vital to the protection of the public), (2) individuals whose positions make it possible, either alone or in conspiracy with another, to steal SNM or commit sabotage, and (3) drivers of motor vehicles and pilots of aircraft transporting certain quantities of SNM and those who escort SNM shipments. The lower clearance level, NRC-R, would be based on a Civil Service Commission check of Federal Government records for adverse information. It would apply to individuals who, while not being in any of the above categories necessitating an NRC-U clearance, do require unescorted access to protected areas.

The proposed program would be administered by the NRC, utilizing the same procedures as are currently applied to clearing its own employees, e.g., use of the Civil Service Commission or FBI for all background investigations. Uniformity in the application of procedures and the availability of established avenues for appeal which would result from NRC's direct administration of the program should minimize the possibility that any individuals would suffer an undue loss of civil liberties, such as rights of privacy, from the personnel clearance process.

In view of the extensive comments received from the public, the NRC will hold a public hearing on this matter early in 1978.

CONTINGENCY PLANNING

Safeguards contingency plans are developed to deal with threats, thefts, and sabotage relating to special nuclear materials, high-level radioactive wastes and nuclear facilities. Contingency plans contain: (1) a predetermined set of decisions and actions required to satisfy stated objectives; (2) an identification of the data, criteria, procedures, and mechanisms necessary to make and carry out the decisions and actions efficiently; and (3) a specification of the individual, group or organizational entity responsible for each decision and action.

During the report period, the NRC staff effort was directed toward application of a previously developed contingency planning methodology. At the national level, contacts have been made with 81 organizational elements of 27 Federal agencies and with three national associations. Those organizational elements that can provide useful information or response assistance have been identified, and inter-agency agreements are planned to formalize procedures for requesting information or assistance, communications channels, and other arrangements.

A proposed change to the regulations in 10 CFR Parts 50, 70, and 73, published for comment on May 19, 1977, would require the development and implementation of safeguards contingency plans by those licensees authorized to operate power reactors or to possess significant quantities of SSNM. The proposed rule was discussed with power reactor licensees in regional meetings during the spring and with affected fuel-cycle licensees in a meeting in August. Public comments are being evaluated before adoption of a final rule.

SAFEGUARDS INFORMATION

Safeguards Information System

NRC is developing an integrated safeguards information system (ISIS) to facilitate the storage, retrieval and processing of information needed by NRC to monitor the status of nuclear safeguards.

During the year, the NRC staff met with licensees and local law enforcement agencies to develop contingency plans for dealing with possible threats, thefts, and sabotage.

The computerized system will include data modules related to nuclear materials inventory, accounting, inspection systems, inspection results, facility design, physical security, licensing, nuclear exports, and nuclear imports. One module, relating to material inventory and accounting, will be compatible with the International Atomic Energy Agency's safeguards information system and will permit direct transfer of data to the IAEA for international safeguards purposes. The core of this module will be NRC's existing nuclear material inventory and accounting system.

The design and structure of ISIS will be completed in stages over a period of about three years, with incremental capabilities installed as they are developed.

Safeguards Supplement to GESMO

As part of NRC's overall review of the environmental consequences of using recycled plutonium to fuel light water reactors, a separate analysis of the safeguards implications was conducted. The safeguards implications of recycling plutonium stem from the potential use of plutonium by malefactors in nuclear explosives or devices to disperse radiological poisons. The results of the analysis were to be published as a draft supplement to the "Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors" (GESMO). (See Chapter 3.)

The draft supplement was extensively reviewed during the year and modified as necessary to assure that it could be unclassified and that the analysis and findings were consistent with relevant NRC rules, e.g., those pertaining to guards, security clearances, and the physical security of nuclear facilities. Modifications were also made to allow publishing the document as a technical report instead of an environmental impact statement (see chapter 3).

Employee Allegations

In April 1977, an employee of NRC's Division of Safeguards wrote an open letter to the President of the United States, to the Chairman of the House Committee on Interior and Insular Affairs and to the Nuclear Regulatory Commission in which he spoke of a general lack of availability, perhaps suppression, of important safeguards-related information. He also expressed his opinion that, as a result of these information problems, existing safeguards were "afflicted pervasively by serious and chronic weaknesses, which pose serious potential hazard to the public health and safety, and which even appear to threaten (potentially, at least) the national security." The Commission appointed a special task force to investigate the matter.

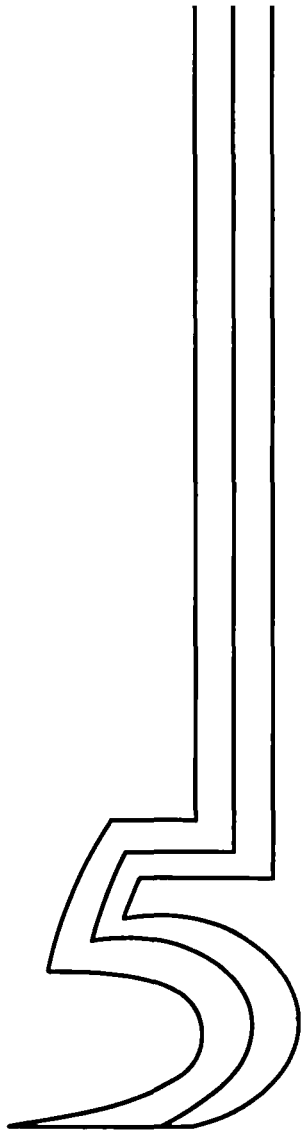
In its conclusions, the task force:

- Disagreed with the employee's central judgment that existing safeguards pose serious public safety and national security hazards.
- Noted some limitations on availability of information both to and within NRC, but concluded that none of these had resulted in a fundamental compromise of safeguards.
- Did not agree with the employee that present safeguards are "decidely non-conservative,"

but did note that safeguards development and analysis should be more rigorous and systematic and found NRC programs improving in this regard.

The Commission requested the staff to implement certain improvements recommended by the task force. The Commission subsequently reviewed a plan of action proposed by the staff and found it responsive to the task force's findings. The following actions were included and have been implemented in the plan: (a) accelerate staff efforts to establish operating procedures for implementing a DOE-NRC agreement on exchange of safeguards-related information; (b) develop operating assumptions regarding selected aspects of safeguards, such as relative ease of fabricating clandestine fission explosives; (c) ensure that, if a safeguards problem does occur, NRC public statements accurately describe the circumstances; (d) ensure that safeguards information essential to performance of staff functions is routinely disseminated on a timely basis; (e) monitor closely the progress of a DOE study on clandestine fission explosives; (f) prepare a paper on the current NRC assumptions concerning threat level and adversary characteristics; (g) maintain contact with Department of Defense and DOE for safeguards incidents at facilities under their jurisdiction; and (h) expedite the development of formal techniques and procedures to increase objectivity of safeguards evaluations and requirements.

Waste Management



During the past year NRC has made progress toward developing the regulations needed to assure the safe disposal of both high-level and other radioactive wastes.

New NRC regulations in the waste management field will require conformance with minimum performance standards (technical, social, and environmental) while allowing for flexibility in technological approach. The regulations will be directed towards:

- Isolating radioactive wastes from man and his environment for time periods suffcient to protect public health and safety.
- Assuring that environmental values are preserved.
- Minimizing the risks to the public health and safety, and the long-term social commitments of land, natural and human resources.

REORGANIZATION AND EXPANSION

In February 1977, the Commission approved a reorganization and expansion of the Waste Management Program. Two functional units, one concerned with high-level and transuranic wastes and the other with low-level wastes, were established under an Assistant Director for Waste Management in the Division of Fuel Cycle and Material Safety. This reorganization was intended to assure effective management control of a rapidly expanding and changing program, to provide identifiable points of responsibility within the organization, and to give emphasis to the Commission's stated priorities for waste management. The number of NRC professional employees working in waste management has approximately tripled in the past year, and funds for obtaining contractual support have almost quadrupled.

In the past, the NRC has generally relied on the national laboratories of the Energy Research and Development Administration (now part of the Department of Energy (DOE)) for quick responses to urgent needs for technical assistance. However, alternative sources for contractual support have had to be developed because the rapid expansion of the DOE's program in waste management has preempted the resources available in the laboratories. In addition, because DOE is responsible for developing high-level waste repositories and will therefore be submitting waste repository applications for NRC review, NRC needs sources of support

independent of DOE's national laboratories. Accordingly, after issuing a request for proposals, the NRC selected 22 private firms to provide technical assistance in the evaluation of waste management options, development of system criteria, coordination of rapid studies of specific issues, and evaluation of specific waste management plans. During the report period, eight competitive procurements were processed and awarded.

HIGH-LEVEL WASTE MANAGEMENT

The NRC has the responsibility to regulate and license permanent repositories for high-level waste (HLW) to insure that public health and safety and environmental quality are protected. Accordingly, the NRC staff is developing the performance criteria and licensing procedures needed to assure timely and appropriate regulatory actions. Proposed regulations regarding HLW repositories are scheduled to be published for public comment in the fall of 1978. These regulations will address:

(1) Performance criteria for HLW solids, i.e., what form wastes must take in a HLW repository.

(2) Site suitability criteria, i.e., what constitutes an acceptable site for a repository.

(3) Repository design criteria, i.e., what constraints must be placed on construction and operation of a repository.

(4) Licensing procedures, i.e., what mechanisms will be used to review proposed facilities to determine if they meet the criteria.

The waste form criteria, site suitability criteria and repository design criteria will specify how the wastes, the site and the repository *should* perform. The NRC staff is also developing methods for predicting how a proposed HLW repository *will* act and whether the predicted actions will meet minimum performance requirements.

Waste Classification

One of NRC's programs is aimed at classifying wastes according to the degree of confinement necessary to ensure their containment until they decay to some acceptable low-risk level. Criteria will be developed to specify what wastes: (1) require isolation in a Federal repository—probably high-level reprocessing wastes, spent fuel, and transuranic contaminated wastes; (2) require confinement in a commercially operated waste disposal facility (shallow land burial)—probably operating reactor wastes other than fuel, structural materials from decontaminated reactors and radioactive medical wastes; or (3) can be dispersed to the environment.

Performance Criteria for Solidified Reprocessing Wastes

The NRC staff is using a systems analysis model to evaluate the various situations which could lead to release of radioactive materials during handling, storage, transportation, and disposal of high-level solid waste from reprocessing. A similar approach will be used to develop performance criteria for spent fuel disposal in deep geological structures.

The three basic mechanisms that control the release of radioactive materials are volatilization, dispersion of particulates and leaching by water. The performance criteria for waste disposal will require control of each of these mechanisms and will be based on an analysis of the possible release pathways, the state of technology for controlling each mechanism, and a balancing of the cost of control against the benefits achieved by reducing the risks to individuals and populations. Although the criteria will be derived from analytical studies for various accident scenarios (e.g., isolation barrier failures), they will be stated in terms of measurable parameters such as impact resistance, thermal stability, and chemical stability (including resistance to leaching by water).

The results obtained to date indicate that the hazards present before the waste is placed underground may be more important in determining the proper solid waste form than those encountered after the waste is placed underground.

Site Suitability Criteria

NRC must develop criteria by which to judge the suitability of any site which the DOE selects for a HLW repository. A proposed site would be suitable if it is capable of containing radionuclides long enough to protect the public health and safety and if it is acceptable on environmental (including socio-economic) grounds. Development of the siting criteria began in August 1976 with the formation of an NRC Earth Sciences Task Force to identify

potential limiting conditions. Subsequently, preliminary criteria were developed based on earth-science, demographic, and socio-economic factors. Those criteria are now being reevaluated and revised. A proposed regulation supported by a draft environmental impact statement is scheduled to be published for comment in the fall of 1978.

NRC has had three groups independently review the preliminary site suitability criteria: a group of experts outside the NRC; State legislators and executives; and the National Academy of Sciences.

Repository Design Criteria

The NRC staff is establishing general regulatory criteria for HLW repositories. The criteria will include such items as:

- Quality assurance measures for design and construction.
- Requirements for protection against natural phenomena (e.g., tornados, earthquakes, floods).
- Requirements for performance of containment barriers.
- Compatibility between waste forms and containment media.
- Nuclear safety (criticality) requirements.
- Physical protection requirements.

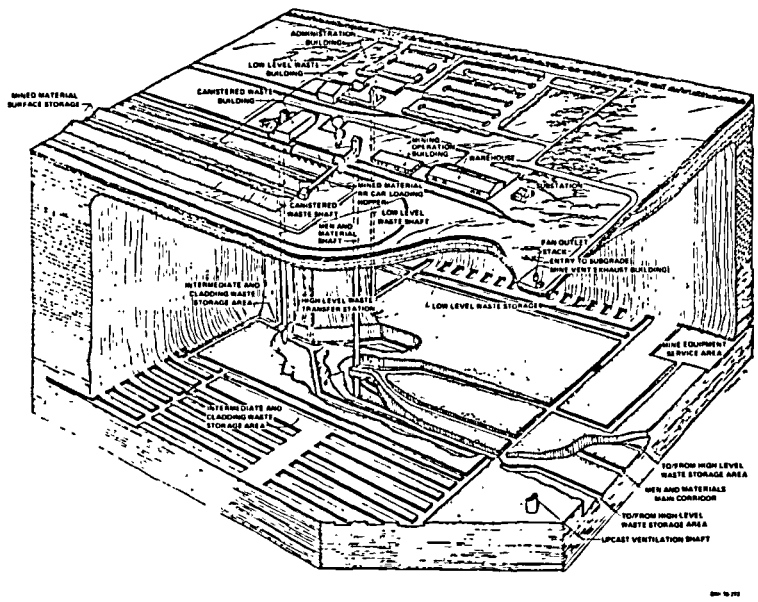
The NRC staff's assessment of the design of proposed repository sites or facilities will be supported by transport and systems analysis models with which the elements of a proposal can be evaluated, and technical procedures which set forth the factors to be considered in licensing evaluations (e.g., standard review plans). The NRC will also establish a level of risk (i.e., radiological performance objectives) which repositories will not be allowed to exceed.

Review of DOE Proposals

After the DOE submits a specific waste repository application to the NRC for license review, NRC will use the criteria and assessment tools described above to determine whether the proposed facility can be constructed and operated without undue risk to the public health and safety.

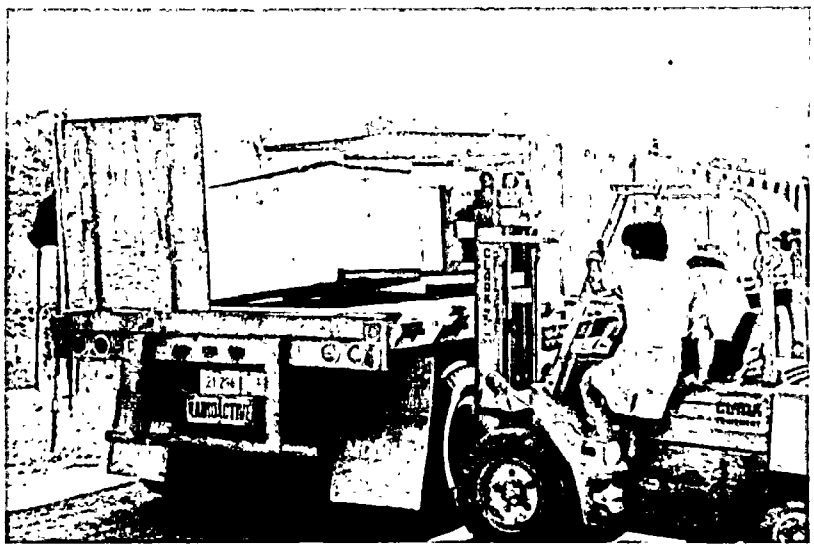
The DOE is also preparing a draft generic environmental impact statement on commercial radioactive waste management. The draft statement will address the environmental impacts associated with the treatment, storage, transportation and final disposition of commercially generated high-level and transuranium-contaminated radioactive wastes.

The NRC will review this statement in detail, since it will provide the basis for future DOE license applications. NRC's review will be two-pronged: an in-house review which will draw upon expertise from throughout the agency; and a review by an outside contractor to provide an independent, detailed scrutiny of the data and calculations.



WASTE ISOLATION FACILITY - PERSPECTIVE

This is the Department of Energy's conceptual design of the probable layout of a bedded-salt repository for high-level and transuranic wastes. NRC will be responsible for the safety review and licensing of these facilities. As designed, the facility could handle both spent reactor fuel and high level waste from fuel reprocessing.



Packages of thorium ore and ore residue are loaded and monitored for shipment from Kerr-McGee Chemical Co. in West Chicago to the licensed burial facility at Sheffield, Illinois. The ore and ore residues were being shipped as part of a program by the licensee to remove some of the more highly concentrated ores from their facility, which has been shut down since 1973.

The DOE statement is expected to be released for public review and comment early in 1978. The NRC's review will be completed by the end of the period allowed for public comment.

LOW-LEVEL WASTES

Task Force Recommendations

As part of the NRC's continuing examination of the technical and regulatory bases for the management of radioactive wastes, and in response to Congressional concerns, an "NRC Task Force Report on Review of the Federal/State Program for Regulation of Commercial Low-Level Radioactive Waste Burial Grounds" (NUREG-0217) was published in March 1977.

In developing its recommendations, the task force was concerned with the objectives of the low-level waste management program, which include establishing a regulatory structure, assuring adequate waste disposal capacity without a proliferation of sites, assuring long-term care without placing a disproportionate burden on a few States, providing for Federal and State participation, and examining alternative disposal methods.

The Task Force recommended that the NRC:

- Initiate action in cooperation with Federal and State agencies to increase Federal control over the disposal of low-level radioactive waste by establishing a Federally administered perpetual care program and by requiring joint Federal and State approval of new disposal sites; NRC licensing, with State participation, of current and new disposal sites; Federal land ownership for all disposal sites.
- Accelerate development of regulations, standards and criteria in cooperation with appropriate Federal and State agencies.
- Initiate studies to identify and evaluate the relative safety and environmental impacts of alternative low-level waste disposal methods and assure that no new low-level disposal sites are licensed until these studies are completed or unless an urgent new need is identified, and assure effective use of existing commercial burial grounds.

Commission Program

Based in part on this report and on 33 public comments received on it, the Commission announced a program in December 1977 which included the following major elements:

- The NRC staff will accelerate development of a comprehensive set of standards and criteria for disposal of low level waste and will examine alternatives to shallow land burial, the only method used at present. This work will be done in cooperation with State governments and with other Federal agencies, including the Department of Energy, the U.S. Geological Survey, and the Environmental Protection Agency.
- Any new land disposal sites will have to be fully justified on the basis of need. Additional capacity may be needed because of regional

needs, equipment limitations, costs and other factors. NRC will be working closely with the States to which it has transferred licensing authority to assure that applications are treated in a similar manner whether under NRC or State licensing jurisdiction.

The Commission stated that it was giving consideration to the recommendation for increased Federal control but was not yet adopting it formally as NRC policy. It stated that a number of unresolved issues needed to be addressed regarding this recommendation and that, meanwhile, States were adequately protecting the public health and safety. The unresolved issues include:

- Technical, financial and institutional requirements for long-term care of disposal sites.
- The respective responsibilities of waste generators, site operators, and Federal and State governments for the cost of licensing, inspection, monitoring and long-term care of the disposal sites, and the development of methods to assure that costs will be met.
- Mechanisms for joint Federal and State participation in repository siting and licensing.
- Alternatives to shallow land burial. (The nature of a more suitable alternative might affect whether Federal or State control is preferable.)

Schedule of Major Steps

The NRC staff's proposed schedule for completing major tasks includes the following:

(1) By August 1978—issue proposed waste classification regulation for public comment.

(2) By September 1978—publish report on study of alternatives to shallow land burial.

(3) By October 1980—issue shallow land burial regulations and guides in final form (initial criteria which will be the basis of the regulations will be available by October 1979).

(4) By October 1981—issue final regulations and guides on alternative methods for low-level waste management (initial criteria will be available in draft by April 1981).

Details of the NRC's low-level waste management program, including a complete schedule, were published as NUREG-0240. The NRC staff's analysis of public comments on the task force report were published as NUREG-0217, Supplement 1.

ENVIRONMENTAL IMPACT OF THE LWR FUEL CYCLE

The "Environmental Survey of the Uranium Fuel Cycle" (WASH-1248) was published by the Atomic Energy Commission in April 1974 to establish a technical basis for estimating the environmental effects of the uranium fuel cycle attributable to the operation of individual light water reactors.

In October 1976, Supplement 1 to WASH-1248, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle" (NUREG-0116), was published by the NRC. The supplement was prepared in response to the July 21, 1976 decision by the U.S. Court of

State legislators and State executive agency officials discuss siting criteria and licensing procedures at an NRC-sponsored high-level-waste management workshop in New Orleans. Similar workshops were held in Philadelphia and Denver.

Appeals, D.C. Circuit, remanding to NRC the reprocessing and waste management portions of the fuel cycle rule. (The Supplement is discussed in detail on page 81 of the 1976 NRC Annual Report.)

Following public review of the Supplement, NRC published, as NUREG-0216, the staff's responses to the many comments received. At the same time, proposed changes to Table S-3 were published (42 FR 13803). A public rulemaking hearing on the changes to Table S-3 was scheduled to begin in January 1978.

NRC's plans for revising WASH-1248 are discussed in Chapter 3.

COMMUNICATION AND COOPERATION

Congressional and State Hearings

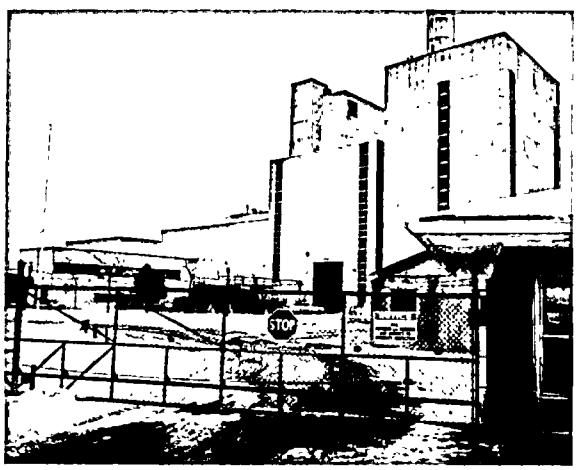
NRC has provided information to aid Congress and State governments in their consideration of the management of nuclear wastes, which has become a topic of considerable interest to them. During the past year, for example, NRC provided testimony for various Congressional hearings (as indicated in Chapter 12) and also for hearings by the Oregon Energy Facility Siting Council, the California Energy Resources Conservation and Development Commission, and the Wisconsin Legislature's Committees on Environmental Protection and Solid Waste Management.

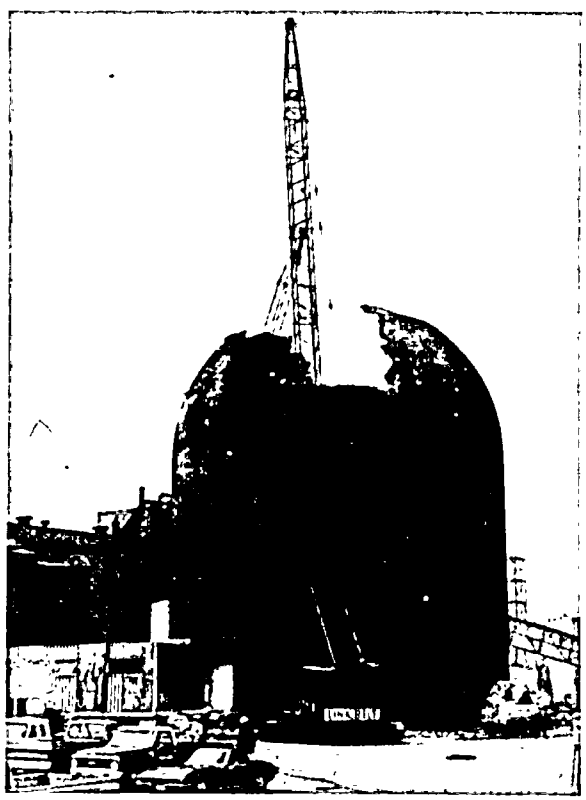
Conference on Public Policy Issues

In October 1976, the NRC, along with the Energy Research and Development Administration, the National Science Foundation, the Council on Environmental Quality, and the Environmental Protection Agency, sponsored a conference on Public Policy Issues in Nuclear Waste Management in Chicago, Illinois. Possible goals for nuclear waste management were presented by an NRC task force. The final report of that task force will be published for comment early in 1978.

Regional Workshops

NRC recognizes that the States have a significant interest in, and can make a substantial contribution to, the development of HLW regulations, particu-





The Enrico Fermi Atomic Power Plant Unit 1, above, was effectively decommissioned in 1974. The eastern Michigan reactor has been mothballed in the containment building, and an oil-fired boiler is now used with the plant's turbine generator to produce electricity during peak loads.

The Elk River (Minnesota) Reactor, right, was shut down in 1968. The reactor and reactor building were completely dismantled and removed from the site.

larly with respect to site suitability criteria. Accordingly, three regional workshops were held in September 1977 to facilitate State review of preliminary drafts of proposed site suitability criteria. Information developed at the workshops will be considered in preparing the draft environmental impact statement in support of the criteria. NRC also is developing procedures for State participation in the licensing process for waste facilities. This will be supplemental to the traditional opportunities for participation in hearings and comments on environmental statements.

DECOMMISSIONING NUCLEAR FACILITIES

Public Concern

Increasing public concern has been expressed about radiation hazards and economic considerations involved in decommissioning nuclear facilities and sites after the end of their useful lives.

Decommissioned facilities and sites must be decontaminated (freed from radioactivity) to levels suitable for unrestricted use, or put in a protected state to ensure that the public is not endangered. The decommissioning of reactor facilities has been relatively well developed. Since 1960 more than 50 reactors, including five licensed power reactors, have been decommissioned, either by "mothballing," entombment, dismantlement or a combination of these methods.

As several more commercial nuclear power plants, as well as other facilities, will be nearing the end of their operational lives at the end of the next decade, the NRC has underway a broad-based assessment, including technical and economic studies aimed at more clearly defining the procedures and financial requirements involved in decommissioning all types of nuclear facilities.

The issues involved and the possible solutions can be considered in the context of recommendations made by the General Accounting Office (GAO) in a report issued June 16, 1977, entitled, "Cleaning Up the Remains of Nuclear Facilities—A Multibillion Dollar Problem."

Financial Planning

GAO's first recommendation was that NRC require specific plans for decommissioning at the time of licensing, including a description of the decommissioning method to be used and of a funding mechanism by which facility owners would pay the costs of decommissioning.

NRC's decommissioning policies, practices, rules and regulations are presently undergoing rigorous examination to alleviate any inconsistencies, differences and deficiencies. NRC is also sponsoring studies by Battelle Pacific Northwest Laboratories (PNL) of the environmental effects, radiological effects, costs and appropriate radioactivity limits associated with decommissioning. Final reports are expected in the spring of 1978 for pressurized water reactors, a year later for boiling water reactors, and over the next two and a half years for each of six fuel cycle facilities under study. PNL and the NRC staff also are reviewing a study by the Atomic Industrial Forum (AIF) on the decommissioning of nuclear power facilities.

A generic environmental impact statement on uranium milling, which NRC expects to issue in August 1978 (See Chapter 3), looks closely at the management of mill tailings, the major consideration in decommissioning this type of facility. Pending issuance of the statement and the issuance of new regulations, NRC requires applicants for new or renewed uranium mill licenses to develop and commit themselves to a tailings management plan, to submit a decommissioning plan and to provide a financial surety arrangement which assures execution of the plan.

Similarly, for fuel cycle facilities other than mills, the NRC requires applicants for new or renewed licenses to provide decommissioning plans and financial arrangements for carrying them out. The staff is exploring what statutory or regulatory changes are needed to formalize these arrangements.

The NRC has not required that specific financial arrangements be made for the decommissioning of power reactors because the utility companies involved are financially stable and the costs of decommissioning are very small within the scale of their operations. Prior to issuance of an operating license, the NRC determines that the applicant has the capability for financing decommissioning. In testimony before the Environment, Energy and Natural Resources Subcommittee of the House Government Operations Committee on September 13, 1977, the NRC presented a preliminary analysis using cost data from the recent Atomic Industrial Forum study. This indicated that the cost of mothballing a power reactor unit assumed to start up in 1985 (with option of delayed dismantling), amortized over a 30-year period, would be about 0.1 percent of the cost of generating electricity.

The NRC staff presently requires that specific decommissioning plans be submitted prior to beginning any decommissioning actions. This will

allow the licensee to take advantage of state-of-the-art technology and the latest rules and regulations. However, as a result of an examination of present policy now under way, it may be decided that this requirement will be imposed before an operating license is issued.

More difficult judgments are involved in estimating costs of terminating operations—presumably including decommissioning—of currently operating power facilities, and studies now under way will assist in identifying the most viable financial routes.

Radiation and Contamination Standards

GAO's second recommendation was that NRC determine the acceptable levels for induced radiation and surface contamination from decommissioned facilities consistent with environmental standards being developed by the Environmental Protection Agency.

NRC agreed in principle with this recommendation and noted that some actions had already been taken in this regard. The Battelle PNL study, referred to above, will be used in developing acceptable radiation and contamination levels. These must be consistent with EPA standards since EPA is responsible for setting standards for the protection of the environment from all sources of radiation. Meetings between the NRC and EPA staffs to coordinate their respective programs in waste management have been taking place at regular intervals.

Facilities Licensed by States

GAO's third recommendation was that NRC encourage States to follow its lead in adopting comprehensive decommissioning planning for facilities under State control.

Agreement State practices for decommissioning the facilities which they license (for example, manufacturers of radiopharmaceuticals, industrial laboratories and academic institutions) are generally consistent with NRC practices, and NRC will encourage Agreement States to continue following NRC's lead in this area.

The NRC currently lacks regulatory authority over naturally occurring and accelerator-produced radioactive materials, which are responsibilities of the States. In March 1976, the NRC formed a task force to review regulatory responsibilities in this area. Its report (NUREG-0301), published and distributed for public comment on July 20, 1977, recommends that the NRC seek legislation which would give it authority to regulate these materials. The staff is preparing recommendations to the Commission on the matter.

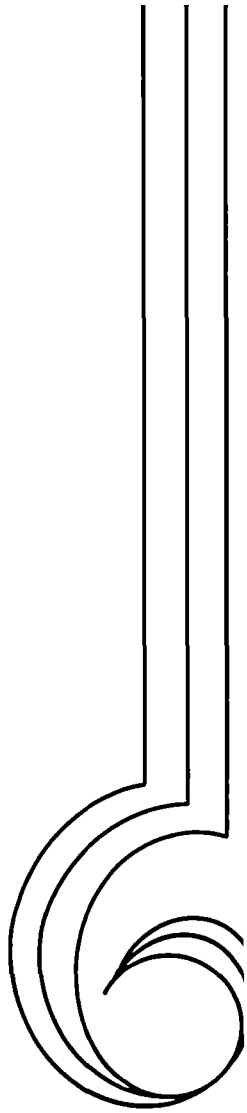
Lead Agency for All Decommissioning

The GAO also recommended to the Congress that it designate the NRC as lead Federal agency to approve and monitor an overall decommissioning strategy for all nuclear facilities, while the Department of Energy continues the research and development aimed at finding alternative methods of decommissioning and decontamination. The GAO stated its belief that "NRC is uniquely suited for the lead role because of its charter to independently regulate commercial nuclear activities to assure public health and safety," and that placing this responsibility with the Commission would "add to the credibility of Federal regulation over nuclear energy."

The NRC supports the general principle that all decommissioning activities should be consistent. It holds the view, further, that decommissioning is a problem in the management of radioactive wastes and that waste management problems, which are national in scope and pose long-term potential hazards, require comprehensive and uniform national policies. It is noted, however, that NRC has no regulatory authority over most facilities of the Department of Energy, and would require specific legislative authority to review DOE's decommissioning activities and to prescribe actions consistent with an overall waste management plan.

Inspection and Enforcement

The inspection and enforcement program is an essential element of the Nuclear Regulatory Commission's regulation of the use of nuclear facilities and materials. The basic mission of the NRC Office of Inspection and Enforcement is to ensure, primarily by field inspection and investigation and by enforcement actions, that materials and facilities under NRC jurisdiction are constructed and used in a manner which protects the public health and safety and the environment and ensures the safeguarding of nuclear materials and facilities. The regulatory program is designed to verify that licensees perform in accordance with applicable sections of the Federal statutes, Commission regulations, and Commission-issued licenses and permits. When situations are identified where licensees are not adhering to these requirements or are conducting operations that might endanger the public or the environment, or adversely affect the common defense and security, enforcement action is taken.



Scope of the Program

The Office of Inspection and Enforcement carries out inspections, investigations and, where indicated, enforcement actions related not only to NRC licensees, but also to contractors and suppliers of licensees, as well as to applicants for licenses and others. The objectives of these activities are:

- To determine whether licensees comply with NRC requirements including rules, regulations, orders and license provisions.
- To identify conditions that may adversely affect public health and safety, the common defense and security, the environment or the safeguarding of nuclear materials and facilities.
- To provide information that may assist in developing a basis for recommending issuance, denial, or amendment of an authorization, permit or license.
- To determine whether suppliers of nuclear safety-related services, components and equipment have implemented quality assurance programs that meet NRC criteria.

In addition, NRC investigates incidents, accidents, allegations and other unusual circumstances involving matters that may be subject to NRC jurisdiction, in order to ascertain the facts and to take or recommend appropriate action.

To evaluate and to inform are important aspects of inspection and enforcement operations. The Office communicates with other parts of NRC, the government, licensees and the public concerning events or conditions that present a potential or actual threat to public health and safety, the environment, or the safeguarding of nuclear materials and facilities. The Office evaluates the results of inspections, investigations, inquiries, enforcement actions and reports by licensees and other organizations in order to:

- Determine the adequacy of licensee performance.
- Understand what has transpired and provide a basis for taking or recommending appropriate action.
- Verify the effectiveness of the inspection, investigation and enforcement programs.
- Identify areas where changes in the regulatory process should be considered.

The NRC enforcement effort consists of a clearly spelled out, evenly applied program of deterrents which escalates according to the nature of the violation and the licensee's past history of noncompliance. A comprehensive statement of this enforcement policy is distributed to all new licensees.

The inspection functions cover the range of NRC-licensed activity, involving both reactors and nuclear materials. Reactor-related activities include inspection of the construction and operation of nuclear power plants and the operation of research and test reactors. In addition, NRC inspects the operations of the contractors and vendors that supply equipment, components and services to power reactors under construction and in operation. Nuclear materials activities include the construction and operation of uranium mills; fuel fabrication, processing and reprocessing plants; waste disposal facilities; and radiography and medical uses of radioactive material. The safeguarding of such material while in transit is also subject to NRC inspection and evaluation.

The Organization

The NRC Office of Inspection and Enforcement consists of a headquarters, located in Bethesda, Md., and five regional offices, located in or near Philadelphia, Atlanta, Chicago, Dallas, and San Francisco. (See Appendix 1 for description of organization.) The headquarters staff develops the inspection program; assures the technical adequacy of enforcement actions; prepares notifications of incidents and generic issues; provides management and technical support to the individual regions and monitors and appraises their program; develops policy, criteria and program requirements for enforcement and investigations; manages investigations conducted from headquarters; coordinates the enforcement program and assures that enforcement decisions meet criteria; and develops the procedures for response to incidents.

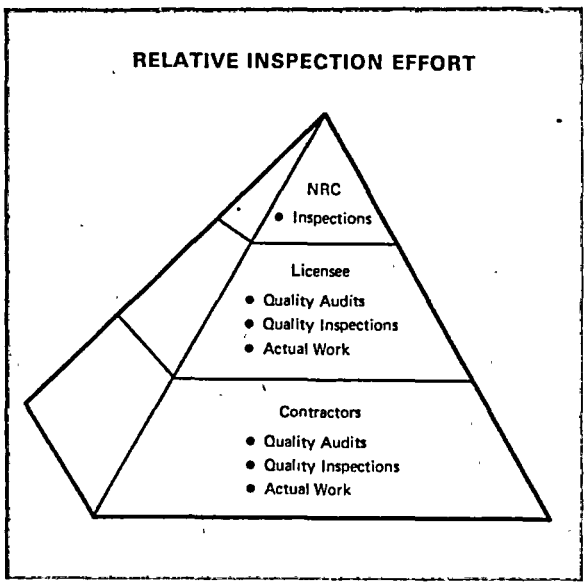
The inspection program is conducted from the five regional offices to which about 80 percent of the Office's total staff is assigned. In each of the regional offices, inspectors are organized into functional groups. Each region has a reactor construction inspection branch; reactor operation inspection branch; and a branch devoted to health physics, including environmental protection and materials licensee safety. Regions I, II, III and V also have a safeguards inspection branch. Region IV (Dallas) is the only region with a licensee contractor and vendor inspection program.

The Inspection and Enforcement Programs

The government-industry approach to the inspection of nuclear power plants provides for multiple levels of inspection and verification. The NRC inspection program is based on the premise that the licensee is responsible for assuring that a facility is operated safely and in compliance with NRC requirements. NRC verifies that the licensee has established the management control systems necessary to meet its regulatory responsibilities.

The inspection pattern for the nuclear industry is pyramidal (see diagram on next page), with each level of activity verified, inspected or audited by those above. The NRC inspection effort is essentially the apex of this pyramid of inspection, i.e., NRC performs the last in the series of inspections and audits conducted by many different groups. NRC inspection manpower is usually far less than that of licensees and contractors, and NRC inspectors cannot possibly inspect all components and activities. Instead, they probe the "pyramid" to the depth necessary to determine whether the licensee's activities and those of the contractors are properly performed.

The inspection program consists of two major components: a preventive or routine inspection component, and a reactive inspection component. Routine inspections examine a sample of the total activities performed by licensees and their contractors, concentrating on determining the effectiveness of quality assurance systems. To gather information for their evaluation, NRC inspectors employ a variety of techniques: they may observe work in



progress; check records of all types; interview people; and, where appropriate, make direct measurements.

Reactive inspections are conducted in response to information received by NRC regarding conditions or occurrences at licensed industry facilities. Such information may come from routine NRC inspections; from an applicant, licensee, contractor or supplier; or from a licensee employee or other member of the public. The NRC response to the information depends upon the significance of the particular condition, event or allegation, as determined by NRC's independent in-depth investigations.

From an enforcement standpoint, each item or condition examined during an inspection or an investigation falls into one of four categories: (1) it is acceptable; (2) it does not comply with Commission rules and regulations or specific license conditions; (3) it deviates from a licensee commitment which is not a regulatory requirement; or (4) more information is needed to determine the category in which the finding lies. Each instance of noncompliance is also categorized according to its relative significance. The three categories of noncompliance in decreasing order of seriousness are: a violation, an infraction, and a deficiency.

Since NRC places great emphasis on the licensee's own effort to identify items which need to be corrected, enforcement action is not usually taken for noncompliance items which are identified by a licensee's internal audit program, provided the licensee adequately corrected the problem and it did not cause a significant safety-related event. However, NRC attaches considerable significance to noncompliance items which it directly identifies. In view of the requirement for multiple levels of inspections and audits under a licensee's quality assurance program, NRC's identification of a noncompliance item carries with it broader implications regarding the effectiveness of the licensee's quality assurance program. For this reason, licensees are not only required to correct the particular problem identified, but also to correct the deficiencies in the quality assurance program which allowed the situation to exist.

INSPECTION ACTIVITIES

The workload of the Office of Inspection and Enforcement is determined by the number of inspections required to meet program objectives. (Investigations and enforcement actions generally derive from inspections.) The three major inspection program areas are those concerned with reactors, fuel facilities, and materials and safeguards.

NRC has identified several ways to improve the effectiveness of the inspection program. First, increasing the amount of time inspectors spend onsite will provide increased opportunity to observe and measure licensee activities, verify licensee compliance, prevent safety-related problems, and respond to incidents and events. In addition, inspectors will gain an improved knowledge of the plant that allows for better technical judgment and more efficient inspection. A program to use resident inspectors will increase onsite time. (This program is discussed later in the chapter.) NRC also intends to increase the proportion of inspections that are unannounced.

Another goal of the Office is to increase the number of inspectors as a percentage of the total staff. This percentage increased from 55 percent in 1976 to 57 percent in 1977; the projection for 1978 is 60 percent.

During fiscal year 1977, the 87 inspectors assigned to nuclear power plants under construction conducted 1,102 inspections at these facilities. There were 75 reactors under construction during this period. A total of 1,630 safety inspections were performed by the 124 inspectors assigned to nuclear reactors licensed to operate. There were 67 reactors with operating licenses. Twenty-one fuel facility inspectors performed 154 inspections at the 38 licensed fuel facilities. Thirty-five inspectors conducted 2,732 inspections of materials licensees. There was a total of 8,703 nuclear materials licensees. In addition, 231 inspections of vendors were performed by the 20 inspectors assigned in this area. A total of 168 vendor organizations were inspected. Finally, 397 safeguards inspections were

performed at various facilities by the 51 inspectors assigned to make them.

Power Reactor Inspection

Nuclear power plant inspections cover the four phases of a facility's life:

(1) Preconstruction activities, when inspections focus on the applicant's quality assurance program for the design and procurement of safety-related systems and components.

(2) The construction period, during which NRC inspects to verify conformity with the design, the suitability of the materials used, and the adequacy of fabrication and construction activities.

(3) The preoperational testing and startup phase, which involves intensive NRC inspections to determine whether the plant will operate as designed and to review personnel plans, training, and qualifications.

(4) Operational phase, with periodic inspections made throughout the facility's life to ascertain whether the licensee is operating the reactor safely, responsibly, and in compliance with NRC requirements.

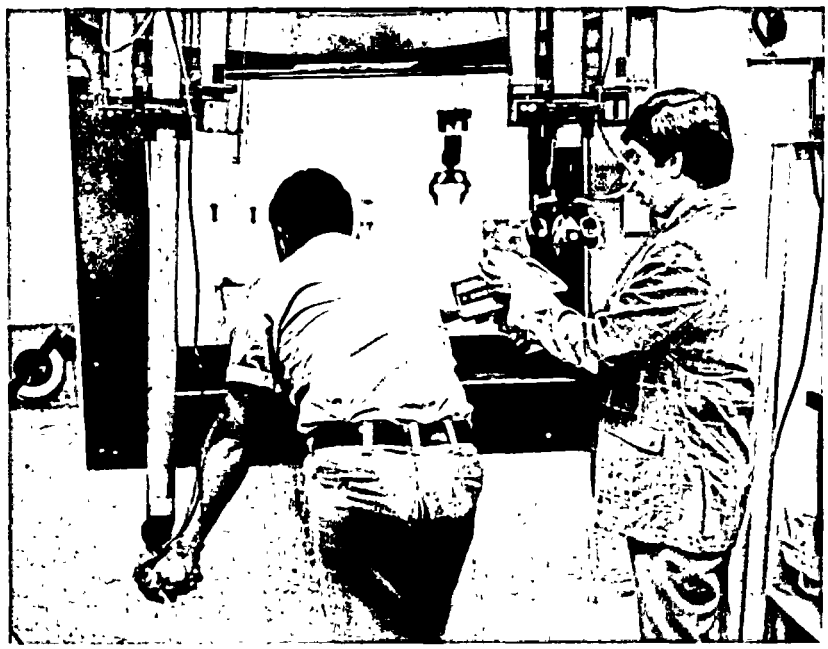
An electrical relay panel of a nuclear power plant under construction is checked by an NRC inspector against the approved design. During the construction of a nuclear plant, approximately 150 site visits are made by an NRC inspector.

Research and Test Reactor Inspection

A comprehensive inspection program for research and test reactors was implemented in January 1977. The overall objective of the program, like that of the power reactor program, is to establish a basis for determining whether activities at a facility are conducted safely and in accordance with regulatory requirements. Because of the variation in requirements placed on different classes of research and test facilities, the inspection program emphasizes the importance of assuring the overall safety of the facility as well as conformance to NRC regulations. The program applies to all classes of research and test reactors and critical facilities. During fiscal year 1977, 135 inspections were performed at the 73 research and test facilities.

Licensee Contractor and Vendor Inspection

Equipment malfunctions in reactor facilities can often be attributed to errors in the selection, design or fabrication of equipment. Because of this, the Licensee Contractor and Vendor Inspection Program (LCVIP) was established in 1974 to minimize the number and significance of such events and to assure conformance with NRC's quality assurance criteria specified in 10 CFR 50, Appendix B. The goal of the LCVIP is to improve nuclear power plant safety by assuring that vendor organizations (architect engineers, nuclear steam system suppliers, and component manufacturers) produce products and services that meet safety requirements. The contractor and vendor organizations provide engineering designs, safety-related services or hardware products, such as vessels, piping, valves and electrical components and instrumentation. Vendor quality assurance programs are inspected directly by NRC. This, however, does not remove the responsibility for product acceptance examinations from the individual licensee. As mentioned earlier, the NRC Region IV Office (Dallas) carries out the vendor inspection program.



At right, an NRC inspector surveys the radiation field outside a shielded cell where an operator is using a remote control device to place highly radioactive material into a container for shipment to the eventual user.

Fuel Facility and Materials Inspection

There are nearly 9,000 organizations that possess NRC licenses associated with fuel facility and nuclear material activities. Fuel facilities are those plants specifically designed to store irradiated (spent) fuel elements; reprocess spent fuel and process plutonium and uranium; fabricate fuel; and perform hexafluoride conversion and uranium milling operations. Materials licenses include licenses for waste disposal; radiopharmaceuticals manufacture; radiography; medical and industrial uses of radioisotopes; and academic programs.

The frequency of inspection of these facilities varies according to their potential hazard to the health and safety of users and the general public. For example, the inspection program for plutonium facilities requires four inspections of the facility's operations and two radiological safety inspections per year, while that for radiography requires one radiological safety inspection per year.

Program improvements over the past year include closer coordination between the Office of Inspection and Enforcement and the Office of Nuclear Materials Safety and Safeguards in renewing licenses. Procedures have also been developed to assure complete and safe disposal of nuclear materials before a materials license is terminated.

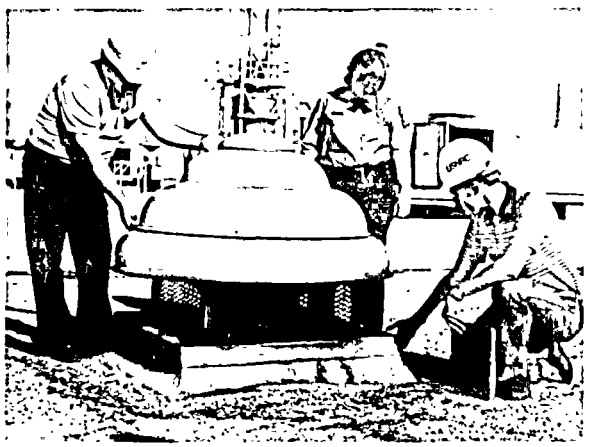
Safeguards Inspection

The two types of safeguards inspections—materials accountability and physical protection—are conducted at nuclear reactors, fuel cycle facilities, and at the other facilities that are licensed to possess or ship special nuclear materials. The inspectable activities include those measures that: (1) assure physical protection of nuclear reactors and fuel cycle facilities against theft of nuclear material or the creation of a radiological hazard through sabotage; (2) control and account for special nuclear materials to detect whether material has been stolen; and (3) protect special nuclear materials that are shipped from one licensee to another, exported or imported.

Material Control and Accountability Inspection. Material accounting inspections are conducted to determine whether the licensee's program assures adequate control and accounting of special nuclear material. In addition, the NRC inspects licensed export and import shipments of special nuclear material to review materials control and independently verify the quantity and type of material shipped.

Both destructive and nondestructive assay techniques are used to monitor special nuclear material inventories. NRC has expanded its effort to develop a mobile measurement capability. Three NRC regional offices have nondestructive assay vans that provide the opportunity to conduct onsite sampling of licensee material.

Physical Protection Inspection. Physical protection inspections are concerned with the level of protection against theft, diversion and sabotage at fixed licensee sites and while nuclear materials are in transit. NRC inspectors examine all elements of a licensee's security program to assure both effective-



During periodic unannounced inspections, NRC safeguards inspectors check the physical security facilities of a licensee's plant, including the intrusion monitoring area, possible routes of surreptitious access to the plant, and an explosives detector device.

ness and conformance to license specification. Materials in transit are also subject to NRC monitoring. This includes unannounced inspections at the points of origin or transfer, or at the destination, and observation or surveillance by NRC inspectors at any point along the shipment route.

Inspector Training and Qualifications

NRC inspectors are highly qualified by academic education, specialized training and experience to perform these various types of inspections. Moreover, the scope of the regulatory program demands a wide variety of skills and inspectors have had training and experience in one or more disciplines, including plant design; construction testing and operation; quality assurance; metallurgy; electrical and instrumentation systems; concrete; welding; health physics; physical protection; materials measurements; and nuclear criticality safety.

To assure that each inspector has reached a high level of proficiency, NRC is establishing comprehensive training and qualification programs for inspectors. Inspectors receive training in power plant design and operation, inspection techniques, physical security, materials accountability, waste materials management, and in each of the major construction technology areas, including welding, concrete, nondestructive testing, quality assurance, electrical systems and instrumentation. Each program combines formal classroom courses, programmed self-study and on-the-job training to provide the necessary knowledge and skills.

During fiscal year 1977, a total of 560 inspectors and other NRC employees attended the training courses. NRC inspectors received 49 student weeks of basic orientation training and 484 student weeks of reactor and construction technology training.

INVESTIGATIONS

A significant part of NRC's inspection effort is involved in responding to reports of radiation incidents, abnormal occurrences, equipment problems,

and allegations of improper or unsafe operations. Although many of these events prove to be minor and can be reviewed during scheduled inspections, some require special response. In these cases, a special inspection is scheduled or, when appropriate, an immediate, full investigation may be initiated. During fiscal year 1977, 80 investigations were conducted by the NRC Office of Inspection and Enforcement. Nine involved exposures of licensee personnel as a result of radiation incidents; 53 dealt with allegations of improper or unsafe working conditions, operations or construction activities; two concerned alleged loss of material; one involved the release of radioactive material in an unrestricted area; and the remaining 15 involved other matters. In 36 of the 80 investigations, licensees were cited for failure to meet NRC requirements.

In addition, a number of significant special investigations were conducted or concluded during the year. These are summarized below.

North Anna Power Station

The North Anna Power Station is owned by the Virginia Electric Power Company, Richmond, Va., and is located on the North Anna River in Louisa County, approximately 40 miles north of Richmond. On August 13, 1976, a major NRC investigation was initiated, based on 52 allegations concerning installation of piping systems at Units 1 and 2.

As a result of the investigation, 12 of the allegations were substantiated. Eight involved the installation or identification of work in a manner that was contrary to that shown on drawings. In all cases of incorrectly identified or installed equipment, the equipment was associated with auxiliary piping systems that have some safety-related functions but are not within the reactor coolant pressure boundary. Because of an implication that some pipefitters knowingly performed work incorrectly, NRC added several phases to its investigations of Unit 1 piping systems important to the integrity of the reactor coolant pressure boundary and of other safety-related piping. These inspections followed the NRC construction inspection procedures with appropriate modifications to reflect the status of construction. The inspections, which are normally performed over a two-to-three year period, were conducted between September 21, 1976 and November 5, 1976. This concentrated inspection effort identified several particular problems, including failure to follow procedures contained in the licensee's quality assurance programs. The licensee has initiated corrective actions that will be evaluated during future NRC inspections.

Beatty Waste Burial Facility

The results of a major investigation conducted in 1976 at the radioactive waste disposal facility in Beatty, Nev. (see NRC Annual Report 1976 for details) were conveyed to the Department of Justice to determine whether any Federal criminal statutes were violated. The Justice Department completed its investigation in May 1977, and the company was fined $5,000 on each of two counts of failure to confine the use of byproduct materials to the locations specified in the license. The company pleaded *nolo contendere.* At the request of the licensee, the NRC license was terminated.

ENFORCEMENT ACTIVITIES

An enforcement action is taken by the NRC in response to reports of noncompliance. Severity of the action is based on the seriousness of an item of noncompliance; the seriousness of several related circumstances; simultaneous items of noncompliance; or on a licensee's previous compliance record. Several threshold levels of NRC action are provided to allow flexibility in the enforcement action response:

- Written Notices of Violation are provided for all noncompliance with NRC license conditions.
- Civil monetary penalties are provided as an incentive for licensees to assure compliance on a continuing basis. They are considered for licensees that evidence significant or repetitive items of noncompliance. These are generally issued when a Notice of Violation has not been effective. Civil penalties may also be imposed for certain first-of-a-kind violations.
- Orders to "cease and desist" operations, or for modification, suspension, or revocation of licenses, are used to deal swiftly and conclusively with licensees who do not respond to civil penalties or to deal with violations that constitute a significant threat to public health and safety or to the common defense and security.

Tables 1 and 2 summarize the enforcement actions taken during the report period.

GOALS AND INITIATIVES

Revised Inspection Program

During 1977, the Commission authorized the Office of Inspection and Enforcement to proceed

Table 1: Civil Penalties Imposed—FY 1977

LICENSEE	AMOUNT	REASON
1. Astrotech, Incorporated, Harrisburg, Pa.	$ 6,600	Multiple failures in radiation safety program
2. Globe X-Ray Services, Inc., Tulsa, Okla.	$ 8,400	Overexposure of individual
3. Virginia Electric Power Co., Richmond, Va.	$31,900	Construction piping and welding noncompliances. Failure of quality assurance program. (See discussion in Chapters 2 and 12.)
4. Northeast Nuclear Energy Co., Hartford, Conn.	$15,000	Unplanned reactor criticality at Millstone, Unit 1. Senior Reactor Operator license suspended. (See discussion in Chapter 7.)
5. Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.	$ 2,000	Whole body and extremity exposure in excess of regulatory limits. Matter pending before Administrative Law Judge.
6. Radiation Technology, Inc., Rockaway, N.J.	$ 4,800	Failure to notify the Regional Office of an incident involving cobalt activity in an irradiator pool; inadequate instructions to employees; failure to limit radiation levels in unrestricted areas. Matter pending before Administrative Law Judge.
7. Arnold Greene Testing Laboratories, Inc. Natick, Mass.	$ 4,500	Whole body and gonadal exposure in excess of regulatory limits.
8. Atlantic Research Corp., Alexandria, Va.	$ 8,600	Two exposures in excess of regulatory limits. Failure to follow safety procedures in radiation area. Matter pending before Administrative Law Judge.
9. Luminous Processes, Inc., New York, N.Y.	$ 3,250	Inadequate evaluation of airborne radioactive materials and excessive contamination in restricted and unrestricted areas at facility in Ottawa, Illinois
10. Duke Power Company, Charlotte, N.C.	$16,000	Release of more than three curies of radioactivity from contaminated secondary system at the Oconee Nuclear Station, Units 1, 2 and 3.
11. Nuclear Fuel Services, Inc., Erwin, Tenn.	$53,000	Failure to implement required physical security program.
12. Pittsburgh Testing Laboratory, Pittsburgh, Pa.	$ 2,000	Whole body exposure of a member of the general public.
13. Public Service Company of Colorado, Denver, Colo.	$ 8,000	Physical security noncompliance items at the Ft. St. Vrain Nuclear Generating Station. (See discussion in Chapter 7.)
14. Pacific Gas and Electric Co., San Francisco, Calif.	$ 7,500	Two exposures in excess of regulatory limits at Humboldt Bay, Unit 3.
15. Commonwealth Edison Co., Chicago, Ill.	$21,000	Personnel errors resulting in a water hammer followed by actuation of the safety injection system at the Zion station; dummy signals inserted in the reactor protection system logic masked significant parameters related to the reactor coolant system.

Table 2: NRC Enforcement Orders—FY 1977

LICENSEE	DATE	TYPE	REASON
Nuclear Energy Services, Inc., CONAM Inspection Division, Houston, Tex.	11/5/76	Show Cause License Suspension	Whole body exposures of three individuals during field radiographic operations. Rescinded, Nov. 12, 1976 after corrective actions had been taken.
G. A. Doehner, M.D. Freehold, N.J.	12/1/76	Show Cause	Failure to submit certain information requested by the Commission on teletherapy unit. Information submitted and order rescinded, Dec. 8, 1976.
International Chemical and Nuclear Corporation U.S. Nuclear Division Irvine, Calif.	12/7/76	Terminating Proceedings	Terms of June 1, 1968 order for disposition of special nuclear material and decontamination of facilities and equipment had been met.
Lewis T. Crosse, Stonington, Conn.	12/20/76	Show Cause License Suspension	Senior Reactor Operator failed to adequately direct licensed activities and observe conditions of reactor license. Failure resulted in unplanned criticality and reactor trip. Rescinded on February 25, 1977 after recertification and reexamination. (See discussion in Chapter 7.)
Babcock and Wilcox Company, Lynchburg, Va.	2/28/77	Requiring Special Reconciliation of Highly enriched uranium inventory.	Order issued as a result of findings of three material control and accountability inspections conducted at Apollo, PA and Leechburg, VA facilities. (See discussion in Chapters 7 and 12.)
Ohmart Corporation Cincinnati, Ohio	4/7/77	Show Cause License Suspension	Inadequate operating procedures for preventing exposure. Existing operations posed immediate threat to employee health and safety. Rescinded April 18, 1977 after licensee took corrective action. (See discussion in Chapter 7.)
Universal Testing Company, Salt Lake City, Utah	4/12/77	Show Cause	Order issued as a result of investigation into suspected unauthorized use of by-product material by unauthorized individual. Rescinded June 17, 1977 after licensee complied with terms of order.
Bionic Instruments, Inc. Bala-Cynwyd, Pa.	9/3/77	Immediate License Suspension Show Cause	Improper storage of cobalt 50 source.
Radiation Technology, Inc. Rockaway, N.J.	9/23/77	Immediate License Suspension	Employee exposure to about 170 rems.

with a revised inspection program that will place NRC resident inspectors full time onsite at power reactors and at major fuel cycle facilities. This program includes three major elements: (1) resident inspectors; (2) performance appraisal teams that will provide national (as opposed to regional) perspective on licensee performance and the effectiveness of the inspection program; and (3) expanded direct measurement of licensee activities and increased observation of licensee operations.

In 1974, NRC initiated a two-year trial program designed to test the concept of resident inspectors. The trial program involved placing an NRC inspector at Two Rivers, Wisconsin, to inspect the Point Beach and Kewaunee sites, and at Benton Harbor, Michigan, to inspect the D. C. Cook and Palisades sites. The trial was completed in late 1976 and evaluated to determine its costs and benefits. The program demonstrated the feasibility of using resident inspectors and served as the precursor of the expanded resident inspection program.

Specifically, the analysis of the trial showed that:

- Inspector effectiveness was improved through increased direct observation of facility operations. Since the inspectors spent more time at the site, they could directly observe more of the licensee activities as they were performed. Therefore, they did not place as much reliance on reviewing records in evaluating the adequacy of facility operations.
- NRC's awareness of facility status was enhanced because the inspector was onsite more often. In addition, NRC's ability to respond to an event or incident was improved. The plant's accessibility to the inspector, coupled with increased knowledge of the facility and its management, facilitated an accurate and timely reporting of problems to the Regional Office and Headquarters.
- Inspectors developed a greater familiarity with plant systems and operating procedures. As a result, licensees devoted less effort to obtaining information for the inspector. Licensee acceptance of the inspector resulted in freer access to the facility and the operating level personnel. This increased the independence of the overall inspection effort.
- Licensee attention to NRC requirements was enhanced as the onsite time of the NRC inspectors was increased.
- There was no indication of loss of inspector objectivity associated with the trial program.

The revised inspection program affords a balanced examination of licensee activities that contribute to safety, safeguards and environmental protection. The resident inspectors will determine whether licensee safety, safeguards and environmental protection activities are adequate and, by observing selected activities, will verify that they are conducted properly and at the required frequency. Specific technical support will be provided by regionally based technical specialists.

In addition, the inspection program conducted by the resident inspector will be complemented by a performance appraisal program that will assess, on a national basis, the safety performance of electric utilities that operate nuclear power plants. Performance appraisal will involve assessment teams which will make in-depth measurements of various aspects of reactor construction and operation. The teams will analyze inspection and licensee reports to identify potential weak spots and correct developing problems before they present a threat to the public. The teams will also examine the performance of the resident and regional inspectors to assure uniformity and objectivity in the NRC inspection program. Thus, the performance appraisal team will provide a national perspective of both licensee and NRC inspection performance.

As the new program develops, resident, regional and performance appraisal inspectors will perform an increasing number of independent confirmatory tests or measurements at the licensee's site. While some radiological measurements have been performed since the early 1970's, NRC is considering a substantial increase in other areas such as nondestructive examination (radiography, ultrasonic testing, etc.) and instrument calibration. The purpose of these measurements will be to gain greater confidence that the licensee's quality assurance system is performing properly.

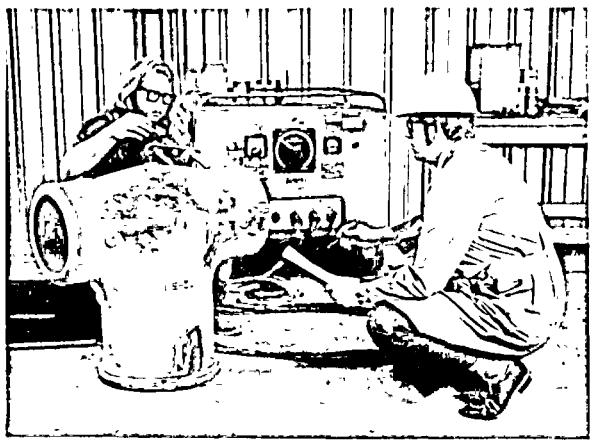
In addition, NRC believes there is more information to be gained about the effectiveness of management controls through observation of an operation or a test in progress than by solely examining records of operations and tests. Thus NRC is considering increasing observation of preoperational tests, power ascension tests, surveillance tests, routine maintenance and operations.

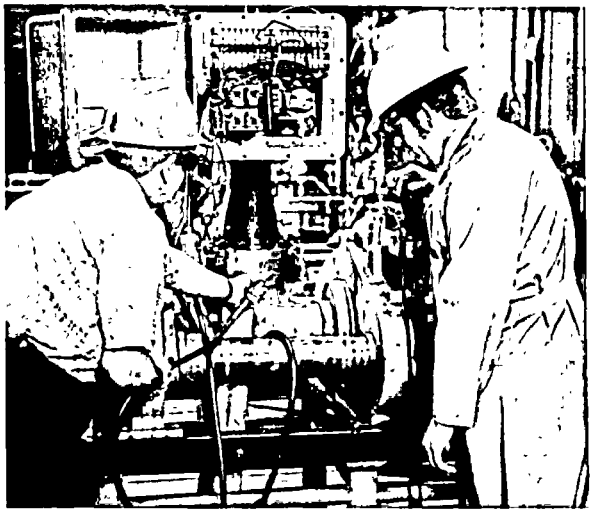
This revised program preserves the underlying philosophy that the licensee is responsible for all safety, safeguards and environmental measures necessary to protect the public. None of the additional observations, tests or measurements performed by NRC will replace any of those performed by the licensee but will serve to verify the licensee's ability to accurately conduct these tests.

Initial implementation is scheduled for 20 sites during 1978 with full implementation in 1981.

Incident Response Center

Over the past year, progress has been made on plans and preparations for prompt and effective





In addition to inspecting reactor sites and construction, under the vendor inspection program NRC also checks on the fabrication of major components of nuclear power plants. During an inspection at this valve manufacturing company, an NRC inspector verifies whether the work is being performed by qualified people using approved procedures. The inspection includes observing such procedures as welding, magnetic particle examination, hydrostatic testing, and final cleaning and packaging of the product for shipment.

NRC response to situations that pose an actual or potential threat to the health and safety of the public. An interim Incident Response Center is located at the Headquarters of the Office of Inspection and Enforcement in Bethesda, Md. Construction of a permanent Operations Center is scheduled for completion during 1978. The center will consist of a conference room for briefing NRC management, a large work room for the technical support staff, a secure communications room, word processing and computer support areas, and a library to house necessary information resources. As of the close of the report period, it had not been necessary to use the interim center in response to an incident.

Third-Party Inspection Program

The Office of Inspection and Enforcement has initiated a two-year trial program starting in June 1977 with the American Society of Mechanical Engineers (ASME), to test the feasibility of using third-party inspection systems to supplement the Licensee Contractor and Vendor Inspection Program (LCVIP).

Third-party organizations are those which provide inspection services that are not under the control of either a licensee or its agents, suppliers or manufacturers. Under the ASME code inspection system, inspections are performed by either insurance companies or State agencies. During the two-year trial period, NRC's staff will inspect all aspects of the existing ASME code inspection system. Sufficient information will be gathered to evaluate the system and to identify changes necessary to assure compatibility with NRC requirements. The NRC staff will continue its routine inspection of suppliers during the trial program.

The program is expected to benefit both the NRC, through expanding the inspection of vendors without expanding the inspection staff, and the ASME. Cost savings may also result from the reductions in the duplication of inspection by licensees, their contractors, the ASME and the NRC.

Reporting Defects and Noncompliance

On June 6, 1977, the NRC published 10 CFR 21 in the *Federal Register*, setting forth the requirements for implementing Section 206 of the Energy Reorganization Act of 1974. Part 21 provides for the reporting of noncompliance with regulations or the existence of defects by individual directors or responsible officers of a firm involved in the nuclear industry. Any director or responsible officer subject to the regulations who fails to provide the required notice to the NRC is subject to a civil penalty not to exceed $5,000 for each failure and a total amount not to exceed $25,000 within any 30-day period for all failures to provide the required notice.

The impact of Part 21 on NRC's reactor inspection program is not yet known. Follow-up inspections or investigations may be required, if and when notifications are submitted to NRC.

Resource Allocation and Management

The Office of Inspection and Enforcement has recently undertaken the development of a resource management system that will provide:

- Methods and measures to assist management in assessing the effectiveness of inspection and investigation policies and programs.
- A consistent methodology for forecasting program needs and allocating resources to meet them.

The results and products will be used to develop budget requests and evaluate alternative policies and programs. Initial results are expected in time for application in the fiscal year 1979 budget formulation process.

Closely related to the resource management system is a program for improving the manpower management within the Office of Inspection and Enforcement. This program will involve: the definition of qualifications needed for specific job/position classifications in the Office; the development of comprehensive career plans for employee progression; an assessment of the current Inspection and Enforcement Professional Training Program; and the development of a model to forecast composition and needs of the Inspection and Enforcement work force.

Enforcement Initiatives

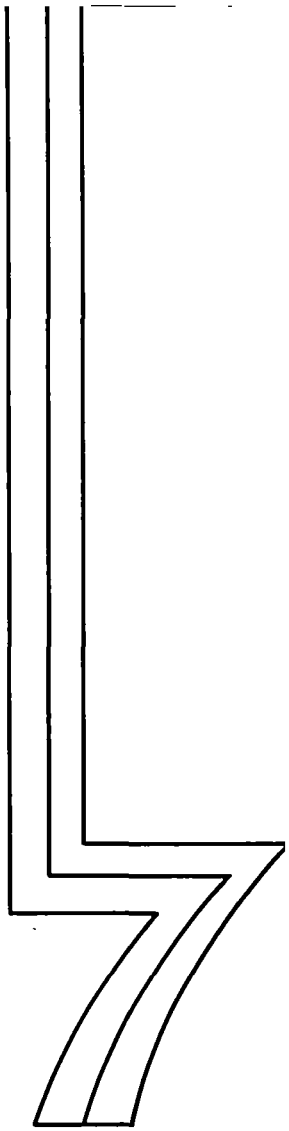
As part of the continuing examination of its programs, the Office of Inspection and Enforcement is looking at enforcement activities to identify possible improvements. Expanding the scope of motivational activities to include positive incentives for licensees could possibly provide additional encouragement for safe and compliant operations. The NRC inspection program is designed to ascertain whether licensees are complying with their license

requirements in a consistent and reliable manner. Accordingly, licensees who have good performance histories should receive appropriate credit from the NRC, perhaps by reducing the normal inspection frequency in certain selected areas.

Tied very closely to efforts to motivate safe operation of nuclear power plants is the development of a system to evaluate the performance and safety record of licensees. NRC is examining techniques and systems for analyzing inspection results, licensee-generated reports and other information to develop a means for assessing how well licensees are meeting their regulatory requirements. If trends that indicate potential problem areas can be identified, NRC can take the action necessary to achieve correction of the item before it threatens the public health and safety.

Finally, NRC is examining the administration of the current enforcement actions to identify areas of possible improvement. The timeliness, clarity and completeness of enforcement activities are all important factors in achieving correction of deficient areas. Any improvements that can be made in this area will enhance the effectiveness of the enforcement program.

Operating Experience



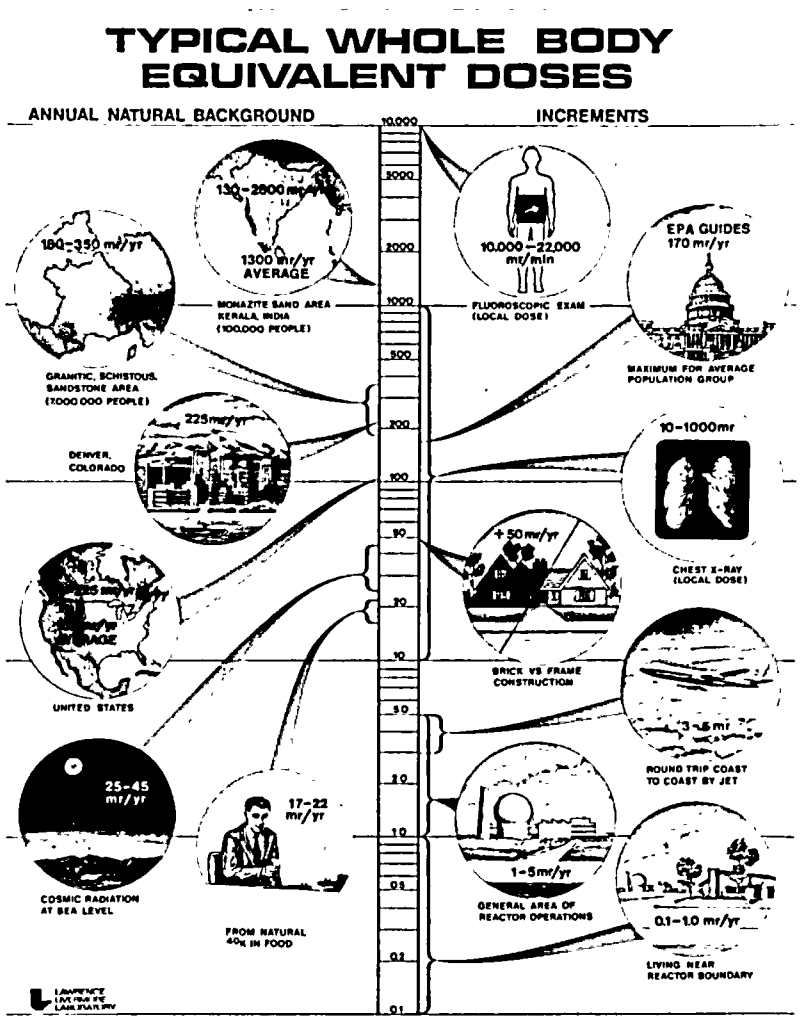
There are two major sources from which the NRC receives information essential to its mission of assuring that civilian uses of nuclear energy are safely carried out: experiment and experience. By sponsoring confirmatory research on a large scale (Chapter 11) and by closely monitoring the actual operating experience of its licensees (the subject of this chapter), the NRC is enabled to confirm the bases of existing regulation and to uncover areas where regulation may need to be altered, refined, supplemented or supplanted. It should be noted that the unplanned and abnormal events which have occurred during the report period in licensed nuclear power plants have taken place within the context of an overall safety record for these kinds of facilities of 366 reactor years of operation without any accident causing detectable injury to the general public, as of December 31, 1977.

Included in this chapter are: (1) a discussion of possible changes in reporting requirements placed on licensees, currently under consideration by the Commission; (2) a summary of occupational radiation exposures, i.e., exposures to employees in licensed facilities; (3) a description of the "abnormal occurrences" reported to the Congress, as required by law, during the report period.

RELIABILITY DATA SYSTEM

In his April 1977 message on energy, the President called on the NRC "to make mandatory the current voluntary reporting of minor mishaps and component failures at operating reactors, in order to develop the reliable data base needed to improve reactor design and operating practice." NRC's Office of Management Information and Program Control was given the responsibility to develop criteria and options for a reporting program in response to the presidential request. Such a program—incorporating the existing Nuclear Plant Reliability Data System (NPRDS)—was forwarded to the Commission in August 1977 and the Commission expressed the view that any mandatory system should be the subject of a rulemaking proceeding in which industry, the public and interested parties will be given the opportunity to express their views. Criteria proposed for evaluating the program, which would entail mandatory licensee participation, include:

(1) Near-term effectiveness: a reporting system must produce a



This chart compares the relative doses received from natural background radiation with those from other sources of radiation.

quality data base for time-sensitive statistical treatment of failure-rate data and the application of reliability techniques.

(2) Standardized reporting: nuclear plant licensees must use a uniform reporting system.

(3) Long-term stability: benefits from the reporting system should accrue to the public, the licensees and the government agencies involved with a minimum of alterations in the system over time.

(4) Benefit-cost impact: this is a major consideration in all new programs.

Occupational Exposures

The NRC requires that external and internal radiation doses to persons employed in occupations involving potential exposure to radiation shall be controlled within strict limits. The NRC standards define the permissible occupational dose in rems-per-calendar-quarter (a rem is a measure of the biological effect of ionizing radiation, being equivalent to the effect of one roentgen of x-radiation). These allowable limits are set forth in 10 CFR Part 20.

The NRC collects, on a calendar year basis, occupational radiation exposure information from the four categories of licensees considered to have the greatest potential for significant personnel exposures: operating nuclear power reactor licensees, industrial radiographers, fuel fabricators and processors, and commercial processors and distributors of specified quantities of byproduct materials.

The annual reports collected from these 450 licensees disclosed that some 92,800 individuals were monitored during 1976 and that nearly half of these persons received exposures that were too small to be detected by personnel radiation monitoring devices. Only three exposures exceeded the maxi-

mum annual limit of 12 rems established by Federal regulations. The cumulative exposures received by all 92,800 individuals was 33,000 "man-rems"—an average exposure of 0.36 rem per person. This is the same average exposure as reported for 1975 (see 1976 NRC Annual Report, page 108). Most of these exposures occurred at the 62 nuclear power plants operating during 1976, where 66,800 persons accumulated a total of 26,555 man-rems (see NUREG-0322).

Exposure information is also collected from these licensees by way of employee termination reports submitted to the NRC whenever an individual completes his employment or work assignment with one of them. These reports revealed that more than 32,000 persons terminated employment with these four categories of licensed facilities during 1976, and that 14,200 of these workers did so more than once. A continuing increase in these figures, at a rate of more than 20 percent each year, indicates a trend toward a greater use of short-term workers in nuclear power plant maintenance.

ABNORMAL OCCURRENCES—1977

Under Section 208 of the Energy Reorganization Act of 1974, the NRC is required to "...submit to the Congress each quarter a report listing for that period any abnormal occurrences at or associated with any facility which is licensed or otherwise regulated pursuant to the Atomic Energy Act of 1954, as amended, or pursuant to this Act. For the purpose of this section, an abnormal occurrence is an unscheduled incident or event which the Commission determines is significant from the standpoint of public health or safety...."

To make the requisite determination, the NRC applies the criterion promulgated in an NRC policy statement (42 FR 10950) on February 24, 1977. This statement defines an abnormal occurrence as an unscheduled incident or event which involves "a major reduction in the degree of protection of the public health or safety. Such an event would involve a moderate or more severe impact on the public health or safety and could include but need not be limited to:

"(1) Moderate exposure to, or release of, radioactive material licensed by or otherwise regulated by the Commission;

"(2) Major degradation of essential safety-related equipment; or

"(3) Major deficiencies in design, construction, use of, or management controls for licensed facilities or material."

During fiscal year 1977, a total of 19 events were determined to be abnormal occurrences. A summary of these follows.

Loss of Electrical Power

On July 5, 1976, while Millstone Power Station Unit 2 (New London County, Conn.) was being shut down for maintenance, the reactor inadvertently "tripped" (automatically shut down). Several motors, not safety-related, failed to start up as they should have under such circumstances. Their failure to start was traced to blown fuses on the individual motor controllers. In preparing for the scheduled shutdown of Unit 2, plant personnel had transferred in-plant electrical loads to the electrical power network, or grid. When Unit 2 tripped, grid transmission voltage dropped. This led to a voltage on the 480-volt motor control center buses too low to pull in the motor's mainline contactors, a condition which prevented the motors from being energized. For this reason, overcurrent was drawn by the contactors, causing the control power fuses to blow.

The licensee treated the situation as a safety concern on the grounds that, under similar low voltage conditions, the operability of the similarly designed 480-volt Engineered Safety Features Actuation System (ESFAS) might not be assured. The immediate corrective action taken was to raise the set point of the ESFAS "loss of power" undervoltage relays so as to assure that emergency power systems would be made operational, with the plant safety system connected to them instead of the offsite power grid.

On July 21, however, the following events took place. With the plant at 100 percent power, the start of a 1500 HP circulating water pump caused the emergency bus voltage to drop below the new ESFAS undervoltage relay settings. Actuation of the undervoltage relays then caused the emergency diesel generators to start, all according to design. The diesels attained rated speed and, when they were capable of accepting load in normal sequence, the load sequence controllers worked correctly. The high in-rush of current required to energize each safety related load in the sequence, however, caused the bus voltages to drop below the new ESFAS undervoltage setting. The undervoltage trip then actuated, causing the load to be shed from the bus. This occurred repeatedly with each load in the sequence.

Upon completion of the sequencing routine, the diesels were at speed and capable of accepting load, and the emergency buses were energized and locked onto the diesels, but safety-related equipment was not being powered because of the undervoltage trips.

This loss of emergency and auxiliary power lasted about five minutes. The plant operators recognized the problem and restored offsite power for emergency and auxiliary equipment by manually lowering the undervoltage setpoint. Because of this

prompt action, there was no adverse consequence from the loss of alternating current (AC) emergency power. Even without the availability of the AC power, diverse and redundant safety resources, such as the steam driven auxiliary feedwater pump, assured that the reactor could be safely shut down, if necessary. But the incidents brought to light a potential "common mode" failure that could have serious consequences if it took place under abnormal conditions. Specifically, a loss of availability of the safety-related 480-volt equipment at the plant could mean that plant operators would be unable to deal with certain postulated accident conditions.

The cause of these incidents was complex in both instances. The July 5 problem was the result of a design defect—improper tap settings on certain voltage stepdown transformers—in combination with a degraded off-site grid voltage which led to inadequate in-plant bus voltages causing the power fuses to blow when the equipment was signaled to start. The July 21 incident came about as a result of a combination of three factors: (1) raising of the ESFAS "loss of power" undervoltage relay set points, in response to the incident of July 5; (2) a design deficiency in the test circuit used to adjust and verify the undervoltage trip set point; and (3) a design deficiency which permitted load shedding from the emergency buses on transient undervoltage after the emergency buses were energized from the onsite emergency power sources (the diesel generators).

Before returning the plant to operation, the licensee took the following corrective action:

- In-plant transformer taps were changed to optimize the voltage at the various buses over the range of grid voltage and inplant load conditions.
- The design of the load shedding feature was modified to prevent load shedding after the diesels have started and energized the emergency buses.
- The design of the undervoltage trip logic was modified to allow plant operation on off-site power during grid voltage transients while preventing operation on off-site power under sustained degraded grid voltage conditions (longer than eight seconds).
- The design of the undervoltage trip test circuit was modified to correct the original design deficiency.

These changes were reviewed in detail and approved in advance by the NRC. Prior to restart of the plant, the NRC issued license amendments to authorize the proposed modifications and verified their implementation by subsequent inspection. In addition, the NRC decided to treat the problem associated with undervoltage protection as a generic safety concern and requested specific information from all licensees who might be affected by it. These licensees have all responded and have optimized their transformer tap settings, thus greatly reducing any concerns about continued operation. Meanwhile, NRC has developed criteria by which to assure that defense-in-depth has been provided against any degraded grid condition. These criteria are being applied to all operating nuclear power plants and to those plants currently under licensing review.

Nuclear Core Power Distribution

The Florida Power and Light Company of Miami, Fla., an NRC licensee, reported this occurrence at its St. Lucie Plant, Unit 1.

The Unit 1 reactor at the St. Lucie plant was licensed by NRC for operation on March 1, 1976, and the licensee proceeded with initial zero power and power ascension testing. Through May of 1976, tests indicated that the reactor core characteristics were matching predictions. Just prior to a June 12 maintenance shutdown of the reactor, unpredicted behavior was detected affecting three core characteristics—axial power shape, radial power distribution, and gross core reactivity. When the reactor was returned to power on June 18, the magnitude of the anomalous behavior in these aspects of the reactor operation increased in a gradual and uniform manner.

Following power ascension testing on July 8, 1976 at the 20, 50 and 80 percent power levels, the unit's azimuthal power tilt—a measure of reactor power distribution symmetry—had been about 3 percent, compared to expectations of no more than about 2 percent. On July 9, the licensee decided to shut down the reactor to a "hot shutdown" condition for testing, on the basis of an azimuthal power tilt as high as 4 percent; axial peak of 1.53, as against an expected value no greater than 1.35; and core reactivity about 0.4 percent greater than expected. Subsequent control rod symmetry checks and rod worth measurements confirmed the presence of the tilt and of the increased axial peaking.

The reactor was shut down and the reactor vessel internals were inspected. A borescopic examination of fuel bundles removed from the core revealed blistering and breaches of the "lumped burnable poison" (LBP) rods. Each of these consists of a stack of alumina pellets, with boron carbide particles uniformly distributed throughout the alumina, clad with Zircaloy tubes; the rods are used to help shape the power distribution in the core and to reduce the amount of soluble boron required in the primary coolant.

Detailed metallographic examination of a number of LBP rods showed the defects to be the result of hydriding of the Zircaloy cladding, brought about by internal moisture. Some rods were subjected to reactivity measurements in the Advanced Reactivity Measurement Facility at the Idaho National Engineering Laboratory. Some of the boron content of the perforated rods was found to be gone and some had been redeposited toward the ends of the rods. This depletion and redistribution of boron in the LBP rods was sufficient to fully explain the measured reactivity increase and axial peaking, while the azimuthal power tilt could be accounted for in terms of a statistical variation in the distribution of defective rods.

All of the LBP rods in the reactor were replaced and reinstallation of the fuel in St. Lucie Unit 1 was completed late in 1976. The NRC confirmed that all other plants using LBP rods of the same manufacture were performing frequent in-core surveillance to assure that a similar problem did not exist elsewhere. NRC also requested that, as the potentially affected reactors were shut down at the end of a fuel cycle, the core be examined for this kind of deficiency.

Steam Generator Tube Integrity

The heat produced in the reactor at a nuclear power plant is used to convert water into steam which will drive the turbine-generators. In plants employing pressurized water reactors, the primary coolant water which extracts heat by circulating through the reactor core is kept under pressure sufficient to prevent boiling. This high-pressure water passes through tubes around which a secondary coolant (also water) is circulating, under somewhat lower pressure. The water in the secondary system is allowed to boil and produce steam to drive the turbine-generators. The assembly in which the transfer takes place is the steam generator. The tubes within it are an integral part of the primary coolant boundary, keeping the radioactive primary coolant in a closed system and isolated from the environment. Thus a loss of integrity (i.e., a leak) in the steam generator tubes would let radioactivity enter the secondary system where it might escape to the environment.

On September 15, 1976, an event at the Virginia Electric and Power Company's Surry Power Station, Unit 2, in Surry County, Virginia, led to the identification of a generic safety concern associated with the progressive degeneration of steam generator tubes at several facilities. A leak had developed rapidly in one of these tubes, because of what was later determined to be intergranular stress corrosion. The leak was quickly detected and the reactor promptly shut down; off-site releases of radioactivity during the event were within regulatory limits.

Corrosion of steam generator tubes had caused some difficulty in the past and several plants, including Surry Unit 2, had made major changes in their secondary water treatment process to combat it. (See 1976 NRC Annual Report, page 26.) These changes, however, gave rise to a new phenomenon at certain plants: a build-up of corrosion products in the annulus between the tubes and their support plates which eventually causes "denting" of the tubes diametrically and deformation of the support plate. The high stress levels induced in the U-bend section of the Surry Unit 2 tubes were evidently brought about by the same process as was responsible for the tube denting, i.e., the expansion of corrosion products in the annulus leading to deformation of the support plate.

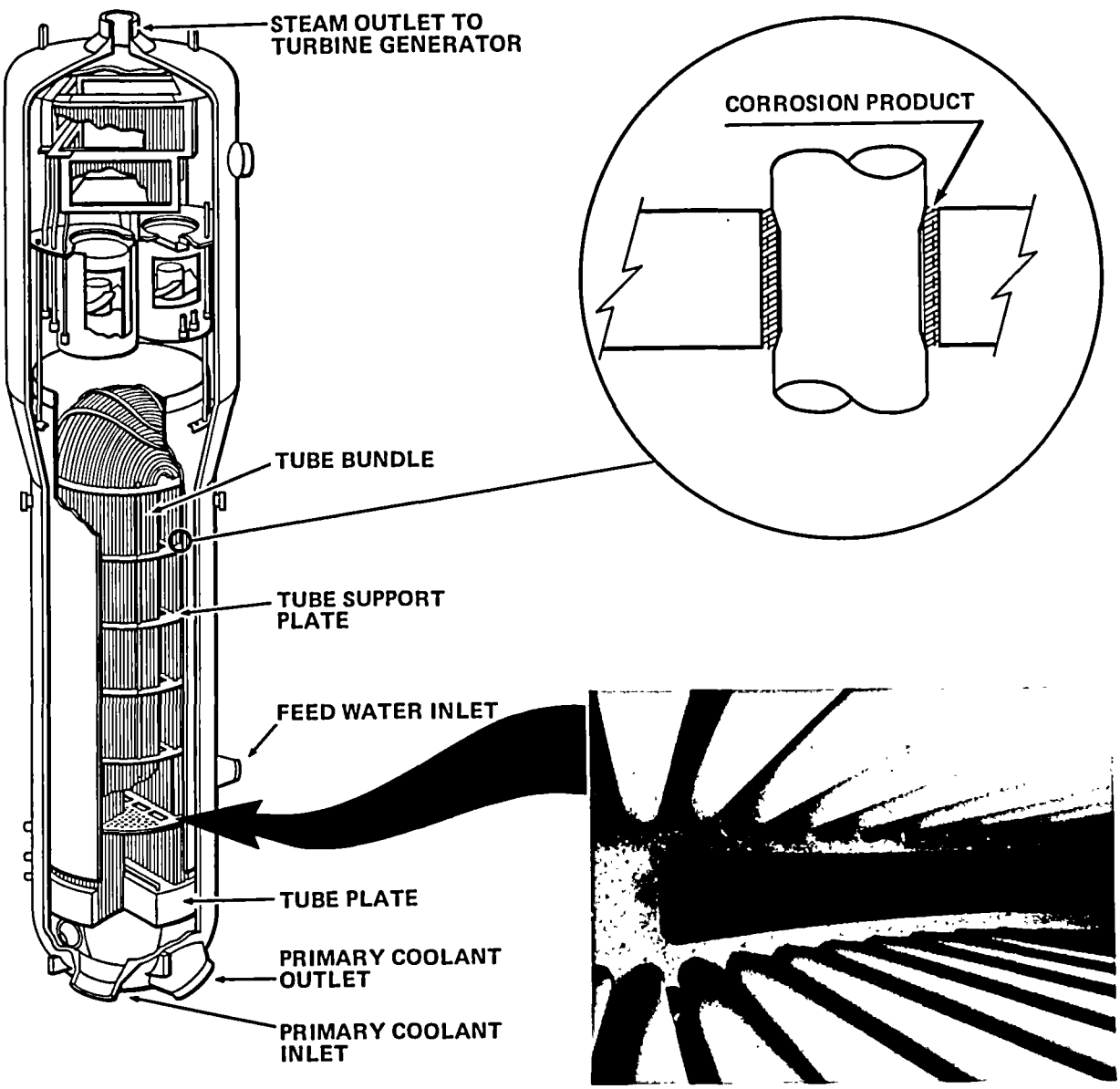
During the first half of 1977, a number of developments took place involving PWR steam generator tubes. They were:

- The discovery of several tube leaks at the Duke Power Company's Oconee Nuclear Station, Units 1, 2 and 3, in Seneca County, S.C., whose reactors had been manufactured by Babcock & Wilcox, Inc.
- Continued degradation of steam generator tubes because of "denting" in the Westinghouse reactors at Surry Units 1 and 2 and in the Florida Power & Light Company's Turkey Point Unit 4;
- Discovery of the denting phenomenon in May 1977 at Maine Yankee Atomic Power Company's Maine Yankee Unit in Lincoln County, Me., and at Northeast Nuclear Energy Company's Millstone Nuclear Power Station, Unit 2, located in New London County, Conn. Reactors at both units were manufactured by Combustion Engineering, Inc. and had used "all volatile treatment" of the secondary coolant from initial startup. It had been thought that lack of this treatment in the other affected plants might have contributed to the tube degradation.

A summary of events involving this problem, and of corrective responses to it by the manufacturers of the PWRs affected, follows.

Babcock & Wilcox Facilities. The first tube leak at the Oconee Station, cited above, was detected in July 1976 and was considered an isolated event caused by aggravation of a manufacturing defect. However, during the last quarter of 1976 and first quarter of 1977, a total of seven plant shutdowns took place to plug leaking tubes. Most of the leaking tubes were adjacent to the "open tube lane," an

PWR STEAM GENERATOR



The buildup of corrosion deposits between the steam generator tubes and the tube support plates, in addition to constricting the tubes, exerts stresses on the tube support plates. The stresses cause hourglassing of the normally rectangular internal bypass flow holes located between the innermost tube rows.

area where one row of tubes was omitted during manufacture to facilitate inspection.

Laboratory examination of the defective tubes showed that the failures were caused by propagation of small cracks from flow-induced vibration. The initiating mechanism behind the cracking is not yet fully understood, but there are indications that the small cracks may have been started by frequent turbine stop and control valve operability tests, which may have caused pressure or flow transients in the steam generators.

As an interim measure, Babcock & Wilcox, Inc., has recommended that the frequency of the turbine stop valve testing, and the power level at which such testing is conducted, both be reduced. The licensee and vendor are investigating the recurring tube degradation at the Oconee plant, and NRC is closely monitoring their efforts. At the close of the report

period, there had been no similar occurrence in other plants with the Babcock and Wilcox "once through" steam generator design. Neither had there been evidence of tube failure from the "denting" associated with the circulating (U-tube) steam generator design or of failure attributable to intergranular stress corrosion.

Westinghouse Facilities. The "denting" of steam generator tubes was first discovered in several plants with reactors and steam supply systems manufactured by Westinghouse Electric Corporation, including Surry Units 1 and 2 and Turkey Point Units 3 and 4. During the half-year following the leak in the U-bend section of a tube at Surry Unit 2, discussed above, several smaller tube leaks located within the tube support plates occurred at Surry Units 1 and 2 and at Turkey Point Unit 4.

Laboratory examinations of defective tubes from these plants indicated that the failures at Surry Units 1 and 2 and Turkey Point Unit 4 were due to small longitudinal cracks in tube sections within the tube support plates. These cracks were caused by stress corrosion cracking in the primary coolant side of severely dented tubes.

A survey of previously submitted steam generator inspection results showed that six Westinghouse-manufactured units had had the potential for the kind of severe U-bend leak which had occurred at Surry Unit 2 in September 1976. These six plants were subsequently shut down to inspect the condition of the tubes at the U-bend sections and to determine the degree of denting. Analysis of the stress condition at the top of the U-bend section and laboratory data demonstrated that only the innermost row of tubes was susceptible to the type of failure which had occurred at Surry Unit 2. The licensees for the six affected plants plugged all the tubes in the susceptible row.

The vendor's tests and analyses indicate that tube leaks or cracks attributable to the denting phenomenon will not result in adverse consequences during either normal plant operation or during postulated accident conditions. Nonetheless, continued deterioration and plugging of tubes in these units could eventually lead to a reduction of heat transfer capability in the steam generators that would decrease the capacity to generate electricity. Ultimately it could become economically infeasible to operate a severely affected unit. For these reasons, the licensees have taken steps to replace the steam generators or steam generator "internals" at the Surry and Turkey Point units. Replacement steam generators had been ordered and installation plans were being developed at the end of the report period.

Combustion Engineering Facilities. For some time, the phenomenon of tube "denting" had been observed only in plants that had been using phosphate treatment for the secondary coolant, or had converted from phosphate treatment to all volatile treatment (AVT). In May 1977, however, in-service inspection at the Maine Yankee plant, a Combustion Engineering, Inc., (CE) unit which had used AVT from the outset of operation, disclosed tube denting. The CE steam generator design includes only two drilled support plates—solid plates with drilled holes to allow passage of the steam generator tubes—as contrasted with the Westinghouse design in which all support plates are drilled; thus the number of locations susceptible to the denting phenomenon is considerably lower in the CE generators. The findings at the Maine Yankee unit, however, led to inspection of the CE steam generators at the Millstone Unit 2 plant in May 1977 and denting was found there also. Though apparently of minor degree, the denting at these units represented the first instance of this particular problem in plants which had used AVT exclusively since initial start-up. First indications were that the denting in these units could be attributed to frequent condenser tube failures and a resultant chloride contamination of the secondary coolant.

Licensees for these two facilities repaired their condensers and, in cooperation with CE, explored various short-term cleaning processes for their steam generators and applied the most effective of them before restarting the unit.

The vendors are actively engaged in finding a long-term solution to the problem. The NRC is studying its generic implications, and is working with the three vendors and the affected utilities to resolve the matter.

Nuclear Material Discrepancies

Over a period beginning in April 1974, there were increasing discrepancies at the Babcock and Wilcox Company's Apollo, Pa., and Leechburg, Pa., high-enriched uranium fuel fabrication facilities between the amount of nuclear material physically and verifiably present in the plant and the amount recorded as present on the books. (The term applied to such discrepancies is "inventory difference," or MUF, for "material unaccounted for.") The facilities, where high-enriched uranium fuel for naval reactors was being fabricated, were temporarily shut down in August 1976 for a re-inventory to try to resolve the discrepancies. A continual loss or gain in material on hand as against material on record may indicate problems in bookkeeping or in measuring techniques and practices. Large inventory differences are of concern because they could be indicative of a diversion of nuclear materials to unauthorized uses, despite the stringent security measures in

effect to detect and prevent any movement of nuclear material out of the facility.

During the first half of 1976, both the NRC and the licensee formed task forces to evaluate the latter's material control and accounting program. The NRC group examined controls, records and processes within the plant, giving particular attention to identifying possible "loss paths" which might account for the inventory difference. Personnel from the National Bureau of Standards and the Energy Research and Development Administration participated in the task force. Preliminary findings of the NRC task force during the first half of 1976 had indicated that inaccurate measurements and undocumented losses were the major reasons for the cumulative inventory disparity. Deficiencies in the material control and accounting program principally involved the measurement of scrap recovery, liquid and gaseous effluents, receipts and shipments, highly enriched uranium wastes for burial, and losses in contaminated clothing. The NRC review also concluded that there had been undocumented transfers from the high-enriched uranium account to the low-enriched uranium account.

The licensee was permitted to resume operations under stricter license conditions and contingent upon a commitment to implement a fundamental nuclear material control plan. The NRC inspected the licensee's operations on three occasions during the period from December 27, 1976 to February 4, 1977. These inspections revealed that the licensee had not fully met the new conditions. The NRC issued an order on February 28, 1977, requiring that the licensee take "special actions in the reconciliation of the highly enriched uranium physical inventory taken on February 22, 1977." These actions were to include the processing of scrap materials with relatively high "measurement uncertainty" through the scrap recovery operation to a form with low measurement uncertainty, and the processing of any volume of material showing a deviation from recorded and expected percentage of enrichment through the scrap recovery operation or through re-measurement.

The NRC ordered that these actions be completed and that any remaining unresolved inventory difference be satisfactorily accounted for by mid-April 1977. On March 21, 1977, the licensee requested a hearing with respect to the NRC order, and a pre-hearing conference was scheduled for April 22. On that date, the licensee and the NRC presented to the Atomic Safety and Licensing Board (ASLB) a stipulation for settlement which affirmed to the board that all the requirements of the NRC order had in fact been complied with by the licensee and that the matters covered by the Order were not a subject of dispute. The ASLB issued a memorandum accepting the stipulation of the parties and terminating the hearing process. The licensee received written consent from the NRC for a resumption of normal operations at the plant.

However, the NRC further required that the licensee submit a plan for upgrading the accounting and control system for high-enriched uranium. The plan was submitted in June 1977 and appropriate sections of it were being incorporated into the license requirements at the close of the report period.

An NRC task force's evaluation, completed in July 1977, concluded that for the 29-month period extending from April 1974 to August 1976, a total of 51 kilograms out of the 90-kilogram MUF could be accounted for in terms of certain previously "unidentified and undocumented loss mechanisms." These mechanisms included the following: (1) loss of high-enriched uranium through commingling with low-enriched uranium; (2) liquid and gas effluents discharged from incinerator scrubber systems; (3) loss of high-enriched uranium via the transfer of contaminated clothing to the licensee's laundry facility; (4) understated accounts of waste shipped for burial; (5) deposits of high-enriched uranium held up in the processing equipment; (6) material embedded in the flooring. The remaining 39-kilogram differential between the inventories was judged to be consistent with inevitable uncertainties in the measurement system and errors in the accounting system.

The NRC has no reason to believe in this case that inventory differences between quantities of material on record and those physically on hand are not explained by the "loss paths" inherent in the operation, discussed above. That does not mean that an inventory difference is acceptable or assumed to be innocuous. Analysis of such differences is part of the material accounting system, and that system is an integral part of the safeguards required in nuclear facilities. Thus NRC bases its judgment and directives on information provided not only by the material accounting system, with its inherent uncertainties, but also on the internal control system, the physical security system, NRC inspections and evaluations, and both NRC and licensee investigations.

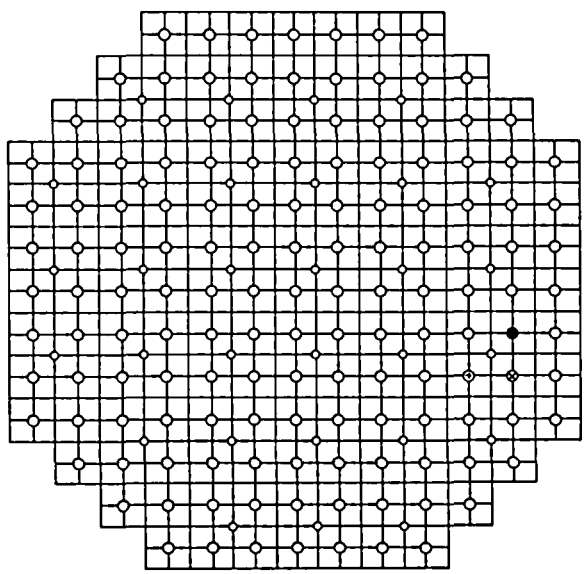
NRC is continuing an intensive inspection program at the licensee's Pennsylvania facilities in order to assure (1) that the licensee's corrective actions are prompt and correct; (2) that the licensee is in compliance with regulatory requirements; and (3) that the licensee has adequate safeguards for the high enriched uranium in its custody.

An unclassified digest of the classified task force report on the inventory differences experienced at these facilities between April 1, 1974 and August 18, 1976 was published on April 25, 1977 under the title "NRC Task Force Report" and was placed in the NRC Public Document Room in Washington, D.C.

Unplanned Reactor Criticality

The reactor at the Millstone Nuclear Power Station, Unit 1, in Connecticut had been shut down for refueling at the time this event took place. The reactor core was partially loaded and testing was in progress on November 12, 1976 to verify the "shutdown margin" with the "strongest" control rod fully withdrawn. Because of personnel error, and inadequate procedural practice, an adjacent control rod had been partially withdrawn when the designated "high worth" rod was withdrawn as part of the verification process. When the latter rod was moved, an unplanned criticality took place in the section of the reactor core involved, resulting in an automatic shutdown of the reactor. Following this mishap, the whole procedure was repeated, including the erroneous withdrawal of the adjacent rod, and only the immediate insertion of the high worth control rod prevented a second automatic reactor shutdown.

MILLSTONE POINT UNIT NO. 1
CORE 5



□ FUEL BUNDLE
○ CONTROL ROD
● HIGH WORTH CONTROL ROD
⊕ ROD SCHEDULED TO BE PULLED
⊗ ROD ERRONEOUSLY PULLED

There was no consequence to the general public or to plant employees from the episode. There were, however, plant personnel on the refueling floor whose safety was jeopardized.

The event was caused by a combination of personnel error, procedural inadequacies, and a failure in administrative control.

On receiving word of the incident from the licensee by phone, the NRC immediately halted all operations at the plant involving fuel loading and control rod movement. Fuel loading was permitted to continue following confirmation by NRC that appropriate corrective and preventive measures had been taken by the licensee and NRC inspectors monitored control room activities at the plant until all fuel loading and control rod testing was completed. The licensee initiated a training program for its personnel, and additional supervisory personnel were assigned to the control room to observe operations. The licensee also took formal action against two of its personnel.

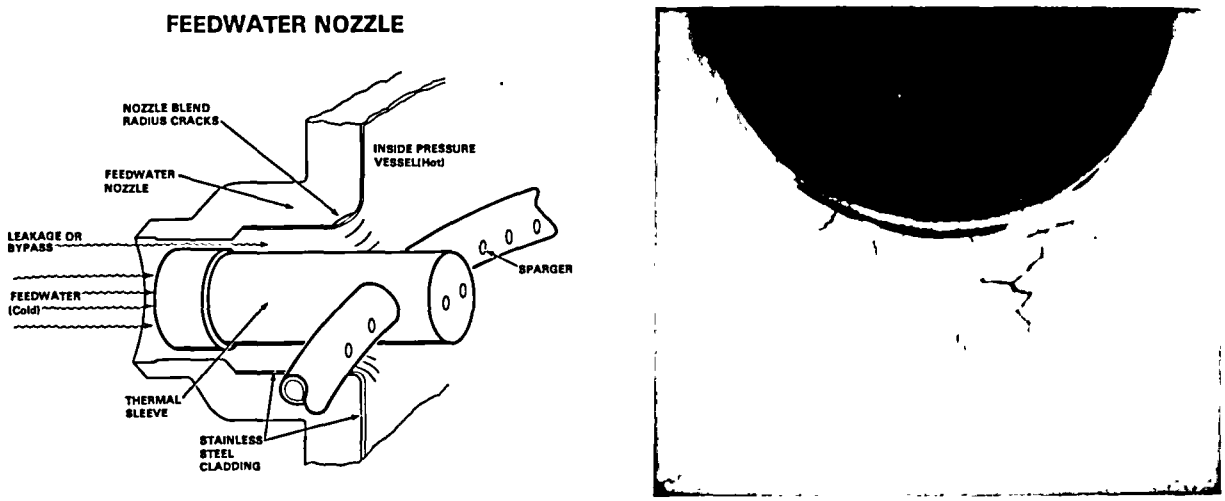
Subsequent enforcement action by the NRC included the imposition of civil penalties in the amount of $15,000 against the licensee, suspension of a senior reactor operator's license, and an enforcement citation against the other licensed operator.

Feedwater Nozzle Cracking

Beginning in 1974, inspections at 20 of the 22 boiling water reactor (BWR) plants licensed for operation in the U.S. have disclosed some degree of cracking in the feedwater nozzles of the reactor vessel at all but two facilities. The exceptions were a plant with less than one year of operation and a plant with welded thermal nozzle sleeves. Two other facilities have not yet accumulated significant operating time and have not yet been inspected.

The feedwater nozzles, part of the "pressure vessel," are an integral part of the primary pressure boundary of the reactor coolant system and the second barrier (after the fuel cladding) to the release of radioactive fission products. None of the cracks found in the BWR feedwater nozzles exceeded the pressure vessel code limits, however, and no immediate action was called for other than removal of the cracks by grinding. Because relatively small amounts of metal have been removed, there has been no significant reduction in safety margins. Nevertheless, the cracking is potentially serious for these reasons:

- Excessive crack growth could lead to impairment of pressure vessel safety margins requiring more complicated repair work than simple grinding.
- The design safety margin could be reduced by excessive grinding.
- The exposure to radiation of the personnel performing inspection and repair tasks can be considerable.
- The repair of these kinds of cracks can result in considerable shutdown time at the plant affected.



Cracks in the nozzle blend area of a reactor pressure vessel feedwater nozzle are illustrated above. The area affected is shown in the drawing at left, and actual cracks are shown in the photograph at right (taken from inside the pressure vessel looking out through the nozzle). The inside diameter of the nozzle is approximately 10 inches.

The reactor vendor, the General Electric Company, and the NRC concluded from their respective studies that the cracking was caused by fluctuations or "cycling" of the temperature on the inside surface of the nozzles; that the stainless steel cladding exhibited less resistance to crack initiation than the underlying low-alloy steel; and that, after initiation in the stainless steel cladding, cracks can be propagated by operational start-up and shutdown cycles. The vendor has performed extensive analysis and scale-model testing to confirm the suspected cause of the cracking and to uncover possible long-term solutions—possibly in a newly designed sleeve, removal of the stainless steel cladding, reduction of the temperature differential at the nozzle, or some combination of these. The licensees involved have increased the number and extent of inspections of feedwater nozzles, with careful repair and reinspection where cracks were found. The vendor advised these operators to revise startup and shutdown procedures so as to substantially reduce the time during which cold feedwater is being injected into the hot pressure vessel.

Independent evaluation by the NRC confirmed that the cracking is caused by thermal cycling, that stainless steel cladding aggravates the effect, and that no significant reduction in safety margins has resulted from the relatively small crack depths observed. NRC required rigorous inspection of all BWR feedwater nozzles during refueling outages and removal of all cracks. Results of these inspections were to be reviewed on a case-by-case basis, and a search for a long-term solution was set in motion.

In a closely related area, the NRC was informed in March 1977 by the General Electric Company that a crack had been found in the nozzle of the "control rod drive (CRD) return line" in a reactor vessel in a foreign country. The CRD return nozzles are the openings in BWR pressure vessels through which the high pressure water used to operate the CRDs is returned to a lower pressure region. Later in March, the Philadelphia Electric Company reported that similar cracking had been found in the CRD return line nozzle at its Peach Bottom Atomic Power Station, Unit 3. The cracks resembled those found in the feedwater nozzles and seemed to be the result of the same kind of cyclic thermal stresses that were causing feedwater nozzle cracks. Both the foreign reactor and the Peach Bottom Unit 3 reactor are representative of a small number of BWRs which do not have a thermal sleeve in the CRD return line nozzle.

The licensee removed the cracks in the Peach Bottom CRD nozzle by grinding out the cracked area, the maximum crack depth being 7/8 inch, and returned the unit to operation with the CRD return line "valved out" and with the flow and pressure in the CRD hydraulic system modified.

Inspection of the CRD return line nozzles at those facilities with thermal sleeves installed in them indicated that these sleeves may not be effective in preventing this cracking phenomenon. The Georgia Power Company found a crack in the CRD return line nozzle at its Hatch Plant, Unit 1, which did have a thermal sleeve. (The crack was removed, the nozzle capped, and the return line rerouted to the reactor water cleanup system.) The vendor is actively pursuing a program to come up

with a permanent solution, and the NRC is closely monitoring the progress of this program as well as the short term actions being taken at affected facilities.

Breach of Security System

On April 19, 1977, during a change in work shifts, an NRC inspector gained access to vital areas of the Fort St. Vrain Nuclear Generating Station in Colorado without a security challenge, in violation of the facility's security program. The inspector was able to pass through guard checkpoints unchallenged and arrived at the control room, at which point a reactor operator challenged him for not displaying a security badge. Had this penetration been achieved by an individual bent on sabotage, he may have been able to carry out his intentions.

The breach of security system was made possible by the failure of personnel on duty at the facility to comply with security directives for the control of access to vital areas of the plant. Following the incident, the licensee, the Public Service Company of Colorado, reviewed the existing security plan and took several measures to strengthen it through personnel instruction, monitoring for enforcement, auditing and increasing security staffing at appropriate points during periods of heavy personnel traffic.

The NRC convened a special meeting in Denver to identify the actions necessary to correct the situation. NRC enforcement action included a civil penalty in the amount of $8,000.

After a rulemaking proceeding addressed to upgrading physical security requirements at all nuclear power plants, the NRC issued revised physical security regulations (10 CFR 73.55) in February 1977 which required more stringent security measures to be implemented in all such plants (see Chapter 4). Initial measures were completed in late May, as prescribed and verified by the NRC.

Fuel Rod Failures

On May 15, 1977, during refueling operations at Dairyland Power Cooperative's LaCrosse Boiling Water Reactor (LACBWR) in Vernon County, Wis., the licensee discovered that an average of four or five rods in each of six fuel assembies were defective, and than an approximate total of 55 inches cumulative length of fuel rod sections from seven separate rods was missing. Several of the missing pieces were later recovered from the top of adjacent fuel assemblies in the reactor core, and another piece was found in the spent fuel storage pool. Besides the six damaged assemblies, some 20 other assemblies showed fission gas release rates above specified limits, as determined by measurements using special test procedures.

The unit had, for about a 5-month period prior to this shutdown, been operating at reduced power levels to maintain radioactive releases within the prescribed limits. The incident brought about a reduction in the electrical generating capacity of the plant, increased radiation levels in the reactor coolant and in various other areas of the plant, and an extended refueling outage in order to evaluate the extent of the fuel rod damage and to recover missing pieces of fuel and cladding. There were no exposures of plant personnel to radiation, no radioactive releases to the environment in excess of regulatory limits, and no health hazards to the general public.

Preliminary indications were that the cladding defects observed on this occasion were similar to circumferential cracks detected in previous fuel rod inspections at LACBWR. But the longitudinal fractures evidenced in the fuel rods of the three most severely affected assemblies seem to have been caused by a combination of fuel-cladding interaction and accelerated stress corrosion cracking. At the intersections of longitudinal cracks and circumferential cracks, whole sections of the cladding were lost.

About half of the dislodged material had been located by the close of the report period, and about half of that had been recovered. Additional television scanning of the reactor vessel internals will be performed, as well as recirculation flow testing of the primary system—with operability tests of the control rod drives before and after the test—in an effort to recover as many fuel and cladding fragments as possible and to ensure that the missing fragments do not interfere with safe operation of the unit. At fiscal year's end, the NRC was studying the licensee's findings with a view to defining the conditions and restrictions under which operation of the plant could be resumed.

Employees Handling Radioactive Sources

On April 7, 1977, the NRC announced that, having evaluated the results of an NRC inspection of operations at the Ohmart Corporation of Cincinnati, Ohio, conducted on March 30 and 31 and April 1, 1977, it had concluded that the company's practices represented an immediate threat to the health and safety of its employees. The company is licensed by the NRC to manufacture and distribute gauging devices containing radioactive sources.

The inspection had revealed that employees handling certain radioactive sources had suffered

exposures in excess of the regulatory limits set forth in 10 CFR 20, providing for a maximum allowable dose to the extremities of 18.75 rems per quarter ("extremities" taken to include hands and forearms or feet and ankles). Most of the exposures were received during two particular source handling operations: the unloading and "wipe testing" of incoming sources, and the loading of sources into individual tubes prior to their insertion in a gauging device. NRC calculations indicate that, for example, an employee loading an 8-curie cesium-137 sealed source into a gauge would receive a hand exposure of about 32 rems for each such operation. The two or three employees who handled most of the sources had been provided with whole body exposure badges and dosimeters, but extremity exposures were not being measured, either by metering or mathematic calculation, and devices for doing so, such as ring badges, were not available to the employees. Neither had the employees been adequately instructed in the safe handling of radiation sources. The cause of the excessive exposures was judged to be a failure on the part of the licensee to exercise sufficient management control.

On April 7, the NRC issued an Order to Show Cause and an Order Suspending License which directed the licensee to suspend all source handling operations, to evaluate personnel exposures, to train and instruct employees, and to develop source handling techniques to assure that exposures to employees would be kept below regulatory limits in all future operations. Following an inspection which confirmed that the licensee was complying with the suspension order and that the immediate hazards had been eliminated, a follow-up inspection on June 20 disclosed that exposures had been effectively reduced by the new procedures.

Radioactive Source Taken

On July 21, 1977, AMF Tuboscope, Inc., of Houston, Tex. reported to the NRC that a sealed radioactive iridium source was missing from the firm's warehouse in Oklahoma City, Okla. The source was contained in a 200-lb. "isolog unit" which was stored in the unlocked warehouse located within a fenced area that was not always locked.

A section of the unit was found in a field about 10 miles from Oklahoma City on August 14, but the radioactive source had been removed. On August 16, State authorities located the unshielded source under a dresser in the apartment of a married couple in Oklahoma City. The man and his wife denied any knowledge of how the source happened to turn up in their apartment, as did the man's brother, a former employee of the licensee. It was ascertained later that the man in whose apartment the source was found had, in June 1977, alleged to the U.S. Department of Labor that he had sustained a radiation injury as a result of his work with a firm other than the licensee. NRC had investigated the claim on June 21 and 22 and found no evidence to substantiate it; examination of the man at a Houston hospital indicated no evidence of significant radiation injury.

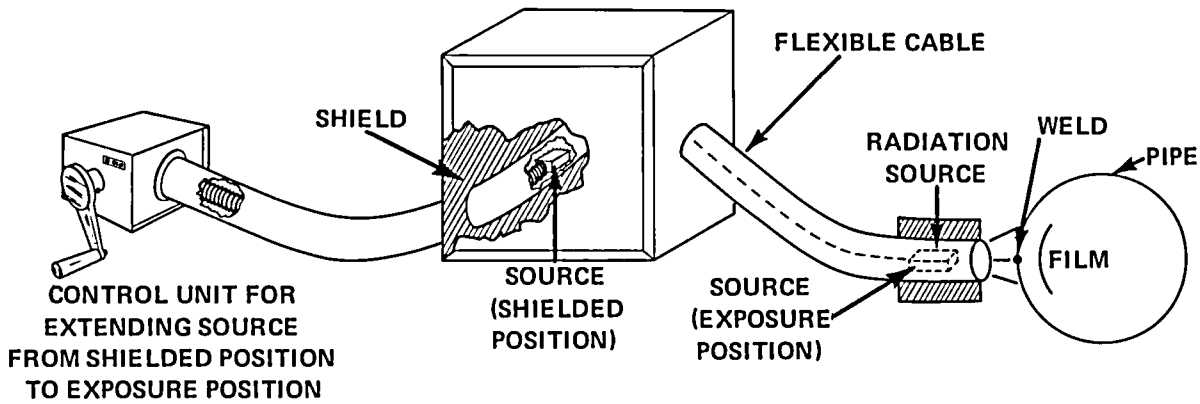
To estimate the radiation exposure of the man and his wife from the unshielded iridium source under the dresser in their apartment, the NRC assumed that the source had been placed there on July 18 and that the occupants of the apartment, in their normal daily routine, moved into and out of proximity with it until it was discovered and removed on August 14. On this assumption, NRC estimated that the couple could have received whole body exposures of about 25 rems each. They were examined at the Oklahoma University Hospital on August 16; preliminary indications showed no evidence of a significant exposure. More selective tests were planned for the couple, and a medical consultant was engaged by the NRC to review the data being collected by the hospital.

Neither the NRC, the State authorities nor the police had, at the close of the report period, been able to establish whether or not the man's brother had been connected with the removal of the isolog unit and subsequent handling of the unshielded source. The man in whose apartment the source was found was charged by State authorities with concealment of stolen property, though how or why the source was taken from the licensee's warehouse had not been established at the close of the report period. The NRC concluded, however, that failure to adequately secure the isolog unit was a contributory cause and sent a Notice of Violation to the licensee on August 4, 1977.

Incidents Involving Radiography

In addition to the facilities licensed by the NRC to operate at the several junctures of the nuclear fuel cycle—uranium milling, fuel fabrication, reactor operation, and so forth—persons and firms using radioactive materials in medical, educational and industrial applications must also be licensed to possess and use such material (see Chapter 3).

During the report period, nine accidents involving radiographers were serious enough to require that they be reported to the Congress as "abnormal occurrences." These events and the NRC's response to them are summarized in the following section, in chronological order, according to the date each one was reported to the NRC.



GAMMA RAY RADIOGRAPHY DEVICE

This type of radiography device is equipped with variable lengths of cable between the crank, the shield, and the exposure position, so that the radiographer operating the crank can be behind a shield or at a safe distance when the radioactive source is exposed. Trouble comes when, either through carelessness or faulty procedures or equipment, the radioactive source is not fully retracted from its exposed position to its shielded position, and the operator has not determined this before approaching the equipment.

July 8, 1976. On the day of the incident, two 2-man teams were working on overlapping shifts to radiograph the same casting. The teams were using two different radiation sources—a 44-curie cobalt-60 source and a 92-curie iridium-192 source. When the first team finished its shift, the radiographers left without cranking the cobalt-60 source back into its shield. The team that remained continued to make radiographic exposures with the iridium-192 source. When one of these radiographers later went to use the cobalt source, he discovered it to be unshielded and immediately left the exposed vault to crank the cobalt back into its shielding. However, in his haste, he cranked the iridium out of its shielding rather than the cobalt into its shielding.

At this point both sources were unshielded and a survey of the vault showed high radiation levels. The second team assumed that the radiation came from the cobalt source. When further efforts to crank the cobalt source in and out failed to reduce the radiation reading to a safe level, the first team was summoned to assist, together with the radiographic supervisor and another technician.

After repeated efforts to crank the cobalt source back, it became apparent that the radiation was coming from somewhere else. The iridium source then was cranked back into its shielding and the radiation returned to a safe level.

All of the individuals involved received doses of radiation during this episode; one radiographer received a whole body exposure of 24 rems and another an exposure to his hands of 43 rems. No adverse biological consequences were anticipated. All of these employees were to be given a minimum of eight hours instruction in safety procedures, and the licensee agreed to install an automatic radiation detection device on the exposure vault. NRC imposed a civil penalty for these violations.

July 13, 1976. An experienced radiographer failed to make sure that a cobalt-60 source was safely shielded and failed to make a radiation survey before he entered the source room. He spent about 78 seconds in the room before realizing that he was exposed to the radiation emanating from the source, receiving a dose later estimated to be 11 rems to the lens of the eye. The exposure was not expected to have any adverse biological effects on the radiographer, who was restricted from further radiographic activity until October 1976.

The licensee indicated that the cause of the accident was a failure to follow understood procedures. The licensee did, however, express the intention of increasing field site inspection and installing gamma-activated alarms in the source rooms at its facility. NRC conducted a special inspection of the licensee's actions the day after notification of the accident and subsequently transmitted a Notice of Violation to the licensee. A reinspection was performed by NRC after corrective actions had been completed.

October 15, 1976. Routine processing of radiographers' film badges for August 1976 turned up an instance of a radiographer's having received a whole-body dose of 22.8 rems. The licensee had the radiographer examined by physicians. This exposure is believed to have a low probability of producing adverse biological consequences.

While NRC investigation failed to identify the specific event which could have caused the exposure, it did bring to light several items of apparent noncompliance with regulatory requirements, mostly related to deficiencies in the management of the licensee's radiation safety program. Accordingly the NRC issued a Notice of Violation and imposed a civil penalty in the amount of $8,400.

November 3, 1976. A radiographer failed to return the radiation source he was using to a safe shielded position before placing the device in a locked mobile van. Thereafter he drove the van to several locations in the Boston area and then parked it overnight at his residence. The next day he picked up his assistant and, enroute to the jobsite, the assistant turned on a survey meter in the driver's compartment of the van and found it offscale on all ranges. The radiographer stopped the van at once and retracted the source into its shielding. The men's film badges showed exposures of 4.6 rems to the radiographer and 0.33 rem to his assistant. NRC evaluation indicated that the radiographer had sustained a whole body dose of 10.3 rems, his wife a dose of 114 millirems, and their child a dose of 60 millirems. In addition, the source in the van had raised radiation levels in areas accessible to the public beyond regulatory limits. From what could be inferred by a complete recreation of the movement of the van, however, it was concluded that no member of the public received a significant exposure.

The licensee conducted a safety training refresher course for all its radiographic personnel; NRC issued a Notice of Proposed Imposition of civil penalties in the amount of $4,500 to the licensee.

November 5, 1976. During a series of radiographic operations at a field site using a 47-curie cobalt-60 source, two radiographers noticed that their pocket dosimeters were discharged. A reenactment of their activities showed that they had been removing exposed film and initiating the next exposure without taking an adequate radiation survey. It was estimated that they had sustained whole body exposures of 15.7 rems and 1.7 rems, respectively, from the unshielded source. It was also estimated that they had received radiation doses to the hands of 1,700 rems and 840 rems, respectively. The licensee employing these radiographers had just been assessed $11,300 for a previous safety lapse, reported to the NRC on July 8, 1976, and described above.

Having issued a Cease and Desist Order on the day it was notified of the overexposures, the NRC elicited commitments from the licensee to intensify its training program for radiographic personnel, to conduct more frequent internal audits, and to employ an outside consultant to audit the level of management control over the radiation safety program. Based on field site inspections, the NRC permitted resumption of activities on November 11. Follow-up inspections confirmed that the commitments were being carried out.

November 13, 1976. A radiographer in the licensee's employ approached an iridium-192 source which was not fully retracted into its shielding without surveying the exposure device. It was estimated that he received a whole body exposure of 5.38 rems, a dose to the gonads of 2.4 rems, and a dose to part of his hand which could have been as much as 3,721 rems. After 10 days the hand showed erythema and thickening of the skin of the palm.

The licensee reprimanded the radiographer for failure to retract the source and failure to assure himself that the source had been retracted before approaching the exposure device. NRC issued a Notice of Proposed Imposition of civil penalties in the amount of $2,000.

December 12, 1976. A radiographer and another licensee employee were making a series of exposures of missile components when the vault in which they were working became uncomfortably warm because of a thermostat malfunction. The radiographer propped open the outside doors of the facility and turned off the radiation alarm system. Later, when he returned to the shielded area to crank the source out for the last shot in the series, he realized that the source was already out and that he had been exposed to radiation while measuring and placing the specimen to be radiographed. Reenactment of the incident indicated that the radiographer had received a dose of about 1,250 rems to his left thumb and about nine rems to the lenses of his eyes. The other employee also received about four rems to his eyes. The radiographer's left hand subsequently exhibited erythema and dry peeling at the tip of the thumb, but permanent impairment of the thumb was not expected.

The principal cause of the incident was identified as the radiographer's failure to make the proper radiation survey and his defeating the purpose of the radiation alarm system. He was taken off radiographic assignments indefinitely by the licensee, and all personnel were given safety training before radiographic operations were resumed. In addition, the alarm system was redesigned to make it more difficult to disarm, and the wearing of audible personnel monitoring devices was instituted for greater protection from accidental exposure. NRC's investigation of the accident uncovered several items of noncompliance with regulatory requirements on the part of the licensee and a civil penalty of $8,600 was imposed.

March 18, 1977. Two radiographers using an iridium-192 source during construction on a bridge

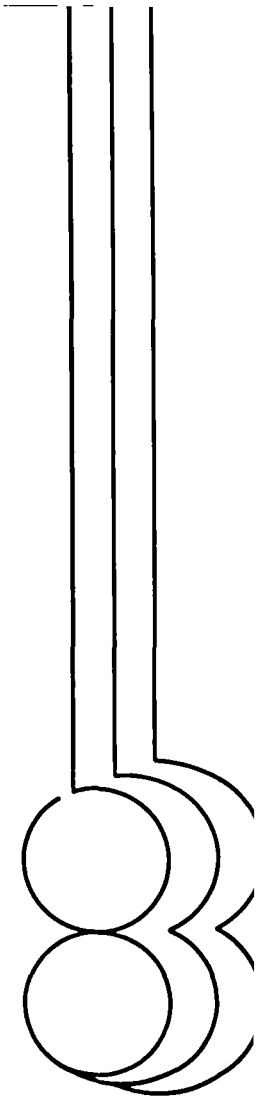
discovered that two painters had been working in the area, having entered by an unobserved route. It was calculated that one of the painters had been in a radiation field of 0.1 to 0.15 rems per hour for 45 minutes and had received a whole body dose of 0.1 rem and that the other painter had worked close to a 73-curie source and had passed under a 46-curie source during his work, receiving a dose of 4.5 rems to portions of each shoulder, 0.6 rems to the eyes, and 0.9 rem to the whole body. Upon examination, neither man showed any sign of illness and they were not expected to be adversely affected.

The accident was attributable to the failure of the radiographers to maintain direct surveillance over access to the high radiation area under their supervision and to post conspicuous warnings at all access points. The importance of surveillance and posted warnings was stressed in the subsequent retraining of all radiographic personnel. NRC investigation led to the imposition of a civil penalty of $2,000 on the licensee.

June 20, 1977. A radiographer and his assistant had completed a series of exposures using a 35-curie cobalt-60 source, which they retracted but left unlocked, with control cables attached, while setting up a 94-curie source of iridium-192 to begin the next exposure. When the latter exposure was completed, the assistant mistakenly operated the cobalt source control crank, thereby exposing the cobalt-60 again. He then entered the cell—carrying a survey instrument, but failing to detect the strong radiation field present there—removed the exposed film and left. The radiographer then entered the cell and placed a new film in place, spending two or three minutes in close proximity to the exposed iridium-192 source and actually bumping it twice with his head. It was later estimated that the radiographer received a dose of four rems to the trunk of the body, up to 11 rems to the gonads, up to 18 rems to the eyes, and between 100 and 400 rems to two small areas on his head. The assistant received a whole body exposure of four rems. Despite these exposures, no clinical evidence of radiation injury was found by the physician who examined the employees.

The cause of the accident was determined to be a failure by both employees to perform an adequate radiation survey on entering the cell, plus the fact that the assistant was inexperienced and had not been directly supervised by the radiographer. All of the licensee's radiographers have since been retrained in the proper use of survey instruments and the supervision of assistants. More frequent audits have also been instituted. The NRC sent a Notice of Proposed Imposition of Civil Penalties in the amount of $6,000 to the licensee. The licensee's response was under review at the end of the report period.

State Programs



The scope of the NRC's program for cooperation with State and local governments broadened considerably during fiscal year 1977. Additionally, closer working relationships were established with State and local governments and with national organizations representing their interests.

NRC has long recognized that the States have a legitimate interest in the regulatory process and that they can play a meaningful role in the process, especially if involved at an early stage. In responding to President Carter's commitment to greater State involvement in the development of Federal policies and programs, the NRC has directed its offices to consult with State or local officials before considering any major action that would have a significant State or local impact. The NRC also continues to assure that assistance is given to States in their regulatory efforts and that State concerns are addressed in NRC regulatory programs.

The principal areas of NRC/State interaction discussed in this chapter are: (a) the State Agreements Program, whereby States may assume certain of the NRC's regulatory authority over nuclear materials; (b) the NRC's "lead agency" role in assisting State and local governments in planning responses to radiological emergencies; and (c) a wide range of liaison and cooperative activities regarding such functions as licensing and siting.

COOPERATION IN LICENSING ACTIVITY

Licensing and Siting Coordination

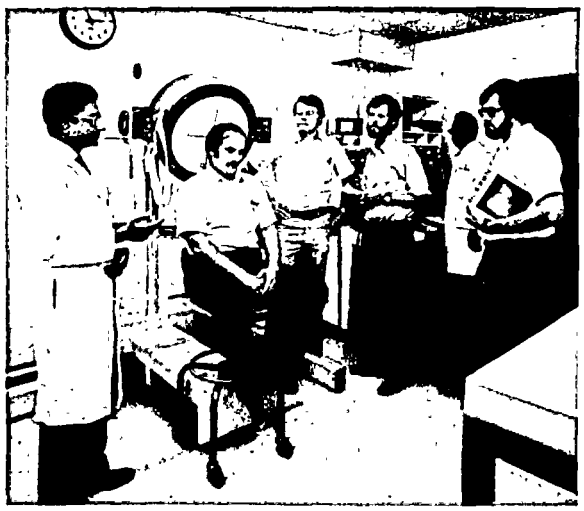
NRC continues to explore ways to work with the States to avoid duplication and minimize cost and delay in the licensing of nuclear facilities. As a result of NRC-sponsored Power Plant Siting Conferences held in April 1975 and June 1976, the Commission adopted a number of recommendations made by State regional organizations. One important measure adopted was that States and the NRC appoint liaison officers to coordinate on licensing matters, thus providing more direct and timely State participation in the licensing process for nuclear facilities. Some States expressed an interest in having their liaison officers also coordinate their waste management activities.

At the end of the fiscal year, the Governors of 48 States had appointed such liaison personnel. The Commission directed that

NRC liaison officers be stationed in the regional offices. The NRC planned to initiate this practice early in fiscal year 1978 by placing liaison officers in the Philadelphia and San Francisco regional offices. The Commission held its first meeting with the State liaison officers in October 1977.

Another aspect of NRC's cooperative effort with States has been the negotiation of agreements to resolve issues over which the NRC and the States share regulatory authority. Thus NRC has sought formal "memoranda of understanding" with States having water quality permit responsibilities relating to nuclear power plants. Discussions leading to such agreements were underway with 13 States at year's end (see also Chapter 2). Another area of potential State/Federal cooperation is in the holding of joint hearings with affected States on nuclear power plant applications. Such hearings have been held with Maryland on the Douglas Point application, and with New York on the Greene County application (see Chapter 2 under "Cooperation with States"). Joint hearings are scheduled to begin early in 1978 with Massachusetts on the Montague application.

Coastal Zone Management. As coastal States begin to develop operational coastal zone management (CZM) plans, the need for closer coordination among State coastal zone management agencies, the NRC, and State energy and siting agencies becomes more apparent. Many nuclear generating facilities under construction or partially completed are likely to become subject to a State CZM "certification" in the future. The NRC serves as a principal point of contact on such facilities, both for the States and for the Federal Office of Coastal Zone Management in the Department of Commerce.



In July 1977, NRC sponsored a five-day training course for Agreement State personnel on the medical uses of radionuclides. Fifteen instructors from the Texas Medical Center presented the course in Houston. At left, a physician in the nuclear medicine department of Methodist Hospital demonstrates procedures used in taking a brain scan. At right, a nuclear medicine technician operates scanning equipment for the State people.

STUDY ON NRC/STATE SITING ACTIONS

On June 10, 1977, the NRC distributed for public comment a draft report entitled "Improving Regulatory Effectiveness in Federal/State Siting Actions" (NUREG-0195). This report was the culmination of some nine months of intensive study by the NRC staff in cooperation with State representatives and other groups, as described below.

For the past few years, there has been a widespread and growing belief that the system for regulating the siting of nuclear facilities needs to be improved. Extensive hearings were held by the Joint Committee on Atomic Energy in 1974 and 1975, and subsequently proposed legislation, although not enacted, emphasized the growing Federal/State relationship in siting actions. The Commission in September 1976 directed the NRC Office of State Programs to examine the matter of Federal/State relationships in regulatory activity involving environmental decisionmaking and to suggest steps for improvement.

From the outset, great importance was attached to obtaining views and counsel from the States,

particularly on questions involving State/Federal roles and relationships. Accordingly, arrangements were made early in the study to work with the staff and committees of the National Governors' Conference (NGC). Two workshops were held with State representatives under NGC auspices. These helped in defining the scope of the study and in reviewing an early draft of the report. Views of other Federal agencies were also sought at meetings organized by the Council on Environmental Quality.

Within NRC, a task force was formed to relate NRC experience to study objectives and to provide means for testing possible alternatives. From outside NRC, panels of experts were formed to assist in two specific areas: (a) how and by whom the need for a power-producing facility should be determined; and (b) the meaning of the terms "efficiency" and "effectiveness" as applied to regulatory activity. Contracts were made with five individuals and groups to provide assistance in a number of areas. A team composed of NRC staff and NGC representatives developed five possible regulatory approaches, ranging from actions that NRC could take on its own initiative under existing legislation through varying degrees of Federal/State coordination to a highly Federalized system requiring major legislative changes.

Regulatory Effectiveness

With the assistance of a group of outside experts, the staff developed the following working definition of "regulatory effectiveness":

> "Regulatory effectiveness in environmental decisionmaking consists of a timely final action that provides for necessary change; is consistent with demonstrated societal objectives and the law; is equitable and practicable; and is based on fully and candidly expressed premises, utilizing a commonly available data base."

Two important assumptions, established early in the study, guided the study team: (a) a national fuels policy is an important, perhaps crucial, feature of any effort to improve regulatory effectiveness (State representatives expressed the view, further, that the Congress should address the matter of providing equity among the States in distributing the costs and benefits of a national fuels policy); and (b) in order to improve regulatory effectiveness, the Federal government should concentrate its efforts on power production rather than fuel cycle facilities.

Using the definition of regulatory effectiveness as a reference point, the study identified the following deficiencies in present environmental decisionmaking:

- The long term plans of utilities are often not exposed to public review and comment until far too late in the process.
- The need for the power to be produced by a proposed facility is regularly litigated at Federal licensing proceedings long after heavy financial commitments have been made by the utility and after the State has passed judgment on this question.
- There is much unnecessary duplication and overlap. For example, there is no system for sequencing Federal and State actions in a logical and orderly way.
- There is insufficient coordination between Federal agencies and the States and the proper role of each is not precisely defined.
- There is insufficient coordination among Federal agencies.
- The coordination of activities within many individual States is inadequate.
- The general public—the ratepayers and taxpayers—are insufficiently involved and informed, are uncomfortable with the present process and generally lack confidence in it.

(See "Siting Standards" in chapter 10 for related discussion.)

Recommendations for Improvement

The study team then identified a broad concept of an effective regulatory system: it would be a system in which the Federal role is primarily to determine the *effect* of proposed actions and in which States have an increasing role in determining the *acceptability* of actions within their purview. The role of States would include determining the acceptability of actions which affect local affairs and which require matching of State and local services to the needs of large projects. By early involvement of States in the planning process and by cooperative use of the technical resources of the Federal government, meaningful regulatory reform would provide for early identification of suitable sites, for increasing the assurance that utilities can proceed with needed facilities, and for greater public participation in the process.

The study proposed that the Congress authorize a revised regulatory process which considers nuclear, fossil and other types of power plants together, for planning purposes, with greatly increased emphasis on early disclosure of utility plans, on multi-State planning, and on voluntary participation by States and combinations of States

in such planning. In the process, site reviews would be separated from facility reviews, and sites would be certified by States as being compatible with their long range plans. Another key element would be the acceptance by Federal agencies of State determinations of the need for power-producing facilities as binding on the Federal review process. NEPA would be modified to allow Federal acceptance of State environmental reviews conducted under specific Federal guidelines. States would be encouraged to adopt coordinated or single permit (one-stop) procedures and would be required to adopt standards at least as stringent as those employed by Federal regulatory agencies.

The proposal would place the Federal responsibility for environmental reviews on a "lead Federal agency" other than the NRC—perhaps the Department of Energy—in order to better relate nuclear, fossil and other forms of generation. This lead agency, in cooperation with States, would assess utility plans on a regional basis and would certify these regional plans to the Congress. If any State chose not to make environmental reviews or failed to qualify for such a role, the lead agency would act for it in the environmental certification of electrical generating sites. In the environmental review of individual projects the NRC would be replaced by the lead Federal agency, which would review the environmental aspects of the site and the environmental effects of construction activities, and would monitor operation of the plant for conformity with environmental requirements. NRC would continue to be responsible for all matters related to radiation health and safety.

A greater degree of Federal coordination would be encouraged through a system of coordinating councils. The councils would be empowered to set time limits on public proceedings, but a Federal agency could be excused from compliance with such limits simply by certifying that such compliance was impossible. The organic statutes of the participating agencies would not be altered.

Distribution of the Report

On June 10, 1977, the Commission directed that the report be distributed for comment to State governors, Federal agencies, industry and the public. Congressional offices were provided with copies for information. In hearings pertaining to licensing reform, held on June 13 and 14, 1977 by the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs, both NRC Chairman Rowden and Governor Robert W. Straub, Chairman of the Subcommittee on Energy Facility Siting of the National Governors' Conference, testified as to the need for a more effective Federal/State regulatory process in siting nuclear facilities. NRC also published nine supporting documents, numbered NUREG-0196 through 0204, relating to the principal study.

STATE AGREEMENTS PROGRAM

Under Section 274 of the Atomic Energy Act of 1954, as amended, the NRC is authorized to enter into agreements under which States assume regulatory responsibility over byproduct, source material and small quantities of special nuclear material. Before entering into such an agreement, NRC must be assured that the State regulatory body has sufficient statutory authority, adequate budget, trained staff and appropriate regulations. There are 25 Agreement States at present, namely: Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Oregon, South Carolina, Tennessee, Texas and Washington. At the end of 1977, negotiations with Michigan were at an advanced stage and discussions were in progress with Rhode Island, Indiana and Vermont.

An NRC task force reviewed the entire State Agreements Program. Its final report, published as NUREG-0388, concluded that the program is successful and that additional States should be encouraged to participate so that the vast majority of material licenses would be administered by the States. Only one specific legislative change was recommended to provide modest "startup" funding to new Agreement States. The task force concurred with the special study's recommendation (NUREG-0301) that NRC seek authority to regulate naturally occurring and accelerator-produced radioactive materials.

NRC Review of State Programs

The NRC maintains continuing oversight of the Agreement State radiation control programs to assure that they protect the public health and safety and that they are compatible with NRC's regulatory program. NRC's oversight is accomplished by orientation meetings with new Agreement States and by formal review of individual State programs. The reviews take place at six-month intervals for States newly designated as Agreement States, and at twelve-month intervals for States with established programs. The reviews cover the six major elements of the Agreement State regulatory programs: organization, administration, personnel, regulations, licensing and compliance. The results

of a program review are summarized in formal letters to the State's radiation control program director and other State Officials. Copies of these letters are also placed in the NRC Public Document Room and in State public document rooms or their equivalent.

During fiscal year 1977, the NRC conducted 26 program reviews. There were also two followup reviews, covering cases where the regular reviews had noted a significant weakness.

The reviews found that all Agreement State radiation control programs were adequate to protect the public health and safety. However, nine programs were found to be incompatible with the NRC regulatory program for calendar year 1976 because State regulations regarding inspections equivalent to those set forth in 10 CFR Part 19 had not been adopted. In all cases, NRC received a commitment that an appropriate regulation would be developed during calendar year 1977.

Based on a certification by the NRC to the U.S. Department of Labor that the radiation control program of an Agreement State is adequate to protect the public health and safety, the Department of Labor exempts State licensees from regulation under the Occupational Health and Safety Act (OSHA).

Technical Assistance

Technical assistance provided to Agreement States by the NRC includes help in reviewing applications involving complex and/or hazardous operations and in the health and safety reviews of sealed radioactive sources and devices, distribution of licenses used in Agreement State regulatory programs, furnishing of resource materials such as technical documents and reports, and assistance in significant compliance actions. NRC also provides medical consultants when required to assist in the evaluation of known or suspected radiation injuries. During fiscal year 1977, increased emphasis was placed on the oversight of uranium mill operations, inactive mill tailings sites, and commercial low-level radioactive waste burial sites. NRC personnel visited all five burial sites in the Agreement States and also visited five uranium mill sites and five inactive mill tailings sites. Technical assistance was provided in the review of environmental reports for three new and one renewal uranium mill application. Technical assistance also was provided for two existing commercial low-level radioactive waste burial sites.

NRC also assists Agreement States by developing model regulations and by reviewing and commenting on proposed changes to State regulations. During fiscal year 1977, comments on regulations were provided to 15 States.

An NRC reviewer (left) observes as an Agreement State inspector measures the external radiation levels of an industrial radiography device during an inspection of a State licensee's facility.

Training

NRC provides training opportunities for State regulatory personnel at no cost to the individual or the States. This applies whether or not the State is an Agreement State. The training programs undergo continuing review to improve established courses and to develop new ones. During fiscal year 1977, NRC offered new courses in uranium mill licensing and inspection, radiation health engineering, environmental chemistry, and calibration methods for teletherapy devices.

During the year, 213 State employees received a total of 428 man-weeks of training at courses such as Health Physics and Radiation Protection, given at Oak Ridge Associated Universities; Safety Aspects of Industrial Radiography, at Louisiana State University; Medical Use of Radionuclides, at the Johns Hopkins Medical Institution; and a Symposium on Regulation of Uranium Mills, held in Colorado Springs, Colo.

Annual Meeting

Radiation control program managers in the Agreement States are invited to attend an annual meeting held in the NRC offices in Bethesda, Md., to discuss regulatory matters of mutual interest. The 1976 meeting was held October 5-7, 1976, and included discussions of medical licensees, waste

management, transportation of radioactive materials, and State/Federal aspects of reactor regulation. At the conclusion of the meeting, an ad hoc committee of State representatives made formal recommendations to the NRC on emergency response planning, NRC training programs and the policy for regulating medical licensees.

GAO Report

During 1977, the General Accounting Office (GAO) conducted a review of the State Agreements Program, giving particular emphasis to NRC's annual evaluation of the individual State programs. The GAO recommended that the NRC:

(1) Clearly relate funding and staff shortages to observed weaknesses in licensing and inspection programs.

(2) Address findings noted during the annual review to the governor of the State.

(3) Develop model legislation to assist States in establishing systems for collecting license fees.

(4) Make copies of the annual review findings available for public inspection by placing them in appropriate State clearinghouses and the NRC Public Document Room.

All the recommendations were adopted by NRC during fiscal year 1977 with the exception of Recommendation 2. The staff continues to believe that weaknesses observed during reviews of Agreement State regulatory programs should be communicated to the governors only in exceptional cases. Model legislation for establishment of license fee systems was sent to the Office of Management and Budget, which referred it to the Council of State Governments for publication as suggested State legislation.

Special Studies

During fiscal year 1977, NRC completed a number of special studies related to the State Agreements Program. These included "The Regulation of Naturally Occurring and Accelerator-Produced Radioactive Materials" (NUREG-0301); the internal study of the State Agreements Program (NUREG-0388); and the "Review of the Federal/State Program for Regulation of Commercial Low-Level Radioactive Waste Burial Grounds" (NUREG-0217, Supplement 1 thereto, and NUREG-0240).

EMERGENCY RESPONSE PLANNING

The planning discussed in this section relates to NRC assistance to State and local governments in planning emergency responses to radiological incidents.

The responsibilities of Federal agencies for assisting State and local governments in developing plans for responding to radiological emergencies are outlined in a Federal Register Notice of December 24, 1975, promulgated by the Federal Preparedness Agency (FPA) of the General Services Administration. The notice, entitled "Radiological Incident Emergency Response Planning; Fixed Facilities and Transportation," gives the "lead agency" role to NRC, while assigning specific supportive responsibilities to the Environmental Protection Agency; the Department of Energy; the Department of Transportation; the Department of Health, Education and Welfare; the Defense Civil Preparedness Agency; and the Federal Disaster Assistance Administration of the Department of Housing and Urban Development. The entire effort is monitored by the FPA.

In carrying out its "lead agency" role, NRC's main efforts have been concentrated on the preparation and issuance of planning guidance, the development and conduct of training courses, the provision of field assistance to States in development and testing of radiological emergency response plans, the review and evaluation of these plans, and

Each year the NRC sponsors a two week training course for new State employees on NRC licensing procedures, as part of a program to maintain compatibility between NRC and Agreement State regulatory programs.

the determination of the instrumentation requirements for measuring offsite consequences of radiological incidents.

Planning Guidance

The basic document for the guidance of State and local governments in the development of their radiological emergency response plans is the NRC publication NUREG-75/111, "Guide and Checklist for the Development and Evaluation of State and Local Government Radiological Emergency Response Plans in Support of Fixed Nuclear Facilities," which was first published in 1974. Supplement 1 was issued in March 1977. The supplement lists 70 planning elements which the NRC deems essential. A State plan must contain at least these 70 elements before the NRC will concur in it.

The NRC intends to review this supplement annually to add or subtract from the list of essential planning elements on the basis of new information, practical experience in the field, and new developments in emergency preparedness.

Training Program Offered

NRC, in cooperation with the States and other involved Federal agencies, has identified a number of areas where training is needed for State and local government personnel involved in radiological emergency response planning and preparedness and has developed formal training courses for some of these areas. These training courses are offered at Federal expense.

A course in radiological emergency response operations is being conducted routinely at the Nevada Test Site of the Department of Energy. This course requires eight days, three of classroom lectures and five of field exercises. Six sessions were conducted in fiscal year 1977. Each class accommodates approximately 20 students from the States and two Federal observers.

Another regular course provides instruction on radiological dose assessments and projections for State radiological emergency response coordinators and their staffs. It is approximately four days long. It was presented five times in fiscal year 1977 and will in the future be offered routinely about once or twice per year. It is designed to help the State coordinator make decisions on what protective actions to take in the event of a release of radioactive material to the environment as a result of an accident at a nuclear facility.

Field Reviews

In support of the Federal interagency field effort in radiological emergency response planning assistance, Headquarters and regional advisory committees have been formed. Each committee has membership from all involved Federal agencies headed by an NRC representative. The advisory committees are the main sources of emergency planning assistance for the States and local governments.

Eight field reviews of State plans were conducted by regional advisory committees during fiscal year 1977. The reviews were designed to give the States specific guidance as to what parts of their plans need improvement. In support of this effort, six visits were made to States to discuss improvements in plans.

During fiscal year 1977, 13 radiological emergency response exercises were conducted by State and local governments. Federal field assistance cadres observed three of these exercises.

Concurrence in State Plans

As lead agency, NRC is charged with reviewing and concurring in the adequacy of State and local government radiological emergency response plans. Washington, New Jersey, South Carolina, and Connecticut, in that order, were the first States to receive formal concurrences. NRC expects to be able to concur in several other State plans during the forthcoming year.

Coordination With Local Authorities

There are 65 operational nuclear power plants today and by 1980 there may be another 15, for a total of 80. The 65 operational plants are located at 58 sites, and within a ten-mile radius of these sites there are portions of 147 counties. There are also 43 cities with a population of over 10,000 within this same ten-mile radius.

In the emergency planning requirements for the operation of these nuclear power plants, NRC requires that "each applicant's emergency plan should include provisions for coping with emergencies, both within the boundary of the plant site and in the environs of the site.... Planning and implementation of measures to cope with plant-related emergencies outside the site boundary, with particular emphasis on the low population zone, should be a coordinated effort involving the licensee and local, State and Federal agencies having emergency

In the upper photo, a Radiological Emergency Response Team, composed of State and local government personnel, participates in a training exercise at an NRC-sponsored training course at the Nevada Test Site. Below, a student team at the training course responds to a simulated transportation accident involving radioactive materials.

responsibilities." This coordination with local authorities is an essential element related to site emergency planning and the NRC requires that each licensee include a description of the personnel and other organizational resources that are available from the offsite agencies.

As a general siting practice, nuclear power plants are located in relatively remote areas with low population densities. Therefore, when a utility or the NRC requests that the county involved develop an emergency plan to support a proposed nuclear plant, the personnel skill and experience for developing the plan may be lacking locally and the county may have difficulty in funding both the development and implementation of a plan. With assistance from State and local governments, NRC is studying ways to overcome these problems.

Determining What Accidents to Plan For

During the past year, the NRC has been working with the Environmental Protection Agency to determine the most severe accidents for which comprehensive radiological emergency plans should be developed by State and local governments. This study was requested by the Conference of (State) Radiation Control Program Directors. The NRC-EPA task force has completed its work and guidance on this matter should be available to the States by June 1978.

Interorganization Committee

In the past, the NRC has worked with the Conference of (State) Radiation Control Program

Directors on emergency response planning matters. During the past year, NRC has also contacted other organizations representing State and local officials with emergency planning responsibilities. An interorganization committee was set up which includes the Conference of (State) Radiation Control Program Directors, the U.S. Civil Defense Council, and the National Association of State Directors for Disaster Preparedness. This committee will meet periodically to review emergency planning policy and to provide the NRC with timely State and local government views.

OTHER LIAISON AND COOPERATIVE ACTIVITIES

In addition to maintaining its State Agreements Program, NRC is committed to greater consultation and cooperation with States in its work. Several actions were taken during the past year in furtherance of this purpose.

During 1977 NRC entered into contracts with Georgia, Illinois, Michigan, Pennsylvania and South Carolina for two-year cooperative efforts in the surveillance of radioactive materials in transit. This program, which has involved other States in the past, is expected to enhance State expertise as well as add substantially to the existing data base on the transportation of radioactive materials. A summary report on the earlier pilot phase of the program is nearing completion.

Throughout 1977, NRC engaged in cooperative efforts with such State-related organizations as the Southern Interstate Energy Board, the Western Interstate Nuclear Board, the National Governors' Association, and the National Conference of State Legislatures.

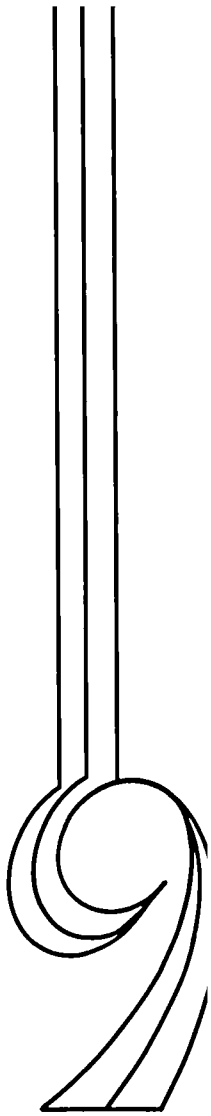
In addition, NRC has continued its co-sponsorship of the Conference of (State) Radiation Control Program Directors as a vehicle for improving Federal/State radiation control activities. Through task force participation, NRC personnel gave technical assistance to the Conference in various aspects of radiation control, including the development of model State legislation and regulations for the reduction or control of public exposure to radiation. NRC representatives also presented technical reports at the annual meeting of the State radiation control program directors in Seattle, June 19-23, 1977.

Washington was the first State to receive NRC concurrence on its radiological emergency response plan for nuclear facilities. Betty McClelland, Director of the Washington State Department of Emergency Services, accepts formal notification from Robert G. Ryan, NRC's Director of the Office of State Programs.

Nuclear power has been a focus of concern in an increasing number of States during the past year. This was reflected in the large number of nuclear-related bills introduced in State legislatures. NRC continued to provide comment to States on proposed legislation when requested, and in several instances presented testimony before legislative committees.

Chapter 9

International Activities



The NRC's international activities, centered in the Office of International Programs, expanded and intensified during fiscal year 1977 as concern over nuclear proliferation brought about a review of U.S. nuclear export policy and worldwide attention focused on issues of nuclear health and safety.

U.S. commitment to international cooperation in the civilian uses of nuclear energy continued to be reflected in the NRC's growing activities, including the conclusion of new agreements involving international safety information exchange, increased participation by foreign nationals in NRC-sponsored regulatory training programs, and expansion of the NRC's foreign visitor program. The NRC also took the lead in planning an international seminar on the safety aspects of spent fuel storage, to be held in February 1978 under the sponsorship of the International Atomic Energy Agency (IAEA).

The NRC conducted a major review of export licensing procedures during the report period and, in June 1977, issued for public comment a proposed new part of the Code of Federal Regulations to cover export-import activities. (This will be supplemented with criteria for nuclear exports once pending nonproliferation legislation is in effect.) Other major NRC efforts included:

(1) Participation in the establishment of a new Federal interagency committee for coordination of nuclear export activities.

(2) Work toward expediting licensing procedures for minor export applications, including review of criteria for nuclear materials exports that are relatively unimportant from a national security standpoint.

(3) Issuance of several major export licenses, including fuel to the Tarapur station in India and a power reactor to Yugoslavia.

(4) Initiation of an automated data system for all NRC export licenses and license applications.

(5) Work toward implementing the U.S.-IAEA Safeguards Agreement, which will permit IAEA inspections of U.S. civil nuclear facilities.

EXCHANGE OF INFORMATION

During the report period, NRC concluded a new regulatory arrangement for the exchange of technical information and cooper-

ation in nuclear safety matters (signed on April 11, 1977) with the Atomic Energy Organization of Iran. More recently, on October 3, 1977, NRC concluded a bilateral regulatory arrangement with the Netherlands. These brought to 13 the number of such arrangements currently in force. Since 1974, when the formal program was initiated, the nuclear regulatory authorities of Brazil, Denmark, France, the Federal Republic of Germany, Italy, Japan, Spain, South Korea, Sweden, Switzerland, and the United Kingdom have entered into similar arrangements with NRC. As fiscal year 1977 ended, NRC was actively engaged in negotiations for arrangements with agencies in several countries, including Belgium, Canada, Israel, Mexico, and the Philippines.

The primary objectives of these arrangements are: to establish formal communications with foreign regulatory authorities for prompt and reciprocal notification concerning safety problems; to exchange information related to public health, safety, and environmental protection; and to foster an international consensus on regulatory matters and safety standards and experiments. The arrangements provide for the reciprocal exchange of regulatory information in the form of technical reports, correspondence, newsletters, meetings, and any other means agreed upon. In some cases, they also provide for future cooperation in reactor safety research and temporary assignments of personnel to laboratory programs under the sponsorship of both parties.

An agreement between the U.S. Nuclear Regulatory Commission and the Atomic Energy Organization of Iran for the exchange of technical information and cooperation in nuclear safety matters was signed on April 11, 1977, in Tehran. Signing were James R. Shea (left), Director of NRC's Office of International Programs, and Dr. M. H. Farzin, Director of the AEOI's Nuclear Safety Division. Observing (from left) were Robert C. Liimatainen, U.S. Embassy; Dr. Akbar Etemad, President of AEOI, and Mehdi Sarram, AEOI.

Research Agreements

In addition to the arrangements for exchange of regulatory safety information discussed above, the NRC has bilateral reactor safety research agreements with 10 countries and one multinational organization. (Details of NRC research activities are discussed in Chapter 11.) At the end of the fiscal year, bilateral research agreements and arrangements were in effect covering cooperative programs with Brazil, Denmark, France, West Germany, Iran, Italy, Japan, South Korea, Sweden, the United Kingdom, and the International Energy Agency (IEA). Under the terms of these agreements, NRC and other countries exchange reports, computer codes, and research results on specific programs. In certain cases, personnel may also be exchanged for extended assignments. In addition to these bilateral agreements, NRC has also agreed—under the auspices of the IEA—to the participation of Austrian, German, Japanese, Dutch, and Nordic Group (Denmark, Finland, Norway and Sweden) personnel in the Loss-of-Fluid Test (LOFT) program, as well as for participation by various IEA countries in the Power Burst Facility (PBF) and Heavy Section Steel Technology (HSST) programs. Japan and the Federal Republic of Germany each have agreed to contribute approximately $1 million per year to the LOFT program. An arrangement with the European Communities for NRC participation in the Whole Core Accident Calculation Group was concluded in July 1977.

These foreign research exchanges provide a means of acquiring reactor safety research results in many areas where U.S. technical and monetary resources are limited. The urgency of establishing improved safety criteria for the operation of nuclear facilities and handling of nuclear materials, and the requirements for large expenditures of technical effort and funds to support experimental facility development and operation, provide ample incentive for such international cooperation. Additional cooperative agreements are being negotiated to augment present exchange commitments.

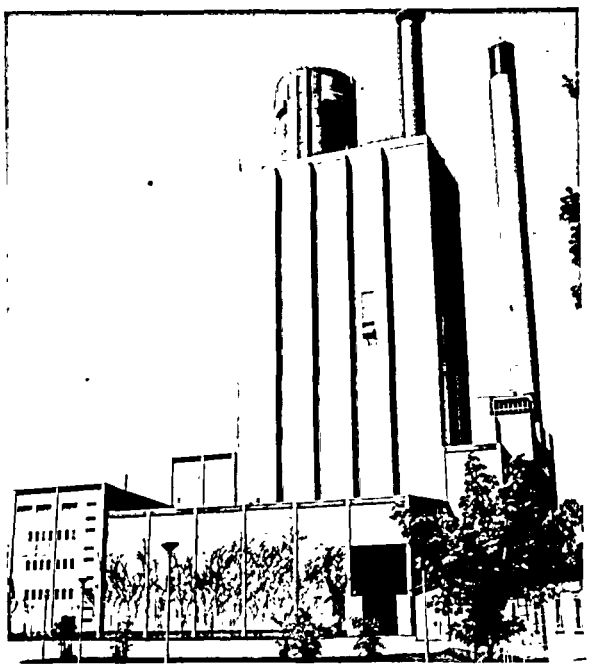
Multinational Projects

NRC participates in two major multinational projects: the Halden nuclear fuel performance project in Norway and the Marviken containment response project in Sweden. As an associate member of the Halden project, to which it is currently contributing about $300,000 annually, the NRC participates in the technical planning and management of the program and receives experimental data on the thermal and mechanical behavior of fuel rods subjected to long-term irradiation. These data have contributed significantly to the understanding of the problems of fuel densification, fuel-cladding mechanical interaction and in-pile release of fission products, all of which are relevant to the safe operation of nuclear power reactors.

U.S. participation in the Marviken project was initiated in March 1973, when experiments were being conducted to study the response of a pressure-suppression reactor containment to simulated ruptures of reactor system piping. The current test program is investigating pressure oscillation phenomena in the containment system. NRC is currently contributing approximately $200,000 per year to the Marviken program, and participates in the technical management and planning of the project.

Selected NRC-sponsored specialists are assigned to laboratories in foreign countries to participate in and follow various reactor safety research problems. Specialists are currently stationed at the Marviken facility in Sweden, the Halden project in Norway, and in Karlsruhe, West Germany, Saclay, France, and Tokai, Japan.

The information NRC receives on foreign nuclear safety research is promptly distributed to key domestic users in government, industry, and educational institutions unless there are proprietary or other restrictions.



The Marviken power station of Stockholm, Sweden is shown above. Full-scale containment experiments have been and are being performed at the facility as a joint project of representatives of Denmark, West Germany, Finland, Norway, Sweden, the United States, France and Japan.

ACTIVITIES WITH INTERNATIONAL ORGANIZATIONS

NRC continued throughout 1977 to work with several international agencies on matters related to nuclear safety and safeguards. Much of the effort was carried out with the International Atomic Energy Agency (IAEA). Substantial cooperation also continued with the two energy agencies of the Organization for Economic Cooperation and Development: the International Energy Agency and the Nuclear Energy Agency.

In addition to the nuclear safety and safeguards activities discussed below, NRC contributed to several important IAEA advisory programs, including the development of guidance on emergency planning, safety and regulatory criteria for waste management, procedures for establishing limits for radioactivity releases to the environment, thermal reactor safety research and development, and regulations for the safe transport of radioactive materials.

International Conferences

Commissioner Richard T. Kennedy and several staff members presented papers on various aspects of nuclear safety and safeguards at the IAEA Conference on "Nuclear Power and Its Fuel Cycle," held in Salzburg, Austria in May 1977. Representatives of some 50 countries participated in this major meeting. NRC representatives also made presentations at the Iran Conference on the Transfer of Nuclear Technology, which was held in April 1977. These conferences provided opportunities for international discussion of a broad range of nuclear power topics, including matters closely related to NRC's responsibilities in health, safety, physical

security protection and nuclear export licensing. In addition, the conferences afforded the first opportunities for international discussion of the President's April 7 nuclear policy statement, which was in several aspects directly relevant to central NRC responsibilities.

IAEA Reactor Safety Standards

NRC has continued its lead role in organizing and carrying out U.S. participation in the IAEA program to develop safety codes of practice and safety guides for nuclear power plants. The NRC coordinates U.S. technical activities associated with this program. The codes and guides will provide a basis for national regulation by developing countries of the design, construction and operation of nuclear power plants. NRC staff members continued to represent the United States on the IAEA Senior Advisory Group (SAG) that oversees the program and on the Technical Review Committees working in the five areas of primary interest: governmental organization, siting, design, operation, and quality assurance. Dr. J. M. Hendrie, who was appointed Chairman of the NRC in August 1977, is the U.S. member of the SAG and has served in this capacity since the inception of the program in late 1974.

During 1977 the Senior Advisory Group, Technical Review Committees, and working groups under them drafted 13 new guides, completed all five proposed codes of practice and one safety guide and forwarded the completed codes and guides to the Director General of the IAEA with the recommendation that they be issued. About half of the 50 or so remaining safety guides planned to date have been drafted and are undergoing review. During the drafting process, the NRC standards staff coordinated the reviews within the U.S., soliciting comments from interested members of the public, industry, and other government agencies.

Nuclear Safety Assistance Via IAEA

In addition to its reactor safety standards program, the IAEA provides guidance and technical assistance on a broad range of nuclear safety matters. NRC is one of several U.S. organizations which contribute to this work. In particular, NRC has given special attention to activities which serve to transmit U.S. regulatory and safety expertise to countries in the early stages of their nuclear power programs.

During the report period NRC staff members presented safety-related lectures at the IAEA International Training Course on Nuclear Power Construction and Operation Management, held at Argonne National Laboratory, and, on behalf of the IAEA, a course on "Boiling Water Reactor Fundamentals" at the Instituto Nacional de Energia Nuclear, in Mexico City. A member of the NRC licensing staff participated in an IAEA reactor safety mission to the Philippines for three weeks in July 1977, for the purpose of advising on the review by the Philippine Atomic Energy Commission of the preliminary safety analysis report prepared in connection with their first power reactor project. Another staff member was made available to accept a one-year assignment as an IAEA advisor to the nuclear safety and regulatory authorities in Mexico.

IAEA Safeguards

During 1977, the NRC continued to work with the Department of State and other U.S. agencies to implement the US-IAEA Safeguards Agreement and to strengthen the IAEA safeguards program. NRC experts also participated in a number of IAEA activities aimed at upgrading the safeguards and physical security systems of member countries. (See also the discussion of International Safeguards, below.)

Cooperation with OECD Agencies

The year 1977 was the first year of full membership of the United States in the Paris-based Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development. NRC continued its participation in several of NEA's safety-related studies and research efforts. This cooperation was begun several years ago under an associate membership arrangement. Safety and regulatory matters make up about two-thirds of the current NEA program. Criteria and standards are being developed for waste management, for protection of workers and the public against ionizing radiation, and for safety and reliability of nuclear plants. NEA is also encouraging an international legal regime in the field of nuclear third-party liability and insurance.

Another OECD organization, the International Energy Agency (IEA), was formed by 18 countries in 1974. One of its programs involves cooperative research on nuclear safety questions. An NRC staff member chairs the IEA Working Group on Nuclear Safety.

The Commissioners discuss matters of mutual interest with a delegation from the Federal Republic of Germany. The NRC staff received visitors from more than 30 countries during fiscal year 1977.

Foreign Visitors to NRC

The increased pace of NRC international activities has been accompanied by a surge of visitors from foreign countries and organizations interested in holding in-depth discussions with the Commission and staff on policy and technical concerns. During fiscal year 1977, NRC received 480 visitors from 31 countries and 4 international organizations. This represents a 17 percent increase over the 410 visitors received during fiscal year 1976, and a 44 percent increase over the 333 visitors during fiscal year 1975.

The NRC permits a small number of employees of foreign regulatory agencies to work temporarily on the NRC staff within their areas of expertise to gain experience that can be usefully applied upon their return home while simultaneously contributing to the work of NRC. Arrangements provide that all salary, housing and other out-of-pocket expenses of these foreign nationals be paid by their permanent employers or the International Atomic Energy Agency. While at NRC, they are assigned duties which do not require access to classified material or sensitive fuel cycle information such as enrichment or reprocessing technology.

Four foreign nationals were given long-term assignments at NRC during the report period. Two staff members from the Israel Atomic Energy Agency had NRC assignments—one with the Office of Standards Development and one with the Office of Nuclear Reactor Regulation. An employee of the Spanish Junta de Energia Nuclear also was assigned to the Office of Standards Development. The fourth foreign national was from the Korean Atomic Energy Bureau and was assigned to the Office of Inspection and Enforcement.

Export/Import Matters

The NRC plays an important role in the U.S. Government's effort to strengthen deterrents to nuclear proliferation and to improve the international safeguards regime. NRC has statutory responsibility for licensing U.S. nuclear exports and determining whether or not proposed exports will be inimical to the common defense and security of the United States. In discharging this responsibility, the NRC considers whether the necessary agreements, understandings, and safeguards are present for each nuclear export and whether these provide adequate assurance that U.S. exports will not be diverted to any unauthorized use.

Revised Export Regulations

At the direction of the Commisson, a staff export licensing study group prepared a complete revision to NRC's Export-Import regulations. These were published for public comment on June 30, 1977 as a proposed new Part 110 to Title 10 of the Code of Federal Regulations.

The basic purposes of the new Part 110 are:

First, to update and clarify the procedures and criteria employed by the NRC in processing, reviewing, granting or denying export licenses.

Second, to codify procedures for public notification and participation in the NRC's export and import licensing review, including provisions for granting or denying requests for hearings and petitions for leave to intervene, provisions for the hearings themselves, and procedures applicable to access to classified information in hearings.

Third, to consolidate all of the NRC's export-import licensing provisions, which were previously scattered throughout the NRC's regulations, into one part, for the convenience of persons, organizations, and companies concerned with nuclear exports and imports.

Most of the substantive provisions of the new Part 110 were incorporated, with minor revisions, from other parts of the NRC's regulations. However, the provisions regarding public participation in the NRC's export-import licensing review process have been significantly revised from the procedures used in the NRC's domestic licensing review process. In brief, on export-import licensing matters, the new regulations provide for hearings consisting of written comments and for legislative-type oral hearings whenever the NRC determines this would be in the public interest and would assist the NRC in making its licensing determinations. The Commission expected to publish the revised regulations in effective form in early 1978.

Revised Licensing Criteria For Certain Exports

In coordination with the Executive Branch, the NRC reviewed licensing criteria for exports that are relatively unimportant from the national security viewpoint. This was done with a view toward publishing, for public comment, proposed amendments to the NRC's export regulations which would significantly revise the general and specific licensing provisions for the export of certain kinds and quantities of special nuclear material, source material and byproduct material. While most of the proposed changes would broaden general licenses, some would restrict general licensing for certain exports. Another proposed change would simplify administrative requirements for the export licensing of minor quantities of special nuclear material.

Adoption of the proposed amendments would result in a significant reduction in the volume and administrative burden of specific export applications processed by NRC, which would, in turn, enable the export licensing staff to give increased attention to expeditious processing of those exports requiring specific licensing action.

Interagency Nuclear Export Group

During 1977, NRC participated in the establishment of the Interagency Subgroup on Nuclear Export Coordination. The primary purpose of the Subgroup is to facilitate interagency review of the nuclear export functions performed by the various U.S. Government agencies. These include (1) NRC's nuclear export licensing functions; (2) DOE's functions regarding nuclear technology exports, foreign distributions of nuclear material, and foreign reprocessing and retransfer approvals; and (3) Commerce Department's nuclear commodity export functions.

The Subgroup is chaired by the State Department, with secretariat services provided by DOE. Other members are the Arms Control and Disarmament Agency, the Commerce Department, the Defense Department and NRC.

The Subgroup has already proven very useful in expediting consideration of particular export applications and in assuring a coordinated U.S. approach. Previously, with less formal means to coordinate cases among the agencies, some matters took an inordinately long time to resolve and there was a higher risk of inconsistencies in decisions. NRC intends to participate fully in the Subgroup's deliberations and will utilize it to the maximum extent possible, consistent with NRC's statutory role and responsibilities, to expedite the processing of export license applications. NRC staff participates in an observer capacity when the Executive Branch is formulating its position on individual export applications filed with NRC.

Automated Export-Import Data System

The NRC is developing a data processing program designed to provide up-to-date information on the status of pending and completed export and import licensing cases. The system will include a master file consisting of all the data elements that are pertinent to the licensing function, various milestones and dates necessary for analyzing the licensing process, and elements identified for use in the NRC inspection and enforcement program. Data bases and software design will allow for system expansion as future requirements dictate.

The system is designed for compatibility with satellite and remote computer stations in order to provide access to information by the NRC's several regional offices and other potential users. In addition, the system will include automatic processing which connects with the Nuclear Materials Management System maintained by DOE.

Export/Import Summary

During fiscal year 1977, the NRC issued 297 export licenses and received 286 new export license applications. The 95 major export licenses issued during this time are listed in Table 1. In addition, the NRC issued over 90 minor export licenses for special nuclear material, over 25 for source material, and over 70 for byproduct materials. Minor amendments were issued for 16 existing reactor export licenses.

SIGNIFICANT EXPORT CASES

Several licensing actions by NRC during the period under discussion were particularly noteworthy because of the issues they raised and/or the overall policy significance of the actions. These are discussed in the following section.

Tarapur (India) Case

As detailed in the NRC Annual Report for 1976, the first petition for intervention and request for hearing on an export license application was submitted to NRC in March 1976, challenging applications XSNM-805 and 845 by the Edlow International Company for licenses to export low-enriched fuel to India. Although the Commission ruled that the petitioners were not entitled to a hearing or to intervene as a matter of right, a legislative-type hearing was held in July 1976 at the Commission's discretion to afford private individuals and groups an opportunity to provide views and information concerning issues arising from the proposed export. (Procedural issues regarding petitioners' rights in this export license proceeding are still being considered by the U.S. Court of Appeals for the D.C. Circuit.)

After an agreement had been reached between the Department of Justice, on behalf of the Department of State, and the petitioners, the Commission, in a divided opinion, authorized the issuance of XSNM-805 on July 2, 1976 [4 NRC 1 (1976)].

In January 1977, another license application, XSNM-1060, requesting additional fuel for the Tarapur plant, was submitted to the NRC. A motion to consolidate this new application with the previous pending application, XSNM-845, was subsequently filed by the petitioners, and the Commission consolidated the applications in the interest of conducting its review in the most efficient manner [5 NRC 1327 (1977)].

After careful evaluation of Executive Branch views and recommendations, the Commission reached a unanimous decision on June 28, 1977 that License XSNM-845 should be issued [5 NRC 1358 (1977)]. At the end of 1977, application XSNM-1060 was still under Executive Branch review.

The Commission has the responsibility for considering all circumstances surrounding the proposed export as they bear on a determination as to whether or not it would be inimical to the common defense and security of the United States. The Commission noted, for example, in approving XSNM-845:

> "...the explosion which the Indian government steadfastly maintained was conducted solely for peaceful purposes, has not been repeated. Second, there is no evidence that the [Tarapur] facility, or any material sent by the U.S. as fuel for that facility, were employed in the development of the device exploded in 1974.... Third, in recent months a new government has taken office in India.
>
> "Newly elected prime minister Morarji Desai of India has recently voiced his opposition to nuclear weapons and reiterated Indian policy not to use nuclear energy for military purposes.... The Commission does take favorable note of the fact that discussions between the Executive Branch and the Government of India are being conducted on a continuing basis, at the highest levels, and with evident sense of urgency.... Diplomacy must have time to work in this important field.... The Commission is inclined to weigh heavily expressions by the Department of State...that maintaining the supply of fuel for the Tarapur facility is an important precondition for insuring that the continuing discussions on a broad range of issues...can proceed without serious disruption.
>
> "Fourth, we believe it is also important to underscore the Department of State's recent action in informing the Indian government of the new U.S. nuclear policy that we will be unable in the future to continue nuclear cooperation with a nonnuclear weapons state that detonates a nuclear explosive device. This step has put the Indian government on unequivocal notice that, even if India explodes a weapon arguably constructed with entirely indigenously produced materials, utilizing technology not directly received from the United States, the United States Government has announced its intention to terminate the supply of fuel to Tarapur."

The Commission also considered the question of the ultimate disposition of spent fuel from Tarapur

Table 1: Major Nuclear Export Licenses

(Major Licensing Actions Taken by NRC—October 1, 1976 through September 30, 1977)

SPECIAL NUCLEAR MATERIAL (One or more "effective kilograms" as defined in 10 CFR 70.4(t))

Licensee	*Kilograms of Uranium*	*Enrichment %*	*Country of Destination*	*Date Issued*
Westinghouse	183,634	3.15	Japan	10/04/76
Mitsui	116,269	3.01	Japan	10/05/76
Mitsui	12,682	3.07	Japan	10/05/76
Transnuclear	11,954	4.15	France	10/29/76
General Electric	9,700	3.1	Japan	11/17/76
Marubeni	3,045	2.87	Japan	11/24/76
Edlow International	136,400	3.55	Sweden	12/06/76
Edlow International	126,400	3.55	Sweden	12/06/76
State University of NY	488	6.0	Canada	12/21/76
Transnuclear	14,159	3.0	W. Germany	12/27/76
Transnuclear	12,997	3.25	W. Germany	12/27/76
Exxon Nuclear	18,500	2.80	Sweden	12/27/76
Westinghouse Electric	44,575	3.35	Switzerland	12/28/76
Transnuclear	574.860	3.65	Belgium	12/30/76
Exxon Nuclear	7,140	2.95	W. Germany	1/06/77
Transnuclear	14,131.3	3.35	Netherlands	1/11/77
Transnuclear	10,395.42	4.3	Belgium	1/11/77
Mitsui	21,797	3.01	Japan	1/25/77
Mitsubishi	20,604	3.30	Japan	1/25/77
Transnuclear	25,258.665	3.35	Belgium	2/04/77
Westinghouse Electric	16,000	3.2	United Kingdom	2/07/77
Transnuclear	156,072.480	3.15	France	2/08/77
Transnuclear	12,384.61	3.20	Switzerland	2/15/77
Exxon Nuclear	11,520	2.80	W. Germany	2/18/77
Exxon Nuclear	2,200	3.15	W. Germany	2/18/77
Transnuclear	42,200	3.40	W. Germany	2/18/77
Marubeni	10,806	2.87	Japan	2/25/77
Mitsubishi	28,392	3.30	Japan	2/25/77
Mitsubishi	10,312	3.30	Japan	2/25/77
Mitsubishi	7,014	3.15	Japan	2/25/77
Mitsui	5,864	3.07	Japan	2/25/77
Transnuclear	5.854	93.30	W. Germany	3/03/77
Transnuclear	2.005	93.30	W. Germany	3/03/77
Transnuclear	10,619.835	3.65	Belgium	3/16/77
Transnuclear	1,501	3.25	W. Germany	3/21/77
Westinghouse Electric	13,500	4.5	Italy	3/31/77
Mitsubishi	20,196	3.33	Japan	4/05/77
Transnuclear	18,001	3.35	W. Germany	4/08/77
Transnuclear	12,621	3.25	W. Germany	4/11/77
General Electric	14,490	3.1	Japan	4/12/77
Westinghouse Electric	144,934	3.14	Spain	4/26/77
Westinghouse Electric (XSNM-865)	73,173	3.14	Spain	4/26/77
Westinghouse Electric (XSNM-866)	73,173	3.14	Spain	4/26/77
Transnuclear	16.04	93.3	France	5/06/77
Transnuclear	20.05	93.3	Sweden	6/03/77
Transnuclear	2.43	93.3	Austria	6/03/77
U.S. Nuclear	4.5	93.3	Japan	6/06/77
General Atomic	2.86	70	S. Korea	6/10/77
Transnuclear	30,362	3.30	France	6/13/77
Transnuclear	4.653	93.15	Canada	6/17/77
Transnuclear	19.048	93.30	Netherlands	6/22/77
Transnuclear	127.318	93.30	France	6/22/77
Transnuclear	100	93.30	W. Germany	6/27/77
Transnuclear	21.559	93.30	Netherlands Canada	6/27/77
Transnuclear	19.35	93.30	Canada	6/27/77
Transnuclear	24.209	93.30	Canada	6/27/77
Transnuclear	46.139	93.30	Japan	6/27/77

Table 1: Nuclear Export Licenses (Continued)

Licensee	*Kilograms of Uranium*	*Enrichment %*	*Country of Destination*	*Date Issued*
Transnuclear	103.3	93.30	W. Germany	6/27/77
Edlow International	12,261.0	2.71	India	6/28/77
Transnuclear	21,054	3.30	Sweden	6/30/77
Transnuclear	1,480	3.40	W. Germany	6/30/77
Transnuclear	25,083	3.00	W. Germany	6/30/77
Mitsui	18,591	3.07	Japan	7/08/77
U.S. Nuclear	114.5	93.30	Canada	7/11/77
Transnuclear	4.360	93.15	W. Germany	7/11/77
Transnuclear	9,400.77	3.65	Belgium	7/11/77
Transnuclear	76.3905	93.30	Belgium	7/11/77
Edlow International	13,638	2.85	Japan	7/20/77
Westinghouse Electric	15,973	3.72	Spain	7/21/77
Exxon Nuclear	79,860	3.20	W. Germany	8/23/77
Transnuclear	12,465.115	3.25	Switzerland	8/23/77
Mitsubishi	16,324	3.25	Japan	8/24/77
Mitsui	25,154	3.01	Japan	8/29/77
Edlow International	53,090	3.55	Sweden	9/09/77
Edlow International	144,800	3.55	Sweden	9/09/77
Transnuclear	30,953.980	3.40	Austria	9/09/77
Mitsubishi	20,674	2.65	Japan	9/13/77
Transnuclear	24,545.110	3.35	Switerland	9/13/77
General Electric	6,005	3.10	Japan	9/13/77
Mitsubishi	24,247	2.85	Japan	9/14/77

SOURCE MATERIAL

(10,000 kilograms or more of uranium or thorium)

Licensee		*Material*	*Country of Destination*	*Date Issued*
Tennessee Nuclear	200,000	lbs depleted uranium	Canada	12/10/76
RMI Company	99,250	lbs uranium	Canada	12/10/76
NL Industries	20,000	lbs depleted uranium	Canada	1/31/77
Rhodia, Inc.	118,388.83	kgs thorium and uranium	France	3/07/77
Nuclear Metals	60,000	lbs depleted uranium	United Kingdom	3/17/77
Nuclear Metals	195,000	lbs depleted uranium	Canada	4/11/77
Edlow International	890,400	lbs uranium	Canada	6/03/77

REACTORS

Licensee	*Facility Description*	*Country of Destination*	*Date Issued*
General Electric Technical Services San Jose, Ca.	Two boiling water reactors, each 2,894 MWt ENEL vi and VIII	Rome, Italy	3/09/77
Westinghouse Electric Pittsburgh, Pa.	One 1,876 pressurized water reactor KORI II	Seoul, Republic of Korea	4/08/77
General Electric San Jose, Ca.	Two boiling water reactors, each 2,894 MWt VALDECABALLEROS I and II	Madrid, Spain	5/05/77
General Atomic San Diego, Ca.	2,000 KW TRIGA MARK III reactor Thai Research Center	Bangkok, Thailand	5/05/77
Westinghouse Electric Pittsburgh, Pa.	1,876 MWt pressurized water reactor KRSKO Reactor	Krsko, Yugoslavia	5/20/77
Westinghouse Electric Pittsburgh, Pa.	3,000 MWt pressurized water reactor Sayago Reactor	Bilbao, Spain	6/03/77
Babcock and Wilcox Lynchburg, Va.	1,200 MWe light water reactor Muelheim Kaerlich A	Essen, W. Germany	6/28/77
Westinghouse Electric Pittsburgh, Pa.	2,785 MWt pressurized water reactor Vandellos No. 2	Spain	9/13/77

and any material produced from the fuel. It decided that withholding XSNM-845 "pending a definitive outcome of the negotiations with India would be inconsistent not only with the overall [U.S.] policy on continued fuel supply, but also with the response thus far received from the Indian Government on this issue...."

The Commission will be acting on other applications for fuel to be used at Tarapur in the future and will continue to follow closely the direction of India's nuclear program and the progress of U.S.-India negotiations on issues related to the nonproliferation of nuclear explosives and the disposition of spent fuel from India's Tarapur reactors.

Buergeraktion Decision

Another export licensing matter receiving detailed attention from the Commission involved an application submitted by the Babcock and Wilcox Company to export major components of a pressurized water reactor intended for installation in the Muelheim-Kaerlich Nuclear Power Station near Essen, West Germany.

In February 1977 a West German environmental group, Buergeraktion Atomschuetz Mittelrhein, filed a petition to intervene and requested a hearing on this export license application. The petition—the first of its kind—raised the issue of whether the National Environmental Policy Act (NEPA) required the NRC to prepare a statement analyzing the impact of the proposed export on the West German environment before acting on the application.

Having evaluated all pertinent information, including the views of the Executive Branch recommending issuance of the proposed license, the Commission in its Memorandum and Order of June 27, 1977 directed that the license be issued (5 NRC 1332(1977)).

The Commission's favorable action on this pending application was based on its finding that all applicable licensing requirements of the Atomic Energy Act of 1954 had been met. Furthermore, the Commission concluded that NEPA does not require preparation of individual environmental statements assessing the site-specific impacts of a particular proposed nuclear reactor export on territory within the sovereign jurisdiction of another nation. Insofar as impacts of exports on the United States and globally must be considered, the Commission decided that the environmental impact statement regarding U.S. nuclear export activities prepared by the Energy Research and Development Administration (ERDA) in 1976 satisfied all of the NRC's NEPA obligations with respect to this reactor export. In addition, the Commission determined that the petitioners—a foreign organization—lacked standing to intervene in the licensing proceedings as a matter of right and that a discretionary hearing would not be granted.

The following excerpts from the Commission Memorandum and Order describe the Commission's views more fully:

> "...In deciding whether our NEPA obligations include preparation of impact statements in cases such as this one, we have been strongly influenced by well-established principles of international law and considerations of foreign policy put before us by the Department of State....A fundamental principle of international law and U.S. foreign policy is that nations have a basic right to conduct their internal affairs free from interference by other nations....In determining whether NRC should assess foreign impacts, it is important that the preparation of an impact statement not be perceived as an intrusion by the United States into the domestic affairs of a foreign state.
>
> "...The Department of State took the view:
>
> '...that any U.S. attempt to make site-specific assessments of environmental impacts within the territory of another country would have major, adverse political consequences. A majority, if not all, governments would be expected to take the position that, among other things:
>
> - decisions affecting primarily their national environments are a matter of sovereign responsibility;
> - relatedly, the degree and means of public participation in the national environmental decision-making process, which involves a relationship between the government and its citizens, should not be substantially influenced by the actions of other governments; and
> - they have full competence to make the necessary analyses and judgements.'"

The Commission decided that "in light of these practical realities, we believe our conclusion also draws support from the firmly established principle that rules of United States statutory law, whether prescribed by federal or state authority, apply only to conduct occurring within, or having effect within, the territory of the United States, unless the contrary is clearly indicated by the statute."

In concurring in the Commission's opinion on this matter, Commissioner Gilinsky believed it important to emphasize what, in his view, the Commission had and had not decided:

> "(T)oday's ruling rejects Petitioner's contentions pertaining to assessment of site-specific environmental impacts within the Federal Republic of Germany as lying outside the scope of our responsibilities under the National Environmental Policy Act.... On the other hand, however, it recognizes that NEPA does prescribe consideration of the non-U.S. impacts of nuclear export licensing decisions insofar as these may affect the global environment."

Commissioner Gilinsky noted that the Commission had not, in its ruling, decided precisely what matters must be considered in examining the global impacts of U.S. nuclear exports once site-specific impacts within foreign countries had been excluded. In this regard, he concluded that:

> "ERDA's impact statement on U.S. Nuclear Power Export Activities... discusses a variety of global impacts resulting from these activities. The adequacy of that statement is not at issue here. In any case, I would anticipate that as with programmatic or generic environmental statements in the U.S. domestic context, the statement will be supplemented from time to time to reflect new developments and increased knowledge about the environmental effects of this country's nuclear activities."

Other Interventions on Exports

During fiscal year 1977, petitions were filed with the Commission for leave to intervene in opposition to proposed nuclear fuel export licenses for both low-enriched and high-enriched uranium. All but one of the low-enriched uranium (LEU) applications involve shipments to EURATOM countries—Belgium, France, the Netherlands, and the Federal Republic of Germany (FRG). The only other petition filed on an LEU export is the previously mentioned application for more Tarapur fuel. The high-enriched uranium (HEU) cases on which petitions have been filed involve exports to the FRG. The South African case, involving another HEU export, remains pending from the previous year.

All petitions were filed by the Natural Resources Defense Council (NRDC) and those proceedings involving common issues have been consolidated. Table 2 lists the export applications pending as of September 30, 1977.

Interventions on LEU Exports. The petitioners' contentions on the proposed LEU licenses to EURATOM are twofold: first, they contend that commercial reprocessing of spent nuclear fuel to extract plutonium constitutes a threat to U.S. security; second, the petitioners feel that the Commission cannot properly determine that exports of low-enriched fuel to EURATOM countries will not be inimical to, or constitute an unreasonable risk to, the common defense and security and the interests of the United States unless such exports are conditioned on a requirement for U.S. approval prior to any retransfer within EURATOM and any reprocessing of the exported fuel.

Both the NRC staff and the Executive Branch submitted that the petitioners lack standing in these matters. The Executive Branch has forwarded its

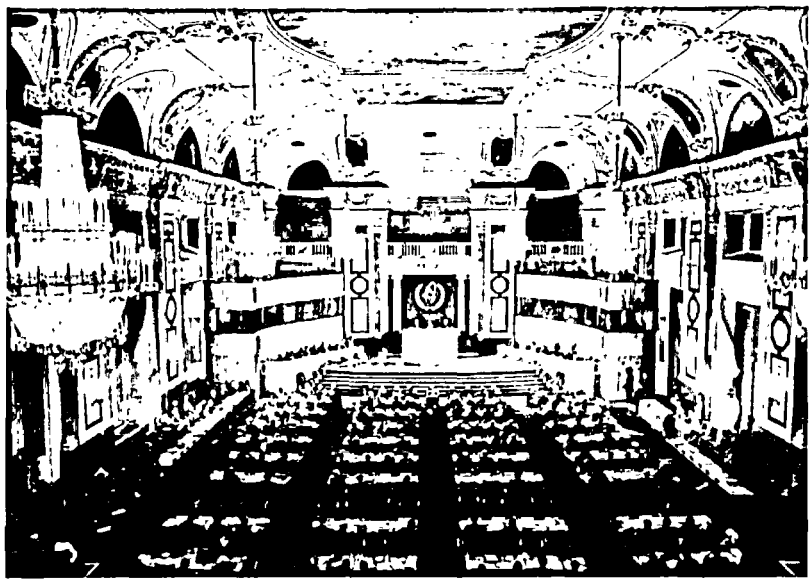
Table 2: Export Licenses with Interventions Pending as of 9/30/77

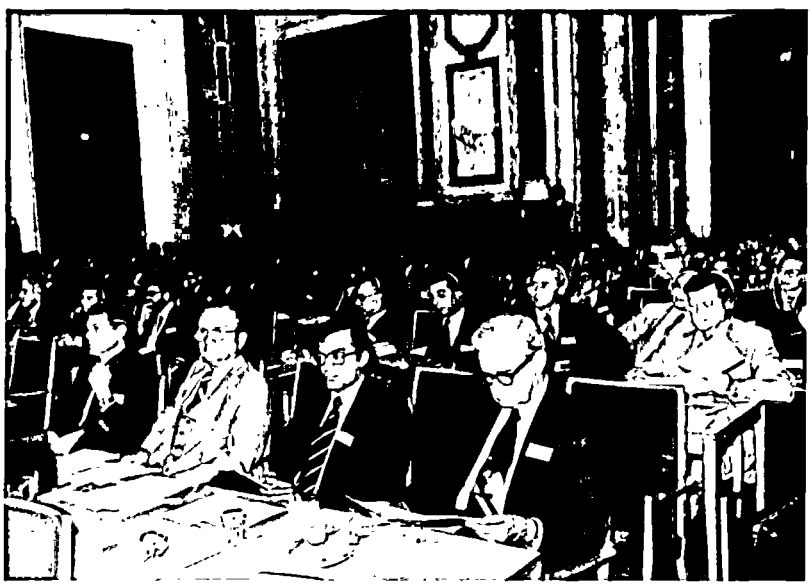
LEU EXPORTS

1.	XSNM-1060	India
2.	XSNM-1117	West Germany
3.	XSNM-1142	" "
4.	XSNM-1145	" "
5.	XSNM-1116	" "
6.	XSNM-1119	The Netherlands
7.	XSNM-1160	Italy
8.	XSNM-1162	Belgium
9.	XSNM-1176	France
10.	XSNM-1180	Belgium
11.	XSNM-1181	West Germany

HEU EXPORTS

1.	XSNM-1026	West Germany
2.	XSNM-1138	" "
3.	XSNM-1195	" "
4.	XSNM-690	South Africa (Pending from FY 76)





Members of the NRC attended the 21st General Conference of the IAEA, held in September 1977 at the Neue Hofburg in Vienna, Austria. High-level officials of the 110 member nations meet annually to plan the Agency's program.

views to the Commission on the merits of nine of the applications subject to intervention petitions. On October 4, 1977, the Commission denied the petitioners leave to intervene on the pending license applications because the NRDC had failed to establish the prerequisite interest in the proceeding required by Section 189 of the Atomic Energy Act of 1954, as amended. The Commission also deferred a decision on whether to hold a discretionary hearing concerning the applications in view of Congressional consideration of pending nuclear nonproliferation legislation, which would resolve issues raised by NRDC.

Shortly thereafter, the Commission received expressions of urgent need for the material covered by license application XSNM-1116 from EURATOM. EURATOM noted that important electrical grids in the FRG would have to be shut down if shipment of the material took place later than November 15, 1977.

After careful review of all relevant factors, the Commission, on November 10, 1977, directed that license No. XSNM-1116 be issued. The Commission's decision was based partly on its view that it would be inappropriate to withhold urgently needed low-enriched uranium that met statutory requirements from a close U.S. ally and signatory of the Non-Proliferation Treaty during a time when Congress is actively considering the precise issue raised by petitioners. Finally, the decision to approve this license also considered the Executive Branch's view

that failure to approve this urgently needed fuel export would have an adverse foreign policy impact.

In approving issuance of this license, the Commission stated that (1) it would continue to process license applications subject to the intervention petitions if present statutory licensing requirements could be met and urgent need demonstrated; and (2) its decisions in this matter do not prejudge the results of its examination of the other pending license applications having intervention petitions. The question of whether and to what extent further public participation will be sought for the remaining applications for exports of LEU to EURATOM will be fully addressed at a later date.

Interventions on HEU Exports. The petitioners (NRDC) on the three applications to export high-enriched fuel for use in several FRG research reactors claim that the NRC must develop specific criteria to assess the risks inherent in the export of HEU. They contend that the Commission must make an independent judgment with regard to the adequacy of the safeguards applicable to the proposed shipment. They are also concerned with the difficulties in safeguards implementation, and the physical security risks associated with the shipment of HEU to the FRG. Furthermore, the NRDC contends that, in connection with these exports, the NRC must prepare, circulate, and consider an environmental impact statement pursuant to section 102(2)(c) of the National Environmental Policy Act.

The NRC staff and the Executive Branch have opposed granting the petitioner leave to intervene on the grounds that the procedural issues raised by the petitioner have already been resolved in the *Tarapur* and *Buergeraktion* decisions.

On December 22, 1977, the Commission, by a unanimous vote, held that the petitioner (NRDC) lacked standing to intervene in the three pending license applications. The Commission requested that a draft order be prepared which, in addition to denying the petitioner standing, would offer an opportunity for receipt of public comments on specific issues raised by the petitions.

Petition on South African Export

At the close of fiscal year 1977, a petition to intervene against the pending application for a license to export high-enriched uranium fuel to South Africa remained before the Commission. The license request was still under consideration by the Executive Branch, awaiting appraisal in light of recent nuclear policy reviews.

INTERNATIONAL SAFEGUARDS

International safeguards are an important consideration in NRC's approval of export license applications. In addition, the safeguards expertise of NRC staff is used in the formulation and implementation of U.S. national policy in this area. Thus, NRC takes an active role in encouraging and contributing to the continued upgrading of safeguards as administered by the International Atomic Energy Agency (IAEA) and shares in the planning associated with the U.S. Technical Support Program on International Safeguards, as administered by DOE.

Key events and developments in the international safeguards area in which NRC participated during fiscal year 1977 included:

(1) Assistance to U.S. Government efforts to formulate policies for defining and improving international safeguards in the context of U.S. nonproliferation efforts, including the development of draft nonproliferation legislation.

(2) Participation with DOE, the Department of State, and the Arms Control and Disarmament Agency in the planning and implementation of the program of U.S. technical support for IAEA safeguards. This program has funding of $3 million for fiscal year 1977 and is administered by the International Safeguards Project Office (ISPO) at Brookhaven National Laboratory under DOE direction, with overall guidance by the State Department.

(3) NRC staff participation in meetings with international safeguards experts, both in the U.S. and overseas, to exchange views on safeguards and physical security topics and long-term assignment of NRC safeguards specialists on the IAEA staff in Vienna. These activities provided valuable information in areas of mutual interest and insights into the views of representatives of other nations on safeguards and physical protection policies.

(4) Regular participation of NRC technical experts in visits of U.S. physical security review teams, headed by DOE, to other countries. This not only contributes to U.S. efforts to strengthen physical security measures worldwide, but also provides an important basis for assessing the adequacy of physical security as it relates to applications for licenses to export significant quantities of special nuclear material.

(5) Discussions with the IAEA regarding the implementation of the U.S.-IAEA Safeguards

Agreement, which was signed in September 1976 and which calls for application of IAEA safeguards on U.S. civil nuclear facilities. A series of discussions was conducted with the IAEA concerning the Subsidiary Arrangements associated with this Agreement. These Arrangements specify the precise manner in which safeguards will be implemented in the United States. Because of its particular concern with the application of IAEA safeguards to licensed domestic nuclear facilities, NRC will publish a new part of the Code of Federal Regulations setting forth regulations to implement the reporting and safeguards requirements of the Agreement for domestic licensees. The agreement is expected to be forwarded to the Senate as a treaty, and possibly brought into force, in fiscal year 1978.

IAEA Report on Safeguards

Another important development in the international safeguards area was the first annual Special Safeguards Implementation Report (SSIR), a critical review by the IAEA of its own safeguards inspection system. The SSIR was provided to the IAEA Board of Governors, on which the United States has a permanent seat, in June and the issues and recommendations in the report were considered by the Board at its September meeting.

The IAEA Secretariat concluded in the SSIR that, for the period covered (calendar year 1976), in none of the 41 States in which inspections were carried out was there any diversion of a significant quantity of IAEA safeguarded nuclear material. The report also noted that this conclusion was based on both quantitative analyses and elements of judgment.

Deficiencies Highlighted. At the same time, however, the SSIR highlighted deficiencies in safeguards implementation in a number of countries which were, in accordance with the Statute of the IAEA, not identified. The report thus indicated that a country's agreement to subject its nuclear activities to IAEA safeguards does not necessarily assure that adequate material control and accounting measures were applied in all cases. Therefore, the NRC could, without knowing it, be approving the export of nuclear materials to countries in which the IAEA was having implementation problems. In this connection, late in 1977 staff papers forwarding major export applications for Commission review began to note that the staff does not have country-specific information which would permit it to reach an independent determination regarding the effectiveness of IAEA or EURATOM material control and accounting safeguards on a country-by-country basis.

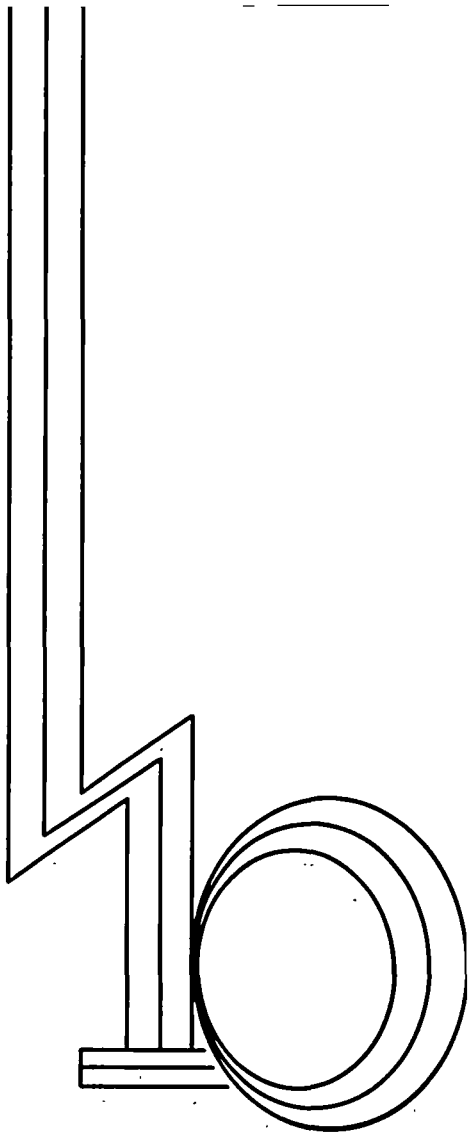
While the Commission and other agencies of the Executive Branch do have knowledge of the overall IAEA safeguards program and some of its limitations and deficiences, no U.S. Government agency, including NRC, has direct access to IAEA safeguards confidential information as a basis for independent evaluations of the effectiveness of IAEA safeguards implementation on a country-by-country basis. In this regard, representatives of the Department of State have expressed the view that for the U.S. Government to insist now on obtaining country-specific inspection reports from the IAEA, or alternatively on U.S. on-site inspections in other countries, would undermine the basic international consensus that has developed around the safeguards system administered by the IAEA.

In light of these developments, the Commission began a reexamination of its role in making assessments of international safeguards against diversion of nuclear material in its export licensing decisions, while recognizing that:

- The Agency's candid review of its safeguards system represents a very significant step in the right direction;
- An intensification of the program to strengthen IAEA safeguards is needed; and
- It is essential that actions the U.S. takes serve to encourage, and not inhibit, the Agency's ongoing efforts to make continuing candid and critical evaluations of its safeguards system.

In addition to its involvement in several U.S. efforts mentioned above, the Commission has actively participated in the development of a comprehensive action plan, under the auspices of the Interagency Steering Group on International Safeguards, for upgrading IAEA safeguards and improving the NRC's knowledge of them. By bringing together a variety of U.S. Government activities, the plan will emphasize the importance the U.S. attaches to improving the international safeguards system, attempt to maximize the impact of U.S. efforts toward this end, and seek to ensure that the U.S. Government is informed of significant safeguards problems. Thus, during 1978, the NRC will focus considerable attention on both the action plan and the reexamination of the Commission's role in making assessments of international safeguards in the context of export licensing decisions.

Regulatory Standards



The development of standards cuts across the range of the NRC's activities. Standards provide for protection of the public and nuclear industry workers from radiation, the safeguarding of nuclear materials and plants from theft and sabotage, and protection of the quality of the environment.

NRC standards are of two types:

- *REGULATIONS* published in Title 10, Chapter I, of the Code of Federal Regulations. These set forth requirements that must be met.
- *REGULATORY GUIDES* which describe methods acceptable to the NRC staff for implementing specific parts of the NRC's regulations.

When a regulation is proposed, it is first published in the *Federal Register* to allow interested citizens time for comment before final adoption, in accordance with the Administrative Procedure Act. Following the public comment period, proposed regulations are revised, as needed, to reflect the comments received. If the regulation is adopted by the NRC, it is published in the *Federal Register* in final form with a date when it becomes effective. After that publication, rules are codified for inclusion in the annual publication of the Code of Federal Regulations.

Some regulatory guides delineate techniques used by the staff to evaluate specific situations. Others provide guidance to applicants concerning information needed by the staff in its review of applications for permits and licenses. Many NRC guides refer to or endorse consensus standards (also called "national standards") that are developed by recognized national organizations, often with NRC participation. NRC makes use of a national standard in the regulatory process only after an independent review of the standard has been made by the NRC staff and after public comment on NRC's planned use of the standard has been reviewed.

The NRC encourages comments and suggestions for improvements in regulatory guides at all times, and they are revised to take account of appropriate comments and suggestions and to reflect new information or experience. Newly issued guides have a comment period of about two months after issuance, following which the staff reviews the comments received and revises the guides, as appropriate.

Copies of regulatory guides are also mailed for comment to many individuals and organizations. When a guide is issued, a staff analysis of it is placed in NRC's Public Docu-

At a facility for manufacturing nuclear power plant components, an NRC inspector observes welding to verify that the welding is correctly performed in accordance with written procedures and that both the welding procedures and the welder have been qualified in accordance with ASME Nuclear Code requirements.

ment Room in Washington, D.C. The analysis indicates the objective of the guide, its expected effectiveness compared to alternative ways of achieving the objective, and other expected impacts, such as on other safety systems, NRC operations, other Government agencies, industry and the public.

Regulations and guides are issued concerning virtually the entire range of NRC's jurisdiction. While many of the standards issued or worked on during fiscal year 1977 are discussed in this chapter, some are discussed elsewhere in this Annual Report under the topics to which they relate (e.g., transportation in Chapter 3 and safeguards in Chapter 4).

ADDRESSING CURRENT ISSUES

The following are current issues of high priority in the program for development of regulatory standards:

- *Steam Generator Tube Integrity*

NRC, in conjunction with industry and the national standards program, has developed standards for inservice inspection and criteria for plugging steam generator tubes in pressurized water reactors that may be affected by corrosion and erosion. (See Chapter 2.)

A new potential failure mechanism in steam generators—"denting" of tubes at the support plates—was observed during fiscal years 1976 and 1977. (See Chapter 7.) NRC is sponsoring efforts to determine the ability of the commonly used eddy-current scanning technique to detect denting. Results of this effort will be used in revising the regulatory guides on steam generator tubes to include consideration of the denting phenomenon.

- *Reactor Components*

During inservice inspections, some snubbers (the components in piping systems intended to resist excessive motion under severe loads, e.g., during earthquakes, while allowing normal motion during operation) have been found to be inoperative. There is concern that these snubbers may have been installed or used improperly in some plants. NRC is developing methods for qualifying snubber designs by means of tests, and is collecting information to help designers make more effective use of snubbers.

- *Reactor Materials*

Results from material surveillance tests indicate that radiation damage to some reactor pressure vessel welds may be more severe than had been anticipated. This has resulted in the need for tighter pressure and temperature controls during reactor startups and shutdowns. During the past year, a review of NRC fracture prevention requirements

resulted in revisions to a regulatory guide on the subject and development of revisions to relevant regulations. Also, NRC's research program on radiation damage to materials has been redirected to place greater emphasis on concerns raised by the surveillance tests.

In a related area, NRC began a review of requirements for nondestructive evaluation of reactor pressure vessels with the intent of issuing a regulatory guide on procedures for the detection, characterization and evaluation of flaw indications in periodic inservice examinations.

- *Early Site Review*

Early site review is intended to make siting decisions possible before there is a critical need for the site and before any large commitments of resources. This requires separation of site review from plant review. The Commission adopted a rule on early site review during the year. (See Chapter 2.) The staff is now developing data on optional methods of making the review.

- *Spent Fuel Storage*

The President's objective of deferring indefinitely the commercial reprocessing of spent power reactor fuel could increase the need for storage capacity until such time as final disposal can be accomplished. Industry is considering the use of independent facilities, possibly located away from reactor sites, to provide this interim storage. However, NRC regulations do not now directly address such independent facilities, so a regulation and supporting guides are being developed to provide a basis for planning and licensing them.

- *Decommissioning*

The NRC is giving increased attention to the eventual need to decommission and decontaminate the growing number of nuclear facilities at the end of their useful service lives. Studies have been initiated to evaluate alternative courses of action, including the following: (1) maintenance in standby status for possible future use, (2) protective storage to allow for decay of high-level radioactivity, (3) entombment, and (4) dismantling.

- *Transportation of Radioactive Materials*

The staff is responding to the continuing public interest in transportation of radioactive materials by involving the public in its environmental studies and ongoing reevaluation of transportation regulations. This activity goes beyond routine public notification procedures.

In the past year, two public meetings involving briefings of the Advisory Committee on Reactor Safeguards' Working Group on Transportation were held to discuss the draft "Generic Environmental Impact Statement on the Transportation of Radioactive Materials by Air and Other Modes" issued in March 1976. In addition, there were four public meetings involving a task group formed by Sandia Laboratories to assist in the environmental assessment of urban transport. The Sandia assessment will provide a basis for issuance of a generic environmental impact statement on the transport of radionuclides in urban environs.

These environmental impact statements on transportation, along with public comments and other information, will help provide a basis for determining whether changes to existing regulations are needed. Transportation of radioactive materials, including standards activities, is discussed in detail in Chapter 3.

- *Licensing of SNM Carriers*

Alternative approaches are being considered for bringing directly under NRC physical protection requirements those domestic carriers that transport special nuclear material in significant quantities. NRC inspections currently are carried out under a cooperative voluntary arrangement with carriers. While cooperation received under the voluntary approach has generally been satisfactory, a legal basis is needed to enable NRC to inspect the security systems of carriers on demand and to require the correction of deficiencies.

- *Performance-Oriented Regulation of Security Systems*

A proposed rule to upgrade physical protection requirements for fuel cycle facilities and for transportation of special nuclear material has been issued for public comment. The regulation is of particular interest in that it allows licensees flexibility in designing their specific security systems so long as they meet prescribed performance requirements. Performance-oriented regulations are also being considered for material control and accounting systems.

- *Upgraded Guard Training and Qualification*

A proposed rule (10 CFR Part 73, Appendix B) to upgrade qualification, training and equipment requirements for guards at fuel cycle and power reactor facilities and for escort guards who accompany domestic shipments of strategic quantities of SNM was published in July 1977 for public comment. Comments received are being analyzed prior to preparing an NRC response to the various issues raised. Major issues include preemployment qualifications, physical fitness requirements, firearms requirements, training facilities, the specification of training courses and the hours of training prescribed for each course.

- *Personnel Clearance Program*

Public comments on a proposed rule requiring security clearances of employees having access to

special nuclear material are being analyzed. Major issues to be resolved include legal questions, the impact of the program on research and test reactors, how to handle licensee contractors who occupy reactor sites in large numbers during outages, program costs versus benefits, and safeguards against infringement of civil liberties in the background investigations. The NRC plans to hold a public hearing on this subject early in 1978.

- *Products Containing Radioactive Materials*

The use of radioactive materials in an increasing number of consumer products such as wristwatches, smoke detectors, or cardiac pacemakers has prompted a review of the criteria used for approving such uses. In fiscal year 1977 an NRC-sponsored computer program was used to estimate individual and population doses from a number of consumer products. Studies were also begun to estimate the amounts of radioactive materials now in use in consumer products. (See also Chapter 3 under "Radioisotopes Licensing.")

Since the United States became a full member of the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development, the NRC has participated in NEA's efforts to develop international standards for smoke detectors.

- *Medical Uses of Radioisotopes*

The NRC is reviewing its regulatory role pertaining to medical uses of radioisotopes, considering the need to protect the general public, medical and pharmaceutical personnel, and patients from unnecessary exposures to radiation. A policy statement and several rule changes are being prepared. (See Chapter 3.)

- *Occupational Exposures*

Radiographers sustain a majority of the occupational overexposures that result in clinically observable radiation injury. Accordingly, the NRC staff is developing standards to improve training and radiation safety for radiographers.

POWER REACTOR STANDARDS

Development of power reactor standards continued during fiscal year 1977 to be aimed primarily at protecting the health and safety of the public and secondarily at reducing the regulatory burden.

Protection Against Fire

The fire protection guidelines for nuclear power plants published in Guide 1.120 in June 1976 were revised in response to comments received. The guide was reissued in November 1977 for an extended one-year comment period. The guide describes how to implement NRC's requirement that the probability and effects of fire must be minimized through fire prevention, detection and suppression. It also provides guidelines for designing fire safety features into nuclear power plants.

Sandia Laboratories, under NRC contract, is continuing to develop the technical bases for guidance in ventilation, fire detection, barriers and fire hazards analysis.

Protection Against Missiles

A revision of Guide 1.115, issued in July 1977, presents additional ways of protecting against low-trajectory turbine missiles. Guidance on risk analysis methods and the use of barriers is included, along with restrictions on placement and orientation of the turbine-generator set.

The staff continued development of a guide on possible tornado-generated missiles. Tests conducted by Sandia Laboratories to develop aerodynamic data on the large pipes that are potentially the most damaging of the postulated tornado missiles showed that assumptions previously used by the staff are conservative.

Nuclear medicine technologists calibrate a "gamma camera" prior to myocardial imaging studies on patients.

Chlorine Releases

Revision 1 of Guide 1.95 was issued in January 1977. It describes acceptable design features for the protection of the operators of control rooms at nuclear power plants in the event of an accidental chlorine release. (Chlorine is used as a biocide in certain cooling systems.) An accidental release of chlorine, which is not radioactive, could have radiological consequences if the operator became incapacitated.

Reactor Containment

Containment Design. In October 1976 the NRC published for comment a regulation that would reduce significantly the number of plants required to have inert containment atmospheres in order to prevent hydrogen explosions under certain accident conditions. This proposed change takes account of increased conservatism in the revised emergency core cooling system requirements. Guide 1.7 was revised and issued for comment in September 1976 in conjunction with the proposed rule.

Containment Construction and Inspection. Several guides relating to the construction and inspection of concrete reactor containments were revised during fiscal year 1977. Revision 1 to Guide 1.90, on inservice inspection of prestressed concrete containment structures with grouted tendons, was issued in August 1977 to reflect public comment received following a public meeting on the proposed changes. Two other guides that also were revised to reflect public comments were Guide 1.103 (issued in October 1976), which describes post-tensioned prestressing systems used in concrete reactor vessels and containments, and Guide 1.107 (issued in February 1977), which describes qualifications for cement grouting for prestressed tendons in containment structures.

System and Component Criteria

General Design Guidance. The Codes and Standards Rule (Section 50.55a of 10 CFR Part 50) was amended to incorporate new nuclear addenda of the ASME Boiler and Pressure Vessel Code.

Modifications to the ASME Code are often introduced through "Code Cases," a document published by the ASME Boiler and Pressure Vessel Committee. Generally, the individual sections of this document explain the intent of Code rules. NRC provides the industry with a timely indication of its approval or disapproval of such code cases through the prompt revision of Guides 1.84, "Code Case Acceptability—ASME Section III Design and Fabrication," and 1.85, "Code Case Acceptability—ASME Section III Materials." Three revisions of each guide were issued during fiscal year 1977. Procedures provide for revision of the guides following each ASME Council meeting that approves new code cases.

Guidance on Specific Systems and Components. Revision 2 to Guide 1.31, "Control of Ferrite Content in Stainless Steel Weld Metal," issued for comment in May 1977, incorporates provisions to facilitate measurement of ferrite levels in weld metal.

Guides 1.124 (issued for comment in November 1976) and 1.130 (issued for comment in July 1977) address design limits and loading combinations for ASME Class 1 linear component supports and plate-and-shell-type component supports, respectively.

Guide 1.68, which describes acceptable methods for complying with NRC regulations on preoperational and initial startup testing programs for water-cooled power reactors, was revised and issued for comment in January 1977. The NRC is currently developing a series of guides that will provide more detailed guidance concerning specific areas of the preoperational and initial startup test programs. Revision 1 to Guide 1.68.1, which describes a preoperational and initial startup testing program for feedwater and condensate systems of boiling water reactors, was issued in January 1977. In the same month, NRC issued for comment Guide 1.68.2, which describes the initial startup test program to demonstrate remote shutdown capability for water-cooled nuclear power plants.

Electric Systems and Components. The NRC is emphasizing development of standards and guides for post-accident monitoring systems. Revision 1 to Guide 1.97, which addresses instrumentation to assess plant conditions during and following an accident, was issued in August 1977.

Emphasis is also being placed on the design of direct current systems and components for nuclear power plants. Guide 1.128, which covers the installation of large lead storage batteries, and Guide 1.129, which deals with the maintenance, testing, and replacement of such batteries, were issued for comment in April 1977.

The following other revisions of regulatory guides were issued during fiscal year 1977: Revision 1 to

Guide 1.108, on periodic testing of diesel generator units used as onsite electric power systems (August 1977); Revision 2 to Guide 1.32, on criteria for safety-related electric power systems (issued for comment in February 1977); Revision 1 to Guide 1.105, on instrument setpoints (November 1976); and Revision 1 to Guide 1.106, on thermal overload protection for electric motors on motor-operated valves (March 1977).

Qualification Testing (Electrical)

Work continues on standards and guides for qualification testing of electric equipment. Supporting research continues at Sandia Laboratories on test source equivalence, synergistic effects, and aging. Underwriters Laboratories is performing an NRC-sponsored study of the adequacy of IEEE Standard 383-1974, on flammability testing. The following guides were issued: Guide 1.131, on qualification tests of electric cables, field splices, and connections, issued for comment in August 1977; Revision 1 to Guide 1.100, on seismic qualification of electric equipment, issued in August 1977; and Revision 1 to Guide 1.63, on electric penetration assemblies, issued for comment in May 1977.

Quality Assurance

Quality assurance requirements for the design, construction and operation of safety-related structures, systems and components of nuclear power plants are established in 10 CFR Part 50, Appendix B. During the past fiscal year, NRC issued the following new and revised guides concerning the implementation of these requirements: Guide 1.123, on quality assurance requirements for the control of procurement of items and services for nuclear power plants, issued for comment in October 1976 and revised in July 1977; Guide 2.5, on quality assurance requirements for research reactors, issued for comment in May 1977; Revision 1 of Guide 1.38, on quality assurance requirements for packing, shipping, receiving, storage, and handling of items for water-cooled nuclear power plants, issued for comment in October 1976 and reissued as Revision 2 in May 1977; Revision 1 of Guide 1.33, on quality assurance program requirements for the operation of nuclear power plants, issued for comment in January 1977; Revision 1 of Guide 1.39, on housekeeping requirements for water-cooled nuclear power plants, issued for comment in October 1976 and revised in September 1977; Revision 2 of Guide 1.88, on collection, storage, and maintenance of nuclear power plant quality assurance records, issued in October 1976; and Guide 1.116, on quality assurance requirements for installation, inspection, and testing of mechanical equipment and systems, reissued in May 1977.

Reporting Defects and Noncompliance

Section 206, "Noncompliance," of the Energy Reorganization Act of 1974 requires that certain persons report the matter to the NRC whenever they become aware of a defect that could create a substantial safety hazard or of a failure to comply with regulations relating to substantial safety hazards.

To implement that section, the NRC published in June 1977 an effective rule, Part 21, "Reporting of Defects and Noncompliance," and conforming amendments to other NRC regulations. The rule is intended to provide the NRC with a new source of information in its continuing endeavor to anticipate problems. Portions of Part 21 became effective on August 10, 1977; the remainder were to become effective in January 1978.

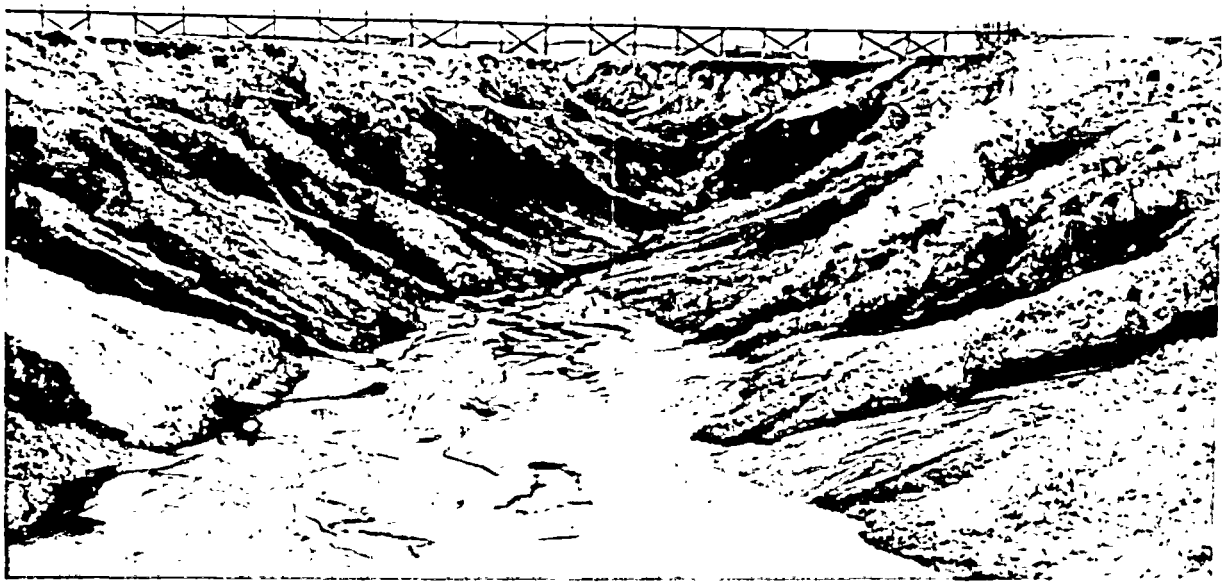
Five regional workshops were held in July to provide for an interchange of information between the staff and the individuals who are subject to Part 21. (See also Chapter 6.)

Inservice Inspection and Surveillance

Guide 1.83, on inservice eddy-current inspection of pressurized water reactor (PWR) steam generator tubes, is being revised to include inspection for the onset of "denting," a new degradation phenomenon observed in some PWRs. Also, Guide 1.121, which provides guidelines for determining when degraded PWR steam generator tubes are no longer acceptable for service, is being revised to include criteria for plugging severely "dented" tubes. (See Chapter 2 under "Action on Technical Problems," and Chapter 7 under "Abnormal Occurrences—1977.")

Revision 1 to Guide 1.99, which provides guidance on the effects of residual elements on predicted radiation damage to reactor vessel materials, was issued in April 1977. Future revisions of this guide will reflect an analysis of damage information now being made by the Metal Properties Council for the American Society for Testing and Materials.

Guide 1.133, issued for comment in September 1977, recommends a program for detecting loose parts in the primary system of light water reactors.



This picture shows erosion gullies of uranium mill tailing deposits resulting from a breach of a tailing retention dam. This situation has been corrected by rebuilding the dam. Continuing inspections will prevent this type of failure from recurring.

Water Control Structures

Nuclear power plants, as well as other facilities in the nuclear fuel cycle, use water control structures such as dams and canals for a variety of purposes. Revision 1 to Guide 3.11, issued for comment in March 1977, addresses the design, construction, and inspection of embankment structures for retaining radioactive materials at uranium mills. In April 1977, the NRC also issued for comment Guide 1.127, which covers the inspection of water control structures associated with nuclear power plants.

Maintaining Safety at Multiunit Sites

In July 1977, the NRC proposed a rule that would require applicants for construction permits and operating licenses for multiunit reactor sites to take proper precautions to ensure the integrity of structures, systems and components important to the safety of any operating unit while construction goes forward on other units. The rule is being considered in response to a petition for rulemaking filed by the Business and Professional People for the Public Interest.

Safety Analysis Reports

In November 1976, the NRC proposed a rule that would apply to applicants for power reactor operating licenses and to holders of such licenses issued after January 1, 1963. The rule would require those applicants and licensees to submit periodically to the NRC any revised pages in their Final Safety Analysis Reports. These revised pages would indicate changes made in the facility or the procedures for its operation and any analyses that are affected by these changes. The purpose of the rule is to provide an accurate reference document for any recurring safety analyses to be performed by the applicant or licensee and by the NRC. The NRC staff is evaluating public comments on the rule and expects to publish it in effective form in 1978.

Operational Testing of Prototypes

On May 19, 1977, the NRC published in the *Federal Register* a detailed evaluation of the need to require full-scale operational testing of pilot models or prototype versions of nuclear power plants, in the configuration they are expected to have in situ, prior to issuance of a license to manufacture a substantial number of basically identical plants. The evaluation was performed in response

to a petition for rulemaking filed by the Atlantic County Citizens Council on Environment.

In denying the petition, the Commission concluded that its present approach to design verification, which relies on a multifaceted program culminating in detailed testing and qualification of the actual as-built plant, provides the greatest assurance that the public will be protected. It found, further, that adding an extra requirement for prototype testing would not be likely to provide any significant increase in this assurance. The petitioners, concluded the Commission, had not shown that the requested rule change would enhance the public health and safety or lessen the impact on the environment. Instead, the Commission concluded, the requested rule change would impede the licensing process and prove costly to the industry, both in time and money, without any corresponding benefit or improvement in the regulatory process.

SITING STANDARDS

The standards on the siting of nuclear plants are of three types: those dealing with procedures for site review, those relating to site safety, and those having to do with protection of the environment.

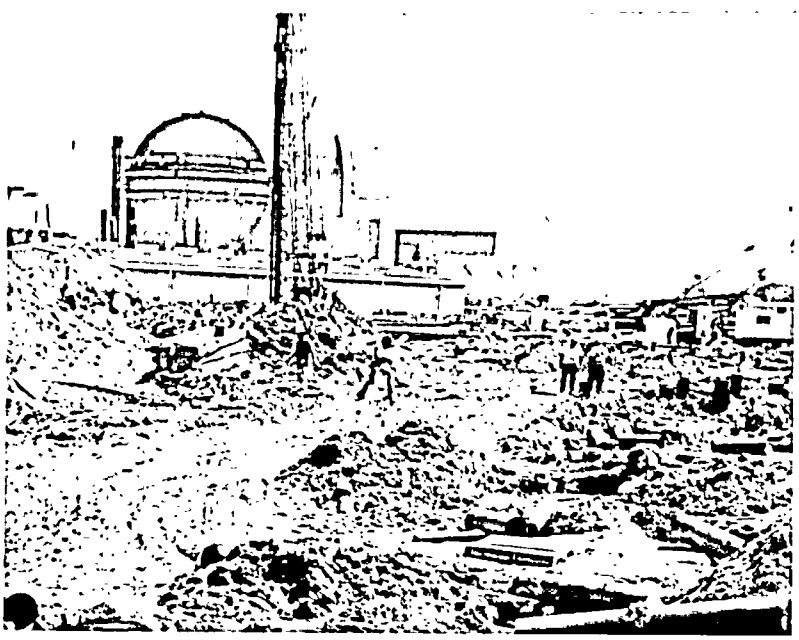
Site Review Procedures

Early Site Reviews. A rule on early site reviews separate from review of the plant was issued in June 1977 and data to support implementation of the rule was in preparation at the end of the year (see Chapter 2).

Siting Policy and Practice. This year the staff completed a review initiated in 1975 of past and existing nuclear reactor siting policy and practice. On the basis of that review, a plan for more detailed review of specific areas was developed. Review of accident evaluation practices was initiated through a contract with Battelle-Pacific Northwest Laboratory.

Siting issues also were the subject of petitions received by the NRC. For example, a petition for rulemaking was received from the Public Interest Research Group relating to population density criteria and minimum distances for the exclusion area and low population zone at reactor sites.

NRC/State Cooperation. Technical siting issues that are of concern to the States as well as the NRC—such as water resources management, regional geology, alternative site selection, and socioeconomic effects—are being addressed in a demonstration program with the member States of the Southern Interstate Energy Board. The program, which began in fiscal year 1977, is designed to resolve siting issues that arise as a part of the site selection and regulatory process. Georgia, South Carolina and North Carolina are working together to address technical issues of common concern. The other member States are reviewing the process for compatibility with their own institutional arrangements. (See Chapter 8.)



One unit of a nuclear power plant in the background continues operation as construction proceeds on its sister plant and another plant on the same site in the foreground.

Site Safety

Standards dealing with site safety are issued to help ensure that nuclear power plants will be able to withstand both man-induced events and natural events such as earthquakes, floods, and extreme meteorological conditions.

In the field of meteorology, Revision 1 of Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," was issued in July 1977. In addition, work went forward on revisions of two other meteorological guides. The staff is also collecting data for the development of standards on extreme wind speeds for coastal areas, extreme ice and snow accumulations, and extreme maximum and minimum temperatures.

In January 1977, in response to a petition for rule change by the New England Coalition on Nuclear Pollution, the NRC clarified Appendix A of 10 CFR 100 (which sets forth geological and seismic siting criteria for nuclear power plants) with respect to considering earthquakes greater than the maximum historic instance. Work also began on an overall examination of Appendix A for possible revision. In other actions concerning geology and seismology, the NRC, on November 7, 1977, denied a petition for rulemaking filed by the Central Maine Power Company to amend the definition of a "capable fault"; published NUREG-0143, "The Correlation of Peak Ground Acceleration Amplitude with Seismic Intensity and Other Physical Parameters"; and began collecting technical data for a guide on methods used for dating fault movement in the assessment of fault capability.

In the area of geotechnical engineering, the NRC issued for comment in September 1977 Guide 1.132, "Site Investigation for Foundations of Nuclear Power Plants," and neared completion of a guide on laboratory testing of soils. A project was initiated with the Corps of Engineers to develop criteria as the basis for a guide on liquefaction of soils.

Two guides dealing with hydrology were issued: 1.135, issued for comment in September 1977, "Normal Water Level and Discharge at Nuclear Power Plants"; and Revision 2 to 1.59, "Design Basis Floods for Nuclear Power Plants." Work went forward on Guide 1.125, "Physical Models for the Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants."

PROTECTION OF THE ENVIRONMENT

Environmental standards are concerned both with the control of radioactive effluents from nuclear facilities and with nonradiological environmental effects. In the past, emphasis has been placed on development of environmental standards for nuclear power plants. Currently, greater emphasis is being placed on other nuclear facilities.

Guide 4.14, on measuring radioactivity in effluents from uranium mills, was issued for comment in June 1977. It is intended to help uranium mill operators design monitoring programs that will be most useful in assessing the impact of radioactive effluents. Other guides on effluent and environmental monitoring programs for nuclear facilities are in preparation.

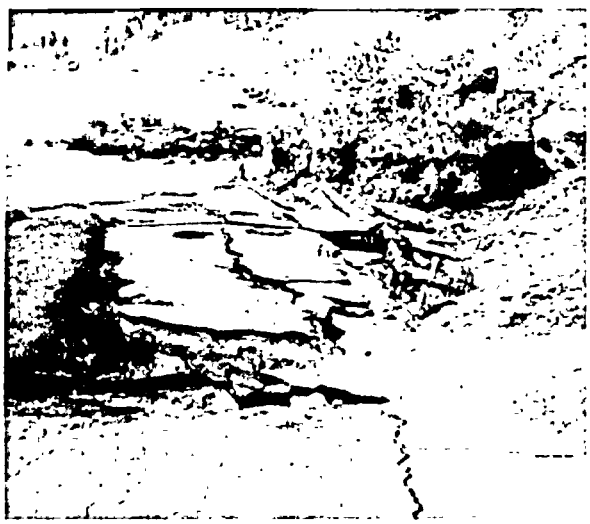
Other issuances during the year included Revision 1 to Guide 4.13, on measuring X- and gamma radiation in the environment around nuclear facilities using thermoluminescent dosimeters (July 1977), and Revision 1 to Guide 4.11, on ecological, biological and land-use studies that should be conducted as part of the assessment of the environmental impact of nuclear power plants (August 1977).

In addition to the concerns with control of radioactive effluents and nonradiological environmental effects, a substantial effort has been made in the examination of the biological effects of low-level radiation on humans. The goal of this effort is to ensure that radiological exposure limits reflect the finding of the most current research being conducted in the field of radiobiology.

Evaluation by the NRC staff of specific radiation epidemiology research findings on the low-level effects of occupational and nonoccupational exposures have included analyses and publication of studies on Hanford (Wash.) mortality experience, radiological effects in the vicinity of a South Dakota uranium mill, and radiological effects in the vicinity of New York State nuclear facilities. In addition, radiobiological analyses have been conducted on the "Hot Particle" question and on health effects in the vicinity of nuclear facilities in Connecticut.

Interagency Coordination

NRC has the responsibility to implement EPA's guidance for protection against radiation, as manifested in the issuance of generally applicable standards. During 1977, EPA published standards (40 CFR Part 190) which limit releases of radioactive material and resulting doses to the public from the operation of various nuclear facilities associated with the nuclear fuel cycle. NRC has formed a task force to establish the program for enforcing these standards.



NRC develops standards for assessing geologic hazards such as earthquakes and faulting. The photograph at the left shows damage to a highway due to high vibratory ground motion from the 1959 Hebgen Lake, Montana, earthquake. A fault scarp of about 15 feet produced during the same earthquake is shown at right.

The NRC also provided comments and technical assistance regarding protective action guides for radioactivity in food (Food and Drug Administration), implementation of the Endangered Species Act (Department of Interior), and implementation of the Toxic Substances Control Act (EPA).

FUEL CYCLE PLANT STANDARDS

The NRC devoted substantial effort during fiscal year 1977 to the development of standards related to the safety and environmental impacts of fuel cycle plants.

Nuclear Criticality Safety

Several objectives for providing guidance to applicants on nuclear criticality safety were realized during the year. Guides 3.33 (issued for comment in April 1977), 3.34 (issued for comment in April 1977), and 3.35 (issued for comment in May 1977) present assumptions to be used in evaluating potential radiological consequences of accidental nuclear criticality in fuel reprocessing plants, uranium fuel fabrication plants, and plutonium processing and fuel fabrication plants, respectively. Revision 1 to Guide 3.4 (issued for comment in August 1977) describes acceptable procedures for the prevention of criticality accidents during operations with fissionable materials outside reactors. Revision 1 to Guide 3.41 (issued in May 1977) provides guidance on validation of calculational methods related to nuclear criticality safety.

Plant Safety

Several NRC guides issued during the fiscal year address safety issues other than nuclear criticality (discussed above). Revision 1 of Guide 3.11, on design, construction, and inspection practices and methods for embankment systems to retain mill tailings at uranium mills, was issued for comment in March 1977. A first revision of Guide 3.27, on procedures for nondestructive examination of welds in liners of concrete barriers in fuel reprocessing plants, was issued in May 1977. Guide 3.40, which characterizes floods to be used as a basis for the design of fuel reprocessing and plutonium processing and fuel fabrication plants, was issued for comment in November 1976. A revision was begun to reflect comments received on the guide. Revision 1 to Guide 3.5, on the contents of applications for uranium milling licenses, was issued for comment in November 1977.

The American National Standards Institute (ANSI) increased its emphasis on the preparation of standards and guides for fuel cycle facilities in the following areas: quality assurance, administrative controls, ventilation, fire protection, and radiological and safety-related features. NRC participated in this effort through the work of staff members on ANSI committees.

Uranium Enrichment Facilities

In anticipation of commercial uranium enrichment activities, the NRC has been developing a regulation to delineate specific requirements for licensing of these facilities. The proposed rule is now nearly complete. Based on recent developments that have suspended plans for enrichment in commercial facilities, work on this regulation has been considerably reduced.

Waste Management

Work continued apace during the report period on a program to develop regulations, standards and guides for nuclear waste management. Under development are a proposed rule for licensing of high-level radioactive waste management facilities and guides in such areas as management of slightly contaminated solid waste from uranium fuel fabrication and recovery operations, performance criteria for solidified high-level waste, and design of radwaste management systems for light water power reactors. (See Chapter 5.)

Decontamination and Decommissioning. An important aspect of the waste management program is the decontamination and decommissioning of nuclear installations once they have completed their useful lives. Technical studies for NRC are continuing at the Battelle-Pacific Northwest Laboratory (PNL) to develop decontamination and decommissioning criteria for light water reactors and fuel cycle facilities. These will be used in developing appropriate regulations and guides. A PNL report on the decommissioning of fuel reprocessing plants (NUREG-0278) was published in October 1977.

Estimates of environmental impacts that would occur from the decommissioning of fuel cycle facilities are contained in two documents which required substantial standards staff effort. These are NUREG-0116 (Suppl. 1 to WASH-1248), "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," published in October 1976, and NUREG-0216 (Suppl. 2 to WASH-1248), "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (NUREG-0116)," published in March 1977.

(The NRC's activities concerning decommissioning are described fully in Chapter 5.)

Spent Fuel Storage

The problem of dealing with the growing inventory of spent reactor fuel, which is being addressed by the NRC, involved standards support in both regulations and guides. There is a need both for increased storage capacity at existing reactor storage pools and for storage facilities at sites other than reactors. A revision to Guide 1.13, on the design of storage facilities at reactors, is under development. Work continues also on a proposed rule for licensing independent spent fuel storage installations and on guides for license application, facility siting, design requirements, and plant protection for such facilities. (See Chapter 3.)

Safeguards Standards

The NRC devoted substantial standards development effort during fiscal year 1977 to the protection of public health and safety in the transport of nuclear materials and to the safeguarding of nuclear materials and facilities against theft and diversion. Developments in these areas are discussed in Chapter 3 and 4, respectively.

RADIOACTIVE MATERIALS IN MEDICINE AND INDUSTRY

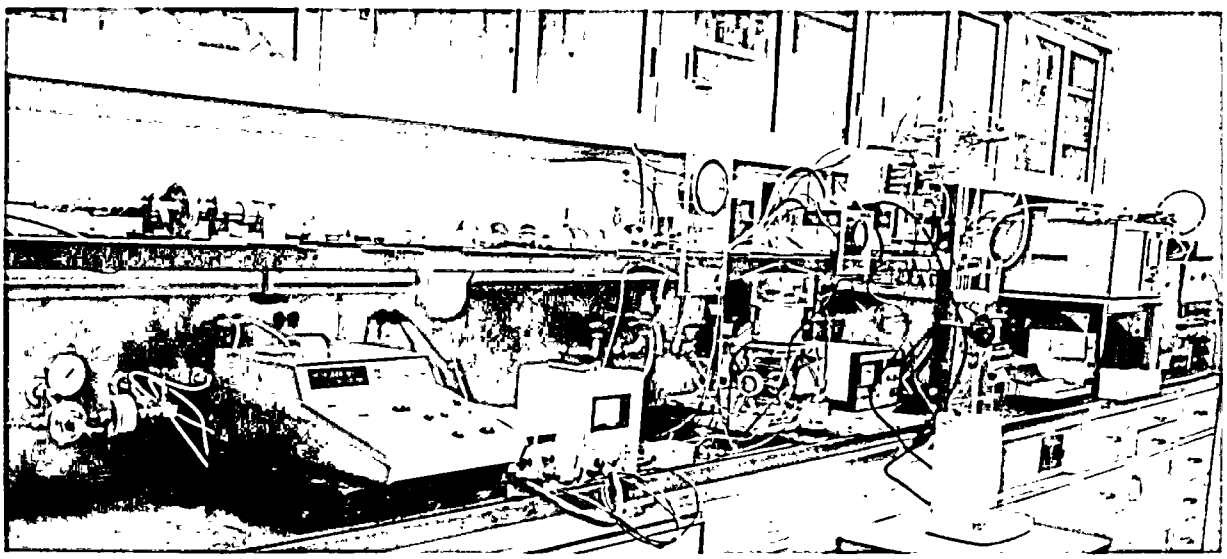
Nuclear Medicine

Substantial activity took place during 1977 in development of standards covering the use of nuclear materials to diagnose and treat human illnesses.

In March 1977, the NRC proposed general licenses to simplify licensing procedures for the routine use of plutonium-powered cardiac pacemakers. The rulemaking proceeding was still underway at the end of the fiscal year.

In July 1977, the NRC published a rule that, in effect, requires a medical institution to be licensed for its nuclear medicine programs rather than the individual physicians practicing within the institution, thereby placing primary responsibility for radiation safety with the institution.

In response to petitions for rulemaking, the NRC amended its general license for in-vitro diagnostic use of radioactive materials so as to authorize hospitals, clinical laboratories, and physicians to use selenium-75 for diagnosing diseases and mock iodine-125 (containing radioactive iodine and americium) to calibrate diagnostic instruments.



This experimental apparatus was developed at the Los Alamos Scientific Laboratory under a research contract. The apparatus will allow various forms of radioiodine to be generated and measured under changing physical conditions, for example, temperature and humidity. Different absorbent materials will be tested against the various radioiodines to determine whether or not criteria can be developed for the production and testing of satisfactory air-purifying respirators for such use. No approved respirators of this type are currently available. NRC guidance for manufacturers and licensees will be based on the results of the findings of these tests.

Products Containing Radioactive Materials

In December 1976, the NRC established a general license for the use of depleted uranium in volume in such industrial products or devices as X-ray units, well-drilling collars, and tool holders. The regulation responded to three petitions for rulemaking.

To provide the regulatory environment for widespread use of personnel neutron dosimeters containing thorium, the NRC exempted the dosimeters from licensing requirements in February 1977. The final environmental statement (NUREG-0137) prepared in connection with the exemption was the first one issued for a consumer product. The statement concluded that, in order to protect the environment, manufacture of the dosimeters can take place only when authorized by a license issued by the NRC or an Agreement State, and each dosimeter must contain no more than 50 milligrams of thorium.

OCCUPATIONAL HEALTH STANDARDS

Respiratory Protection

The NRC's rule change that included new requirements governing the use of respiratory protective equipment (respirators) to protect workers against airborne radioactive materials was published in November 1976 and became effective in December 1976. Licensees had until December 1977 to achieve full compliance with the new requirements. Guide 8.15, on acceptable practices for respiratory protection, and an associated manual on respiratory protection (NUREG-0041) were issued in October 1976.

Research work was begun under contract with Los Alamos Scientific Laboratory (LASL) to develop acceptable performance criteria for air-purifying respirators to protect against airborne radioiodines.

LASL also provided measurements of the amount of protection provided by respirators. This information will be used for revising and updating guidance to licensees on the amount of allowance that may be made for the protection that is provided when respirators are used to limit the internal radiation doses to workers who are exposed to airborne radioactive materials. All approved airline respirators were scheduled for testing this year. A revised informal report (LA-NUREG-6612 MS) with recommendations on the protection afforded by air-supplied hoods and helmets was completed in July 1977. The information will be used in providing additional and updated guidance to licensees on the acceptable use of these respirators.

Medical Institutions

Regulatory Guide 8.18 and an accompanying report (NUREG-0267) were issued in December

1977 to provide medical institutions with guidance on actions that should be taken in the design and operation of medical facilities to ensure that workers are adequately protected from the harmful effects of ionizing radiation.

Health Protection at Uranium Mills

Progress was made in evaluating the hazards associated with the inhalation of uranium ore dust by uranium mill workers. The principal hazard arises from thorium-230, a decay product of natural uranium, which is retained in the lungs and lymph nodes for long periods of time. Measurements made to date, however, indicate that many airborne particles of uranium-ore dust are too large to be deposited in the lungs, so that thorium-230 may be less of a problem than had been supposed.

A regulatory guide on acceptable health physics programs for uranium mills is being developed. It will set forth the NRC staff position regarding health physics measurements that should be performed at mills and will take into account the importance of the chemical toxicity to the kidney of "yellowcake," the final product of a mill. The guide will draw heavily on preliminary measurements from studies of the inhalation of uranium-ore dust.

Overexposures of Radiographers

Overexposures of industrial radiographers to radiation have continued to be of concern (see Chapter 7 under "Abnormal Occurrences—1977"). During fiscal year 1977 the staff developed an action plan to reduce such overexposures. The plan would improve safety in radiography through licensing and standards measures that would require improvement of radiography instruments, better training for radiographers, and adequate detection and alarm systems to warn them of radiation exposure.

Exposures at Nuclear Power Stations

In March 1977, the NRC issued for comment a revision of Guide 8.8. It provides considerably more detailed guidance on planning, designing, constructing and operating a light-water reactor nuclear power station to meet the objective that exposures of station personnel to radiation during routine operation must be as low as is reasonably achievable.

Testing for Personnel Dosimetry

Evaluations of the degree of accuracy that is provided by personnel dosimetry processors in the United States indicate that improvement is needed in the performance of some processors. Personnel dosimetry devices are used to measure the radiation dose received by workers in NRC-licensed facilities. To obtain more accurate processing of dosimeters, the NRC staff is considering a regulation to require that personnel dosimetry results be accepted only if acquired from a processor who has successfully passed certain prescribed accuracy tests. The test criteria would be adapted from a consensus standard (ANSI) now in the approval process.

In preparation for the new regulation, the NRC is funding a two-year pilot study to be conducted by the University of Michigan. The objectives of the pilot study are:

(1) To provide processors an opportunity to correct any process problems that they may have prior to publication of the new regulation in effective form.

(2) To test the ANSI standard for practicality as well as for degree of difficulty.

(3) To develop a detailed procedures manual for use by subsequent testing laboratories.

EMERGENCY PLANNING

A revision of Regulatory Guide 1.101, "Emergency Planning for Nuclear Power Plants," was issued in March 1977. The guide provides information on the adequate content of emergency plans that licensees submit in their Final Safety Analysis Reports.

A petition for rulemaking by the Public Interest Research Group, *et al.* (PIRG) proposed a number of new requirements in this area. The Commission concluded that the present NRC regulations provide adequately for emergency planning and that the PIRG's proposal would not further ensure the protection of the health and safety of the public. The Commission also stated its belief that NRC's emergency preparedness program will provide a continuing level of emergency planning sufficient to protect the public health and safety. Therefore, on July 14, 1977, the Commission denied the petition

for rulemaking (42 FR 36326-8). (See discussion of "Emergency Response Planning" in Chapter 8.)

Significant progress was made during the fiscal year in upgrading emergency planning programs for fuel cycle facilities. An amendment to 10 CFR Part 70, published in effective form in March 1977, requires plans for coping with emergencies at such facilities. Guide 3.42, on development of emergency plans for fuel cycle facilities and plants licensed under 10 CFR Parts 50 and 70, was issued for comment in August 1977.

NATIONAL STANDARDS PROGRAM

The national standards program is conducted under the aegis of the American National Standards Institute (ANSI). ANSI acts as a clearinghouse to coordinate the work of standards development in the private sector.

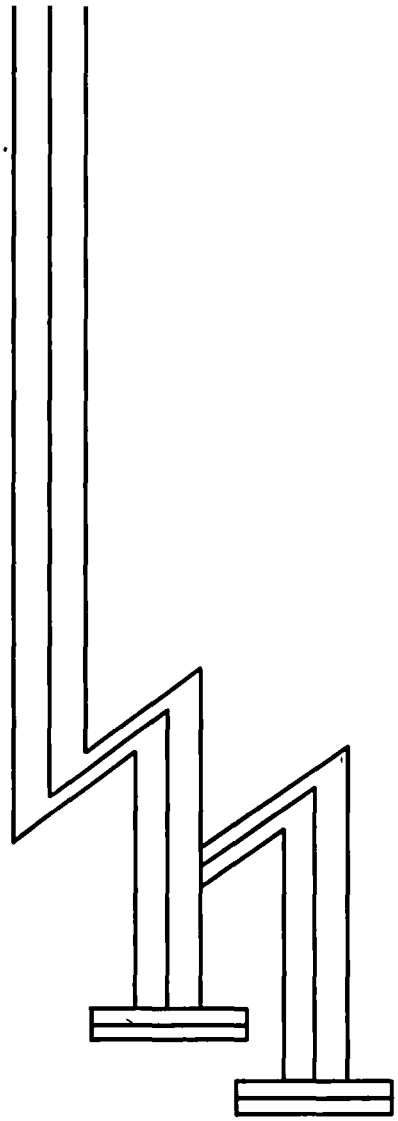
The NRC staff is active in the national standards program, particularly with respect to setting priorities so that efforts are concentrated on developing standards that can be most useful in protecting the public health and safety. NRC participation is based on the need for national standards to define acceptable ways of implementing the NRC's basic safety regulations.

The actual drafting of standards is done by experts, most of whom are members of the pertinent technical and professional societies. Approximately 230 NRC staff members participate in the development of nuclear standards, mostly as members of working groups organized by technical and professional societies. These societies are listed in the accompanying table. National standards are used in the regulatory process only after independent review for suitability by the NRC staff and after public comments on their intended use have been solicited and considered by the NRC staff.

SOCIETIES SPONSORING NUCLEAR STANDARDS DEVELOPMENT ACTIVITIES IN WHICH NRC STAFF MEMBERS PARTICIPATE

American Association of Physicists in Medicine
American Concrete Institute
American Conference of Government and Industrial Hygienists
American Institute of Chemical Engineers
American Institute of Steel Construction
American Insurance Association
American National Standards Institute
American Nuclear Society
American Society of Civil Engineers
American Society of Mechanical Engineers
American Society for Nondestructive Testing
American Society for Quality Control
American Society for Testing and Materials
American Welding Society
Health Physics Society
Institute of Electrical and Electronics Engineers
Institute of Nuclear Materials Management
Instrument Society of America
Metals Properties Council
National Council on Radiation Protection and Measurements
National Fire Protection Association
National Sanitation Foundation
Society of Naval Architects and Marine Engineers
Welding Research Council

Regulatory Research



Although the NRC believes that the nuclear facilities and activities it has licensed have an adequate level of safety under its conservative safety requirements, confirmatory research is carried out to define with increasing precision the safety margins provided in them. This research program seeks four basic goals:

- To provide a detailed basis on which to assure protection of the public health and safety, environmental quality, and the security of nuclear activities.
- To provide independent safety data and analytical methods which meet the needs of regulatory activities.
- To provide better quantified estimates of the margins of safety existing for various reactor systems and other licensed activities.
- To establish a broad exchange of safety research information with other Federal agencies, industry and foreign groups.

The international and intergovernmental exchange activities related to research are discussed in Chapter 9. This chapter provides an overview of the technical programs carried on by NRC's Office of Nuclear Regulatory Research.

Fiscal year 1977 saw significant progress in the NRC research program, with the issuance of research information letters (RIL's) on eight separate research activities. An RIL is issued to other NRC user offices on completion of a substantial, coherent and reasonably complete body of experimental and/or analytical research work. Thus, whereas 1975 and 1976 could be called years of initiation and transition, 1977 is best categorized as the first year of fulfillment in many NRC research efforts. Progress during fiscal year 1977 in each of the NRC's five major research programs—Water Reactor Safety, Advanced Reactor Safety, Fuel Cycle and the Environment, Safeguards, and Risk Assessment—is summarized below and discussed in detail later in this chapter.

Water Reactor Safety Summary

In the area of light water reactor (LWR) safety research, exceptional progress was made in the Loss-of-Fluid-Test (LOFT) Program, in primary system integrity studies, in cladding oxidation measurements, in analysis development, in fracture mechanics and in fire protection research.

Measured test data in LOFT are showing good agreement with predictions. The LOFT experiments using the nonnuclear core simulator were completed and preparations for nuclear tests begun.

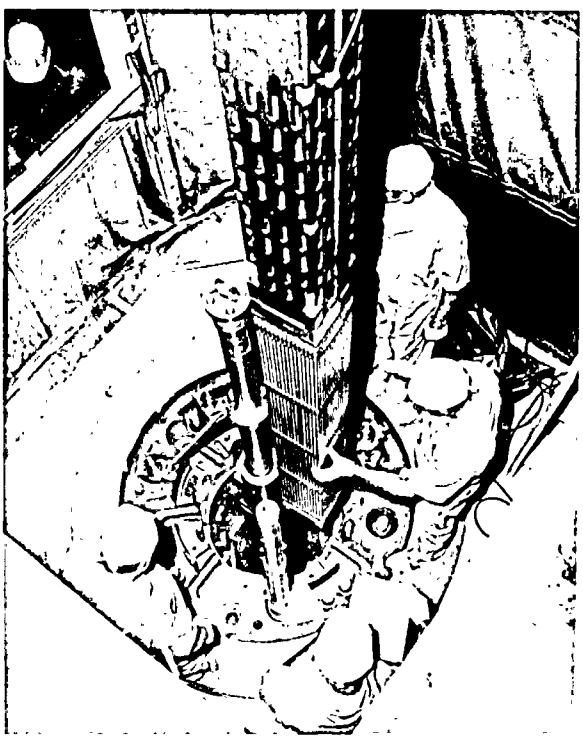
The first test involving the core with nuclear heat is scheduled for April of 1979.

Experiments on Zircaloy fuel cladding showed that the oxidation rate of Zircaloy at 1205°C (about 2200°F) is only about 70% of that postulated in current licensing calculations. These results lead to the important conclusion that, because of this lower oxidation rate, a self-sustaining metal-water reaction should not take place even at temperatures as high as 1315°C (2400°F).

In other Zircaloy fuel cladding experiments, results have indicated that estimates as to the amount of embrittlement due to oxidation have been conservative, with the rate of diffusion of oxygen into beta Zircaloy only half of the value used in licensing evaluation calculations.

In January 1977, an RIL was issued presenting data that confirmed the conservatism of certain fission product decay heat values assumed by the NRC licensing staff in evaluating emergency core cooling systems (ECCS). Three experiments involving measurements of the fission product decay heat (U-235 irradiated in a thermal flux) to confirm the validity of the new decay heat calculations showed excellent agreement between the measurements and the results of the summation calculations. This signifies that the American Nuclear Society (ANS) decay heat standard for the first 200 seconds of a loss-of-coolant accident (LOCA) is conservative.

In the area of primary system integrity, tests have been run at Oak Ridge, Tenn., to check the analytical predictions of the conditions under which flaws in reactor vessel steels could grow into cracks. In every case, the results tended to support predictive methods used in licensing reviews which indicate that the addition of cold ECC water to a reactor vessel in a LOCA should not cause failure of the vessel.



Crews at the Idaho National Engineering Laboratory began loading the LOFT nuclear core on September 9, 1977. Nine working days later the core loading was completed. Prior to loading, some fuel modules were instrumented with transducers. After the core was loaded, more than 40 other instruments were installed in the vessel to measure such phenomena as temperature, pressure and flow of the core outlet coolant, core inlet pressure, upper plenum pressure and temperature, and fuel module linear motion.

Advanced Reactor Summary

Significant developments in fast reactor confirmory research during the report period include the llowing:

- Calculations of a postulated core-disruptive accident in a liquid metal fast breeder reactor, using "best estimate" analyses, indicated a significantly reduced damage potential compared to conventional, more conservative calculations.
- Critical experiments were initiated in the Zero Power Reactor-9 at Argonne National Laboratory (ANL) to provide experimental data for validation of neutronics methods in the SIMMER code.
- Results of an initial series of significant, first-of-a-kind, in-pile safety research experiments, successfully performed in the Annular Core Pulse Reactor (ACPR) at Sandia, are having a major impact on understanding fuel behavior under postulated accident conditions.
- Preliminary data from a post-accident heat-removal program are providing a basis for the development of codes to be used in assessing containment integrity under postulated core-melt conditions.
- Initial experiments were completed to determine an upper bound to the radiological source term from a postulated core-disruptive accident.
- Data from several different aerosol transport experiments provided a basis for improving the aerosol code used in fast reactor siting and risk assessment, and the initiation of code verification.

Fuel Cycle-Environmental Summary

The fuel cycle and environmental research programs are concerned with the protection of the public health and safety and the preservation of the quality of the environment. Significant progress in this past year has been achieved in the following projects:

- Determining source terms and ambient exposure levels of radon from operations associated with uranium milling.
- Developing and testing improved methodologies for predicting the impact of the nuclear industry on populations of important fish.
- Measuring the characteristics of low level waste, waste effluents and environmental transport processes at licensed waste burial grounds.
- Characterizing releases from operating power reactors.

Safeguards Research Summary

Significant progress was made during the year in developing methods for evaluating the effectiveness of safeguards systems. Research projects were completed on the relationships of white-collar crime to safeguards in the nuclear industry and on the structure and drafting of safeguards regulations were completed. To assist the NRC staff in inspecting licensee physical protection equipment, a catalog describing commercially available equipment and an inspector's evaluation guide for use with the catalog were published. In the continuing Integrated Safeguards Information System (ISIS) study, an analysis of information requirements and an assessment of existing NRC information systems related to safeguards were completed.

Risk Assessment Summary

The risk assessment methodologies developed in the Reactor Safety Study (RSS), published by the NRC in 1975 (NUREG-75/014), are of significant potential use in many areas of nuclear safety research.

The work performed during 1977 in risk assessment research included:

- Further development of risk assessment and probabilistic analysis methodology, the examination of LWRs of differing designs from those analyzed in the RSS, and performance of risk assessments for other parts of the nuclear fuel cycle.
- Research to meet the needs of other NRC offices (such as in the analysis of generic issues) and to develop useful tools for licensing reviews.
- Training of personnel in probabilistic analysis and risk assessment to increase the use of those techniques in the licensing and regulatory processes.

Water Reactor Safety Research

The purpose of the Water Reactor Safety Research Program is to enhance NRC's ability to independently confirm the safety of nuclear plants under postulated accident conditions. Many of the potential accidents studied are "design basis accidents," which are hypothesized to help determine whether the proposed design of a commerical nuclear power plant will afford the protection to the public that is required by NRC regulations. The research data and analytical methods developed under the programs are used in the analyses of these postulated accidents to increase confidence in the margins of safety that have been estimated during licensing reviews.

The program is divided into six principal categories:

- Systems engineering research—primarily related to potential loss-of-coolant accidents (LOCAs) and the operation of emergency core cooling systems (ECCS).
- Fuel behavior studies—dealing with the behavior of nuclear fuel in abnormal and severe accident conditions.
- Analysis development—in which computer codes used in the analyses of postulated accidents are developed and validated.
- Metallurgy and materials research—related to maintaining the integrity of the primary system (piping, vessel, etc.).
- Site safety studies—related to siting and safety design requirements for nuclear facilities to withstand severe environmental phenomena.
- Research support—dealing with such operational safety matters as fire protection, qualification testing of components, and noise analysis.

SYSTEMS ENGINEERING

Systems engineering research provides experimental data for developing and verifying the computer codes used to evaluate emergency core cooling systems and other safety features of nuclear power plants.* Systems engineering research directed toward ECCS performance is accomplished through two types of tests—integral systems tests and separate effects tests.

Integral Systems Tests

Integral systems tests for pressurized water reactor (PWR) LOCAs are conducted in the loss-of-fluid-test (LOFT) and Semiscale facilities, located at the Idaho National Engineering Laboratory of the Department of Energy (DOE).

LOFT Facility. The LOFT facility is a 55-megawatt (thermal) pressurized water test reactor used for studies of the response of a PWR to a loss-of-coolant accident. These integral systems tests—so called because they investigate the interdependent thermal, hydraulic, mechanical and nuclear aspects of system response—have so far been conducted without nuclear fuel. In 1978, the studies will include experiments with a nuclear core.

Fiscal year 1977 saw the completion of several tasks preparatory to the loading of the nuclear core, including: refurbishment of special quick-opening valves for use in simulating a pipe break to initiate a loss-of-coolant experiment; assembly of the initial nuclear core and spare fuel modules; tests of containment leak rate; installation and check of instrumentation; preparation of the final Safety Analysis Report; and conduct of the final nonnuclear experiment to evaluate the emergency core coolant bypass process.

The final LOFT experiment without nuclear fuel was completed May 3, 1977. Its purpose was to evaluate the ECC "bypass"—loss of emergency core cooling water injected during the decompression ("blowdown") phase of a LOCA. The water in the LOFT system was heated to 555° Kelvin (540° Fahrenheit) and the system pressure was controlled at 15.5 million Pascals (2250 pounds-per-square-inch—psi), typical of the conditions in a commercial PWR. In this experiment, boric acid was added to the reactor safety water prior to the simulated pipe rupture, as it is in a commercial PWR. After the pipe rupture, emergency core cooling water was injected into the reactor inlet pipe by an accumulator system and by the high pressure and low pressure injection pump systems.

The results from a LOFT experiment (reported in the 1976 NRC Annual Report) in which ECC water was injected directly to the bottom of the reactor vessel, compared with those of the 1977 experiment where the injection was via the reactor inlet pipe, showed that the difference in water inventory is due to ECC bypass.

The 1977 experimental data generally were in good agreement with computer calculations using the RELAP analytical model (see "Analysis Development," below). The data indicated a behavior which, if it applies to a commercial PWR as expected, means a more rapid delivery of emergency cooling water than is presently predicted with the conservative models used in licensing review.

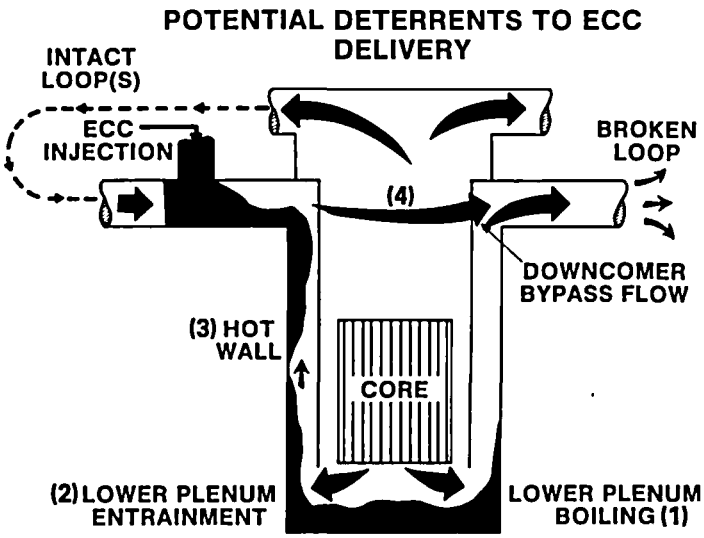
Semiscale Facility. The Semiscale facility is a small-scale nonnuclear experimental system used to investigate thermal and hydraulic processes expected to occur in a full-scale PWR in the event coolant water is lost from the primary cooling system. The results of these investigations are employed primarily in developing, assessing, and verifying computer codes used to predict the behavior of a nuclear system experiencing loss or reduction of coolant flow. An additional objective is to provide information in support of other safety research programs, especially the LOFT program.

Three series of tests at the Semiscale facility during fiscal year 1977 provided new insights into LOCA-related behavior. The first series was intended to investigate the effectiveness of four alternate ECC injection concepts being considered by reactor manufacturers ("cold leg" injection is presently used). The four concepts were: (*1*) lower plenum injection, (*2*) upper plenum injection in conjunction with cold leg injection, (*3*) use of an upper plenum vent valve in conjunction with cold leg injection, and (*4*) pump suction leg injection. The tests showed that, except for the pump suction injection concept, the alternate concepts provided more effective core cooling than was generally available through use of cold leg injection alone. Pump suction injection did not provide consistently good core cooling over the range of pump conditions calculated to occur during a LOCA.

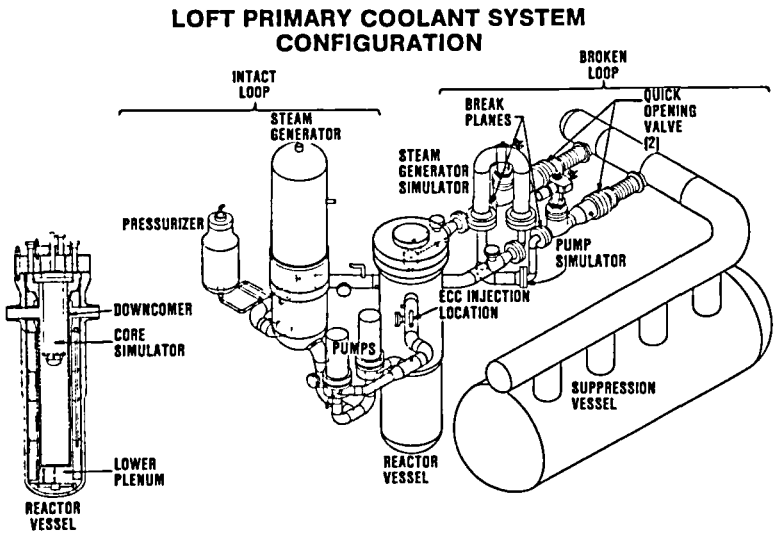
The second series of tests was designed to provide counterpart information for the nuclear tests to be conducted in the LOFT facility next year. Direct comparison of data from LOFT and Semiscale will indicate the effects of physical scale or

* An ECCS—which actually consists of several independent systems, each designed to provide full protection to the reactor—is designed to prevent serious consequences if a loss-of-coolant accident should occur. The coolant transfers heat from the fuel rods during reactor operation. The LOCA is the principal design basis accident used in assessing the effectiveness of emergency systems in light water reactors. The function of the ECCS is to provide water to keep nuclear fuel rods cooled following a LOCA.

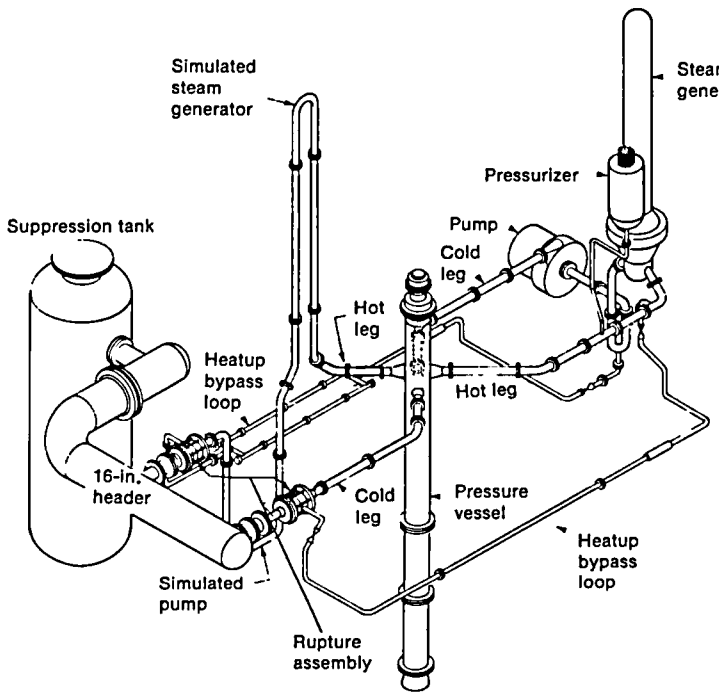
Pictured here are the various mechanisms which may prevent emergency core cooling (ECC) water from reaching the reactor core during a loss of coolant accident. As numbered these mechanisms are: (1) boiling of water which remains in the lower plenum; (2) entrainment (carryout) of water which reaches the lower plenum by passing down through the core as steam; (3) hot wall effect, in which ECC water is prevented from flowing down the downcomer by the upflow of steam generated by ECC water boiling in the downcomer; and (4) bypass, or direct carryout of the injected ECC water. The first three effects were evaluated separately during the first three LOFT experiments, and the data showed that analytical models now used to predict commercial reactor performance yield conservative results. All four effects were evaluated in Experiment L1-4. The conclusion derived from the initial evaluation of L1-4 are: (1) boiling of fluid in the lower plenum does not contribute significantly to loss of emergency core cooling; (2) entrainment of fluid in the lower plenum is not significant; (3) hot wall delay is not significant in LOFT; (4) bypass of emergency core coolant is predicted reasonably well by an analytical model which allows for asymmetric flow; and (5) with a few exceptions, agreement between analytical model predictions and experimental behavior is good.



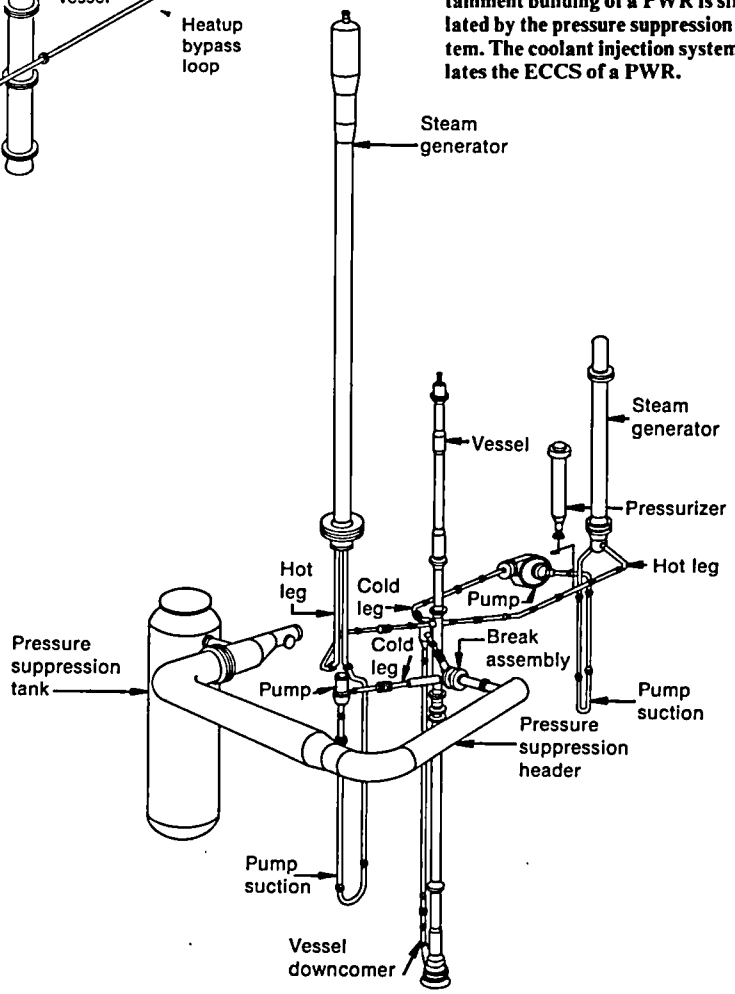
The major component of NRC's Loss of Fluid Test Facility (LOFT) at the Idaho National Engineering Laboratory is a 55-thermal megawatt reactor (small diagram at left), housed in a high-pressure containment building with auxiliary systems for reactor plant support and a contiguous underground control room. The reactor coolant system diagrammed here shows one intact heat-dissipating loop (left bracket) that models three unbroken loops of a four-loop plant, and a special broken or "blowdown" loop (right bracket), featuring special quick-opening valves, that can simulate a ruptured loop in a commercial-scale pressurized-water reactor plant. The blowdown loop discharges into a suppression tank to simulate the back-pressure conditions of the larger reactor. Emergency coolant injection systems include water-filled accumulators that can quickly inject a large volume of water into the reactor system; high-pressure injection pumps that can produce a small-quantity, high-pressure coolant flow; and low-pressure injection pumps that can provide large volumes of water for core cooling after a major preliminary system rupture or experiment.



SEMISCALE—MODELS 1 AND 3



The Semiscale configuration at left (Mod-1) at the Idaho National Engineering Laboratory, used in fiscal years 1975 through 1977 to simulate the operation of an emergency core cooling system (ECCS) during a loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR). It consisted of a pressure vessel with simulated reactor internals, including a 5.5-foot-long electrically heated core, an intact (unbroken) coolant flow loop with active steam generator and pump; a broken loop with passive components; a pressure suppression system; and a coolant injection system. The intact loop simulates three coolant flow loops of a four loop PWR, and the broken loop simulates the PWR loop ruptured during a LOCA. The containment building of a PWR is simulated by the pressure suppression system. The coolant injection system simulates the ECCS of a PWR.



Semiscale Mod-3, which is being constructed at the Idaho National Engineering Laboratory, improves on the Mod-1 configuration in that the electrically heated core will have a 12-foot heated length and the broken loop will contain a steam generator and pump scaled to a commercial pressurized water reactor. A new pressure vessel will permit studies of upper head emergency core cooling injection concepts associated with some recent PWR designs, and an external downcomer will be designed to permit a better simulation of core reflood behavior. The external downcomer design also will allow direct access to the core region for thermal and hydraulic measurements, an important aspect of model development.

size on the transient thermal and hydraulic phenomena which occur, and the capability of present calculational techniques to account for such scale effects.

The third series (12 tests) was designed to provide information about the effect on the maximum fuel rod cladding temperature caused by rupture of different numbers of steam generator tubes during a LOCA. The basis for this concern is discussed in Chapter 2, under "Steam Generator Tube Defects". Preliminary evaluation of the results indicates that maximum Semiscale cladding temperature occurred during tests in which the rupture (at the beginning of the reflood phase of the LOCA) of a limited number (14 to 20) of PWR tubes was simulated.

The hardware needed for the new Semiscale Mod-3 system was designed and procured.

Separate Effects Tests

In the separate effects tests for PWRs, three segmented phases of a postulated LOCA are studied: (*1*) the blowdown phase in which the coolant water is suddenly changed to a mixture of water and steam as the result of depressurization and is discharged from a break in a coolant peipe; (*2*) the steam-water mixing phase (also called "bypass" or "refill" period) during which steam leaves the pipe break and the emergency cooling water is injected into the reactor vessel, and (*3*) the reflooding phase during which water reaches the reactor core and provides cooling. The facilities and tests are listed in Table 1. Work performed during fiscal year 1977 is discussed below.

Thermal Hydraulic Test Facility. During the past year the Thermal Hydraulic Test Facility (THTF) at Oak Ridge became operational.

More than 20 tests have now been conducted in the THTF, five with all rods heated, two with two rods inactive and the remainder with four inactive rods to simulate the local thermal conditions with control rod thimbles. The principal objective of the tests was to explore conditions affecting time to reach critical heat flux (CHF) which occurs when the rods become blanketed with vapor causing a marked reduction in heat transfer from the rods. The results of the tests have shown that the pres-

Table 1: Separate Effects Tests

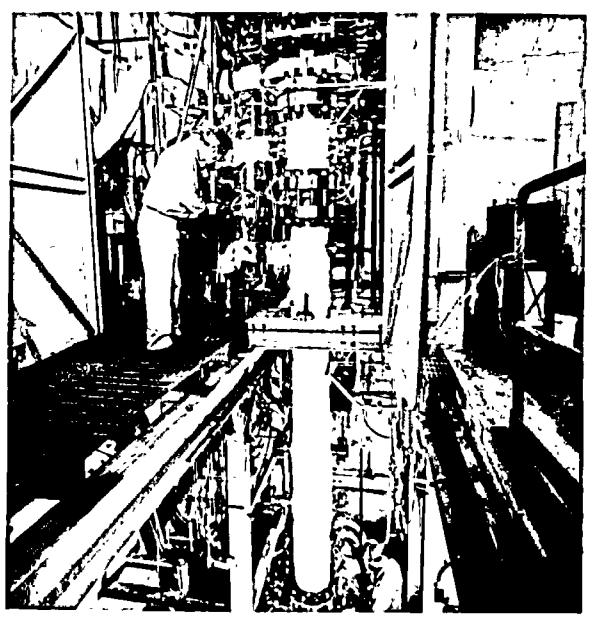
FACILITY/TESTS	PURPOSE	LOCATION
Thermal-Hydraulic Test Facility (THTF)	Simulation of PWR blowdown phase of LOCA	Oak Ridge National Laboratory (Tenn.)
Two-Loop Test Apparatus (TLTA)	Simulation of BWR response to blowdown and ECC injection	General Electric (San Jose, Calif.)
Pump Tests	Performance of pumps under two-phase (steam, water) flow conditions	MPR Associates, Washington, D.C., and Combustion Engineering Co. (Windsor, Conn.)
Containment Tests	Performance of BWR pressure-suppression system during LOCA	Lawrence Livermore Laboratory (Calif.)
Steam-Water Mixing Tests	Steam-water mixing, ECC bypass, downcomer penetration hold-up	Battelle-Columbus Laboratories (Ohio) and Creare, Inc. (Hanover, N.H.)
Full-Length Emergency Cooling Heat Transfer Facility (FLECHT)	Heat transfer in ECC reflooding phase	Westinghouse Corp. (Pittsburgh, Pa.)

ence of the four inactive rods had little effect on the time to reach CHF. Under the conditions tested in the THTF, the mean time to CHF has varied from 0.7 to 1.4 seconds. The shortest time observed was about 0.2 second and the longest about 3.2 seconds.

Predictions of THTF behavior based on the RELAP-4 MOD5 computer code were in good agreement with the observed trasient flow and depressurization as well as the thermal behavior in the lower half of the test bundle (where the maximum cladding thermocouple temperatures were observed). This indicates that current computer models can be used to predict transient behavior during blowdown in a full-length PWR system.

Two-Loop Test Apparatus. Research applicable to the response of a boiling water reactor (BWR) to blowdown and emergency core cooling injection is carried out in the nonnuclear two-loop test apparatus (TLTA) at San Jose, California (see p. 172, the 1976 NRC Annual Report). The facility, which models the principal components of a BWR, is used to determine hydrodynamic behavior, time to critical heat flux, and transient heat transfer rates during blowdown and reflood, as influenced by variations in power, system pressure, coolant flow and break location. Tests are planned to investigate the interaction between steam upflow from the core and the emergency core cooling spray downflow during a postulated BWR LOCA.

During the past year blowdown tests were run in TLTA on an 8 × 8 simulated BWR fuel rod bundle. The 8 × 8 bundle which is used in the newer BWRs and in certain refueling cycles, takes longer to depressurize in a blowdown test than the 7 × 7 bundle tested previously. This means a longer time to critical heat flux which implies cooler fuel rods during the LOCA when the 8 × 8 design is used.



The Thermal-Hydraulic Test Facility (THTF), at Oak Ridge National Laboratory in Tennessee, consists of a test section with 49 full-size reactor fuel rod simulators (12-foot electrically heated length) and a circulation loop with its associated equipment. It is designed to simulate the temperature and flow conditions which the rods would experience during the first 20 seconds (blowdown phase) of a hypothetical loss of coolant accident in a pressurized water reactor. Some 500 sensors, each recording data 20 times per second, monitor what happens.

Pump Tests. NRC researchers are closely following two-phase (steam-water) pump tests sponsored by EPRI at the Combustion Engineering Company plant at Windsor, Conn., in which 1/5-scale pump data will be used to develop models of pump behavior for analyzing LOCAs. MPR Associates, Inc. (Washington, DC.) is under NRC contract to compile a pump data bank and to assist in analysis.

Containment Tests. At Lawrence Livermore Laboratory in California, 27 tests have been run on a 1/5-scale model of a BWR pressure suppression system to measure its ability to withstand the force of pressurized air forced into it during a hypothetical LOCA. (The basis for this concern is discussed in Chapter 2, under "Action on Technical Problems.") The results show that pressure loading is much less than that predicted by computer codes now used in licensing reviews, thus confirming that there is a good margin of conservatism in the codes.

Steam-Water Mixing Tests. Separate effects tests investigating ECC bypass and attendant steam-water phenomena are being conducted for NRC at the Battelle-Columbus Laboratories, in Ohio, (BCL) and at Creare Inc., in Hanover, N.H. These tests, and apparatus, are designed to determine the degree of ECC-bypass, establish lower plenum filling rates, define controlling physical phenomena and develop transient ECC filling models. (Earlier tests at 1/15 scale were discussed in the 1976 NRC Annual Report, page 174.)

During fiscal year 1977, BCL fabricated a 2/15 scale model of a PWR-like pressure vessel and completed a series of tests for comparison with smaller scale data (e.g. 1/15 and 1/30 scale). The 2/15 scale tests support previous findings that condensation plays a key role in the bypass phenomena and in general show a behavior similar to the 1/15 scale results. The 2/15 scale data base is being extended and compared to the correlations derived previously.

Creare's effort in 1977 has been to develop a transient refill model for predicting the rate of lower plenum and downcomer filling. This model development incorporates the effects of hot walls,

This 1/5-scale test facility at Lawrence Livermore Laboratory, California, is used in studies of the mechanical effects of steam injection on the Mark I boiling water reactor torus-type containment. Tests using this facility complement research activities conducted in West Germany and Sweden.

depressurization, condensation, ECC subcooling, etc. Initial comparisons with 2/15 scale transient data (the correlations were developed from 1/30 and 1/15 scale experiments at Creare) show a satisfactory predictive capability.

A conceptual design for an ECC Bypass Test Facility (EBTF) which would use both 1/5 and 1/3 scale vessels was completed in 1977. This study and others to be completed in fiscal year 1978 will help determine the need for larger scale experiments in this area.

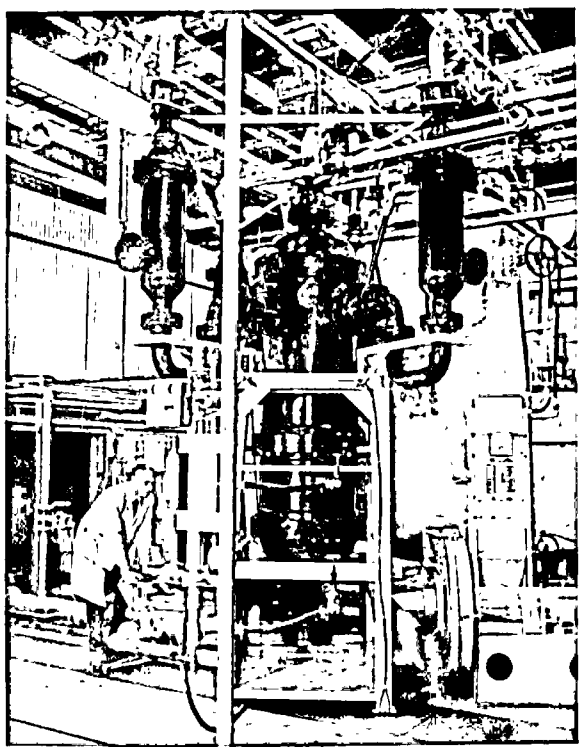
Reflooding Experiments. A series of reflooding experiments completed by Westinghouse in the Full Length Emergency Cooling Heat Transfer (FLECHT) facility has provided useful data on the amount of heat transferred from 12-foot-long fuel rods arranged to simulate a portion of a 15 × 15 fuel rod array during low (less than one inch-per-second) ECC reflood rates. For these tests the heat generated was peaked near the top of the bundle to represent fuel rod power distribution near the end of core life.

The current FLECHT program is jointly sponsored by NRC, EPRI and Westinghouse. The facility is currently being modified to simulate a portion of a 17 × 17 PWR fuel rod bundle and to better represent the upper plenum of the reactor vessel.

Instrumentation Development. NRC is sponsoring development of advanced two-phase (steam-water mixture) instrumentation at Oak Ridge National Laboratory (ORNL) as a supplement to existing efforts by other NRC contractors. Work is currently concentrated on the development of probes to measure the void fraction (gas-liquid ratio) and two-phase velocity, both within a bundle and in the upper plenum. The instrumentation will be used to obtain localized measurements in reflood facilities to be built and operated in Germany and Japan under a cooperative program with the U.S.

FUEL BEHAVIOR

An important goal of reactor safety research is to improve the understanding of the response of



This 2/15-scale pressurized water reactor facility at Battelle Columbus Laboratory in Ohio is capable of operating with up to 3.8 kilograms per second (30,000 lb/hr) of steam at 0.52 million Pascal (75 psi) and 0.032 cubic meter per second (500 gal/min) of cooling water. In addition to quasi-steady coolant penetration tests, experiments can be run for plenum filling, ramped core steam, and with fixed or communicating cold leg steam. Transient tests can be initiated with either hot or neutral wall temperatures. An initial series of tests has been completed for each of these modes of operation.

fuel pellets and cladding to postulated nuclear accidents. Research in this area involves experiments conducted in both the laboratory and non-commercial operating nuclear reactors. The data derived are used in the development of computer codes, which, in turn, are checked by comparison of their predictions with the results of other experiments.

Power Burst Facility Tests

The Power Burst Facility (PBF) at the Idaho National Engineering Laboratory is a principal tool for determining the behavior of power reactor fuel rods under normal, off normal and accident conditions. Small clusters of instrumented fuel rods are installed in a heavy walled tube which is inserted in a central space of the PBF core. The PBF can provide test conditions typical of several types of potential accidents, including the LOCA, power-cooling-mismatch, inlet flow blockage, and reactivity-initiated (power surge) accidents. The tests provide in-reactor data for development and verification of fuel rod analysis codes. The data also provide an in-reactor check on results obtained from the other separate-effects fuel rod tests discussed later in this section. (PBF experiments are described in the 1976 NRC Annual Report, pages 175 and 176.)

Twenty-two tests were performed in PBF during 1977, including 15 to determine the dynamic characteristics of the PBF core for use in reactivity-initiated accident tests, four to investigate the effects of irradiation on fuel rod behavior during flow coastdown in power-cooling-mismatch accidents, and three to investigate the effect of fuel rod design parameters on the coefficients of heat transfer between the fuel pellets and Zircaloy cladding.

Research was completed on single fuel rods exposed to power-cooling mismatch conditions. Results show that Zircaloy fuel rod cladding (a metal alloy, mainly zirconium, used to contain the fuel pellets) normally does not fail even when low coolant flow rates cause prolonged film boiling. The fuel rods, both fresh and irradiated, reach cladding temperatures in excess of 2400° F for times of several minutes without failure while the reactor was operating. It was found that the cladding will generally not fail unless it becomes so heavily oxidized that it is brittle at room temperatures. Zircaloy oxidation this severe would require higher temperatures over longer periods than are currently predicted for any light water reactor accidents involving power-cooling mismatch, whether related to a reduction of coolant flow or to an increase in fuel rod power.

Near the end of the year, the PBF was shut down for two major modifications that will increase its overall utility and efficiency. The first will allow controlled blowdown (rapid depressurization) of the PBF test loop to permit tests of fuel rod behavior during a variety of loss-of-coolant accident sequences. This modification was completed during the first quarter of fiscal year 1978. A new PBF data acquisition and reduction system also was installed to increase the speed and accuracy with which the PBF data can be recorded and processed.

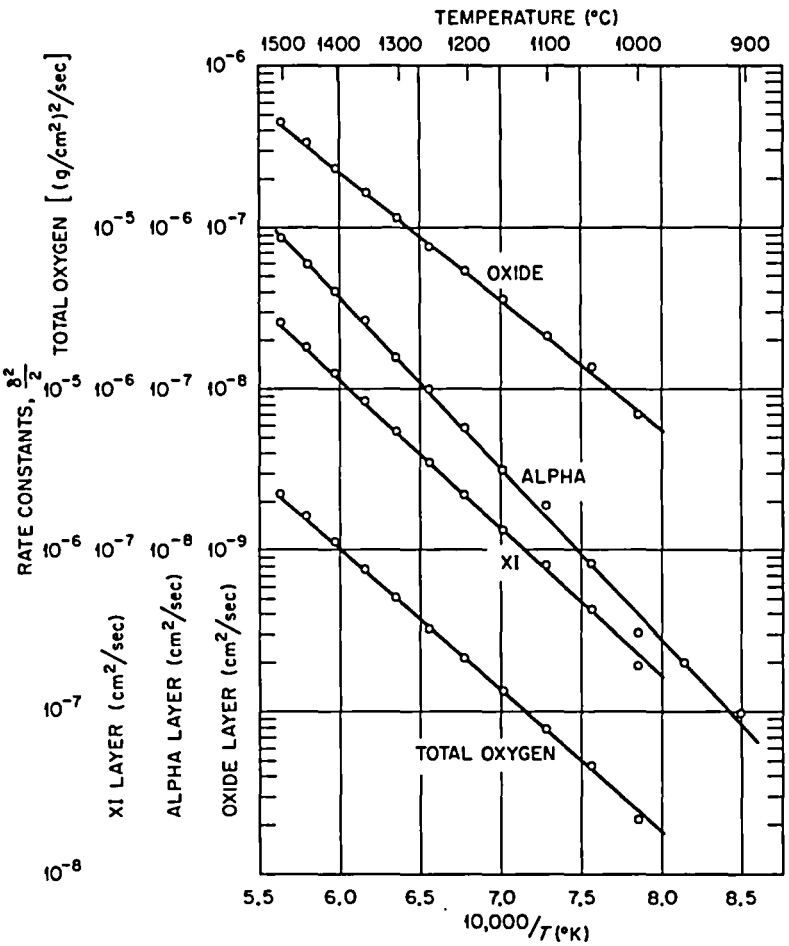
Cladding Research

Oxidation Experiments. The oxidation of Zircaloy during a LOCA would release heat which could raise the temperature of the fuel rods and cause oxygen to diffuse into the cladding, embrittling it. Because of these effects, a program has been conducted to obtain reliable oxidation and diffusion data as a basis for establishing the conservatism of models used in licensing reviews.

The program is now complete. A Research Information Letter (RIL) titled "High Temperature Oxidation of Zircaloy Fuel Cladding in Steam" was issued on March 14, 1977 and the results presented are now under review for possible inclusion in a modification to the ECCS rule provided in Appendix K of 10 CFR 50. Both oxidation and diffusion rates were shown to be lower than values used in licensing calculations. The differences amount to almost a factor of two in the rate constant near the maximum temperature (about 1200°C or 2200°F) anticipated in a postulated LOCA. In experiments testing the effects of other variables on the oxidation rate, neither the temperature, the flow rate of steam, the addition of small quantities of oxygen, nitrogen, or hydrogen to the steam, nor small variations in the composition of the Zircaloy cladding had a significant effect.

Deformation Experiments. Important information on the extent of flow blockage that might result from cladding deformation is being obtained from the first 16-rod-bundle burst test performed at ORNL. The test was conducted in a steam atmosphere designed to simulate the post-blowndown phase of a hypothetical LOCA. A shroud surrounding the bundle was heated to simulate adjacent fuel rods.

Preliminary information indicates that the cladding burst at a slightly higher temperature and lower internal pressure than would have been predicted from individual-rod burst test results. Although the evaluation is not yet complete, the water flow tests of the burst bundle are encouraging. They



This chart showing oxidation rate measurements for Zircaloy in steam between 900 and 1500°C (1650-2730°F) summarizes results of tests conducted at Oak Ridge, Tennessee. Data shown are for the rates of growth of: the oxide layer; the brittle, oxygen-stabilized alpha layer; and the Xi (oxide + alpha) layer, as well as the rate of total oxygen consumption. Quality of the test results is reflected by the extent to which the data points (open circles) fall on straight lines.

indicate the largest pressure drop associated with the zone of the greatest number of bursts is no larger than that caused by a typical spacer grid normally used in a PWR.

Irradiated Zircaloy Experiments. The strength and ductility of Zircaloy cladding from representative spent commercial reactor fuel are being measured at Battelle-Columbus Laboratories. The data (to be used in computer models to predict cladding behavior during off-normal operation and accidents) have shown no significant differences in behavior from that of unirradiated material when tested at the high temperatures predicted during a LOCA, thus validating the other, more extensive test programs using unirradiated cladding.

"Creepdown" Studies. Reactor operating conditions cause cladding to creep down into eventual contact with the fuel. Knowledge of the rate at which such creepdown occurs is of great importance in developing models of fuel element performance.

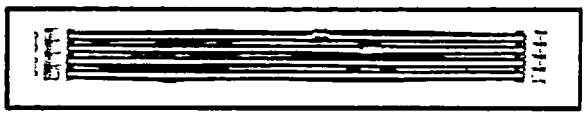
Researchers on ORNL have devised an experimental microcomputer-controlled system which has successfully measured cladding deformation with time at temperatures of 371° C (700° F) and higher, and at external pressures as high as 21 megapascals (3000 psi).

Results to date indicate how the deformation of Zircaloy cladding with time varies as a function of temperature and external pressure.

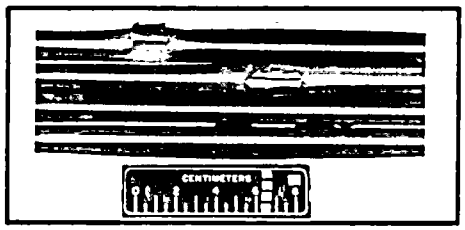
Decay Heat Experiments

In a loss-of-coolant accident in a light-water reactor, fissioning would cease, and within seconds the major sources of heat in the fuel rods would be the beta and gamma rays from the decay of accumulated fission products. In 1971 the American Nuclear Society Standards Committee No. 5 presented a curve (revised in 1973) for the decay heat of the products of thermal-neutron fission of uranium-235. NRC has required an additional 20 percent conservatism in this curve for licensing purposes.

VIEW OF SOUTH FACE OF BUNDLE BETWEEN INTERIOR GRIDS



CLOSE-UP OF BURSTS



Deformation and burst patterns of electrically heated PWR fuel rod simulators first 16-rod bundle test at Oak Ridge National Laboratory are shown above. Burst temperatures were between 840° and 860° C. Three feet of the 6 and 1/2-foot length of the fuel rod simulators were heated.

In 1974 experiments were initiated at ORNL and Los Alamos Scientific Laboratory (LASL) to determine the variations of decay heat for thermal fission of uranium 235 during the first few minutes after shutdown. These experiments were completed during fiscal year 1977, and a RIL summarizing the results is under review. Preliminary indications are that the overall one-standard-deviation uncertainty in the experiments is about 4 percent. Thus the added 20 percent used in NRC license reviews appears to be very conservative.

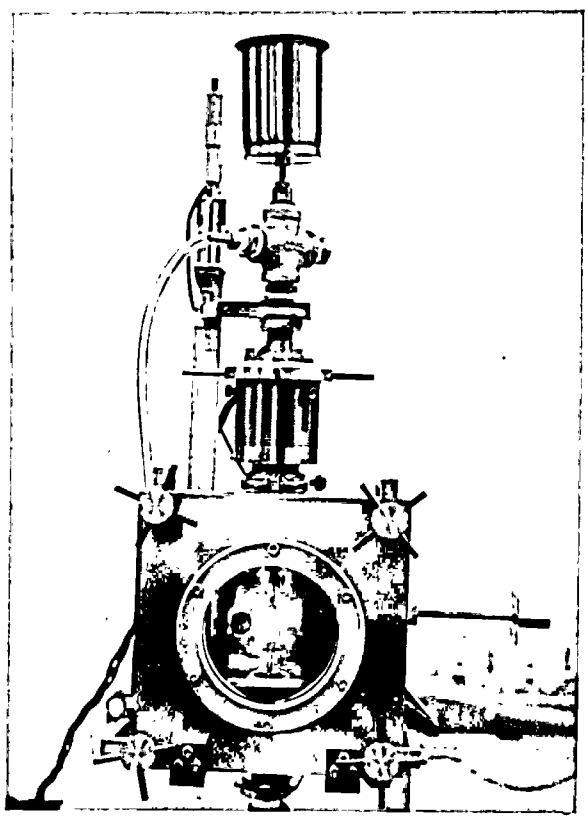
Transient Fuel Response and Fission-Product Release

The release of gaseous and volatile fission products and the associated fuel swelling affects fuel performance and contributes to the radiological source terms for design basis accidents. Information needed for an understanding of these phenomena is obtained from ex-reactor transient-heating experiments on irradiated commercial reactor fuel, and from the gas-release predictions of a computer code called GRASS (Gas Release and Swelling Subroutine).

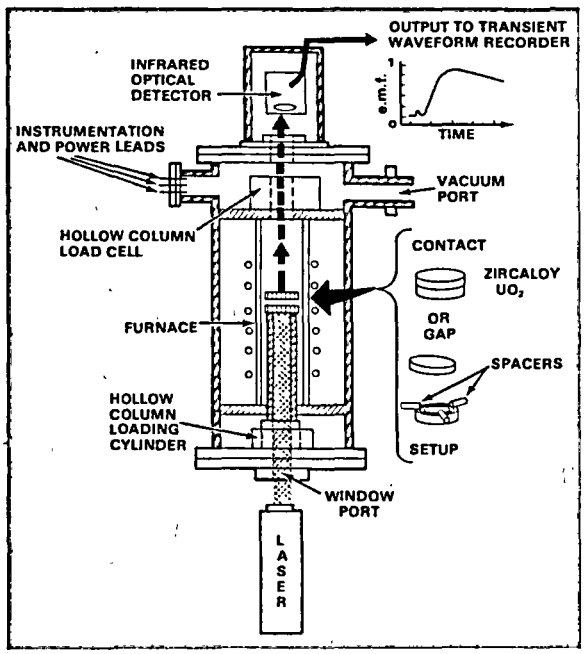
In experimental studies at Argonne National Laboratory, fuel is heated by a direct-electrical heating technique that produces radial temperature profiles similar to those of nuclear heating and permits the simulation of a variety of thermal transients.

Quantitative relationships have been developed from the experiments that link measured gas release with transient temperature history and transient-induced microstructural changes. The empirical observations and correlations are being used in the development of GRASS, which has successfully predicted gas release for a series of power-cooling-mismatch simulations performed in the direct-electrical heating equipment. The physical process modeled in GRASS appear to be applicable to a variety of in-reactor conditions, including LOCAs and high-burnup steady-state operation. The predictions of GRASS are also being tested against available gas-release data from a variety of sources.

Results are being obtained at ORNL for fission product release from high burnup commercial LWR fuel tested under conditions similar to those of a postulated LOCA and spent fuel transportation accidents. Eight experiments have been performed with irradiated pressurized water reactor fuel-rod segments in steam and in dry air atmospheres. Preliminary scale-up calculations indicate that release from full-length fuel rods, on a percentage basis, should be significantly lower than the experimental release from short test rods.



In this photo, unirradiated UO_2 fuel pellets are used to proof-test the specimen chamber of the direct electrical heating apparatus at Argonne National Laboratories at Illinois.



Schematic diagram of Modified Pulse Design (MPD) test apparatus located at Richland, Washington, which is used for measuring thermal gap and contact conductance between fuel and cladding. It involves a heat pulse (supplied by the laser) and an infrared optical signal detector (top of diagram) to monitor the energy transmitted through UO_2-Zircaloy samples when in contact or separated by a small gap. The interfacial thermal conductance can be determined from measurement of the thermal energy transmission characteristics and data on the thermal properties of the UO_2 and Zircaloy specimens used.

Halden Reactor Tests

Comprehensive data for verification of fuel performance computer codes are being obtained from two identical, instrumented six-rod test assemblies designed and constructed at Pacific Northwest Laboratories (PNL) and irradiated in the Halden Reactor in Norway. The assemblies carried instrumentation to measure cladding elongation and fission gas release as well as local fuel centerline temperature and rod power. The rods varied in gap size, fuel density and stability and fill-gas composition. An area of continuing safety interest is the effect of these parameters on fuel temperature.

Of particular interest is the transfer of heat across the fuel-cladding-gap, characterized by a gap conductance. The results of the irradiation experiments permit assessment of the gap conductance for each rod type. It is significant that all conductances inferred from this test were higher than values predicted by NRC computer codes, a fact which verifies the conservatism of these codes. Another significant result was a pellet-cladding mechanical interaction for all rods (with gap sizes ranging from 2 to 15 mils) after about 3000 MWD/MTU burn-up. This indicates fuel expansion and relocation in excess of code predictions—again confirming NRC licensing review conservatism.

Gap Conductance Tests

As part of the overall program to refine the understanding of heat transfer in nuclear fuel rods, PNL applied a technique for measuring contact conductance to the fuel-cladding gap studies. This technique makes it possible to study the effects of temperature, gas pressure, gas composition, interfacial contact pressure, gap separation, and surface morphology.

As an example of the results obtained using the Modified Pulse Design technique, the Figure at left compares experimental gap conductance data with calculations based on an existing code (i.e., GAPCON-THERMAL-II) and calculations using theoretical models for estimating the temperature discontinuity at a surface. Results of all experiments to date indicate the models in fuel performance codes now used in licensing review are conservative.

Fuel Meltdown Studies

In addition to fuel rod damage studies, NRC sponsors research on phenomena associated with hypothetical fuel meltdown accidents. This research was prompted by the Reactor Safety Study (NUREG 75/014) which noted that the only way to release large amounts of radioactivity from a nuclear reactor would be to melt the fuel.

At Sandia Laboratories, the interaction between molten core materials and concrete is being investigated. This interaction can significantly affect the time and mode of failure of the containment building. In large-scale experiments, up to 200 kilograms of molten steel (about 1700 C) have been poured into concrete crucibles. In small-scale experiments, up to 15 kg of molten refractory oxides (about 2800 C) have been generated via a thermite reaction with concrete crucibles. The principal parameters investigated include composition of the concrete; mass, temperature and composition of the molten material; and the geometry of the interfacial contact area. In addition to qualitative identification of phenomena by visual observations, quantitative

results are provided by instrumentation and post-test examination. An analytical model (INTER-1) of the melt/concrete interaction has been developed to help extend the range of the applicability of the experiments.

Programs at Sandia and Argonne National Laboratory (ANL) address all aspects of steam explosions ranging from the contact of molten core materials with water to failure of containment by an explosion. The emphasis to date has been on determining the conditions under which steam explosions could be initiated.

ANALYSIS DEVELOPMENT

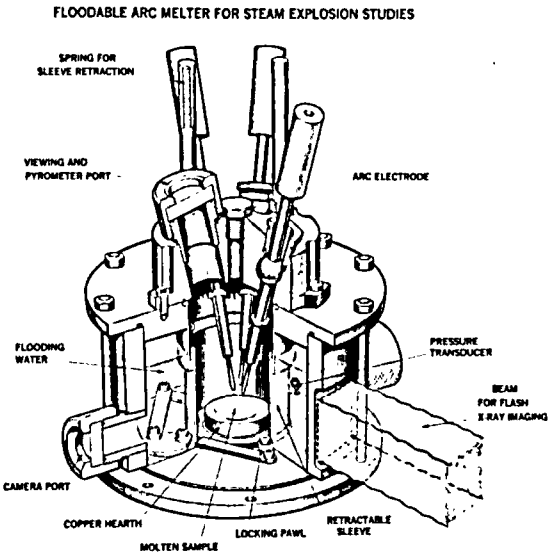
Computer code development, improvement and application have a high priority in the NRC research program, since computer codes form the basis of nearly all research methodologies employed by NRC. Moreover, codes can be used to predict the course of postulated accidents and their potential consequences.

The credibility of the codes in reactor safety assessment depends on how accurately they predict results of safety research experiments and on the validity of the experiments in simulating actual reactor structures, systems, or components under postulated accident conditions.

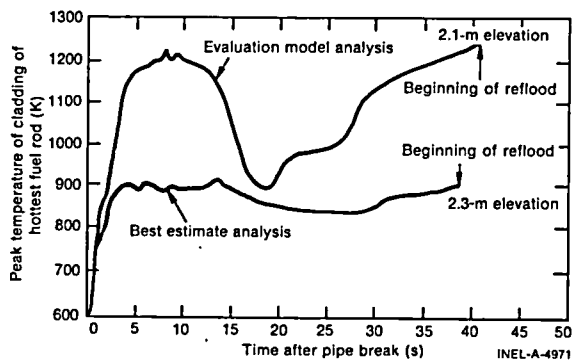
Improving Existing Codes

RELAP-4. The RELAP-4 computer code, developed for NRC at INEL, can be used to analyze thermal and hydraulic transients in light-water reactors and related systems. A major use is for analysis of reactor system behavior during hypothesized LOCAs. The "evaluation-model" version of the code provides a deliberately conservative analysis for use in licensing reviews. The "best-estimate" version provides an analysis of the realistic behavior of a reactor system. During the past year, work was completed on the best-estimate form of RELAP-4 (RELAP-4/MOD6 Version 2) for analyzing the response of a PWR to emergency core coolant. The results agreed well with experimental data obtained from LOFT, Semiscale, and FLECHT tests.

COBRA-DF. Under NRC sponsorship, PNL is developing a code (COBRA-DF) to simulate transient thermal-hydraulic behavior in nuclear reactor cores and vessels. Current emphasis is on LOCA analysis capability for PWR systems equipped with upper head injection ECCS. Areas of significant effort include fuel rod top/bottom quench modeling, hydrodynamic modeling of



More than 150 small-scale experiments using actual reactor core materials have been performed in this specially designed test chamber at Sandia Laboratory in New Mexico. Current results demonstrate that explosions do not occur naturally when small masses (25 g) of LWR core materials contact water unless an external force is supplied. This force "triggers" an explosion by collapsing the insulating layer of steam between the hot and cold liquids.



Results from a study of the quantitative differences between best-estimate and evaluation-model analyses of a postulated loss-of-coolant accident in a pressurized water reactor are reflected in this chart. The analyses encompass an accident transient from the severance of a cold leg pipe to the beginning of core reflood. The evaluation-model analysis embodied basic requirements set forth in NRC regulations for reactor licensing analyses. The best-estimate analysis was based on mathematical models considered most representative of reactor response to the postulated accident. The chart reflects a substantial margin of conservatism in the evaluation-model analysis. Maximum temperature of the cladding of the hottest fuel rod at the beginning of reflood was calculated to be approximately 650°C (1800°F) for the evaluation-model analysis and 1200°F for the best-estimate analysis. Although rupture of the cladding was predicted by the evaluation-model analysis, fuel rod deformation was not predicted by the best-estimate analysis.

thermal nonequilibrium processes, relative motions of water and steam phases, and separate-effects studies of phenomena such as upper head mixing and draining.

COBRA-DF is an extended version of COBRA and retains all the capabilities of the COBRA-IV code (See 1976 NRC Annual Report, page 178). In addition to thermal nonequilibrium and relative phase motion capabilities, COBRA-DF is constructed so that complex geometries typical of reactor vessel internals can be accounted for through model inputs.

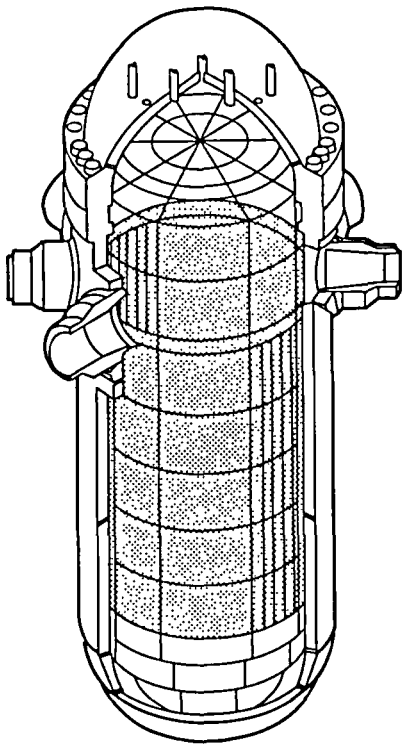
Advanced Systems Codes for LOCA

Development is continuing on two advanced systems codes for describing a hypothetical loss-of-coolant accident (LOCA). The present system code (RELAP-4) is known to be deficient since it cannot account for the effects of thermal non-equilibrium and unequal velocities of the steam and water phases.

TRAC. The Transient Reactor Analysis Code (TRAC), developed at Los Alamos, is an advanced best-estimate computer program designed to predict the thermal and hydraulic response of LWRs to LOCAs and other transients. TRAC will also be used to verify built-in safety margins and the effectiveness of engineered safety features designed to cope with abnormal conditions. The first production version of TRAC, completed in December 1977, and scheduled for public release in March, 1978, includes steady-state and transient analysis capability for LOCAs in PWRs. The transient capability includes the blow-down, refill, and reflood stages of a LOCA. Subsequent versions will address LOCAs in BWRs, anticipated transients without scram, and reactivity-initiated accidents in both PWRs and BWRs.

TRAC differs from other codes for LOCA analysis in having more detailed geometrical models of reactor components and in its more complex and realistic models of two.phase fluid flow and heat transfer phenomena. TRAC incorporates new methods being developed for the numerical calculation of nonequilibrium two-phase thermal-hydraulic processes in one, two, and three dimensions.

TRAC is highly modular in structure, both by function and by system component, giving the user the capability to model a fullscale PWR and most experimental facilities in which separate and integral effects tests are being conducted. Thus, TRAC can be used to model tests ranging from blowdown of a single pipe to flow in complicated networks containing pipes, valves, steam generators, etc.



The advanced computer code "TRAC," used in analyzing hypothetical loss-of-coolant accidents, can model a variety of detailed reactor component geometries and the phenomena affecting them. This cell noding diagram shows one possible three-dimensional calculational mesh for a typical pressurized water reactor.

As TRAC evolves, it is being applied to a broad range of reduced-scale water-reactor safety experiments. Comparisons of TRAC calculations with results of these experiments are providing verification of the thermal-hydraulic models used in the computer program. In a cooperative NRC reflood experimental program with Germany and Japan, TRAC is being used to analyze and synthesize the larger-scale upper plenum (Germany) and reactor core (Japan) experiments. Pre-test predictions of these experiments will be used to validate the treatment of multidimensional and scale effects in TRAC.

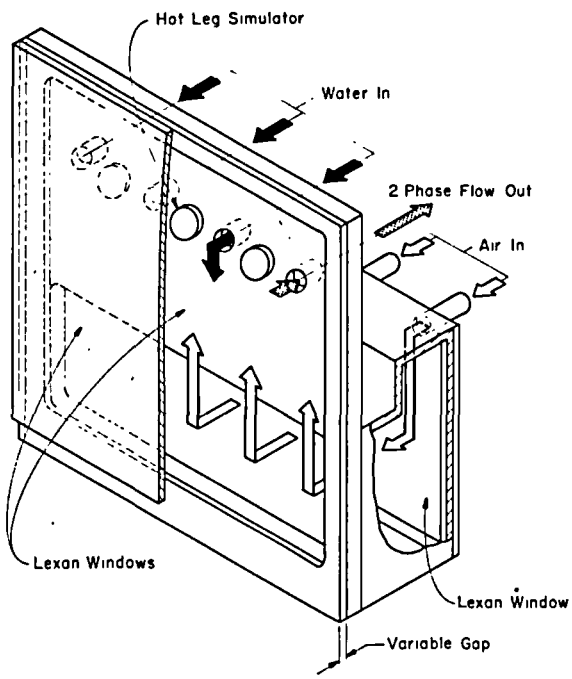
In addition to TRAC, the LASL program includes the development of several other advanced codes for the computation of thermal-hydraulic processes occurring in specific reactor components. The K-TIF code has successfully simulated laboratory tests performed by Creare, Inc. and Battelle-Columbus Laboratories of ECC water injection into a PWR downcomer. The SOLA-FLX code has been developed for predicting the coupled fluid and structural dynamics of a PWR core support barrel following a postulated cold leg pipe break.

In addition, studies employing the advanced component codes K-FIX and SOLA-DF have provided new insights into two-phase flow processes. For example, comparisons of one- and two-dimensional computations of critical flows in nozzles have provided a rational basis for the use of break-flow multipliers in systems codes. These are crucial for the accurate prediction of PWR blowdown transients.

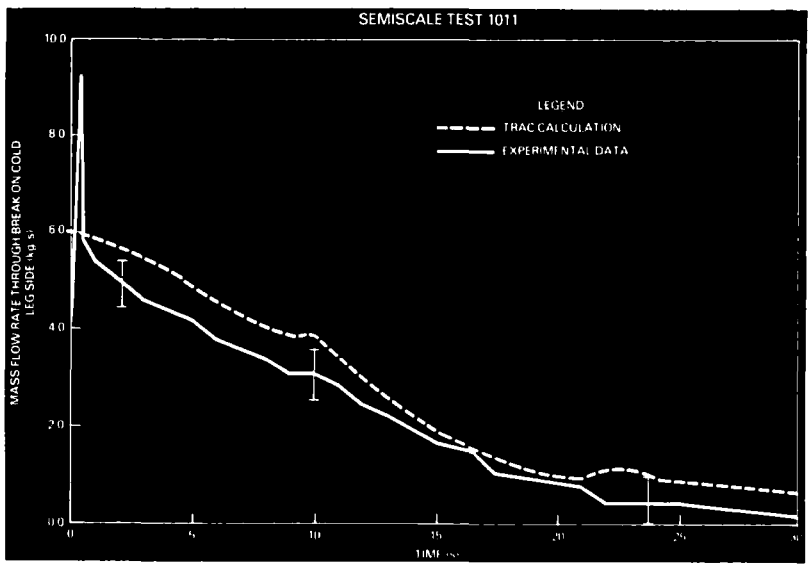
In support of the TRAC development, NRC sponsors a small-scale experimental project at LASL. The project consists of two categories: fabrication and execution of experiments and development of advanced instrumentation techniques. Two series of experiments are under way. The first involves the study of two-phase flow conditions in an "unwrapped" downcomer geometry. Initial downcomer experiments will use air and water. In later experiments, the air will be replaced by steam. The second series of experiments involves quantification of the rate of water entrainment or de-entrainment from structure into a steam flow stream in the plenum region of a PWR vessel during a LOCA.

The latter experiments will also provide a testbed for development of several different diagnostic techniques. Specifically, a system is being developed to measure the velocity and flow directions of the water droplets in steam mixtures. The system uses a Storz lens (a slender, rod-shaped lens) that permits internal viewing of two-phase flow experiments. The lens is coupled to a low light level video (TV) system whose signals will be processed to provide a digital output describing the flow field. Other work on developing advanced diagnostics techniques involves the use of hot film anemometry to measure droplet impingement rates and allow inference of droplet velocities. Hot film anemom-

Unwrapped Downcomer Experiment



Countercurrent air-water flow is being investigated in a 2 × 3 foot transparent slab simulation of an unwrapped downcomer (the "unwrapped downcomer" is a simulation of the cylindrical downcomer of a reactor in which the "cylinder" has been opened and flattened into a slab). Water is injected in three cold-leg nozzles at the top and air comes up from the bottom. The mixture then leaves the "broken" cold-leg. The resulting flow patterns can thus be observed.



This figure shows a comparison between the mass flow rate of coolant through the broken cold leg during a Semiscale isothermal blowdown test and estimates made using the TRAC computer code. Uncertainty error bands for TRAC results (due to initial condition and modeling uncertainties) are estimated to be of the same magnitude as the measurement uncertainties shown here.

eters will be used in both downcomer and deentrainment experiments.

THOR. Brookhaven National Laboratory (BNL) is developing THOR, a fast-running LOCA code based predominantly on one-dimensional, nonequilibrium flow with unequal steam and water phase velocities. Increased computing efficiency is achieved by employing global flow and component descriptions where these are sufficiently accurate and by employing detailed, time-consuming calculations only where necessary (near the pipe break, for example). Additional features of the THOR code are its separate treatment of individual flow and heat transfer regimes and tracking of flow regime interfaces, such as water levels. Modeling techniques have been successfully demonstrated. The THOR code development is supported by fundamental experimental research at BNL, by the integral systems tests and the separate effects tests, described previously.

In addition, a medium pressure (1.0 MPa or 150 psi), high flow rate (0.013 cubic meter per second or 200 gpm) steam-water test facility is under construction at BNL to measure the actual rate of vapor generation during rapid depressurization or flashing. The experimental results will be used in developing a phenomenological correlation for the nonequilibrium rate of vapor generation during flashing flows, which can, in turn, be used to calculate the discharge flow rates during a hypothetical LOCA.

In the instrumentation area, two different types of local probes (optical and radio frequency) have been developed to measure the local void fraction and phase velocities. Both are being evaluated for application in the two-phase flow systems.

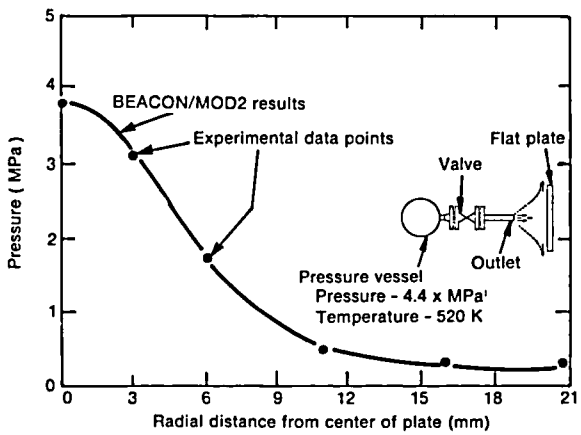
In addition to the experimental and instrumentation development efforts, constitutive relations for nonequilibrium phase change rates are being developed. A new phenomenological correlation for phase-change rate in dispersed-droplet post-dryout regimes has already been developed and published.

Fuel Behavior Codes

The fuel behavior information obtained from the experimental programs discussed earlier in this section provides the basis for development and verification of the NRC-sponsored computer codes FRAP-S and FRAP-T (Fuel Rod Analysis Program-Steady State and Transient). This effort involves concurrent work on the codes and on the correlations for material properties that are used by both codes. The codes involve more than 40 important parameters in more than 20 key models that describe aspects of the fuel and fuel rod behavior. Each code is updated yearly and published with documentation including a description of the analytical models and user instructions, a description of the related materials properties models, and a description of the code verification which includes comparisons of predictions with available data. During fiscal year 1977, FRAP-S2 and FRAP-T3 were sent to the Argonne Code Center.

Advanced Containment Code

INEL is developing a multidimensional computer code (called BEACON) for analysis of the physical conditions within containment systems during postulated accidents. The code uses advanced numerical and modeling techniques that will be applicable to both PWR and BWR containment systems. BEACON/MOD1, the initial version of the code, was completed and checked out. This version has an improved equation-of-state for water and air mixtures and a capability to couple a network of one- and two-dimensional computational regions. An interphase mass and energy transport model and an advanced numerical scheme with related improvements were incorporated into a second version of the code (BEACON/MOD2).



This figure shows the results of a checkout analysis using the BEACON Code (Mod 2) to simulate a water jet which is flashing to steam as it impacts on a flat plate. The calculated pressure distribution on the plate compares well with the experimental data.

METALLURGY AND MATERIALS

Protection of the public is assured by maintaining the integrity of the primary system (vessels,

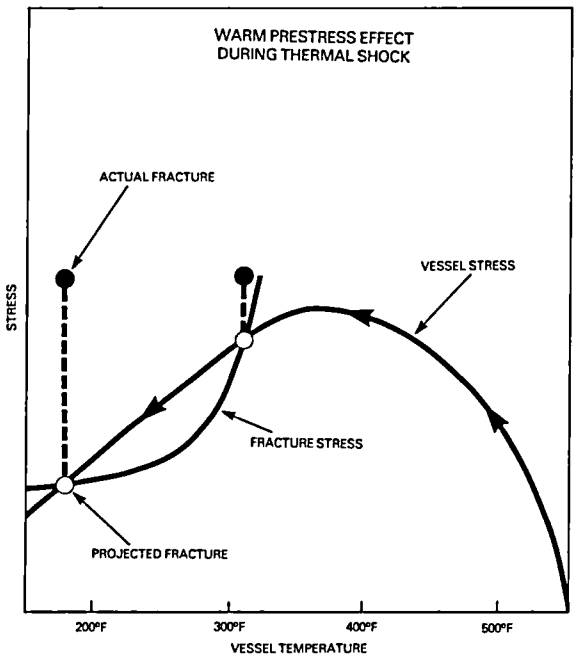
components and piping) in nuclear power reactors. Primary system integrity is governed by the properties of the materials, including their response to the nuclear environment, and the size and orientation of flaws that may exist. NRC research activities in these areas during 1977 are discussed below.

Structural Integrity of Pressure Vessels

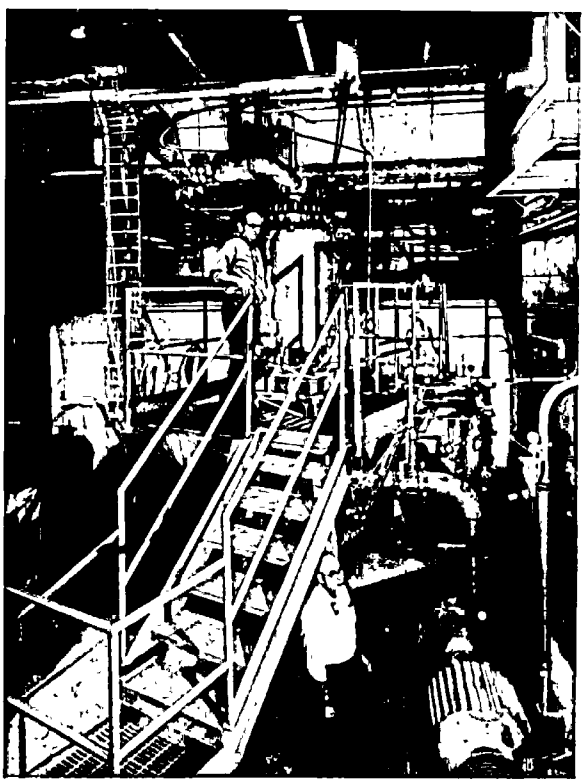
The major objective of the NRC-sponsored Heavy Section Steel Technology Program is to develop analytical methods for accurately predicting the margin of safety against fracture of large nuclear reactor pressure vessels. The capability of these vessels to perform satisfactorily under overload conditions, even though large flaws may be present, has been repeatedly demonstrated in tests.

During 1977 the tenth in a series of pressurization tests of deliberately flawed six-inch thick steel pressure vessels was performed at ORNL. Vessels made of typical forging and plate materials were subjected to pressures two to three times the design pressure before leakage occurred. In each case, the flaws, some of which extended nearly through the wall, did not impair the ability of the vessels to accept higher than design pressures. The third test of one vessel demonstrated that a weld repair has the same capability to endure defects as the parent metal of the vessel wall at its highest toughness capability at operating temperature. The weld repair was made in accordance with the recommendations of the American Society of Mechanical Engineers (ASME) Code, which takes into consideration the constraint and restrictions that would exist if a vessel had been in operation and a repair was deemed necessary. After the simulated repair was accomplished, a large flaw was then placed in the repair region and the vessel was again tested. More than the design pressure was required before leakage occured.

A hot reactor pressure vessel abnormally stressed by the cold emergency cooling water injected dur-



Injection of emergency core cooling water during a loss-of-coolant accident causes thermal stresses in the vessel wall (path beginning at lower right). Fracture is normally projected when the vessel stress and fracture stress levels coincide. An experimental investigation conducted by the Naval Research Laboratory has shown that the peak stress value attained by the vessel results in a warm prestress effect that precludes failure at lower stresses (later in time) when the vessel stress exceeds the fracture stress of the virgin material. It has been concluded from these studies that the warm prestress effect, while not preventing the extension of shallow cracks, can preclude complete crack penetration of the wall.



At the Thermal Shock Test Facility at Oak Ridge National Laboratory, six-inch-thick cylinders of reactor pressure vessel steel, initially heated to 550°F, have been subjected to the thermal shock of an alcohol-water mixture at -10°F flowing through the cylinder. Many thermal-hydraulic tests have been performed, including four tests on vessels containing cracks purposely placed in the inner walls. These experiments have shown that linear elastic fracture mechanics (an analysis technique) can be used to properly characterize this kind of thermal shock.

ing a postulated LOCA could produce a thermal shock that might cause existing small flaws on the inside surface of the vessel to grow. Four experiments have been performed to simulate such conditions in cylindrical steel specimens 21 inches in diameter with six-inch-thick walls. The predicted behavior of flaws in the specimens has been confirmed, thus validating the analytical methods used to evaluate the behavior of reactor vessels under similar hypothetical accident conditions. These tests, and complementary work performed by others, indicate that such cracking may be self-limiting to a fraction of the wall thickness. Additional experiments to verify this are being concluded.

An experimental program is being conducted at the Naval Research Laboratory to establish warm prestress, a phenomenon that can inhibit crack extension by elevating the fracture toughness of the vessel material. While extension of shallow flaws cannot be precluded, deep flaws can be limited to less than one-third of the vessel wall thickness. Thus, warm prestress can be a key element upon which to base the assurance of vessel integrity during a LOCA.

Fracture Toughness

Reactor pressure vessels can have large flaws and still sustain overloading because of the high fracture resistance of the materials of construction. Because bombardment by high energy neutrons reduces fracture resistance, a major effort is being made to quantify the effects of irradiation on pressure vessel steels, using specimens up to four inches thick. Several series of irradiation of large specimens have been performed, including specimens made from vessel materials known to have a reduced fracture toughness. The methodology to test such materials is being developed.

Design Criteria for Piping and Nozzles

NRC research at ORNL on the structural behavior of piping system components and nozzles in water reactor pressure vessels is aimed at evaluating the margins of safety in current criteria, codes and standards, and at developing any needed revisions to the rules. NRC activities are coordinated with other safety-related piping and pressure vessel research through the Pressure Vessel Research Committee of the Welding Research Council and the ASME Boiler and Pressure Vessel Code committees. (See Chapter 10 for a discussion of the relationship between the NRC and industry committees.)

During 1977 computer programs were developed and validated for detailed stress analysis of cylindrical reactor pressure vessels with isolated nozzles and with two and three closely spaced nozzles. The programs will be used in 1978 to analyze pressure vessels over the range of dimensional and loading parameters permitted by the current design rules. Results will then be compared with established criteria and stress limits to evaluate existing margins of safety. Preliminary results from studies on vessels with isolated nozzles indicate that the maximum stress index (a measure of the stress in the nozzle relative to the nominal stress in the vessel) is conservative for a range of geometries which includes most reactor vessel nozzles.

Piping system component studies included examination of the ASME Code rules for the design of flanged piping joints and the development of a complete set of revised rules which provide better assurance against the use of marginal flange designs in the more critical reactor plant piping. The new rules, which have been adopted into the ASME Code, are also much simpler to use than the older rules. ORNL has also completed a study of dimensions of standard manufactured piping products including elbows, tees, reducers, and caps; and the development of a supplementary standard which provides for better dimensional and geometric shape controls and more definitive proof-test requirements. This supplementary standard is being incorporated into a new standard by the Manufacturer's Standardization Society.

Crack Arrest

A rapidly growing crack can be arrested if it encounters tougher material. Conventional measurements of fracture resistance are not capable of characterizing this phenomenon. For this reason, Battelle-Columbus Laboratories has been developing methods of measuring the material property associated with crack arrest. During the past year, test procedures were developed to the point that they have been submitted to the American Society for Testing Materials (ASTM) for consideration as a standard practice. At the same time, a crack-arrest data base for reactor pressure vessel steel and weldments is being generated.

Future plans call for testing of irradiated steels and using the theory of crack arrest to analyze the results of thermal shock experiments. This effort is supported by dynamic photoelasticity studies at the University of Maryland.

Radiation Embrittlement

Currently, NRC regulations and the ASME Code (Section III) require reactor vessel steels to maintain a minimum fracture toughness throughout the vessel lifetime. This requirement poses no particular problem for new reactor vessel construction; however, for certain older vessels which did not have the benefit of present technology, a combination of metallurgical and nuclear factors may prevent them from meeting this requirement after some years of service. The problem stems from the fact that nuclear radiation progressively reduces the fracture resistance of pressure vessel steels. Under NRC sponsorship, the Naval Research Laboratory (NRL) is conducting systematic investigations of the merits of heat treatment (annealing) to reduce radiation embrittlement in these older reactor vessels.

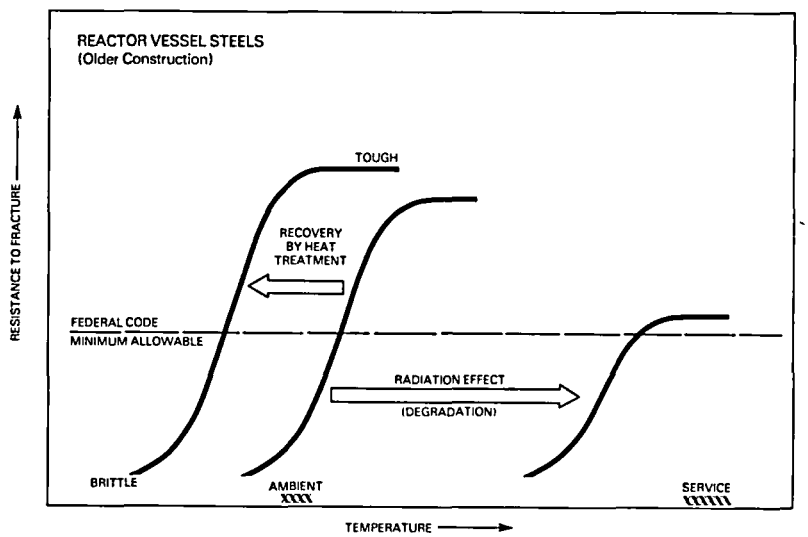
Heat treatment to reduce radiation effects is one option proposed in the event that fracture resistance approaches the minimum value allowed by the Code. Preliminary tests show this method to be promising. In anticipation that this option may be exercised, NRL is developing detailed data on vessel steel annealing and reirradiation behavior. Because heat treatment may be necessary more than once during the vessel lifetime, cyclic irradiation-annealing behavior is being investigated. The insights into steel performance gained from these investigations should help NRC in future decisions on the method's applicability in individual cases.

Crack Growth

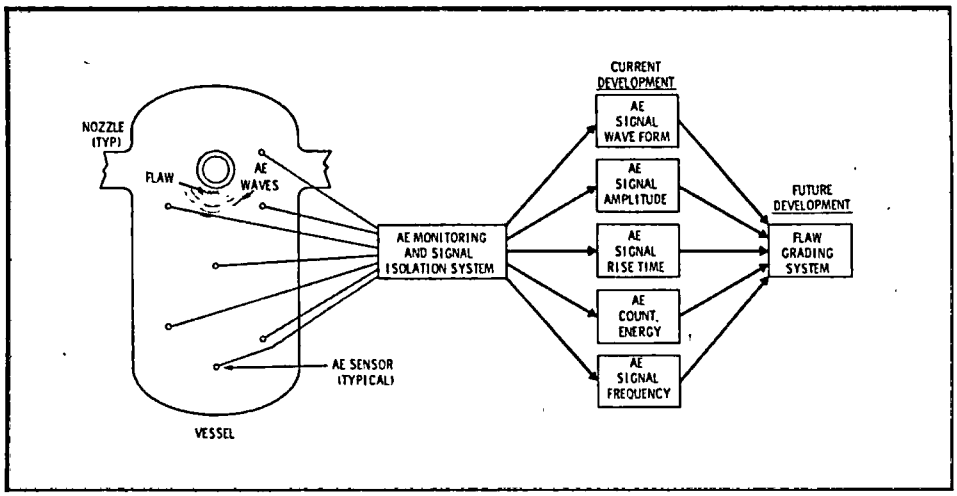
Reliability projections for nuclear pressure vessels depend on the accuracy of predicting the course of cyclic crack propagation under service conditions. At NRL and under the HSST Program, specimens of reactor vessel material are cyclically loaded in high pressure chambers (autoclaves) to simulate the reactor environment; irradiated as well as unirradiated materials are being investigated. The observed crack growth rate is characterized as a function of the various loading conditions, temperatures and water chemistry to which the vessel is subjected during its lifetime. It has been demonstrated that the water environment can accelerate the cyclic crack growth rate in comparison to the rate in an air environment. This program is being coordinated with similar studies by the Electrical Power Research Institute and laboratories in Europe and Japan. The data being generated will form the basis for Code rules to be used by the vendors as well as NRC to define conservative estimates for crack extension during the plant lifetimes.

Acoustic Emission

Acoustic emission is a key technique in the nondestructive detection of flaws in solid materials. Elastic waves are generated in a solid as a flaw grows. In the acoustic emission technique these waves are sensed and used to detect and locate flaws in pressure vessels (nuclear and non-nuclear) during hydrostatic testing. Even greater benefits might be realized if the technique were used for continuous monitoring to detect growing flaws in the pressure boundaries of operating nuclear reactors. To achieve the benefits of continuous monitoring, however, requires additional developments in (1) the capability to evaluate the significance of a flaw



Schematic illustration of the detrimental effect of nuclear radiation on unimproved reactor vessel steels, and of the potential of post-irradiation heat treatment for recovery of radiation embrittlement. Federal regulations and the ASME Code currently require that all reactor vessels exhibit a minimum level of fracture resistance over the vessel lifetime. In anticipation of future needs, the Naval Research Laboratory, under NRC contract, is investigating the heat treatment method across a range of irradiation/reirradiation conditions for steel plates and welds.



This illustration diagrams an example of the relationship between acoustic emissions and flawed vessel walls, used as a development concept for the inservice monitoring of nuclear pressure vessels. Based on the facts that a pressure vessel with a growing flaw produces acoustic signals, and that advanced instrument systems can detect and analyze acoustic signals, Pacific Northwest Laboratories, Richland, Washington, is seeking to determine which emission parameters (boxes under "current development") correlate best with flaw growth. Fracture mechanics techniques are used to study the correlations. In work to date, four of the five paraments shown—wave form, amplitude, rise time and energy—show indications of desired correlations in laboratory specimens. The results from this PNL program are closely integrated with those of the Heavy Section Steel Technology program at Oak Ridge National Laboratory.

from the acoustic emission signals, (2) the capability to distinguish different flaws, and (3) the capability to distinguish between signals from innocuous sources and those from material degradation sources.

When the acoustic emission parameters most directly correlated to flaw growth and flaw/noise signatures have been identified, this information will then be translated into a form directly usable in the field for evaluating flaws. This may take the form of a computer program algorithm which will automatically analyze incoming acoustic emission data from a reactor vessel monitoring system and indicate the significance of the flaw producing the acoustic signals.

Steam Generator Tube Integrity

Late in 1976, NRC initiated a program at PNL to: (1) conduct burst and collapse tests on baseline and artificially flawed tubes representative of those presently installed in PWR steam generators, and (2) develop criteria for establishing the margins to failure of tubes in which flaws are found during inservice inspections.

The following steps are being taken in this program:

(1) Tubing typical of that being installed in PWR steam generators is being acquired.

(2) A large number of defect geometries are being studied, including approximately 315 burst specimens and 160 collapse specimens representing at least 50 different defects in four different sizes of tubing.

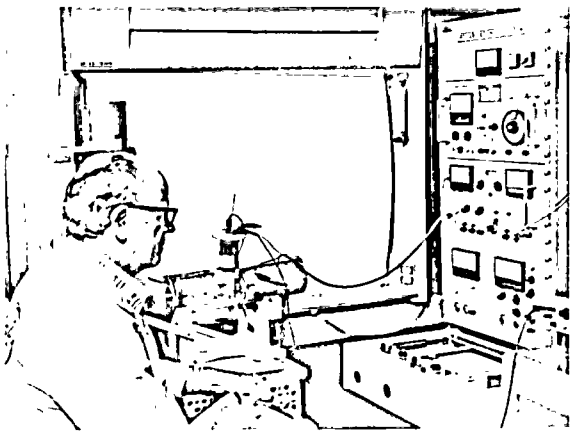
(3) The defects are precision-machined and their dimensions measured from cast replicas.

(4) The machined defects are examined with the presently eddy-current testing technique.

(5) The tubing specimens are burst- and collapse-tested in temperature and water chemistry environments simulating that found in actual PWR steam generator service.

Throughout the program, data such as baseline tubing ovality and material strength is carefully recorded. This record, together with the defect geometry (from the replication technique), the eddy current test readings, the burst (or collapse) pressure, and the resultant geometry of the burst (or collapse) tubes, provides the basic information for judging the margin of safety of tubes found, during a typical inservice inspection, to have defects. The data developed during the eddy current test inspections in conjunction with the well-defined geometries of the defects being inspected should clarify the efficacy of the present in-service inspection techniques in accurately defining the type and geometry of defects in PWR steam generator tubing.

Substantial progress was made in this program during 1977. Burst testing is well along, and the data developed are being analyzed. Results show that the tubing maintains considerable strength, even in the presence of rather severe defects. For instance, a tube with a ½-inch long slot that penetrated through 87 percent of the wall of the tube still had a margin-to-failure of 4.4 times the operating pressure of a steam generator.



This portable electrochemical cell has been designed, constructed and successfully tested on a welded section of stainless steel pipe by General Electric at San Jose, California. The prototype cell has only been used with the laboratory polarization equipment shown. Because the equipment is not suitable for routine shop or field application, a portable polarization unit is being designed for use with the cell.

Detection of Sensitization

An electrochemical method has been developed to allow predictions of susceptibility to steam corrosion cracking in the BWR environment in thermally treated and welded stainless steel. The method is rapid and nondestructive. Measurements on thermally treated and as-welded stainless steel piping material indicated good correlation with laboratory stress corrosion cracking tests.

Under the NRC program, the General Electric Company is developing a portable electrochemical cell for use in shop-fabricated and field-constructed welded pipes and other components. The unit would also have application for welded pipes in existing plants. By comparing the measurements produced by the portable cell with laboratory data on stress corrosion cracking tests of material with similar levels of sensitization, welded pipes or other components with a high potential for stress corrosion cracking may be identified prior to putting them into service.

A small portable electrochemical cell has been designed, constructed and successfully tested on a welded section of stainless steel pipe. The prototype cell has been used with laboratory polarization equipment. Because the polarization equipment is not suitable for routine shop or field application, a portable polarization unit is being designed for use with the electrochemical cell.

SITE SAFETY STUDIES

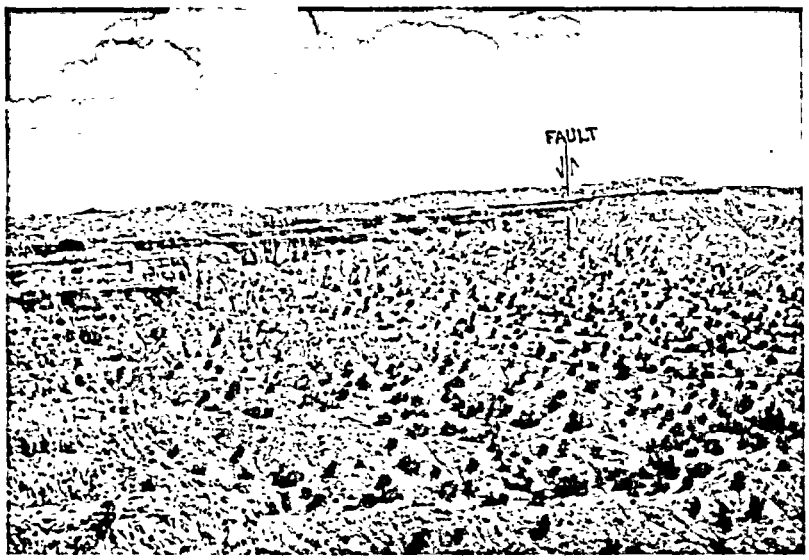
The main purposes of NRC's Site Safety Research Program are to improve the agency's ability to estimate reliably the potential effects of earthquakes, tornadoes and floods and describe their distribution in time and space; to verify engineering methods used to mitigate the effects of severe natural phenomena; to determine margins of safety; and to assess alternative concepts of nuclear facility siting, such as underground and floating plants. The program is closely coordinated with related programs in other Federal agencies (USGS, NOAA, NSF, DOE) and other organizations (New York State, EPRI).

The program has four sub-elements: (1) Geology and Seismology, (2) Meteorology and Hydrology, (3) Civil Engineering and (4) Siting Concepts.

Geology and Seismology

The geology and seismology research program consists of projects concentrating on regional studies of areas in the Eastern U.S. where large earthquakes have occurred, and on the distribution of faulting and earthquakes in areas of potential siting interest in the western United States. Studies of faulting processes and confirmation of acceptable methodologies for dating movements on faults are also included; as are investigations of experimental methods in earthquake prediction.

During the past year, maps showing the classification of known geologic faults according to how recently they have moved were completed for the California coastal zone from north of Los Angeles to Pt. Arena. (A similar map showing the region south to the Mexican Border was published previously.) Also, investigations were completed in an apparently aseismic block in the Eastern Mojave Desert. A seismic monitoring network, maintained for three years, will be continued by the U.S. Geological Survey. A study on dating fault-movement



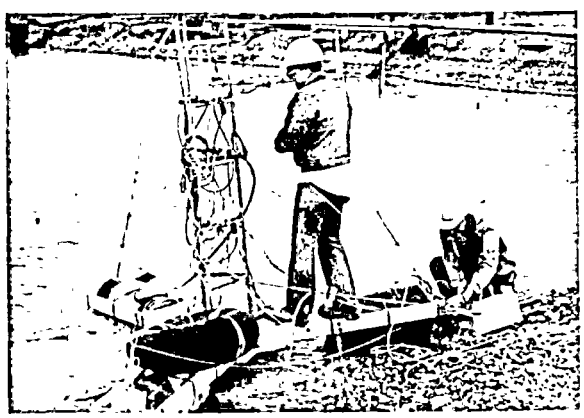
On the left side of the geologic fault shown in the photograph there are several buried soil horizons which were formed during the same time as the single soil horizon to the right of the fault. Each of the multiple soil horizons was formed during a period of deposition and stability between movements on the fault. The number of buried soils indicates the minimum number of earthquakes that occurred on the fault during the time of the soil formation, which can be estimated by geochemical dating methods. From this study the approximate recurrence rate of earthquakes on this fault can be determined. The area shown is near Albuquerque, New Mexico. Similar soils occur over a wide area of the semiarid western and midwestern states.

intervals by use of stratigraphy of calcareous soils was completed. In the area of the Charleston, S.C., earthquake epicenter, a 4,000-feet-deep test hole penetrated the coastal plain sediments and bottomed in sedimentary rocks below basalt which apparently were deposited in a now-buried Triassic-Jurassic basin. The possibility that the large earthquake of 1876 was associated with faults in this basin will be investigated further. Investigations were increased on the geology and seismology of areas in the eastern U.S. where large earthquakes occurred in the past. More than 135 regional network seismic stations are in operation to monitor earthquake activity. An overview of the earth-crustal and geodynamic features of the central mid-continent region was published.

Meteorology and Hydrology

Research in meteorology and hydrology is concerned with improving NRC's ability to predict the effects of severe events on nuclear facilities, in addition to obtaining a better understanding of the behavior of specific components of facilities during normal conditions. Research in flooding and similar events is aimed at quantifying the important parameters for use in models that will enable water levels to be calculated. Studies in heat dissipation are directed toward establishing ultimate heat-sink performance criteria. Research on severe weather is aimed at the quantification of the characteristics and regionalization of maximum parameters associated with severe weather phenomena, especially tornadoes and lightning. Research in atmospheric turbulence involves the acquisition and analysis of high quality data in order to evaluate models that describe diffusion conditions of topography, buildings, and thermal stability.

Three monitoring stations have been installed in the Atlantic Ocean off the coast of Florida to permit measurements of hurricane surge and wave height. An analysis of the historical hurricane data record has been completed; a report will be issued in fiscal



An instrumented raft is made ready for deployment at pond center at a geothermal site in southern Idaho. It is used to measure humidity, temperature, wind speed and direction, and net thermal radiation directly over the water. This measurement program has been accomplished on a geothermal retention basin considered as an analog to an ultimate heat sink. The relatively small pond was monitored during a two-week period in April-May 1977 to establish thermal exchange to the atmosphere as influenced by the late spring weather. The data display heat transfer by the mechanisms of convection, conduction, and thermal radiation for water at temperatures as high as 50°C. A data volume will be prepared and will include the data from this first measurement program on a cooling pond analog.

year 1978 that describes an approach to evaluating the probable maximum hurricanes that could affect the Gulf and East Coast.

Upgrading of the historical tornado data record to include intensity ratings has been completed and is available on computer tapes. Independently, tornado data for each 250 square miles of the United States have been compiled for hazard probability assessments. Photogrammetric and doppler radar data continue to provide insights into the tornado vortex structure.

Wind tunnel tests have been completed to model the effects of power plant buildings perturbing the mean atmospheric flow and dispersion. A comprehensive evaluation of past diffusion field experiments is nearing completion; the final report is expected early in 1978.

Civil Engineering

Research in civil engineering is directed toward improving NRC assessment capability in those design procedures used to assure the adequate support of plant structures, systems and components at the site. Improving this capability requires an understanding of the influence of soil properties and stratigraphy on available strong motion accelerograms. Such records are used to estimate seismic motions for design purposes. During the year static and dynamic tests were completed on experimental test specimens representing reinforced concrete wall sections. Test conditions are intended to represent the simultaneous loading imposed on a containment wall by internal pressure (as from a LOCA) and a maximum design earthquake. Soil conditions at many additional accelerograph station sites were determined through field and laboratory tests; reports describing these are completed and ready for publication.

Siting Concepts

The siting concepts studies will provide information which may be used in evaluations of the safety, practicality, and costs of alternative siting concepts, such as underground and floating plants. A current effort is analysis of plant costs as a function of earthquake intensity. During the year a preliminary study was completed on the potential benefits and penalties of underground siting of nuclear power plants. This study indicated that the expected benefits of underground siting alone, in terms of improved safety, do not appear to offset the penalties. A follow-on study suggested that the principal expected safety benefits might be realized through application to surface plants of simpler and possibly less costly concepts, such as controlled venting and filtration of the containment atmosphere during severe accident conditions.

RESEARCH SUPPORT

The activities in research support encompass research related to reactor operational safety (fire protection, qualification testing, human engineering, noise diagnostics) as well as a number of programs which supply basic information to support NRC regulatory efforts.

Fire Protection Research

Experiments conducted at Sandia Laboratories have provided data related to fire propagation among cable trays. These tests were a part of a longer term program to evaluate separation distances, effectiveness of conduits, fire barriers, penetrations, and fire retardant coatings in preventing fire propagation similar to that observed in the Browns Ferry fire. (The Browns Ferry fire is discussed in the 1975 NRC Annual Report, pages 92-94, and in the 1976 NRC Annual Report, pages 26 and 185.)

During this past year the fire propagation tests conducted at Sandia involved two different fire situations. Both were performed with a stacked cable tray configuration which simulated vertical and horizontal separation of safety divisions. In the first situation, fire was generated by an overcurrent in the bottom tray of an eight-tray stack. It burned the cables in that tray, but the fire did not spread to other trays in the stack. The results provide general confirmation of requirements currently contained in NRC Regulatory Guide 1.120, "Fire Protection Guidelines for Nuclear Power Plants." A second test evaluated the consequences of an exposure fire (supported by a fuel source other than the cables) which results in a "fully developed" fire in one cable tray. Small-scale tests indicated that such a cable fire could be generated by exposing the tray to flame from standardized gas burners for a five-minute period. When a fully developed fire was produced in the bottom tray of the stacked array, the fire spread to all trays in that division and to the division above, but not to a division separated horizontally.

The Sandia tests showed that existing separation and fire retardancy standards for redundant safety cables are not sufficient, by themselves, to protect against fires. They confirmed the need for the pres-

ent NRC licensing requirement to provide additional measures to protect against disabling of vital systems in the event of such fires. These measures include fire barriers between cable trays, fire detection systems, and systems such as sprinklers to extinguish fires.

Stacked cable trays are tested at Sandia Laboratories, New Mexico, to assess the degree of protection afforded by the vertical and horizontal separation of safety divisions. The cable tray at the very top of the photo represents the vertical safety division separation being tested.

Qualification Testing and Evaluation

Results obtained in the Quality Testing and Evaluation Program will provide insights into the behavior of certain electrical and mechanical components located inside the containment which might be exposed to the LOCA environment. The initial question in this program was whether there is any difference between the effect upon components created by the simultaneous application of the LOCA environmental factors (as would be the case in reality) and the effect of the sequential application of several environmental factors (as is done in most qualification testing).

Studies of the post-LOCA radiation source involve determination of the energy and particle spectrum versus time. Basic studies have revealed that beta radiation contributes a significant fraction of the energy and that the spectrum "hardens" (high energy component increased relative to low energy component) with time. This information, applied to energy deposition versus penetration depth calculations, allows evaluation of the adequacy of laboratory sources in simulating the LOCA radiation environment.

Aging factors have been combined into a conceptual model which, when verified, should make it possible to predict the differences in response between aged and unaged materials. Efforts to locate and obtain specimens of naturally aged polymer materials (cable insulation) are underway. Comparison of these naturally aged specimens to artificially aged samples of the same materials will allow verification of the conceptual model.

Tests of components to determine differences in the results produced by simultaneous versus sequential exposures yielded mixed results. The tests—involving exposures of connectors, cables, cable splices and containment coatings to heat, chemical spray, humidity and radiation—reveal that there is significantly more visible damage caused by simultaneous exposure, but that the ability of components exposed either way to function is quite similar.

Results also showed that certain electrical cable connectors failed under conditions that might occur in a loss-of-coolant accident. On the basis of those test results and results of the cable fire tests described above, the Union of Concerned Scientists (UCS) on November 4, 1977, filed a "Petition for Emergency and Remedial Action" with the NRC. The petition, alleging that the tests showed the NRC's safety criteria to be deficient, requested that all licensing, construction, and operation of nuclear power plants cease until such deficiences had been corrected. The NRC staff conducted a preliminary analysis of the petition and issued a press release on November 5 stating that the requested action was not warranted. The Commission requested a full staff analysis of any matters of safety significance raised by the petition. On the basis of the staff's report, which was presented to the Commission on November 11, the Commission concluded that there was no need for the immediate actions requested by UCS. However, the Commission requested the staff to complete its preliminary survey of the use of electrical connectors in operating reactors and to prepare a written report of that survey. Information received from some 65 plants was being analyzed at the close of the report period for the annual report.

Human Engineering

NRC conducts human engineering research to reduce the potential for human error. A Human

Engineering Research Review Group has been formed to coordinate the various related human engineering activities within NRC. A program has been started at the INEL System Safety Development Center to (*1*) review and analyze the NRC Licensee Event Reports and recommend research on methodology in those areas where significant human errors occur, and (*2*) prepare a plan for applying the "critical incident" technique, "accident investigation" technique and other human-factor investigative techniques to inspection procedures at operating power reactors.

Noise Diagnostics

Experimental and analytical studies are being made of the effectiveness of reactor "noise" analysis techniques for detecting and diagnosing safety-related anomalies in commercial nuclear power stations. Reactor "noise" refers to the random fluctuations of sensor signals that result from various processes in the reactor. The fluctuating signals provide information ("signatures") about the dynamic performance of the power plant without disturbing its operation. These then can be used to analyze the "health" of the plant, including analysis of flow-induced vibrations, reactor stability monitoring, and timely detection of loose parts and similar anomalies.

Accomplishments of this program in 1977 include: (*1*) analyzing neutron noise signatures obtained from the Browns Ferry Nuclear Plant to assess their value for monitoring reactor stability and detecting flow-induced vibrations; (*2*) developing a methodology for predicting the response of in-core neutron detectors to various postulated safety-related malfunctions; and (*3*) completing an assessment of utility company capabilities and experience with loose-parts monitoring systems in their nuclear generating stations and recommending means by which the value and reliability of these surveillance systems might be increased.

Nuclear Safety Information Center

The Nuclear Safety Information Center (NSIC) at Oak Ridge, now in its fourteenth year of operation, is concerned with information on all aspects of nuclear facility safety. Its function is to gather all published information pertaining to nuclear safety, and to repackage this information to serve the needs of the nuclear safety community. Incoming literature is listed in the NSIC computerized data file, which now has over 125,000 items. Over 11,000 accessions were added to the Center's computer file during the past year. In addition to several reports in preparation, fourteen reports with the ORNL/NUREG/NSIC designation were published, and may be obtained from the National Technical Information Services, Springfield, Virginia. The NSIC staff answered over 1000 information requests and consulted with over 130 vistors in 1977. The selective dissemination of information program continues to be an effective means of disseminating information, and over 370 members of the nuclear community now receive this biweekly abstract service. The Center also publishes a bimonthly technical progress review, *Nuclear Safety*, which is now in its eighteenth year.

Faculty Institute on Reactor Safety

Under NRC sponsorship, the Argonne National Laboratory Center for Educational Affairs has developed a series of annual institutes on nuclear reactor safety addressed to the academic community. The activity is intended to develop university curriculum material pertinent to reactor safety. Each institute is five days long and consists of lectures, organized discussions, and workshop sessions presented by speakers from industry, government, and academe. Printed collections of lecture notes and bibliographies are prepared to serve as basic sources for university course development.

The first institute, devoted to light water reactor safety, was held December 13-17, 1976. The principal emphasis was LOCA/ECCS research but attention was directed to fuels, materials, and probabilistic risk analysis as well. It was attended by 24 faculty members representing 24 institutions. About 500 pages of lectures and notes resulted from the presentation, a copy of which was sent to U.S. university nuclear engineering departments. Copies were also filed in the NRC Public Document Room (Washington, D.C.).

Computer Code Software Exchange and Information Center

The Argonne National Laboratory Code Center serves as the software exchange and information center for computer programs developed under NRC sponsorship. In this role, the Center collects, tests, and maintains a library of software packages for distribution to contractors, other government agencies, and commercial and industrial establishments.

Advanced Reactor Safety Research

The overall objective of NRC's Advanced Reactor Safety Research program is to achieve an independent capability for safety assessment and for the development of licensing standards for the advanced reactor concepts to be selected by the DOE. The immediate objective is to develop and verify a family of safety codes that will apply to such concepts.

FAST REACTORS

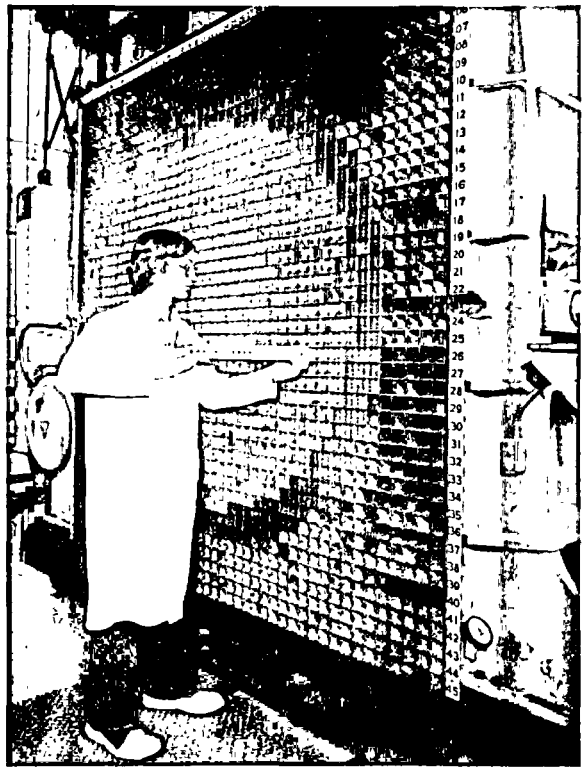
In a fast breeder reactor (FBR), the neutrons emitted in the fissioning of a nucleus cause fissioning of other nuclei in a controlled process. This process requires a higher fuel enrichment than in current commercial reactors, and results in the non-fissile part of the uranium (U-238) being converted into fissile plutonium which can be used as fuel. More plutonium is made in a breeder than fissile material is used, so there is a net excess of plutonium. A similar cycle has been studied to convert non-fissile thorium to fissile U-233.

The major safety concerns related to the commercial light water reactor (LWR) differ from those of an FBR in that removal of coolant or movement of fuel tends to slow down the neutron reaction in the LWR, whereas the reverse may be true in an FBR. On the other hand, because an LWR operates at high pressure, a leak may lead to a rapid loss of coolant and a requirement for emergency core cooling, while in an FBR, which operates at low pressure, the safety systems may continue to cool the core.

NRC's fast reactor program of generic safety research is divided into five programs: Analysis, Safety Test, Aerosol Release and Transport, Material Interactions and Systems Integrity. (The general scope of each of these areas is described on page 186 of the 1976 NRC Annual Report.) The five areas are discussed below.

Analysis Programs

The continuing effort to develop necessary computer codes and mathematical models consists mainly of work performed at Argonne National Laboratory, Los Alamos Scientific Laboratory, and Brookhaven National Laboratory.



A technician loads mock breeder-reactor fuel assemblies into one of the halves of the ZPR-9 critical experiment facility at Argonne National Laboratory in Illinois. This core had a composition typical of current LMFBR designs and had a simple geometry for ease of analysis. It went critical on August 8, 1977, with a critical fissile mass of 333 kilograms of fissile plutonium. Other loadings simulate, in a static "snap-shot" sense, the sequence of events assumed during a loss-of-flow accident. The results provided valuable experimental data on the physics of damaged LMFBR cores.

Argonne National Laboratory. Work in the Applied Physics Division of the Argonne National Laboratory (ANL) is focused on the analysis of those potential accidents which, although having a very low probability of occurrence, might, under the worst accident circumstance, endanger the structural integrity of the reactor. The computer codes developed at ANL include:

- EPIC computer model, intended to describe how fuel and coolant move in and around one fuel pin during such an accident.
- FX2-POOL and FX2-TWO POOL codes which model the motions of the reactor's fuel and steel when the chain reaction rate is very strong or when the fuel and steel have melted. (These scoping codes are used to evaluate in an approximate way the potential for structural damage to the reactor containment during various hypothetical accidents.)

- COMMIX (COMponent MIXing) code, which has a wide range of applications to heat transfer and fluid dynamics problems.

In addition, a program of LMFBR safety-related critical experiments has been in progress in the Zero Power Reactor-9 which will provide experimental data for validation of the neutronic methods used for certain LMFBR accident analyses. The VIM Monte Carlo code already in use at Argonne will be used to make detailed calculations of the experimental configurations. When validated against these experiments, the VIM code can be used to validate neutronic formulations in other codes which are used in analysing hypothetical core-disruptive accidents (CDAs).

Los Alamos Scientific Laboratory. Several LMFBR safety research programs are being conducted at Los Alamos Scientific Laboratory (LASL). In one of these, the SIMMER code is being developed. SIMMER (a two-dimensional coupled neutronics fluid-dynamics code) is to be used in detailed "best estimate" analyses of postulated core disruptive accidents in LMFBRs. The first version of the code has been completed and is being used to develop a detailed understanding of accident phenomena. The results will be used in future code development work and to aid in planing verification experiments. It is premature to rely on the absolute magnitude of the damage potential computed by SIMMER-I, but the trends shown are reasonable.

A major experimental verification program is being developed to establish the credibility of the SIMMER codes for solving core-disruptive accident problems. This program includes specific SIMMER model development and verification experiments related to two-phase momentum exchange and multicomponent condensation. In addition, a small-scale laboratory simulation of an unprotected flow coastdown accident is being conducted as a scoping experiment. Comparisons with SIMMER calculations of this experiment will indicate where model improvements are most needed.

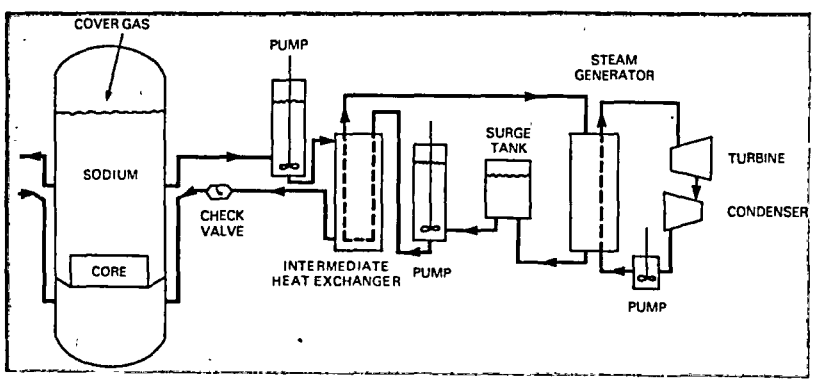
LASL is also studying the needs and requirements for in-reactor tests comprising three major tasks: analysis and planning of experiments and of facilities, conceptual design of possible facilities, and assessment of diagnostic systems for use in safety experiments. A major development in the latter task involves the use of the PARKA critical assembly at LASL as a neutron source for safety test diagnostics. Experiments have been performed, for example, to assess the efficacy of using the fast neutrons from fissioning fuel to measure the motion of the fuel. A second diagnostic research task at LASL involves flash x-ray cinematography for observing fuel motion.

Brookhaven National Laboratory. Work on a benchmark system code, SSC (Super System Code), to simulate thermal-hydraulic transients in LMFBR systems is being carried out at Brookhaven National Laboratory (BNL). The SSC computer programs predict system conditions, such as maximum coolant and cladding tube temperatures in the reactor following a variety of disturbances. The SSC family of computer programs consists of three series: SSC-L for loop-type designs such as the Clinch River Breeder Reactor: SSC-P, tailored specifically to pool-type designs such as ERDA's EBR-II reactor and the French *Phoenix* plant; and the SSC-S computer code, which can be used to investigate the ultimate cooling capability of a plant.

The SSC computer programs are designed for maximum flexibility. For example, SSC-L could be adapted to simulate system transients in a gas-cooled fast breeder reactor. Experimental programs being planned by DOE for the Fast Flux Test Facility (FFTF) and EBR-II will be used to validate SSC programs.

Safety Test Programs

Programs at LASL and Sandia Laboratories are designed to provide NRC with the technical basis



The SSC-L benchmark system code developed at Brookhaven National Laboratory models loop-type fast breeder reactors such as the design diagrammed at left. Other codes of the SSC family of computer programs are tailored to other types of reactors.

to participate in planning for new safety research facilities to be built by DOE and for new foreign facilities where the U.S. participates under exchange agreements. Because of a delay in DOE's program in this area, the NRC effort has been cut back and emphasis placed on the testing of devices for fuel motion detection.

In another major program, NRC is sponsoring research in the Annual Core Pulse Reactor (ACPR) located at the Sandia Laboratories and is cooperating with DOE in the upgrading of that facility. Planning and preparations to upgrade the capabilities of the ACPR neared completion in fiscal year 1977 on schedule and within budget allocation. This will dramatically improve both pulse and steady-state performance without appreciably impairing the dynamic characteristics, and will, thus, increase ACPR's usefulness for most areas of fast reactor safety research. A coded-aperture-imaging fuel motion detection system, to be installed in the ACPR, will provide a unique capability not previously available to study fuel motion in safety experiments. The ACPR, which was shut down in October 1977 for installation of the new core, control system and facility modifications, is scheduled to be operational in July 1978.

Aerosol Release and Transport

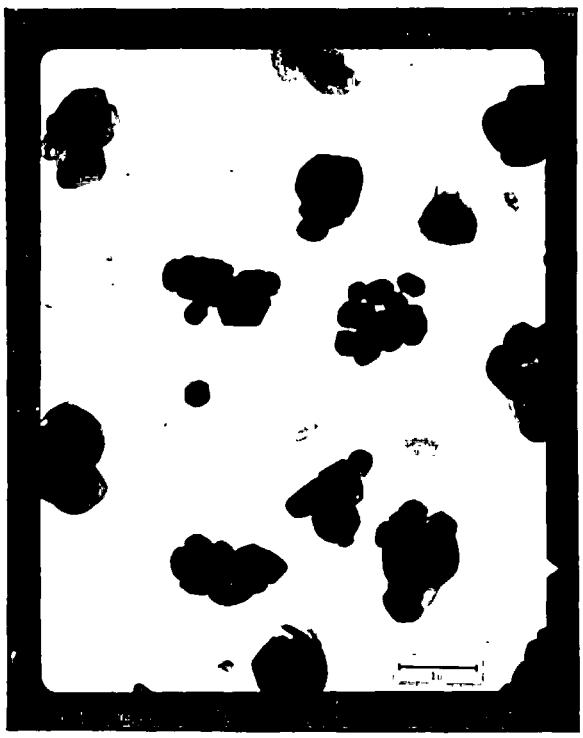
Quantitative information on radioactive aerosols which may be released from nuclear fuel in a serious accident is required by NRC in evaluating the potential radiological risk of fast breeder reactors. Modeling the behavior of aerosols allows predictions concerning time dependence of airborne radioactive particles which may diffuse into the containment building and leak to the environment. Experiments to ascertain the key properties of aerosols and to test analytical methods and conditions were started at Oak Ridge National Laboratory (ORNL) during fiscal year 1977. The ORNL equipment is suitable for studying aerosols in either sodium or gas-cooled breeder reactors using either uranium or thorium-based fuels.

Oak Ridge Program. The ORNL experimental program focuses on determining how much fuel and fission product may escape from the primary containment in a postulated accident. The program also includes investigations of how the material discharged from primary containment will be suspended as aerosols within the secondary containment and how the material concentrations there change as the particles agglomerate and settle out.

The discharge from primary containment is investigated through a "Capacitor Discharge Vaporization" technique in which electrical energy stored in capacitors is used to convert UO_2 (as a surrogate for fuel) into a high-temperature molten state typical of extreme accident conditions. Samples are studied by vaporizing them inside instrumented laboratory vessels. One vessel now being completed will include a sodium pool to typify the LMFBR thermal environment. The medium (coolant) in which the simulated fuel is vaporized, however, may be varied.

The behavior of aerosols in the secondary containment is being studied in the Nuclear Safety Pilot Plant (NSPP), a vessel about 10 feet by 20 feet in size, in which sodium and uranium can be burned to produce an aerosol mixture. Data on sodium aerosols, fuel aerosols and their mixtures, will be used to verify codes used in predicting the potential radiological consequences of LMFBR accidents.

Battelle Columbus Laboratories. A computer code (HAARM-2), based on the development of the aerosol behavior model, is being improved to



Experimental measurements have been made at Battelle-Columbus Laboratory to determine the effective densities and actual dimensions for agglomerates of sodium oxide particles. Tests using a Millikan cell type apparatus have indicated that porous agglomerates, shown above, can be substantially less dense than those for solid spheres of identical masses, but considerably larger in diameter. These findings were incorporated into the analytical code HAARM-2 to provide more accurate and physically realistic predictions of aerosol settling behavior within a reactor containment.

provide more realistic descriptions of aerosol particles. The code predicts particle growth by agglomeration of the aerosol, particle settling on the containment floor and leakage from the containment.

Sandia Laboratories. In 1977, tests were initiated at Sandia Laboratories to create uranium dioxide aerosols in a manner that closely replicates those which would be produced if a core disruptive accident were to occur. Neutron-induced fission heating in the Annular Core Pulse Reactor is used to convert fuel into vapor. The data obtained are used to confirm that the aerosols obtained with the capacitor discharge technique at ORNL properly simulate those that might occur in a reactor accident.

This time sequence photo (read right to left) shows the vaporization of a fuel pellet in an experiment conducted in Sandia Laboratories' Annular Core Pulse Reactor (ACPR). A 1-inch-long unclad uranium dioxide fuel pellet was melted and about half of it was vaporized during the few milli-seconds of an ACPR power pulse. In addition to measuring the aerosol particle size distribution, optical pyrometer measurements were made of the pellet surface and interior temperatures. Framing camera pictures (at 5000 frames per second) were taken of the vaporizing pellet. This was the first time the process of pellet disassembly by rapid vaporization from fission heating had been recorded photographically. Current plans are to apply this technique to other phenomena of importance in fast reactor safety research.

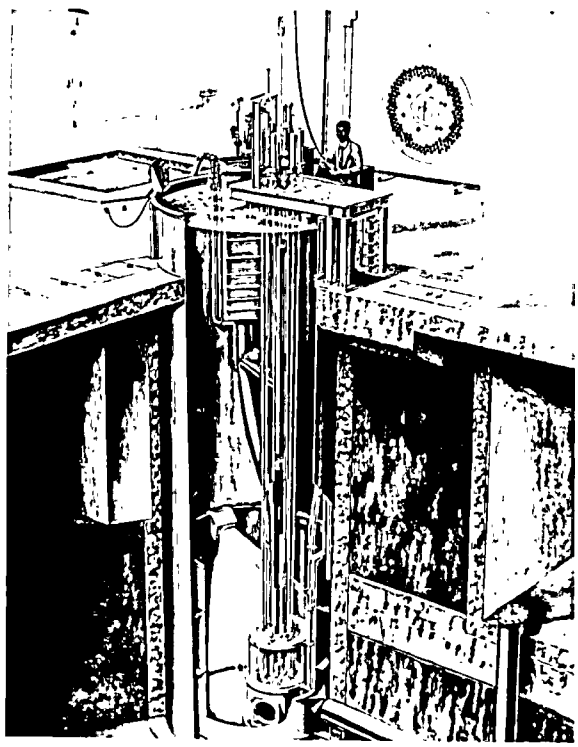
Materials Interactions

Work on the interactions of materials under core disruptive accident conditions includes experiments and model development in several areas: prompt-burst energetics (described below), system changes following the loss of original core geometry, and the degree of penetration by melt-through of post-accident core debris. In-pile experiments in the ACPR as well as out-of-pile experiments at several laboratories are conducted. The program has already generated significant information on fuel coolant interactions, material equations of state, and post-accident heat removal, all of which are discussed below. In addition, data needed for models in the SIMMER code can be extracted from such work and the code's predictions tested. An effort is also being made to arrange exchange agreements to take advantage of related foreign work.

Two facts concerning NRC's LMFBR research should be noted. First, the data needs are based on regulatory experience and reflect a range of interests not normally associated with the DOE's breeder reactor development program, and, second, this particular materials interaction work is applicable to a variety of breeder concepts, even though individual experiments usually focus on one coolant and fuel type at a time.

Sandia Laboratories. "Energetics" is a term given to the level of energy from a hypothetical core disruptive accident which might be available (as mechanical work) to damage the primary vessel.

Prompt Burst Energetics. Investigations associated with hypothetical accidents in fast reactors have been concentrated on the mechanical energy developed within the pressure vessel during what are termed prompt-burst excursions (near-explosions lasting several milliseconds) and the effects of



The Annular Core Pulse Reactor at Sandia Laboratories, New Mexico, is an experimental tool used in such areas of fast reactor safety research as prompt burst energetics, fuel-coolant interaction, equation-of-state, fuel failure phenomena, initial and extended fuel motion, and post-accident heat removal.

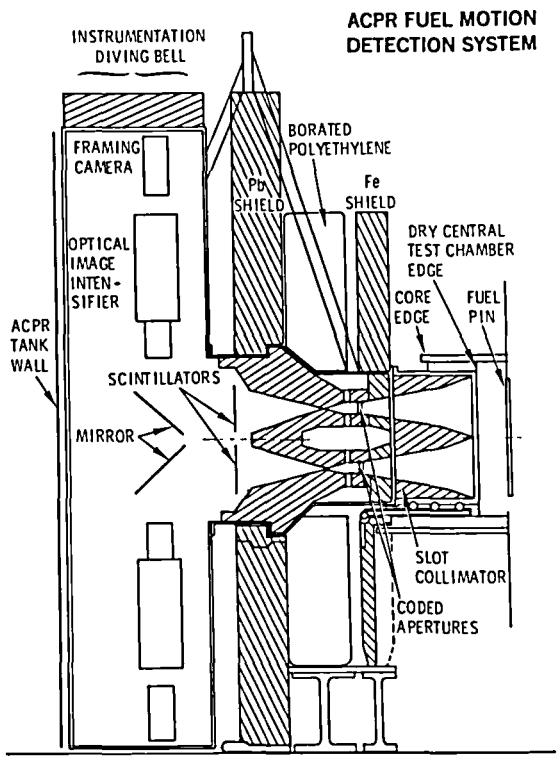
fission products on total energy release. The program includes tests in the ACPR in which single UO_2 fuel pins in sodium are subjected to fission heating at rates corresponding to the most severe hypothetical reactor excursions. Similar tests with uranium carbide (UC) also were initiated as part of a cooperative international effort. These were the first tests ever performed on this time scale. Heating conditions are varied to ensure that situations leading to violent interactions between the fuel and coolant are not overlooked. In the UO_2 tests performed to date, the conversion of thermal energy to work has been extremely low, and the high pressures observed are thought to be caused largely by fuel vapor pressure. All test to date have produced significant fuel motion within the cladding prior to the rupture of the clad. This indicates a potential mechanism for rapidly reducing the reactivity excursion.

Equation-of-State. The term "equation-of-state" refers to a formula used to relate pressure, volume and temperature when a material (such as reactor fuel) is vaporized. Although fuel vapor appears to be the dominant source of pressure buildup, pressure vs temperature data in the extreme temperature ranges that would occur in core-disruptive accidents have been extremely limited in the past. Under this NRC program, two independent new techniques have been developed to obtain these data, one using in-pile neutron heating, the other, electron-beam heating. Experiments using the techniques to produce equation-of-state data for UO_2 containing fission product simulants have been initiated.

Fuel Failure. It has long been postulated that release of fission gases in fuel, if fast enough, might disperse the fuel and, thus, greatly reduce the chances of damage during a core disruptive accident. The nature of fuel failure just prior to and during melting, therefore, is being examined to evaluate the effectiveness of this "shutdown" mechanism. In tests initiated during 1977 in the ACPR, clad fuel pellets containing fission products have been failed under accident conditions and the failure mode recorded by high speed photography.

ACPR Fuel Motion Diagnostics. The conduct of fuel motion experiments demands diagnostic techniques capable of observing the motion of molten fuel with high temporal and spatial resolution, and significant progress was made during the year in developing such a system. The "coded aperture" system, to be installed in the upgraded ACPR, will form three-dimensional images of the motion of fuel in coolant through multiple containment barriers of the experimental tests apparatus.

The availability of the coded-aperture system and the improved capabilities of the ACPR have also made it possible to conduct small-scale tests of loss-of-flow and transient overpower phenomena. The hardware for such tests is being designed.



In the "coded aperture" fuel-motion diagnostics system to be installed in the Annular Core Pulse Reactor at Sandia, New Mexico, a fission gamma-ray beam from a test fuel pin will pass through the slot in the ACPR core, be encoded by a special coded aperture and recorded on film as a shadowgram or pseudo-hologram of the moving fuel at 5000 frames per second. The holograms then are reconstructed to produce real images of the special distribution of the moving fuel.

Brookhaven National Laboratory. Several out-of-pile laboratory experiments on the transition and post-accident heat removal phases of hypothetical core disruptive accidents have been and are being conducted at BNL. These include: hydrodynamic dispersion tests (with air-water, air-mercury and possibly water-mercury as simulating fluids) to help resolve the question of liquid dispersal and possible recriticality in a core-disruptive accident; liquid dispersion tests performed in a subassembly-size boiling pool with internal heat generation, using water as the simulant; thermal and hydrodynamic characteristics of a larger boiling pool with internal heat generation, and water as the simulant; and the completion of flow-freezing experiments with simulant materials. The results of these tests will be used in analyzing freezing and/or streaming

of core debris during a hypthetical core disruptive accident.

Systems Integrity

A research program to determine what data NRC needs to provide an independent capability for assessing structural integrity of breeder reactors and certain plant systems began in fiscal year 1977. It included studies of containment system integrity under conditions in which the melting core might penetrate the primary vessel, as well as tests on reactor and containment materials at elevated temperatures.

Debris Bed Studies. The Debris Bed Studies Program at Sandia is designed to determine conditions under which LMFBR debris would be cooled by natural processes following an accident. These in-reactor experiments attempt to accurately simulate LMFBR debris conditions by fission-heating fuel material in liquid sodium. Three experiments of an initial series have been performed in the ACPR, marking the first time that LMFBR post-accident conditions have been properly simulated.

Molten Pool. If fuel debris from a hypothetical core-disruptive accident cannot be adequately cooled, molten pools of UO_2 will be formed, posing a significant threat to the containment. Experiments to determine the thermal behavior of such pools and their effects on containment materials are performed in the ACPR with fission-product decay heating simulated by fission heating. The primary purpose of these experiments is to confirm the feasibility of such studies and to provide data for the design of future experiments involving specific safety issues.

Molten Core Technology. If the integrity of the primary reactor vessel is breached during a hypothetical core meltdown, containment of the molten core must be provided by materials outside the vessel. Out-of-pile experiments at Sandia assess the inherent retention capability of such containment materials, and will provide a basis for evaluating improved system designs.

Data also are being gathered on concrete erosion rates, composition and rates of released gases, and aerosol releases. A melt facility at Sandia is used for preparation of steel melts for concrete interactions, and a similar facility is being prepared for tests using molten UO_2 and containment materials.

Sodium Containment. To complement these studies, a large facility has been constructed which will accommodate up to 224 kg (493 lb.) of sodium at very high temperatures. It will be used in tests of the compatibility of sodium with materials such as concrete and with liners which protect the concrete. Several preliminary sodium-concrete tests have provided a qualitative basis for understanding a variety of tests results previously obtained under different conditions.

GAS-COOLED REACTORS

High Temperature Gas-Cooled Reactor (HTGR) is a graphite moderated and helium cooled system. It is a concept of interest because of its potential for the reduction of thermal pollution, reduced operating costs and improved resource utilization. The objective of NRC's HTGR program, as in other reactor programs, is to develop independently verified methods of analysis and the data required for their use by NRC licensing reviewers in evaluating design and generic safety issues.

Only one vendor has been involved in HTGR design and development, and this has limited the comprehensiveness of NRC efforts to obtain computer codes needed for safety assessment. Research is under way in fields ranging from fuel particle failure and fission product transport to the transient response of the reactor system to design-basis accidents. This work is being carried out for NRC at three of DOE's national laboratories.

Analysis Program

The HTGR program at Los Alamos Scientific Laboratory (LASL) has empasized the development of analytic models and their incorporation into computer codes. In the fission product transport area, for example, early versions of three codes were developed and released. One, called LARC-2, deals with fission product transport in fuel and graphite during a loss of forced circulation accident. SUVIUS addresses fission product activity in the primary coolant and plated out on primary system surfaces. LEAF is used to model fission product releases from containment.

In the structural analysis area, an initial version of the NONSAP-C code for evaluation of static and dynamic response of a pre-stressed concrete reactor vessel (PCRV) has been used successfully to analyze several problems related to the structural dynamics of the HTGR PCRV.

A major analytical effort at LASL is the development of a systems code named CHAP (Composite HTGR Analysis Program). CHAP is a modular

systems program which analyzes the response of the whole system and has the capability of analyzing the effects of transients on various components of the reactor system. Component models with varying degrees of sophistication can be used, depending on the problem. An initial version of the code (CHAP-1) which models the 3000 MW(t) HTGR has been released.

A small analytical program at ORNL concerned with the development of analytic models of reactor components, has produced the ORTAP code. ORTAP is specialized for the analysis fo the Ft. St. Vrain reactor transients, and has been used in direct support of licensing needs for that facility.

Efforts at BNL in the gas reactor area have included review of vendor codes, development of a computer program to model the response of an HTGR core to earthquakes, and the development of analytical models to calculate gas mixing and possible combustion in the secondary containment following depressurization accident.

Experimental Program

The objective of the HTGR experimental program is to confirm and extend the understanding of HTGR phenomena involved in both design basis and beyond ("worse than") design basis accidents and to provide data for use in analytical models of those phenomena.

The major portion of the experimental program is being carried out at BNL. It includes work in fission product transport, primary coolant phenomena, and materials properties, as well as work on beyond-design-basis accidents.

The fission product transport investigations include examination of the chemical state of the fission products under accident conditions, the interactions which may occur with other materials, and the absorption of the fission products on structural surfaces. Scoping experiments have been performed on the generation of graphite aerosol particles which might enhance the transport of fission products during certain accidents.

The primary coolant phenomena experiments involve gas mixing and the interaction of helium coolant impurities with each other and with various system materials, including graphite. Gas mixing experiments have been limited to small-scale scoping tests. The interaction studies are performed in a low pressure high temperature loop. The studies are also designed to provide quantitative data on processes such as carbon transport.

The materials test program objective is to assess the integrity and performance of structural materials used in the HTGR primary system over the expected life of the reactor. To meet this objective the effect of chemical environment on certain properties of primary system metals is being examined. These tests will vary in duration from several weeks to several years so that extrapolation can be made with confidence for the life of the reactor.

The experimental program dealing with beyond-design-basis events has involved a series of tests in which core materials have been heated to extremely high temperatures. Oxide pellets heated in a graphite crucible are observed to undergo a rapid conversion to uranium dicarbide (UC_2) at about 2300°F, with the release of carbon monoxide.

The experimental program at LASL has been concerned with design-basis accident phenomena. Testing of fuel particle-failure temperatures for irradiated fuel particles subjected to a slow temperature increase was initiated in 1977. Another experimental tests series is investigating the effects of earthquakes on HTGR core block assemblies. The experiments are designed to provide scaling information so that the adequacy of using scale models can be determined.

Safeguards Research

NRC's research program in the safeguards area is aimed at providing data needed to assess alternative safeguards regulatory policy options, strategies, or procedures, and to evaluate for licensing purposes the effectiveness of safeguards proposed by licensees or applicants.

The program is designed to provide results which are as complete and technically accurate as possible. This is an ongoing process, and operational needs for the information resulting from this program must be satisfied promptly to ensure the transfer to applicable results. Four projects were completed during fiscal year 1977 and their results were made available to the appropriate offices of the NRC. These projects dealt with evaluation methodology, the physical security equipment catalog and evaluation guides, threats from white-collar crime, and effectiveness evaluation. A brief manual is being prepared by Battelle for use by the NRC staff.

Evaluative Methodology

This category of safeguards research provides systematic methods for evaluating safeguards systems, sub-systems and components with respect to the prevention of theft and sabotage at fixed nu-

clear sites, taking into account adversary characteristics, resources, actions and modes of action. The evaluative methods will be used in licensing reviews and assessments and in support of NRC efforts to generate greater licensee initiative and responsibility in this area.

The NRC safeguards research on evaluation models consists principally of three major projects. In one, Sandia Laboratories is working at Albuquerque on models for the evaluation of safeguards systems for fixed site physical protection. Another Sandia project, at Livermore, Calif., is aimed at transport protection. In the third project, the Lawrence Livermore Laboratory is working on material control models. These groups coordinate closely, and while specific models and data bases vary between projects, the general evaluation methodology being pursued is the same. The basic approach involves three distinct but interdependent steps. One involves characterization of an adversary in terms of postulated numbers, resources skills and other attributes. A second step characterizes the facility and its safeguards system, and the third step involves a description of the interaction between the adversary and the safeguards capabilities and its use to produce an evaluation of the facility's safeguards effectiveness.

Physical Protection Equipment Study

A study which completed Phase I of a continuing NRC safeguards research activity entitled, "Inspection Methods for Physical Protection," provided data and guidance for NRC evaluation of physical protection equipment. The two major products of this study are an NRC Catalog of Physical Protection Equipment (NUREG-0274) and a "Guide for Evaluation of Physical Protection Equipment" (NUREG-0273).

White-Collar Threats

The Battelle Human Affairs Research Centers reported on an exploratory study for NRC of potential threats to nuclear safeguards systems from white-collar adversaries who may use guile and deception rather than physical force. This report is entitled, "The White-Collar Challenge to Nuclear Safeguards" (NUREG-0156).

Safeguards Information System

Because of the increasing scope and complexity of the safeguards area, NRC initiated development of an Integrated Safeguards Information System (ISIS) during 1977. The general systems design is being developed under contract with Boeing Computer Systems, Inc.

Work completed at the end of the year included a definition of requirements based on an analysis of the NRC Headquarters and regional office organizations to determine current and future information needs. In addition, an analysis of the impact of information requirements on licensees and of the capabilities of NRC/DOE/IAEA and licensee systems has been performed. The current information processing and disemination capabilities will be evaluated for possible incorporation into the ISIS general design. (See also Chapter 4.)

Making Safeguards Documents Intelligible

Because licensees, inspectors, and others must have clear, uniform understanding of safeguards documents, NRC contracted with Battelle Human Affairs Research Center to explore how to improve them. This research resulted in a report, "The Structure and Drafting of Safeguards Regulatory Documents," (NUREG-0377).

Fuel Cycle and Environmental Research

The Energy Reorganization Act of 1974 provides that the NRC shall perform fuel cycle and environmental research with respect to those matters which are timely and of idrect utility in the regulatory process. NRC research in this area, accordingly, is directed toward providing the technical bases for conversion of EPA radiation protection criteria into NRC regulatory rules and guidelines; developing technical information concerning the impacts on man and the environment of the construction and operation of nuclear facilities; creating better methods, procedures and models for evaluating sites for nuclear facilities and for predicting the health, safety and environmental impacts of the installations; initiating special studies to assess the effectiveness of regulatory practices and actions, and transferring results of the research to other NRC offices for application in their regulatory functions.

Environmental Research

The environmental research program provides the technical bases for environmental impact as-

sessments and the criteria for licensing and environmental monitoring standards. The program is divided into four parts, discussed below.

Radiation Dosimetry and Health Effects. During FY 1977, a project was initiated to improve the data base for predicting adverse health effects which might result from exposure to radioactive materials in a serious accident. Results achieved in fiscal year 1977 contributed to improvements in the dosimetry models—published in 10 CFR Part 50, Appendix I—for keeping exposure to levels as low as reasonably achievable. In addition, measurements were made at four operating nuclear power stations where new construction is under way as part of an effort to determine the sources and levels of radiation to which site construction workers might be exposed. New measurements also are being made of ambient levels of radium and uranium particulates present in uranium mills in order to better assess the occupational exposure at those facilities.

Ecological Impact Studies. A series of studies has been undertaken to assess, confirm or improve methods for predicting the potential impacts of the nuclear industry on important species, ecological systems and physical environments. Studies in progress to develop and test methodologies for predicting the impact on populations of important fish include recent modeling and measurement studies to assess the impact of nuclear power stations at Indian Point, N.Y. on the population dynamics of striped bass in the Hudson River. Other studies have modeled and measured the dilution, distribution and effects of chemical antifouling agents in reactor cooling water discharges.

Socioeconomic and Regional Studies. Studies of secondary socioeconomic impacts associated with construction and operation of nuclear power stations at Plymouth, Mass., and Waterford, Conn., were undertaken in connection with environmental impact statements associated with power plant licensing. Work also continued during 1977 on the study of future electricity demand in individual States. At the end of the period, the projected demands in 15 states had been examined, and the results were being used in analyzing the need for power in the cases of the Marble Hill and Erie nuclear stations. The Energy Facilities Siting Council of the Commonwealth of Massachusetts and NRC initiated a joint project to develop a methodology for assessing energy facility siting on a regional basis.

Environmental Dispersion and Effluent Monitoring Studies. A unified transport model was developed for use in coordinated thermal, chemical, radioisotope and plume entrainment analyses to provide a reliable method for predicting dispersion of power plant discharges to lakes, rivers, estuaries and other waters. Levels of radioiodine, carbon and tritium in the vicinity of the Quad Cities nuclear station in Illinois were measured as part of a study to identify the species of radioiodine in reactor effluents and to confirm environmental assessments and predictions made in connection with power plant licensing.

Fuel Cycle Research

Fuel cycle safety research covers all aspects of fuel cycle regulation except reactor safety and safeguards. Studies are oriented toward verification of facility system performance, especially of effluent control systems which limit the release of radioactive material to the environment.

Facility Safety and Waste Management. Concentrations and distribution of radioisotopes were measured in the plant systems and effluent control systems of two operating PWR's to test the as sumptions used in establishing the as-low-as-reasonably-achievable release limits for such power stations. Similar measurements will be made in reactors of other types, especially boiling water reactors, and in fuel fabrication plants and uranium mills. Concurrent studies will be carried out to confirm the performance of specific process operations, such as reverse osmosis, which are used to limit the release of radioactivity from nuclear facilities. The resulting data will provide a basis for confirmation or revision of NRC's requirements for the desgin of effluent control systems.

Waste management research is aimed at providing an independent NRC appraisal of DOE waste management plans, alternatives, costs and benefits. This research also will develop data required to support the licensing of commercial waste disposal activities and to establish standards for future siting and use of low level burial sites and alternative disposal methods. Under an agreement with the U.S. Geological Survey the data base relating to the movement of radionuclides from licensed waste burial grounds has been expanded. Sampling now is being carried out at two sites, and will continue at these and other sites through fiscal year 1979. Analysis of the resulting data will reflect the retention capabilities of these sites and indicate whether remedial actions or modifications of practices are needed.

Transportation. In response to Public Law 24-79, NRC completeed the development and testing of a plutonium air transportable package, de-

signed to retain its contents under conditions equivalent to the crash and explosion of a high flying aircraft. Performance test standards for this package were developed by NRC and reviewed by the ACRS and a select committee of the National Academy of Science.

Other plutonium package research is underway to determine the containment required to prevent the escape of powdered plutonium oxide and other powders through fractures in vessels and vessel seals. Major test fixtures were designed and delivered during 1977 and some initial results have been obtained.

Other major research tasks are directed at providing the licensing staff with analytical methods to evaluate the performance of shipping packages. One task saw an initial version of a computer program called SCALE completed. The program is capable of performing the criticality safety, thermal and radiation shielding calculations which are required in the analysis of safety during transport. A second task involved measurements of shock and vibration experienced by shielded casks during actual truck transport.

Risk Assessment Research

Methodology Development

In order to improve the quality of future risk assessments, a significant amount of work is now being done in the area of methodology development. This work includes:

- Applying and modifying Reactor Safety Study (RSS) methodology and insights to the nuclear fuel cycle. Programs dealing with the long-term storage of high level waste in geologic media, fuel processing and the management of radioactive gases, are designed to provide information important to safety. One result of this work will be the identification of areas where resources should be directed to gain more information. Programs covering the front end of the nuclear fuel cycle and the management of low level wastes are in the planning stage.
- Checking and improving the RSS consequence model in regard to meteorology, the effect of rain, and better predictions on health effects, as well as making sensitivity studies to determine important parameters.
- Improving modeling capabilities in regard to seismic effects, fire effects, human errors, and common cause failures.

Methodology Applications

The methodology employed in the Reactor Safety Study has proven useful in a number of areas. These are discussed in the following paragraphs.

A sizeable effort is underway to examine reactors whose safety feature designs are significantly different from those of the two reactors examined in the RSS, in order to extend the applicability of engineering insights gained in the RSS and to explore their effects on predicted risks. This effort will aid in the future application of probabilistic techniques to licensing processes and risk assessments.

In-house analyses and research to assist other NRC offices continues as a major effort. Requests from the ACRS and the various NRC program offices attest to the growing recognition of the usefulness of probabilistic techniques in regulatory processes. Examples of such applications are the assessed impacts of seismically induced fires, turbine missiles, DC battery failures, reactor vessel overpressurization incidents and computerized reactor protection systems.

The FRANTIC computer code (NUREG-0193), which estimates reactor system reliability as a function of tests, maintenance and hardware characteristics, was transmitted to the Office of Nuclear Reactor Regulation (NRR) by Research Information Letter #18, November 1977. The code is used by NRR to establish improved technical specifications for testing and allowed downtimes.

The computer code OCTAVIA has been developed to calculate the failure probabilities of pressure vessels, and in particular, to assess the potential impact of overpressure transients on vessel integrity.

Studies have been performed on safety improvements achievable by alternate containment designs. Work is underway to provide a quantitative assessment of the risks from accidents equivalent to or less than the design basis accident in severity. Work also is underway to examine ways in which probabilistic techniques can be used to aid inspection and enforcement processes. And work is underway to provide a technical basis for guidance to states on emergency plans.

A program has continued for the training of NRC personnel in the techniques and applications of the Reactor Safety Study methodology. Five

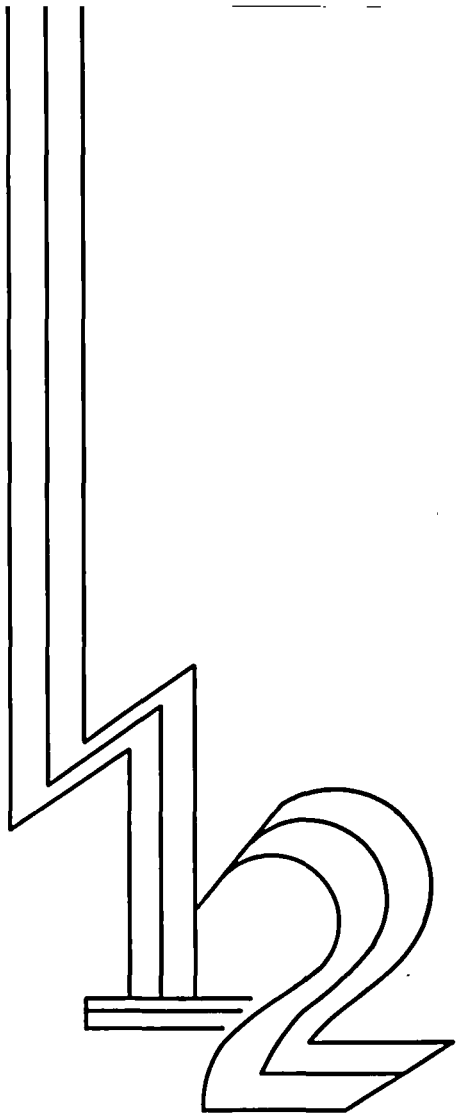
two-week courses have been conducted, and more are planned. Plans are also being developed to train NRC personnel to help develop probabilistic analysis capabilities in the work of other offices.

There is some opinion that it is necessary to define criteria for an acceptable level of risk for nuclear power plants. The quantitative determination of acceptable levels of risk on a broad socially acceptable basis for any endeavor is a formidable task. Although the Reactor Safety Study made a first step in quantitative risk assessment, the quantification of benefits and the comparison of risks and benefits in commensurate terms appear to be extraordinarily difficult tasks which may require many years of research. It has been determined that such analyses would be a useful, long-term program, and such a program is now in the process of formation.

Risk Assessment Review Group

During the report period, the Commission appointed a Risk Assessment Review Group to review the peer comments in the final Reactor Safety Study (RSS) report, to clarify the achievements and limitations of the study, and to make recommendations on the further development and use of risk assessment methodology in the regulatory process. The group consists of seven distinguished scientists under the chairmanship of Professor Harold Lewis of the University of California, Santa Barbara. The group has met monthly since August 1977 and expects to report to the Commission by June 1978. It has heard presentations from the staff of NRC and other Federal agencies, critics of the RSS, experts in risk assessment from overseas and distinguished scientists in the many disciplines involved in the RSS.

Informing The Public



As the government agency entrusted with assuring protection of the public health and safety in nuclear activities, the NRC recognizes its special responsibilities for keeping the general public informed, identifying and responding promptly to public concerns, and providing for meaningful public participation in its regulatory proceedings.

Since the regulation of nuclear energy involves vital interests of the whole society, the Commission has endeavored to follow a policy of openness and candor with the public in every possible activity of the agency. Establishing and maintaining public confidence in the independence and fairness of nuclear regulation is fundamental to its success.

The Commission took additional steps in fiscal year 1977 to enhance the openness of the regulatory process. These included the development of procedures to stimulate the free and timely flow of safety-related views and information in internal agency deliberations, routinely making public minority views on significant issues, and the opening of many meetings of the Commission to public observation under provisions of the Government in the Sunshine Act.

The Commission also widened opportunities for participation in the adjudicatory process by providing that parties in a licensing proceeding can petition the Commission for a discretionary review of an Atomic Safety and Licensing Appeal Board decision or action (see Chapter 13).

This chapter discusses the NRC's activities in informing the public of its actions and events of interest, in responding to issues of special concern raised during the year regarding nuclear regulation, and how the public participates in the regulatory process.

To keep the public informed and aware of NRC activities and policies, public announcements are issued on a daily basis to the news media by headquarters and the five regional offices. In addition, some 5,000 addressees, including industry, the scientific community and others of the general public, are sent a weekly compilation of the releases. They cover situations and issues ranging from the setting of a date for a public hearing and proposing that a licensee be fined for noncompliance with agency requirements to interruptions to power from a nuclear plant, malfunctions and incidents with safety implications. Many of the more important actions proposed or taken by the NRC also are published in the *Federal Register.*

Making Documents Available

Most NRC documents, including periodic reports on abnormal occurrences at licensed facilities and the operating and construction status of nuclear plants, are available to the public through the National Technical Information Service (NTIS), Springfield, Va., or the Government Printing Office. NRC documents are listed in Energy Research Abstracts, Department of Energy journal published by the Oak Ridge National Laboratory; Government Research Abstracts, published by NTIS; and Atomindex, published by the International Atomic Energy Agency. The NRC also issues a monthly listing of available NRC documents.

The NRC maintains its primary Public Document Room at 1717 H Street, N.W., Washington, D.C. More than 200,000 documents comprising some 5,000,000 pages are available at this main repository, and nearly 7,000 people avail themselves of its facilities each year—including about 4,000 who visit the PDR personally. These facilities include typewriters, copying services, and a microfiche reading machine. The range of documents on hand includes all material relating to licensing cases and facilities, rulemaking proceedings, research and topical reports, regulatory guides, judicial decisions, reports to Congress, and many other special periodic reports of interest to the public.

Public access to detailed information on specific nuclear plants under licensing review or already licensed to operate is afforded at more than 130 local public document rooms throughout the country. These facilities are typically located in libraries in cities and towns near proposed and actual nuclear plant sites (see Appendix 3).

Freedom of Information Act. An increasing activity in the NRC's response to public concerns involves the release of documents pursuant to requests under the Freedom of Information Act (FOIA). The FOIA requires the NRC, like other government agencies, to make available on request for public inspection and copying, any identifiable record in its possession unless the record falls within one of nine exemption categories. Exemptions include, for example, information that is classified in the interest of national security or foreign policy, trade secrets and commercial or financial information, certain investigatory files, and certain interagency and intra-agency memoranda of a "pre-decisional" nature.

While the range of documents routinely made available in the NRC's public document rooms goes well beyond FOIA requirements, the NRC has followed a liberal disclosure policy in releasing thousands of pages of documentation that could legally have been withheld under Exemption 5 of the Act. Material released as a result of FOIA requests is placed in the Headquarters Public Document Room to give full public access to documents released to any individual.

In addition, documents so released pertaining to a particular plant are furnished to the appropriate NRC local document room (see Appendix 3 for list of all local PDR's). The large volume of requests being received due to national interest in nuclear matters and the short action deadlines prescribed by the Act require a substantial amount of manpower for processing. For example, during fiscal year 1977 the NRC received 407 FOIA requests, resulting in the release of almost 70,000 pages of material. More than 21,000 man-hours were expended by agency staff in meeting these requests, about half of which were devoted to answering requests from public interest groups. For the most part, the documents requested related to technical, health, safety and safeguards matters and involved the search, retrieval and processing of information from all major NRC offices.

The Privacy Act of 1974. This Act, which became effective in 1975, provides that individuals have the right to determine the existence of agency records about themselves, to seek access to those records, and to have corrected any records which are not accurate, relevant, timely or complete for agency purposes. During fiscal year 1977, the NRC received 121 Privacy Act requests, most of which were from agency employees seeking access to personnel or security related records about themselves. As is the case with other Federal agencies, the NRC has found that there has been relatively little use of the Privacy Act by the general public.

NRC Historical Office. To assure that the public is informed about regulatory activities over the long term, an NRC Historical Office, under the direction of a Chief Historian, was established in August 1977. The central task of the Historical Office is to produce a multi-volume history of nuclear regulation and licensing in the United States. In addition the Historical Office is to provide shorter historical studies on various aspects of NRC activity, for use both within the agency and by the public.

FREE FLOW OF INFORMATION

The Commission moved positively during its third year of operation to improve the free and timely flow of safety-related information and views in internal agency deliberations as well as externally. Several events during fiscal year 1977 evoked critical publicity leading to public concern and Congressional hearings.

Among matters of special concern to the Commission, the public and the Congress were allega-

The NRC and the Energy Research and Development Administration held a joint press conference on August 4, 1977, to discuss their public reports on inventory accounting differences at facilities possessing high enriched uranium, plutonium, and uranium-233. Inventories are one mechanism used to protect against theft of weapons-usable nuclear material. At right above, Dr. Clifford V. Smith, Jr., Director of NRC's Office of Nuclear Material Safety and Safeguards answers a reporter's question during the press conference. At lower right, Dr. Ernst Volgenau, Director of NRC's Office of Inspection and Enforcement, discusses a point in more detail with a reporter following the press conference.

tions of suppression of individual views on technical issues within the NRC staff. These matters were thoroughly aired and the NRC announced formal procedures aimed at bringing any staff minority views out into the open. Another event involved the release of a Justice Department internal memorandum which alleged that the Regulatory Staff of the former Atomic Energy Commission had concealed important information from an Atomic Safety and Licensing Board in 1973. This charge was refuted by the NRC.

None of these events presented grounds for immediate corrective action involving safety at any licensed facility.

Openness of Internal Views

Because nuclear technology is complex, even experts sometimes find it difficult to understand all aspects of the issues that must be decided to determine whether there is reasonable assurance that a given activity presents no undue risk to the public health and safety. Thus, the Commission must bring to bear the widest possible range of technical competence, experience, diversity of viewpoints, and information and research results relating to safety from all available sources.

This process is seen, in particular, in the safety reviews of reactors where independent evaluations are conducted by both the NRC staff and the statutory Advisory Committee on Reactor Safeguards (ACRS) with the conclusions independently tested in public hearings by licensing boards where further views from the public can also be considered.

The basic safety evaluation work in this process is done by the NRC staff, centered in the Office of Nuclear Reactor Regulation (NRR), which represents one of the widest spectrums of technical disciplines in government. Normally, informal discussions and considerations of the issues involved among the individual members of the various sections, branches, divisions and offices concerned lead to a consensus opinion on each case.

Events during the first two years of the NRC's operations, however, prompted the Commission to develop formal procedures for resolving in a routine and open manner technical issues arising during development of a proposed staff position. (These events included the resignations of two staff members from NRR in February and September 1976 and their allegations that dissenting opinions were discouraged within the agency—see 1976 Annual Report, pages 200-201.) In this effort, the Commission stressed that it is the duty of each staff member to report any situation he believes to be unacceptable from the standpoint of public safety,

and announced its intent to bring dissenting staff views before the public.

Technical Issues Aired. The new formal procedures for resolving differences on technical issues evolved after the resignation in September 1976 of an engineer in NRR who expressed his belief that the NRC had "covered up and brushed aside" safety questions he had raised and also asserted that others on the staff agreed with him but did not speak out "for fear of harassment, reprisals or loss of their jobs." These allegations were taken with the utmost seriousness by the NRC, as well as by the Congress, the regulated industry, and the public.

As a matter of first priority, the Commission acted swiftly to identify the nature of the safety concerns and to inform the public of the Commission's judgment on those concerns and any actions taken or planned. No grounds for immediate corrective action at any licensed facility were identified by the NRC or the independent ACRS. The staff reported that the engineer had expressed dissatisfaction with "the pace and nature" of staff actions to prevent over-pressurization during start-up or shutdown in pressurized water reactors, and that his concerns had been considered, along with the contrasting views of many others, in deciding the proper course of action to deal with the problem. (See 1976 NRC Annual Report, page 201.)

As an additional measure, in November 1976 the Director of NRR urged each staff member to identify any significant technical issue he felt was receiving inadequate attention—without fear of adverse personnel action or reprisal—which could be considered at a special meeting of the ACRS. "By this means," wrote the Director of NRR, "I hope we can all come to agreement that all current technical issues of significance are being dealt with in an open, acceptable fashion."

A total of 27 issues raised by individual NRR staff members were presented to the ACRS in December, and their authors were invited to discuss their views. The Committee concluded that although many of these issues presented previously recognized problems in a new context, none was entirely new to the Committee and none represented matters warranting immediate restrictions on the operation of existing commercial nuclear power plants or a major change in regulatory requirements for licensing new reactors. At the same time, however, the ACRS expressed its belief that some of the issues represented matters requiring resolution "with a fairly high priority."

In the spring and summer of 1976, the Commission's Office of Inspector and Auditor had interviewed many employees to help NRR develop more effective policies and procedures to assure full consideration of all relevant views concerning personnel and management practices as well as the technical matters assigned to the office. An additional inquiry was conducted at the Commission's direction after the NRR engineer's resignation in September. In October, the Senate Committee on Government Operations began an investigation in the wake of the resignation in which the Committee staff interviewed many NRR staff members and examined internal investigative documents of NRC's Office of Inspector and Auditor.

The concerns expressed by individual staff members and all allegations that dissent within the staff had been discouraged or suppressed were explored at length at a hearing conducted by the Senate Government Operations Committee in December 1976, with testimony presented by the former NRC engineer, four members of the technical staff who had expressed concerns, the ACRS, and the Chairman and senior management officials of the NRC. The record of the hearing, setting forth fully the positions of all concerned as well as new procedures adopted by the NRC, may be found in local NRC public document rooms located throughout the country (see Appendix 3 for addresses).

(Allegations by another NRC employee regarding the availability to and within the NRC of important safeguards-related information are discussed in Chapter 4.)

Policy on Dissent. It is the Commission's conviction that the free flow of information and viewpoints is the foundation of sound regulation. Three successive Chairmen have spearheaded efforts to establish and maintain a climate conducive to this, including an "open door" policy extending up through the management chain to the Commissioners' offices. It has been stressed that, whether or not an individual judgment on a safety matter prevails—as it cannot always be expected to do—it is not only a staff member's right, but his duty to apprise appropriate management of any situation he deems unacceptable from the standpoint of protecting the public.

In November 1976 the Office of Nuclear Reactor Regulation for the first time established formal procedures for managing disagreements on technical issues that may arise during the development of staff positions. While the usual informal interaction and discussions among the individual staff members concerned will continue to take place in developing a collegial judgment on the matter at hand, any continuing disagreement will be taken routinely through successively higher levels of NRR management in efforts to resolve it.

If the disagreement is not resolved, and the dissenting staff member considers the matter significant, the dissent and its basis will be sent along

with the main staff position and its rationale to the ACRS and the Public Document Room. The information will be available, as appropriate, to NRC licensing boards and all parties to proceedings in which the technical matter at issue is involved.

The importance of treating disagreements in a routine, rational and professional way was strongly underlined by Chairman Hendrie in remarks to NRC management in September 1977 which were distributed to each member of the staff. Noting that dissent on regulatory matters should not be taken as disloyalty to the organization or in any personal context, he stated, "I think we have to be able to live easily, comfortably, and routinely with disagreements and letting people have their say." While the need for additional appearances by staff at ACRS meetings or hearings to discuss individual views may create an additional workload, the Chairman added, "It is an overhead burden that is, I believe, unavoidable in our affairs.... We must accommodate all this in a very routine way. It means that on both sides, from the staff member who feels strongly enough about his point of view that he would like to have it go forward and be reflected in the papers of the case, to his supervisor and on up the management chain, there must be a very professional approach. The key word is *professional* behavior in trying to deal reasonably with a set of procedures like this. I will expect staff members to act professionally and I will expect all the managers, above and below, to act professionally."

Promptly Informing the Boards

During the year the Commission took action to assure prompt transmittal to licensing boards of new information discovered by the NRC staff which might have safety significance relative to proceedings in the board's jurisdiction—even before the staff has evaluated the information.

The traditional practice of the NRC staff, and the Regulatory Staff of the Atomic Energy Commission before it, had been to evaluate the safety significance of a newly reported matter before sending it to the appropriate licensing boards. The rationale for this was that an unevaluated report would be likely to inject confusion in a proceeding. This practice, however, resulted in a delay in notifying an Atomic Safety and Licensing Board of discovery of a geologic fault at the North Anna nuclear plant site in Virginia in 1973. The delay was criticized in minority comments in the decision of that board, published in September 1975; again in minority comments in the decision of an appeal board that reviewed the initial decision, published in April 1976; and in the Nuclear Regulatory Commission's decision on the matter in November 1976 which also was published.

Fault Discovery in 1973. On May 17, 1973, the Virginia Electric & Power Co. (VEPCO) informed the AEC Regulatory Staff that a "chlorite seam" had been discovered during site preparation for North Anna Nuclear Power Station Units 3 and 4 which the utility proposed to build near Units 1 and 2, under construction since 1971. (A chlorite seam is a type of mineral formation frequently found in East Coast excavations which sometimes indicates possible faulting.) The staff arranged for a site visit in June when trenching, then underway, would better expose and determine the extent of the seam.

On June 18, 1973, Regulatory Staff members, accompanied by a geologist from the U.S. Geological Survey which had acted as consultant to the AEC in previous evaluations of the North Anna site, conducted an inspection which revealed that the chlorite seam was associated with a zone of geological faults of undetermined age. The AEC project manager issued a report on the site visit, including preliminary conclusions, on June 21, 1973, which was placed in the Public Document Rooms at AEC headquarters in Washington, D.C., and at Louisa, Va.

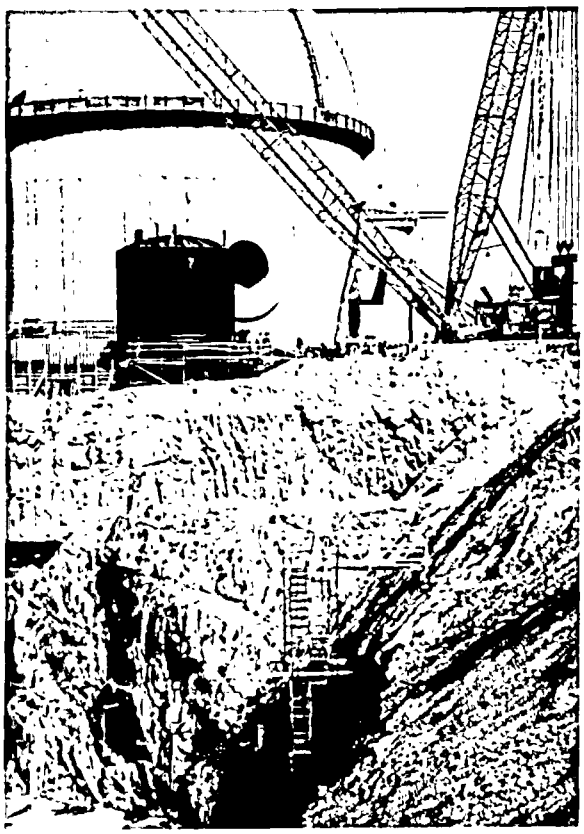
The AEC staff also decided that its geologist should set forth the preliminary staff conclusions regarding the safety significance of the fault in the form of an affidavit for presentation to the licensing board. This was provided to the board on August 3, 1973.

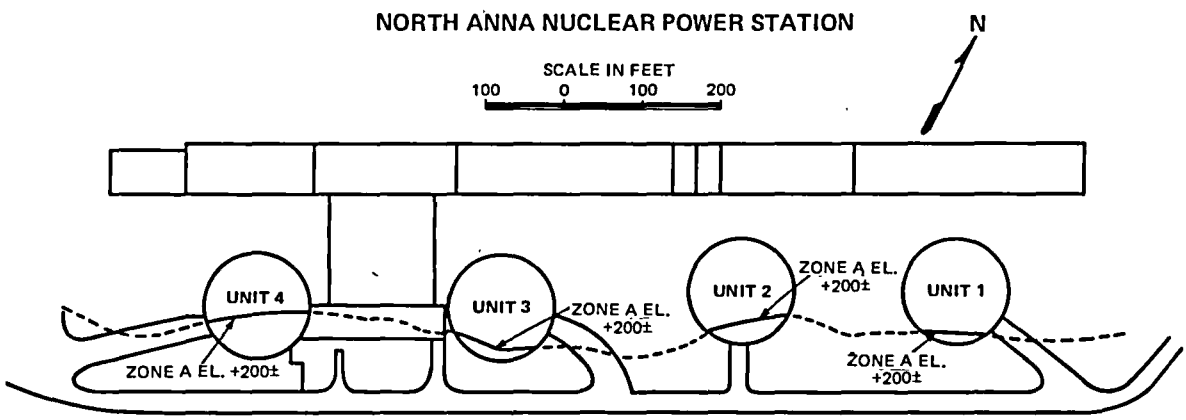
Board Actions. After discovery of the fault, the licensing board conducted extensive hearings on the question of whether the facilities could be built and operated safetly. Experts from the AEC, the U.S. Geological Survey and the Virginia Department of Mineral Resources testified that the fault was not "capable" (inactive and not of safety significance), and the board agreed. This conclusion was affirmed by the U.S. Court of Appeals for the D.C. Circuit. The Court concluded, "the evidence in this case establishes that the fault is not 'capable' and has not moved for at least 500,000 years."

The AEC issued construction permits for North Anna Units 3 and 4 in July 1974.

The AEC also ordered, in May 1974, a separate hearing on allegations against VEPCO that it had made material false statements concerning seismic conditions at the North Anna site. The licensing board's decision of September 1975 imposed a $60,000 penalty on the utility. An appeal board review of that decision in 1976 reduced the penalty to $17,500.

NRC Action. The Nuclear Regulatory Commission reviewed the appeal board's decision and, on November 12, 1976, increased the fine on VEPCO





Chlorite seams observed in 1970-71 in connection with construction of Units 1 and 2 of the North Anna Nuclear Power Station were found in 1973 to continue into the site of Units 3 and 4. Some of the seams were later determined to be faults in the excavations for Units 3 and 4. The photo at left shows the excavation for the Unit 3 containment building. At right one of the chlorite seams, which is a fault, can be seen in the wall of the containment excavation for Unit 2. The drawing below the photos traces the path of the fault of primary concern—Zone A—through the site of the four containment buildings at elevation +200±. The fault was determined to be "not capable," that is, inactive and not of safety significance.

to $32,500. (VEPCO has appealed this decision in the U.S. Court of Appeals for the Fourth Circuit; see "Commission Review" in Chapter 13.) In its decision the Commission stated, in reference to the staff's 1973 delay in informing the licensing board of VEPCO's report that it had discovered a chlorite seam:

> "We find the staff's delay in informing the Board and the explanations given for that delay unacceptable. The Licensing Board, the parties and the public have a right to be promptly informed of a discovery of this magnitude, before staff evaluation of that discovery and regardless of whether the record is technically open. No other policy is consistent with the staff's obligation to help the Commission fulfill its statutory mandate."

The Commission's decision also took note of the NRC staff's description of its current practice, "to make every effort promptly to report information of this kind to the affected licensing boards and parties, and then to provide staff evaluation of the information reported when it is completed." The Commission stated:

> "We believe this statement of current practice correctly reflects the staff's obligation, and the staff is hereby directed to insure the practice is fully enforced."

Justice Department Memorandum. An internal memorandum released in October 1977 by the Department of Justice in response to a Freedom of Information Act request made serious charges against the former AEC Regulatory Staff (now NRC) regarding its handling of the North Anna fault discovery. Allegations in the memorandum, dated May 11, 1977, and prepared by a Justice Department employee investigating the possibility of criminal prosecution against VEPCO at the request of an intervenor in the licensing proceedings, received wide publicity and prompted a Congressional hearing.

Going back to the 1973 discovery of the chlorite seam at the North Anna site and citing the staff's delay in formally notifying the AEC licensing board until the staff had evaluated the significance of the event—all of which had been made a matter of public record on several occasions—the author of the memorandum charged the staff with "concealing" discovery of the geologic fault from the board and "demonstrating pervasive bias" against public scrutiny.

These charges were rejected by the NRC as unfair and unsupported at a hearing before a subcommittee of the Senate Committee on Environment and Public Works on October 13, 1977. NRC testimony acknowledged an obsolete staff practice in not promptly notifying the licensing board—a practice that had been publicly judged unacceptable by the Nuclear Regulatory Commission and corrected. Both Congress and the NRC are continuing to investigate certain aspects of this matter.

CONGRESSIONAL OVERSIGHT

Since the inception of civilian control of nuclear energy, the Congress has exercised close surveillance over nuclear affairs. Until 1977, the primary legislative and oversight role had been assigned to the Joint Committee on Atomic Energy (JCAE), to which all legislative proposals pertaining to nuclear matters were referred. Specific provisions in the Atomic Energy Act of 1954, as amended, required special and periodic reports to that Committee from the Commission, and that the NRC "keep the Joint Committee fully and currently informed" on all of its activities. Legislation abolishing the JCAE was signed into law September 20, 1977.

In reorganizing their committee systems during 1977, both Houses of the Ninety-Fifth Congress redistributed legislative jurisdiction and oversight authority reposing in the JCAE to several committees in both the House and the Senate.

The legislation abolishing the JCAE requires the Commission to keep committees having jurisdiction over its functions under rules of the Senate and the House, "fully and currently informed" regarding NRC activities. Consequently, materials that were routinely sent to the JCAE in the past and information on significant developments are forwarded to the appropriate committees.

Public concern over nuclear issues has been reflected in an increasing number of Congressional hearings involving the NRC. During fiscal year 1977, all of the Commissioners, the Executive Director for Operations and many of the senior staff participated one or more times in 32 days of hearings conducted by either the full committee or subcommittees of 14 Congressional committees. The following list shows the date, committee and subject of each hearing:

12/13/76—Senate Committee on Government Operations (Adequacy of Consideration of Dissident Staff Views in NRC Licensing Reviews)

2/17/77—House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment (NRC Authorization for Fiscal Year 1978)

3/ 8/77—House Committee on Appropriations, Subcommittee on Public Works (NRC Appropriations for Fiscal Year 1978)

3/ 8/77—House Committee on Government Operations, Subcommittee on Energy, Environment and Natural Resources (West Valley Fuel Reprocessing Facility)

3/19/77—Senate Committee on Environment and Public Works (Overview of NRC Budget)

3/30/77—House Committee on the Judiciary, Subcommittee on Administrative Law and Governmental Relations (Public Funding of Intervenors in Federal Agency Proceedings)

3/30/77—Senate Committee on Environment
4/ 1/77 and Public Works, Subcommittee on
4/ 4/77 Nuclear Regulation (NRC Authorization for Fiscal Year 1978)

4/ 8/77—Senate Committee on Governmental Affairs (Nuclear Waste Management and Federal Energy Reorganization)

4/21/77—House Committee on Public Works and Transportation, Subcommittee on Investigations and Review (NRC Interface with EPA in Implementation of Clean Water Act)

4/29/77—House Committee on Interstate and
5/ 2/77 Foreign Commerce, Subcommittee on Energy and Power (NRC Authorization for Fiscal Year 1978)

5/ 5/77—Senate Committee on Appropriations, Subcommittee on Public Works (NRC Appropriations for Fiscal Year 1978)

5/ 6/77—Senate Committee on Governmental Affairs, Subcommittee on Energy, Nuclear Proliferation and Federal Services (Nuclear Proliferation Legislation)

5/16/77—House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment (Nuclear Waste Management)

5/19/77—House Committee on Interstate and Foreign Commerce, Subcommittee on Energy and Power (Status of Nuclear Plants/Licensing Process)

5/23/77—Senate Committee on Foreign Relations, Subcommittee on Arms Control, Oceans and the International Environment (Nuclear Non-Proliferation Legislation)

5/26/77—House Committee on International Relations, Subcommittee on International Security and Scientific Affairs and Subcommittee on International Economic Policy and Trade (Nuclear Non-Proliferation Legislation)

6/ 9/77—House Committee on Science and Technology, Subcommittee on the Environment and the Atmosphere (Environmental, Health and Safety Aspects of President's Energy Plan)

6/13/77—House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment (Licensing Reform)

6/15/77—House Committee on Science and Technology, Subcommittee on Environment and the Atmosphere (West Valley/Decommissioning Costs)

6/28/77—Senate Committee on Commerce, Science and Technology, Subcommittee on Science, Technology and Space (Radiation Exposure Hazards)

6/30/77—House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment (Diablo Canyon Status)

7/11/77—Senate Committee on Environment and Public Works, Subcommittee on Nuclear Regulation (Proposed Clinch River Breeder Reactor)

7/12/77—House Committee on International Relations, Subcommittee on Africa (Export License Review Procedures)

7/29/77—House Committee on Interior and Insular Affairs, Subcommittee on Energy and the Environment (Safeguards Concerns)

8/ 1/77—House Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations (Storage of Spent Fuel)

8/ 8/77—House Committee on Interstate and Foreign Commerce, Subcommittee on Energy and Power (Strategic Special Nuclear Material Inventory Differences)

9/13/77—House Committee on Government Operations, Subcommittee on Environment, Energy and Natural Resources (Economics of Nuclear Energy: Decommissioning Costs)

OPPORTUNITIES FOR FORMAL PUBLIC HEARINGS IN NRC PROCEEDINGS

Type of Proceeding	*Opportunity for Hearing*	*Purpose of Hearing*	*Criteria for Granting Hearing*	*Unit Deciding To Hold Hearing*
RULEMAKING Proceeding	Prior to issuance of final rule.	To determine whether a proposed rule should be adopted.	At the discretion of the Commission	Commission (which may decide to hold informal or "hybrid" hearing).
MANUFACTURING LICENSE Proceeding*	Mandatory hearing prior to issuance of manufacturing license.	To determine whether a license authorizing the manufacture of a production or utilization facility of a particular design should be issued.	Mandatory hearing on safety and environmental issues.	Mandatory hearing before Licensing Board.
CONSTRUCTION PERMIT Proceeding*	Mandatory hearing prior to issuance of construction permit.	To determine whether a particular production or utilization facility should be constructed at a particular site and, where indicated, to resolve adverse antitrust matters.	Mandatory hearing on safety and environmental issues; on antitrust matters, upon request by interested persons or Attorney General or at discretion of Commission.	Mandatory hearing before Licensing Board.
OPERATING LICENSE Proceeding*	Prior to issuance of operating license.	To determine whether a particular production or utilization facility should be permitted to operate; antitrust review where significant changes have occurred since previous antitrust review.	Request by any person whose interest may be affected by proceeding who raises genuine issue of material fact, and at discretion of Commission; in addition, in the case of antitrust review, there must be determination by the Commission that significant changes have occurred.	Commission, Appeal Board or Licensing Board, as appropriate.
MATERIALS LICENSE Proceeding	Either prior to or after issuance of materials license.	To determine whether a particular materials license should be issued or remain in effect.	Request by any person whose interest may be affected by proceeding and at discretion of Commission.	Commission, Appeal Board, Licensing Board or Administrative Law Judge, as appropriate.
SHOW CAUSE Proceeding (to modify, suspend or revoke a license or for other appropriate action).	Prior to issuance of final Commission Order.	To determine appropriate action to be taken.	Upon demand by person cited in Show Cause Order or by request of other persons whose interest may be affected, upon making requisite factual showing.	Commission

* An opportunity for hearing is also provided prior to issuance of amendments to manufacturing licenses, construction permits and operating licenses which involve significant hazards considerations. If there are no significant hazards considerations, opportunity for hearing may be provided after such amendments are issued.

8/14/77—Senate Committee on Energy and Natural Resources, Subcommittee on Energy Research and Development (Nuclear Non-Proliferation Legislation)

9/27/77—House Committee on Science and Technology, Subcommittee on Environment and the Atmosphere (Environmental and Health Research Related to Nuclear Fuel Cycle)

FORMAL PUBLIC PARTICIPATION

Besides keeping the public informed through its communications program, the NRC also provides for active public participation in proceedings leading to licensing decisions. It is mandatory that public hearings on each application for a construction permit be conducted by an Atomic Safety and Licensing Board (see below). Notice of such a hearing is published well in advance in the *Federal Register* and posted in a public document room near the proposed construction site, together with a copy of the full application. Local newspapers also carry notice of the hearing. Interested persons or groups are invited to petition the licensing board for the right to participate in the hearing by: (1) submitting a written statement at the hearing; (2) making an oral presentation at the hearing; or (3) becoming an "intervenor" in the proceeding with full participatory rights, including cross-examination of other participants. Should the licensing board disallow a petition, appeal may be made to the Atomic Safety and Licensing Appeal Board (see below) by the petitioner. In some instances, the Commission may rule on a petition. Ultimately a petitioner may seek a ruling in the appropriate Federal Court of Appeals and the Supreme Court of the United States.

These same rights and procedures apply to hearings of a Licensing Board on an application for an operating license, with the difference that such hearings are not mandatory and need not take place unless requested by one or more interested parties.

To facilitate public participation, hearings of the licensing board, with rare exceptions, are held in communities near each proposed facility site. Intervenors involved in a hearing participate fully in prehearing conferences with other interested parties for the exchange of data and identification of issues in contention.

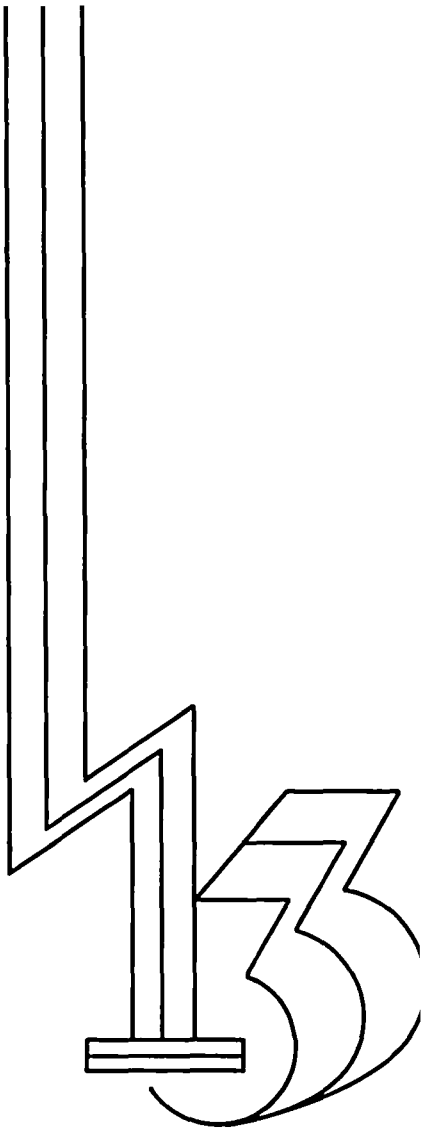
Government in the Sunshine Act

The Government in the Sunshine Act became law on September 13, 1976 and became effective on March 12, 1977. The Act regulates the conduct of meetings of certain governmental bodies like the NRC whose decisions and actions are determined by a commission or board of several members. The enactment of the Law (5 USC 552b) had the effect within the NRC of facilitating a process, adopted earlier by the Commission, to make its official deliberative sessions more accessible to public observation. The Sunshine Act specifies how the Commission should notify the public of its meetings and the procedures it must follow in scheduling such meetings. The Act provides that all Commission meetings must be open to the public unless the Commission determines that one of the Act's 10 exemptions applies. The exemptions are designed to protect discussion of certain kinds of material which Congress has determined should not be discussed in open session, such as classified information, proprietary commercial information, items involving personal privacy, and issues in pending litigation.

The Commission's regulations implementing the Sunshine Act (10 CFR Part 9) detail the Commission's procedures for operating under the Act. The regulations specify that advance notice of meetings be given to the public by publishing notices in the *Federal Register*, putting notices in the Commission's Public Document Room, maintaining a special mailing list for such notices, and submitting the notices to several newspapers for publication. The regulations also outline the procedures the Commission follows in deciding whether to close a meeting, what records of its meetings are kept, and similar administrative details. In addition, the Commission has expanded its conference room and has installed audio and visual systems to accommodate the public when the conference room is filled to capacity.

Between the day the Act went into effect, March 12, 1977, and the end of the fiscal year, the Commission discussed many of its agenda items in sessions open to the public. Details as to the precise nature and numbers of open and closed Commission meetings will be presented to the Congress in a separate report, as required by 5 USC 552 (b)(j). The Commission strongly supports the principles of open government enunciated in the Sunshine Act and will continue to balance this goal with the need to protect certain information in the best interests of the public.

Proceedings and Litigation



Whether as petitioners, intervenors, initiators of appeals and reviews, witnesses, or interested citizens, members of the general public are intimately and influentially involved in the judicial and quasi-judicial proceedings of the NRC. The following are accounts of the adjudicatory activity during the report period of the Atomic Safety and Licensing Boards, the Atomic Safety and Licensing Appeal Boards, the Commission, and the NRC as a party to Federal court actions.

ATOMIC SAFETY AND LICENSING BOARDS

Public participation in the licensing process reaches fruition in proceedings conducted by Atomic Safety and Licensing Boards, for it is here that members of the public may place their concerns, information and conclusions regarding a particular licensing action on the record before an independent tribunal which will take these matters into account in rendering a decision.

The Atomic Energy Act of 1954 requires that no construction permit for a nuclear power plant and related facilities be issued until a public hearing has been held on the application. An independent Atomic Safety and Licensing Board conducts this hearing. This board is authorized to issue a decision on the application (known as an "Initial Decision") which, subject to the NRC's review and appellate procedures, may become the final NRC decision. The notice of hearing inviting public participation is published shortly after receipt of a construction permit application, thereby notifying the public of the hearing process at an early stage. Commencement of the hearing itself must await the completion of the NRC staff's safety or environmental review. (Ample notice of the proceeding is also given to the appropriate State and local agencies, as well as other interested groups.)

Once a nuclear power plant or related facility has been constructed under a construction permit issued by NRC, the Atomic Energy Act requires that a second opportunity for hearing be provided before a license may be issued to operate the facility. A similar opportunity is provided before certain license amendments may be issued. Thus, within certain legal requirements, members of the public, State and local agencies, and other interested groups may cause a hearing to be held at these stages of the licensing process. Public participation is also invited in proceedings instituted by the NRC staff.

The Atomic Energy Act also requires that, prior to the issuance of a construction permit for a nuclear power plant or related facility, a determination be made by NRC as to whether the activities licensed by it would create or maintain a situation inconsistent with the antitrust laws, and that the NRC take appropriate action should the determination be affirmative. While the procedures laid down by the Act for this review are more complex than those outlined for other reviews, a similar opportunity to trigger a hearing before a licensing board is provided to persons affected by a situation allegedly inconsistent with the antitrust laws.

Each of these boards consists of three members drawn from the membership of the Atomic Safety and Licensing Board Panel—a body of legal, technical, environmental and other experts appointed by the Commission. As of September 30, 1977, the Panel included 18 full-time and 44 part-time members. Of these 62 members, 20 are lawyers, 19 environmental scientists, 12 engineers, eight physicists, two economists and one chemist. (See Appendix 2 for names of members.) The Commission appoints members to the Panel based upon recognized experience, achievement, and independence in the appointee's field of endeavor. In assigning individuals to a given licensing board, consideration is given to the kinds of issues involved in the proceeding before that board. A hearing on a particular application may be divided into two phases—one concerning the health and safety, and common defense and security aspects of the application, as required by the Atomic Energy Act; and the other concerned with the environmental considerations required by the National Environmental Policy Act. Separate Initial Decisions covering these matters may be issued. (Antitrust problems in an application are heard and decided by a board of three antitrust experts.)

The increasing complexity of the issues raised in the licensing process is reflected in the published orders of the boards. During the report period, these orders have dealt with such matters as whether a regional Environmental Impact Statement is required covering all nuclear plants proposed for construction in the Pacific Northwest; whether the civil rights statutes have some bearing on an application for a construction permit; whether a licensing board has the authority to rule on antitrust matters raised at a time when neither a construction permit application nor operating license application is pending; whether it is necessary that the terms of a fuel supply contract be disclosed on the record of a hearing; whether all co-owners of a facility must be co-applicants; and whether the Commission has jurisdiction under NEPA to perform an environmental review of activities proposed by another Federal agency.

The licensing process is also procedurally complex in that a number of decisions may be called for prior to construction and eventual operation of a nuclear power plant. Thus, a prospective licensee may apply for a Limited Work Authorization (LWA), by which he may gain an early start on plant construction (at his own risk, with no guarantee the construction permit will later be authorized), but the LWA will not be issued until a favorable Initial Decision on environmental and site-suitability issues is made. During the report period, some applicants sought exemption from LWA prerequisites in order to start construction work even earlier than the regular LWA process allows for, and these petitions required Initial Decisions by the licensing board. Two decisions were issued on such requests during fiscal year 1977. In addition, three decisions were issued covering environmental and site-suitability matters leading to LWAs. These decisions involved five nuclear units.

An applicant who has received an LWA and carried out the authorized construction work may proceed to certain structural work, still as his own risk, under a second authorization (LWA-2), if such is approved by the licensing board. Two such decisions were rendered during the report period, affecting seven units. In addition, one of the original LWA decisions also authorized an LWA-2 for one unit.

Complete construction of the plant may be carried out only after a licensing board has made favorable findings in regard to radiological health and safety matters. Five such decisions were issued during the report period, covering nine units. One of these decisions also dealt with environmental matters. There were no operating license decisions issued during the period.

The NRC adopted regulations in fiscal year 1977 under which applicants may obtain early site review and approval of proposed sites for nuclear generating stations, and these reviews may also entail a hearing before a licensing board. If the board approves the site, the approval would remain in effect for a period of five years, barring any substantive change in circumstances.

A second joint NRC-State hearing was begun during the report period, concerning the proposed Greene County Nuclear Station in New York. The first such joint hearing, involving the Douglas Point Station in Maryland (discussed in the 1976 NRC Annual Report, page 207), was delayed, partly as a result of the applicant's deferrals in schedule.

Antitrust considerations were dealt with in two Initial Decisions during this period. These decisions involved the Davis-Besse/Perry and Farley plants. Both decisions were reached after a full scale antitrust hearing, and both found a situation inconsistent with the antitrust laws, requiring the imposi-

tion of appropriate license conditions. (The decisions were under appeal at the close of the report period.)

ATOMIC SAFETY AND LICENSING APPEAL BOARDS

Continuing a practice begun in 1969 by the Atomic Energy Commission and similarly followed by the Nuclear Regulatory Commission, three-member Atomic Safety and Licensing Appeal Boards are authorized to exercise the Commission's authority and perform its review functions in facility licensing proceedings. Since the establishment in 1972 of the Atomic Safety and Licensing Appeal Panel, board members for individual proceedings have been selected from that Panel by its Chairman (or, in his absence, its Vice-Chairman). (See Appendix 2 for current membership of the Panel.)

Appeal boards entertain appeals from the Initial Decisions of licensing boards and certain licensing board orders respecting intervention. Appeal boards also review Initial Decisions on their own initiative and, in limited circumstances, consider interlocutory questions posed or rulings referred by a licensing board. The appeal board is the highest level within the Nuclear Regulatory Commission at which a party may seek administrative review as a matter of right. However, effective June 1, 1977, parties have been permitted to seek discretionary Commission review of certain types of questions decided by appeal boards. The Commission also may consider an appeal board action on its own initiative. Where there is no Commission review, the decision of an appeal board represents the final order of the Nuclear Regulatory Commission; it is then subject to review in the Federal courts.

During fiscal year 1977, appeal boards completed or undertook review of 268 matters. They produced 85 published decisions (numbered ALAB-350 through ALAB-434), which appeared in the NRC's monthly publication, *Nuclear Regulatory Commission Issuances*. The monthly issues are bound into hard-backed volumes; during 1977, Volumes 3 and 4 (covering issues from January through June and July through December 1976, respectively) were released. Brief summaries of appeal board (as well as Commission and licensing board) opinions, headnotes of significant legal issues, and references to important technical questions which appear with the published opinions were prepared under the direction of the Appeal Panel staff.

During the report period appeal boards rendered a number of decisions of significance to reactor licensing. Attracting perhaps the most public attention and comment were several opinions in the *Seabrook* (New Hampshire) proceeding. At the close of fiscal year 1976, the appeal board had issued a decision which suspended outstanding construction permits for this facility pending the development of additional fuel-cycle information. On the basis of new information, the Commission later vacated that decision. In January 1977, the appeal board again suspended the construction permits, this time on the basis of a decision of the Environmental Protection Agency (EPA) which cast doubt on the type of cooling system that the facility might employ. The Commission upheld this suspension. Thereafter, following EPA's reversal of its earlier decision and approval of a particular cooling system, the appeal board reinstated the construction permits. At the same time, it issued a lengthy ruling on the various safety and environmental issues with which it had not dealt earlier—including the financial qualifications of the applicants, seismic and geologic matters, alternate sites and energy sources, the routing of transmission lines, and other site considerations. (The *Seabrook* Appeal Board, in conjunction with the board assigned to the *New England Power Co.* (Rhode Island) proceeding, had determined earlier that, under current regulations, applicants have no responsibility to provide particular emergency planning measures (such as evacuation) for protecting persons in the areas outside a facility's low population zone.)

Appeal boards issued several other decisions on important health and safety questions. The appeal board in the *Indian Point* (New York) proceeding issued several orders and completed its evidentiary hearings on the seismic issues which it had been directed to address by the Commission; shortly after the close of the fiscal year, that board issued a decision disposing of the various questions before it. In the *Prairie Island* (Minnesota) proceeding, in which it had earlier held evidentiary hearings and issued a decision concerning the integrity of the facility's steam generator tubes, the board issued a supplemental decision dealing primarily with the phenomenon of "denting" and its effect on steam generator tube integrity. In the *Hope Creek* (New Jersey) proceeding, the appeal board analyzed the probabilities and potential effects of liquified natural gas and liquified petroleum gas accidents at the facility. And in a *Diablo Canyon* (California) opinion, the board explored the extent to which plant security plans may be made available to intervenors in licensing proceedings and set forth standards to govern such disclosures.

Among the environmental issues considered by appeal boards, several besides those discussed in the *Seabrook* proceeding are noteworthy. In the *Hartsville* (Tennessee) proceeding, the appeal board

expanded upon several earlier rulings and indicated the need in the future for analyzing the health effects of alternative energy fuel cycles and comparing them with effects of the nuclear fuel cycle. In that same proceeding, as well as in *Seabrook* and *Catawba* (South Carolina facility), the appeal boards provided additional guidance with respect to consideration of the "need for power" issue. In the *Indian Point* proceeding, the appeal board considered various license conditions bearing upon the installation of cooling towers at that facility and the ability of a local governmental body to impose conditions with respect to those towers.

In several proceedings the boards considered the suspension of permits pending development by the Commission of a revised rule quantifying the environmental effects of reprocessing and waste disposal. And in 13 different proceedings, appeal boards ruled on the effect of the values contained in that revised rule on the cost-benefit balances for the particular reactors under review.

In the area of the Commission's antitrust responsibilities, appeal boards issued several opinions during fiscal year 1977 dealing with the scope of NRC antitrust jurisdiction in particular factual contexts. Specifically, appeal boards considered the extent to which antitrust review could be initiated for facilities already in operation (*St. Lucie 1* and *Turkey Point* (Florida) proceedings), for facilities which had received a construction permit but for which no operating license was yet sought (*South Texas* proceeding), and for facilities where a petition for antitrust review was filed on an untimely basis but prior to completion of the construction permit proceeding *(St. Lucie 2).* And, on December 30, 1977, the appeal board in the *Midland* (Michigan) antitrust proceeding rendered the first appellate decision on the merits of the antitrust aspects of an application; reversing a licensing board, it found that activities under the license would maintain a situation inconsistent with the antitrust laws, and it remanded the case to the licensing board for the determination of appropriate license conditions to remedy that situation.

Finally, appeal boards considered a host of procedural questions, many with significant impact on licensing proceedings generally. Several opinions applied criteria enunciated by the Commission and earlier by appeal boards concerning the standing of parties to intervene in NRC proceedings. The appeal board in the *Clinch River* (Tennessee) proceeding spelled out the rights of interested States to advance on behalf of their constituent communities certain issues bearing upon a plant's socioeconomic impact on such communities. The appeal board in the *Midland* proceeding spelled out rules governing the sequestration of witnesses at NRC hearings. In *Greenwood* (Michigan), the appeal board permitted an appeal from a licensing board's protracted failure to take action on an intervention request. Several appeal board decisions treated such subjects as the limited circumstances in which review of interlocutory orders will be permitted, and requirements for stating exceptions and filing briefs before an appeal board.

COMMISSION REVIEW

Review of Appeal Board Actions

On June 1, 1977, the Commission adopted a new rule (10 CFR 2.786) to provide a procedure for parties to petition the Commission for a discretionary review of a decision or action of an Atomic Safety and Licensing Appeal Board. Under previous rules, a party to an adjudicatory proceeding had no formal right to call for Commission review of the result of the proceeding. The new rule provides that a party may file a petition for review with the Commission within 15 days after the appeal board decision is rendered. Any other party may, within 10 days after service of a petition for review, file an answer opposing Commission review. No further pleadings are authorized. If the Commission does not grant the petition, in whole or in part, within 20 days after the petition is filed, and the time for consideration is not extended, the petition is deemed denied. Acting under the new rule, the Commission during 1977 granted petitions for review in two matters, *Public Service Company of New Hampshire* (Seabrook Station), and *Consolidated Edison of New York, Inc.* (Indian Point Station, Unit No. 2).

Significant Decisions

During the fiscal year, the Commission issued several significant decisions. One of these, *In the Matter of Nuclear Regulatory Commission* (Licensees Authorized to Possess or Transport Strategic Quantities of Special Nuclear Materials), CLI-77-3, 5 NRC 16, involved Commission review of a staff decision made under 10 CFR 2.206 not to issue an order to show cause, as sought by the Natural Resources Defense Council, Inc. in a petition. The NRDC requested that the NRC either immediately implement emergency safeguards measures to protect strategic special nuclear material ("SSNM") or revoke licenses to hold such

Three members of the Nuclear Regulatory Commission visited the site of the Seabrook Nuclear Power Station in New Hampshire as part of their consideration of appeals concerning the construction permits for the two plants. Members of the Commission who visited the site were Peter Bradford, third from left; Richard Kennedy, fourth from left; and Victor Gilinsky, far right. (World Wide Photo)

material. While recognizing the prudence of upgrading safeguards in this area, the Commission concluded that existing safeguards programs are adequate to provide reasonable assurance that current activities of licensees are not inimical to the common defense and security and that the staff decision not to take the emergency action requested was not an abuse of discretion.

Other major decisions involved reviews of appeal board actions:

North Anna Power Station. In November 1976, the Commission rendered its decision in the first case in which a licensee was charged with violation of Section 186 of the Atomic Energy Act for making "material false statements" in connection with a license application. An intervenor had questioned whether Virginia Electric and Power Company (VEPCO), in seeking its construction permits, had supplied the Commission with inaccurate information concerning geologic and seismic conditions at its North Anna (Virginia) site. Most of these alleged "material false statements" were affirmative representations in VEPCO's submissions to the Commission. Three consisted of omissions, or complete failures to provide information.

The Commission weighed the meanings of "material," "false" and "statements," and, with respect to the first two words, upheld the findings of the appeal board, that a statement is "material" if it has a natural tendency or capability to influence the decision of the person or body to whom it is submitted, and "false" even if it is made without knowledge of its falsity. Contrary to the appeal board, however, the Commission determined that a "statement" is not limited to affirmative represen-

tations, and that failures to provide information can be treated as false statements. Based on this finding, the Commission held that additional penalties should be imposed with respect to the three failures to provide information.

Pebble Springs. An intervenor group, and six of its members, sought to intervene in the Pebble Springs (Oregon) construction permit proceeding solely on the basis that the members were customers of Pacific Power and Light Company, one of the joint applicants. Acting on a certification from the appeal board, the Commission held that, in domestic licensing proceedings, intervention as a matter of right is governed by contemporaneous judicial standing doctrines which require a petitioner to allege both (1) an injury that has occurred or will probably result from the action involved to the person asserting it, and (2) an interest arguably within the zone of interests protected by the statute. In addition, however, in view of the "important role of public participation," the Commission held that boards may, under specific guidelines, as a matter of discretion grant intervention to petitioners who are not entitled to intervention as a matter of right but who may, nevertheless, make some contribution to the proceeding.

Wolf Creek. Applicants had requested a determination that they could legally proceed with construction of offsite portions of a railroad spur and plant access road for the Wolf Creek (Kansas) facility prior to issuance of a Limited Work Authorization and without Commission approval. Denying this request, the Commission held that the NRC must consider, under the National Environmental Policy Act, the environmental impacts of activities attributable to the operation of nuclear power plants, even if they take place "offsite," and where necessary may impose license conditions to minimize those impacts.

Seabrook. In March, the Commission affirmed an appeal board suspension of the construction permits for the controversial Seabrook (New Hampshire) plant. By statute, through its controls over thermal discharges, the Environmental Protection Agency (EPA) has the leading role in determining the type of cooling system to be used at a nuclear power plant. In an "initial determination," the EPA regional administrator approved the use of a "once-through" cooling system at Seabrook. With the expectation that this system would be finally approved by EPA, the NRC licensing board thereafter concluded that the NEPA cost-benefit analysis favored building the proposed plant at the Seabrook, N.H. site. The board found the Seabrook site unacceptable for a closed-cycle cooling system. Consequently, it made no alternate site comparison on any basis other than once-through cooling. After the licensing board's initial decision and commencement of construction, the EPA regional administrator rendered a second decision vacating his earlier determination. With the final cooling system for the proposed plant in doubt, the Commission, in a lengthy and complex decision, instructed the licensing board to conduct the additional necessary site comparison. The two major holdings of the opinion were (1) that the test to be employed in assessing whether a proposed site is to be rejected in favor of any alternative site considered is whether that alternative site is obviously superior to the proposed site, and (2) that ordinarily the cost-benefit comparison between an applicant's proposed site and any alternative site may properly reflect the actual cost and time necessary to complete a facility at each of the locations in question.

South Texas. In its first major decision concerning its antitrust responsibilities, the Commission examined the Section 105 framework for antitrust review of license applications in the context of a petition for antitrust review, where the construction permit had been granted for the plant, but the operating license had not. Reviewing the statute and legislative history, the Commission concluded that the Section 105 regime limited antitrust review to a thorough examination at the time of the construction permit application and a narrower second review at the operating license stage. The Commission rejected the view that Section 186 of the Act endowed it with ongoing antitrust review responsibilities to revoke or modify existing licenses, independent of the licensing process.

JUDICIAL REVIEW

Significant Cases

Carolina Environmental Study Group, Inc. v. AEC, et al. (W.D.N.C., No. C-C-73-139, appeal docketed in the Supreme Court).

This suit, filed by a citizen group, challenged the granting of a construction permit to Duke Power Company for the McGuire facility in North Carolina. Plaintiffs alleged that the Commission's environmental review, required under the National Environmental Policy Act (NEPA), was inadequate. They also attacked, on constitutional grounds, the limitation of liability in the Price-Anderson Act. The district court held this case in abeyance pending the D.C. Circuit Court's decision

in *C.E.S.G. v. AEC.* Following that decision (510 F.2d 796), the court dismissed the case except as to the Price-Anderson issue. On March 31, 1977, the court concluded that the plaintiffs had standing, that the case was ripe for decision, and that the limitation on liability violated both the due process and equal protection clauses of the Constitution. An appeal was made to the Supreme Court and jurisdictional statements have been filed.

Natural Resources Defense Council, Inc., et al. v. NRC, et al. (D.C. Cir., Nos. 74-1385, 74-1586).
Vermont Yankee Nuclear Power Corp. v. NRDC (Sup. Ct., No. 76-149).
Baltimore Gas & Electric Company, et al. v. NRDC, et al. (Sup. Ct., No. 76-653).

The Court of Appeals for the District of Columbia Circuit, by its July 21, 1976 decision in this consolidated case, set aside the waste management and reprocessing portions of the Commission's uranium fuel cycle rule ("Table S-3"). That rule had assigned numerical limits to the environmental effects acceptable as a consequence of the licensing of a nuclear power plant and was intended, for purposes of making an environmental assessment under NEPA, to quantify the additional environmental impact of licensing a particular reactor, insofar as the fuel cycle was concerned. Without Table S-3 in place, the Commission's analysis of the environmental effects of the proposed Vermont Yankee plant was found to be inadequate, and the Vermont Yankee operating license was remanded to the Commission for further consideration pending an adequate assessment of the fuel cycle issues. On February 22, 1977, the Supreme Court granted Vermont Yankee's certiorari petition and consolidated it with the *Aeschliman* case, discussed below. The Supreme Court has decided to hold the *Baltimore Gas* case in abeyance pending its decision in *Vermont Yankee.*

Nelson Aeschliman, et al. v. AEC, et al. (D.C. Cir., No. 73-1776).
Saginaw Valley Nuclear Study Group, et al. v. AEC, et al. (D.C. Cir., No. 73-1867).
Consumers Power Company v. Nelson Aeschliman, et al. (Sup. Ct., No. 76-528).

On review of the construction permits issued for Consumer Power Company's Midland (Michigan) facility, the Court of Appeals for the District of Columbia Circuit disapproved the Commission's treatment of energy conservation issues, ruling that the Commission had placed too stringent an evidentiary burden on groups seeking Commission consideration of energy conservation issues. The court also held that Advisory Committee on Reactor Safeguards (ACRS) reports must be sufficiently explicit to inform the public of all identified hazards of reactor operation and that licensing boards have the obligation to return cryptic reports to the ACRS for further elaboration. The court remanded the case to the Commission for the purpose of restriking the NEPA cost/benefit balance, including an assessment of unaddressed fuel cycle issues. On February 22, 1977, the Supreme Court granted certiorari and consolidated this case with the *Vermont Yankee* fuel cycle case. These cases were argued on November 28, 1977.

State of New York v. NRC (2d Cir., No. 75-4278).
Natural Resources Defense Council, Inc., et al. v. NRC, et al. (2d Cir., No. 75-4276).
Allied-General Nuclear Service, et al. v. NRDC, et al. (Sup. Ct., No. 76-653).
Commonwealth Edison Company, et al. v. NRDC, et al. (Sup. Ct., No. 76-762).
Baltimore Gas & Electric Company, et al. v. NRDC, et al. (Sup. Ct., No. 76-774).
Westinghouse Electric Corp. v. NRDC, et al. (Sup. Ct., No. 76-769).

In another consolidated case, New York State and citizen groups sought review of the Commission's November 14, 1975 *Federal Register* notice which set forth procedures for hearings on the Generic Environmental Statement on Mixed-Oxide Fuel (GESMO) and outlined agency standards for licensing activities related to the use of mixed-oxide fuel prior to a Commission decision on wide-scale use of plutonium recycle. On May 26, 1976, the Court of Appeals for the Second Circuit issued its decision upholding, in full, both the GESMO hearing procedures and associated individual licensing procedures. However, interim licensing, except that for "experimental and feasibility purposes," was forbidden. This prohibition covers all separations, conversion, fuel fabrication, imports and loading of mixed-oxide fuel in reactors unless it can be shown that the action is not related to commercial plutonium recycle. Current use of mixed-oxide fuel remains unaffected. The Supreme Court granted petitions for certiorari by a number of utilities and a manufacturer.

Natural Resources Defense Council, Inc., et al. v. Robert C. Seamans, Jr., et al. (D.D.C., No. 76-1691).
In re Robert W. Fri, Acting Administrator of ERDA (D.C. Cir., No. 77-121D).

NRDC and other environmental groups have sued ERDA and NRC seeking to block construction of the waste tanks projected for the Hanford and Savannah River facilities. The complaint alleges that ERDA has failed to comply with NEPA by not issuing an environmental impact statement for the waste tank construction and that ERDA

has failed to obtain licenses from NRC under section 202(4) of the Energy Reorganization Act. The request for relief is directed both against ERDA and against NRC. NRC is named as a defendant because plaintiffs seek a declaratory judgment that NRC has licensing authority in this matter and the NRC erred in refusing a factual hearing on the jurisdictional issue of whether the tanks are for long-term use. The case was awaiting decision on cross-motions for summary judgment at the close of the report period. (See "Cases Initiated," below.)

Virginia Electric and Power Company v. NRC (4th Cir., No. 76-2215).

North Anna Environmental Coalition v. NRC (4th Cir., No. 76-2331).

VEPCO and the North Anna Environmental Coalition petitioned the Fourth Circuit to review the Commission's North Anna opinion which imposed a $32,500 fine on the utility for false statements concerning geologic faulting at the site.

The Fourth Circuit consolidated the cases and permitted the Commonwealth of Virginia to intervene. Basically, NRC argues that the $32,500 civil penalty assessed against VEPCO was proper; that an intent to deceive is not a necessary element of an actionable false statement; that the materiality of the statement must be judged from the point of view of an NRC employee reviewing the utility's application for a power plant license, not the lay public's understanding; and that omission of information can constitute a false statement. The case was argued on December 6, 1977 and was awaiting decision at the end of 1977.

Audubon Society of New Hampshire, et al. v. United States, et al. (1st Cir., No. 76-1437).

New England Coalition on Nuclear Pollution v. NRC, et al. (1st Cir., Nos. 76-1469, 76-1525, 77-1219, 77-1306, 77-1342).

Public Service Company of New Hampshire v. NRC, et al. (1st Cir., No. 77-1419).

These seven cases present a series of challenges to various Commission actions on the proposed Seabrook facility. In *Audubon Society*, two environmental groups petitioned the First Circuit to review the appeal board's July 14, 1976 order declining to stay the issuance of construction permits for the Seabrook Station, Units 1 and 2. Petitioners originally sought a stay of construction until the appeal board could pass upon their exceptions to the licensing board's initial decision. This case was the primary vehicle through which intervenors have sought judicial stays of the Seabrook project. Stays have been denied by the First Circuit on a number of occasions, most recently on July 28, 1977. Unlike the other Seabrook cases, *Audubon Society* was not focused on specific issues. It was dismissed as moot on October 28, 1977.

In consolidated case Nos. 76-1469 and 76-1525, NECNP petitioned the First Circuit for review of the Commission's October 5, 1976 order directing review of ALAB-349, the decision suspending the Seabrook construction permits on fuel cycle grounds. The cases have been held in abeyance pending the District of Columbia Circuit's clarification of its stay of mandate in the fuel cycle cases. In February 1977, the District of Columbia Circuit declined to clarify its mandate. The fuel cycle cases were under review by the Supreme Court in *Vermont Yankee* at the close of the report period. NECNP also claimed that the Commission's direction of review of the appeal board decision was illegal for failure to state reasons. In May 1977, the Commission's rules on review of appeal board decisions were completely revised. No. 76-1469 was dismissed as moot on October 28, 1977.

On May 13, 1977, NECNP instituted case No. 77-1219 to review the Commission's March 31 Seabrook decision which suspended the Seabrook construction permit pending further licensing board hearings and setting standards for striking the NEPA cost/benefit balance. On July 11, 1977, NECNP filed No. 77-1306, a petition for review of the appeal board's April 7 decision (ALAB-390) which ruled that under existing regulations consideration need not be given in a licensing proceeding to the feasibility of devising an emergency evacuation plan for persons located outside of the low population zone for the particular facility. And on July 28, the Coalition brought No. 77-1342 to review ALAB-422 and ALAB-423, which completed the appeal board's consideration of virtually all issues in the Seabrook facility and lifted the stay on the Seabrook construction permits. In this case, review of ALAB-421 issues concerning the application of the interim fuel cycle rule to Seabrook is also sought.

In the *Public Service* case, No. 77-1419, the lead applicant for Seabrook sought review of that portion of ALAB-422 which provides that, based on NEPA, the Commission can order an applicant to change the routing of its transmission lines.

Cases Concluded

Tennessee Valley Authority v. NRC (E. D. Tenn., No. 177-35).

TVA filed suit in Federal District Court seeking a declaratory judgment that NRC lacks statutory authority to order TVA to cease and desist from removing structures from the Phipps Bend site without prior NRC approval. The complaint was filed after most if not all of the structures had been removed. TVA claimed that NRC was precluded

from exercising NEPA authority over TVA's land acquisition and property management activities, an issue which is also pending before the Commission's appeal board. On September 14, 1977, the District Court granted NRC's motion to dismiss the complaint as inappropriate for declaratory judgment.

Citizens Action for Safe Energy, Inc. v. NRC (10th Cir., No. 77-1136).

An environmental group sought Court of Appeals' review of the appeal board's 2-page order in ALAB-370 regarding Black Fox Units 1 and 2 (Oklahoma). The appeal board dismissed as interlocutory the petitioners' claim that the licensing board had denied them discovery on certain issues and had erroneously refused to compel the joinder, as parties to the proceeding, of the Bureau of Indian Affairs of the Department of the Interior and the Cherokee Indian Nation. On June 21, 1977, in a short memorandum opinion, the Tenth Circuit adopted the NRC position and dismissed the petition for review as interlocutory.

William D. Young, et al. v. NRC (D.C. Cir., No. 77-1181).

Petitioners sought review of the licensing board orders of December 15 and 21, 1976, which authorized the issuance of a Limited Work Authorization (LWA) for TVA's Hartsville facility (Tennessee), claiming that the Commission erred in authorizing licensing based on proposed revisions to Table S-3, and that, in any event, the licensing board should not have summarily disposed of their contention that those S-3 values tilted the NEPA cost/benefit balance against an LWA. Petitioners, on July 7, 1977, moved to voluntarily dismiss their petition for review as moot in view of the licensing board's issuance of a construction permit for the Hartsville facility superseding the previously issued LWA. NRC advised the court of NRC's consent to petitioner's motion and the court dismissed the suit on July 14, 1977.

Union of Concerned Scientists, et al. v. NRC, et al. (D.D.C., No. 76-0370).

Plaintiffs sued under the Freedom of Information Act to compel disclosure of certain NRC memoranda being withheld under the Exemption 5 privilege. NRC sought summary judgment, which was granted as to 67 of the 77 documents requested. Minor portions of the remaining ten documents were ordered to be disclosed.

Natural Resources Defense Council, Inc. v. NRC (D.D.C., No. 76-9592).

In a suit under the Freedom of Information Act, plaintiffs sued to compel disclosure of GESMO documents. On April 14, 1977, the court affirmed NRC on 60 of the 80 documents at issue.

Westinghouse Electric Corp. v. NRC (3d Cir., No. 76-1611).

On March 22, 1977, the Third Circuit ruled that NRC had statutory authority to disclose proprietary information, dismissing the challenge to NRC's rule on disclosure of proprietary information. Westinghouse petitioned for review of an amendment to the Commission's rules of practice on the treatment of trade secrets or confidential commercial or financial information on the grounds that the amendment jeopardizes its ability to protect such information from disclosure to its competitors.

Concerned Citizens of Rhode Island, et al. v. NRC (D.R.I., No. CA 76-0520).

An environmental organization filed a complaint seeking to enjoin the NRC from taking any further steps to process the application of New England Power Company to construct two reactors at the former naval station at Charlestown, R.I. The site is presently administered by the General Services Administration. The complaint claimed that the Atomic Energy Act precludes the NRC from acting on an application where the utility does not own the construction site. Plaintiffs also claimed that NRC staff review will violate NEPA by unduly influencing GSA's NEPA inquiry into possible sale of the site to private parties other than the utility. After hearing oral argument on April 19, 1977, Judge Pettine declined to interfere with the Commission's environmental review and dismissed the complaint, holding that plaintiffs must await an adverse final order and then seek judicial review in the Court of Appeals.

Cincinnati Gas and Electric Company, et al. v. NRC, et al. (D.D.C., No. 76-2376).

A number of utilities sought a reduction in NRC license fees, asserting that under the Independent Offices Appropriation Act of 1952 only some 5 percent of NRC's costs can be passed on as license fees. Plaintiffs requested an injunction against further collection of fees, refunds of fees previously collected, and a court order imposing the lower fee schedule they propose. On March 15, 1977, Judge Gesell heard oral argument and dismissed plaintiffs' complaint from the bench, finding that only the Court of Appeals can pass upon the validity of NRC's fees schedule.

City of Louisville, et al. v. NRC (W.D.Ky., No. C-77-0053-L(B)).

The City of Louisville and other governmental units sought to overturn an *ex parte* appeal board order (ALAB-371) which instructed the licensing board that the absence of co-owners from the Marble Hill application did not necessitate postponement of the hearings on matters independent of the

ownership issue. On March 7, 1977, the court adopted the NRC position, denied the motions, and dismissed the complaint.

Natural Resources Defense Council, Inc., et al. v. NRC (D.C. Cir., No. 76-1966).

NRDC and East Tennessee Energy Group petitioned the Court of Appeals to review the Commission's August 1976 Clinch River opinion, claiming that the limitations imposed on the environmental analysis of the proposed Clinch River Breeder Reactor violate NEPA. NRC's motion to dismiss the action on the ground that the Commission opinion was not a final order reviewable by the court was upheld and the petition was dismissed on January 31, 1977.

Sierra Club, et al. v. NRC, et al. (D.C.C., No. 1867-73).

This suit, brought by three environmental groups (a fourth group was later permitted to intervene) charged the Atomic Energy Commission and its Commissioners, Eximbank and its Directors, and the Secretary of State with a series of alleged failures to comply with NEPA. Specifically, plaintiffs alleged that the defendants have a "nuclear power export program" and that each of them must prepare an impact statement on the program as a whole and on each individual action any one of the defendants may take in furtherance of the program.

The AEC decided to issue a programmatic Environmental Impact Statement regarding the nuclear export program announced on June 14, 1974 (39 Fed. Reg. 20835). NRC and ERDA were substituted as parties in place of the AEC. The draft environmental statement was issued in August 1975. In March 1976, the final environmental statement was issued. In view of ERDA's publication of the final environmental statement, ERDA-1542, the District Court on September 22, 1976, dismissed the action as moot.

The Babcock and Wilcox Company v. NRC, et al. (D.C. Cir., No. 77-1457).

On May 17, 1977, the Babcock and Wilcox Company (B&W) filed a petition for review of NRC's May 9 denial of B&W's request to seek injunctive relief against United Technology Corporation's proposed takeover of B&W. The company also filed a motion for expedited consideration of this petition and sought summary reversal and injunctive relief requiring NRC to order a Section 184 license transfer hearing. The Court of Appeals denied the motion for summary judgment and injunctive relief, and on September 16, 1977, dismissed the case as moot in light of the withdrawal of United Technology's tender offer.

Utility Workers of America, Local 1-2 v. Consolidated Edison Company of New York and NRC (S.D.N.Y., 77 Civ. 3688 (WK)) (2d Cir., No. 77-6131).

On July 29, 1977, plaintiffs filed an Order to Show Cause challenging physical search requirements for employees under Part 73 of the NRC regulations as unconstitutional under the Fourth and Fourteenth Amendments. On August 5, 1977, the District Court denied the plaintiffs' motions, and plaintiffs thereafter voluntarily dismissed their complaint and appeal when NRC delayed the effective date of its "pat-down" search requirement in order to study the issue further. Subsequently the Commission modified its regulations by eliminating most pat-down searches.

Cases Initiated

United States of America and the Trustees of Columbia University in the City of New York v. City of New York, et al. (S.D.N.Y., 77 Civ. 3485).

The United States, on behalf of NRC and ERDA, and Columbia University, filed a joint complaint against the City of New York asserting that the city's refusal, on radiological health and safety grounds, to permit an NRC-licensed reactor to operate violates the Supremacy Clause of the United States Constitution. The complaint seeks a declaration and injunction against enforcement of section 105.107(c) of the city's Health Code which purports to require a city radiological health and safety review and permit for operation of an NRC-licensed reactor.

Natural Resources Defense Council, Inc., et al. v. NRC, et al. (D. New Mexico, No. 77-240-B).

Natural Resources Defense Council, Inc., et al. v. NRC (D.C. Cir., No. 77-1570).

These two cases brought by the Natural Resources Defense Council challenge operations of a uranium milling operation in New Mexico. On May 3, 1977, NRDC, the Central Clearinghouse of New Mexico, and two individuals filed suit against NRC and the New Mexico Environmental Improvement Agency (NMEIA) seeking to enjoin operations of United Nuclear's Church Rock Mill which NMEIA licensed May 3, alleging violations of NEPA and the Atomic Energy Act. The gist of the complaint is that neither NRC nor New Mexico has prepared an environmental impact statement for the Church Rock Mill. Plaintiffs contend that New Mexico, as signatory to a section 274 State Agreement to regulate radioactive materials, is exercising Federal power and therefore must comply with NEPA. They also contend that NRC's continuing review powers over State programs constitutes sufficient Federal involvement to

call for preparation of an environmental impact statement (EIS). Second, plaintiffs argue that, in order to comply with section 274, State programs must be "compatible" with the NRC program and that compatibility requires preparation of an EIS where NRC would prepare one in a non-agreement State. NRC currently prepares an EIS for each new milling license and first renewal. A similar petition for review was filed June 30, 1977, naming only NRC as a respondent.

Natural Resources Defense Council, Inc., et al. v. NRC (D.C. Cir., No. 77-1489).

On May 31, 1977, petitioner filed a protective suit in the Court of Appeals against the possibility that the District Court, in *NRDC, et al. v. Seamans, et al.* (D.D.C. No. 76-1691), might hold that the Commission's refusal to assert licensing jurisdiction on waste disposal tanks is exclusively reviewable in the Court of Appeals. NRC's motion to dismiss is pending. The case is being held in abeyance pending decision by the District Court.

John Abbotts, et al. v. NRC (D.D.C., No. 77-624).

John Abbotts, the Public Interest Research Group, and the Natural Resources Defense Council, Inc., have brought a Freedom of Information Act suit challenging an NRC decision, rendered about a year ago, to withhold certain safeguards documents. The safeguards documents involved fall into three categories: (1) records relating to the NRC program for onsite reviews of SSNM facilities initiated in early 1976, (2) records concerning the NRC investigation and review of conditions at the Nuclear Fuel Services facility in Erwin, Tenn., in late 1975 and early 1976; and (3) studies done for or relating to NRC's Special Safeguards Study and the Draft Safeguards Supplement.

Natural Resources Defense Council, Inc., v. NRC, et al. (D.C. Cir., No. 77-1448).

On May 13, 1977, NRDC filed a petition for review of the NRC's March 14 *Federal Register* notice promulgating an interim rule quantifying the environmental effects of the uranium fuel cycle. On July 5 NRDC requested that the D.C. Circuit hold the case in abeyance until the Supreme Court reaches a decision in the *Vermont Yankee* fuel cycle case. NRC consented to that motion.

Central Power & Light Company v. NRC, et al. (D.C. Cir., Nos. 77-1464, 77-1654).

On May 18, 1977, Central Power & Light Company, one of four holders of a joint license to construct the South Texas nuclear generating station, petitioned for review of the appeal board's March 18 decision in Docket Nos. 50-498A and 50-499A (ALAB-381). That decision held that under Commission regulations the licensing board did not have authority to reopen a concluded construction permit proceeding for the purpose of initiating a hearing to determine whether antitrust conditions should be imposed on the permit. On July 26, 1977, the Central Power and Light Company filed No. 77-1654, to review the Commission's *South Texas* decision. In that decision, the Commission examined the section 105 framework for antitrust review of license applications in a situation where the construction permit had been granted to the applicant, but the operating license had not. Reviewing the statute and legislative history, the Commission held that the section 105 regime limited antitrust review to a thorough examination at the time of the construction permit application and a narrower second review at the operating license stage. The lawsuits have been consolidated.

Martha G. Drake, et al. v. The Detroit Edison Company, et al. (E.D. Mich., No. G77-364 CA7).

On July 29, 1977, plaintiffs filed their complaint challenging the sale by Detroit Edison Company to Northern Michigan Electric Cooperative, Inc. and to Wolverine Electric Cooperative, Inc., of 11.28 percent and 8.78 percent respectively of Detroit Edison's proposed Fermi Unit No. 2.

NRC advised the court that its procedures allow the public an opportunity to contest the proposed transfer of ownership before approval is given. NRC's motion to dismiss was denied by the court. The court, however, stayed further proceedings until the outcome of the NRC review.

Natural Resources Defense Council, Inc., v. NRC (2d Cir., No. 77-4157).

On August 25, 1977, the Natural Resources Defense Council filed a petition to review the Commission order denying NRDC's request that a rulemaking proceeding be initiated to determine whether radioactive wastes generated in nuclear reactors can be safely disposed of and to suspend licensing of plants pending such a determination. The case was pending before the Second Circuit at the close of the report period.

Cases Pending

Minnesota Environmental Control Citizen's Association, et al. v. Atomic Energy Commission, et al. (D. Minn., No. 4-72-109).

Plaintiffs, a citizens' association, sought to enjoin further development and operation of Northern States Power Company's Monticello and Prairie Island facilities on the ground that the Prairie Island construction permit and the Monticello pro-

visional operating license were issued without preparation of an environmental impact statement. On July 28, 1972, Judge Lord issued an opinion refusing to enjoin the construction or provisional operation, but holding that before full operating permits for these facilities could be granted a full NEPA review was required. The court retained jurisdiction over the matter to ensure that such a review was performed. During the past five years, the Commission has undertaken this environmental review, and both licensing proceedings are nearing completion.

West Michigan Environmental Action Council, Inc. v. AEC, et al. (W.D. Mich., No. G-58-73).

Citizen group plaintiffs sought an injunction against increased use of mixed oxide fuel in Consumer Power Company's Big Rock Point power reactor. In June 1974, the court placed the case in abeyance pending the outcome of the GESMO proceedings and NRC review of Executive Branch comments. See *State of New York v. NRC* (2d Cir., No. 75-4278, *et al.*), under "Significant Cases," above.

Lloyd Harbor Study Group v. NRC (D.C. Cir., No. 73-2266).

Long Island Lighting Company v. Lloyd Harbor Study Group, Inc. (Sup. Ct., No. 76-745).

A citizens' group challenged the issuance of a construction permit for the Shoreham facility on grounds that the NEPA review was deficient in that it: (1) reserved for generic treatment the question of incremental impact of the uranium fuel cycle; and (2) failed to consider the consequences of a "Class 9" accident. On November 9, 1976, the D.C. Circuit entered a one-page order which dismissed the "Class 9" contention but remanded the fuel cycle aspect of the case for further consideration in conformity with *NRDC v. NRC* (D.C. Cir., No. 76-1586). On November 30, the utility petitioned the Supreme Court for a writ of certiorari. The Supreme Court has taken no action on the certiorari petition, thus in effect holding the case in abeyance pending its disposition of *NRDC v. NRC* (Sup. Ct., No. 76-149).

State of New York v. NRC, et al. (S.D.N.Y., No. 75 Civ. 2121) (2d Cir., Nos. 75-6115, 76-6002 and 76-6081).

New York sought to halt air shipment of plutonium pending the preparation of an environmental impact statement. New York appealed the District Court's denial of its motion for preliminary injunction, motion for summary judgment, and dismissal of the Civil Aeronautics Board and the Customs Service as parties to the litigation. The Second Circuit in essence upheld the rulings and remanded the case to the District Court for further proceedings.

United States v. New York City (S.D.N.Y., No. 76 Civ. 273).

On January 15, 1976, the plaintiffs, the NRC, ERDA and Department of Transportation (DOT), sought a judgment declaring a New York City Health Code provision dealing with the transportation of nuclear materials through the city to be inconsistent with the Federal statutory scheme governing the transportation of hazardous materials. The Government's request for a preliminary injunction against enforcement of the Health Code provision was denied on January 30, 1976, the court finding that no irreparable injury would occur pending a decision on the merits of the case. DOT has published regulations under the Hazardous Materials Transportation Act (which became effective January 1977) which allow interested persons to seek a ruling that a local ordinance is inconsistent with DOT regulations. On February 28, Brookhaven filed its request for such a regulation with DOT, arguing that the city's restrictions on shipping new and spent fuel were inconsistent with DOT's regulations. NRC and ERDA have written DOT in support of Brookhaven's position.

Culpeper League for Environmental Protection v. NRC (D.C. Cir., No. 76-1484).

Fauquier League for Environmental Protection v. NRC (D.C. Cir., No. 76-1532).

Petitioners challenged an appeal board decision, not reviewed by the Commission, which concerned the routing of high-voltage transmission lines from VEPCO's North Anna Power Station. Petitioners contend an alternate route would have been preferable from an environmental standpoint. The appeal board, relying in large measure on evidence brought out during seven days of licensing board hearings, concluded that the route chosen was environmentally sound. The court consolidated these cases and heard oral argument on April 25, 1977. The case was awaiting decision at the close of the report period.

Natural Resources Defense Council, Inc. v. NRC (D.C. Cir., No. 76-1525).

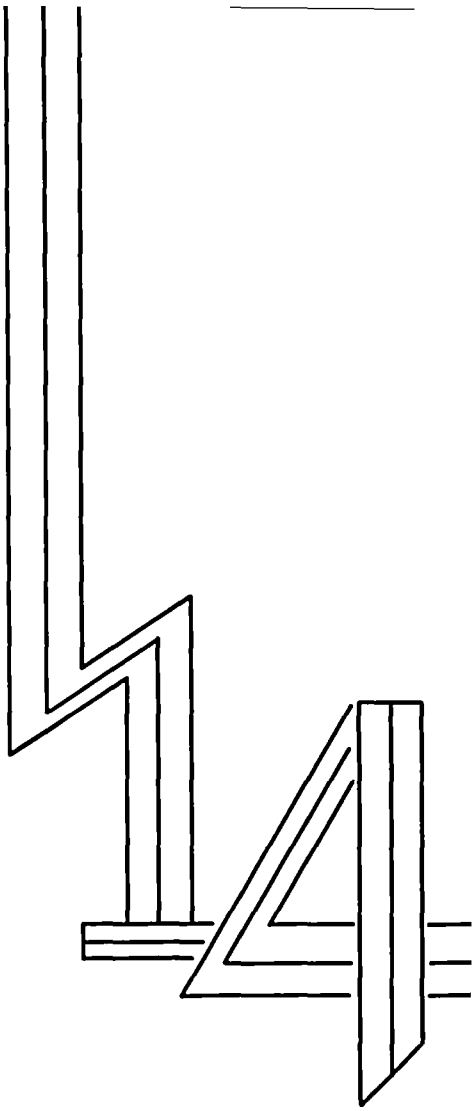
Petitioners sought leave to intervene in two NRC export license proceedings involving applications to ship reactor fuel to the Tarapur Atomic Power Station in India. On May 7, 1976, the Commission denied the motions, finding that petitioners lacked standing. Petitioners sought review in the Court of Appeals. The State Department intervened and filed a motion to dismiss. Oral argument was heard on December 8, 1976. On June 22, 1977, the Commission consolidated the license application pending before the court (XSNM-845) with a follow-on application for nuclear material for use at Tarapur

(XSNM-1060), in order to preserve the procedural issues pending before the court should the Commission grant the earlier filed application. On June 28, the Commission approved issuance of XSNM-845 and petitioners on June 30 obtained a court order directing the Commission to suspend that license in order to preserve the court's jurisdiction over the case before it. On July 5, NRC moved to vacate the order of suspension, pointing out that the Commission's consolidation order had preserved the status quo, and emphasizing the need for the export from a foreign relations viewpoint. The State Department filed a similar paper. On July 6, the Court of Appeals vacated its suspension order, and the export license was issued. No decision had been rendered on the December 8 argument at the close of the report period.

Martin Hodder, et al. v. NRC (D.C. Cir., No. 76-1709).

Petitioners sought review of the partial initial decision authorizing issuance of a Limited Work Authorization (LWA) for Florida Power and Light Company's proposed St. Lucie Plant, Unit 2, claiming NEPA's requirement of full consideration of alternatives has not been satisfied. This contention had been dismissed by the licensing board, but the appeal board, finding the record to be insufficient, remanded the case to the licensing board for further hearing while refusing to revoke the LWA. On October 21, 1976, the Court of Appeals denied petitioners' motion for injunctive relief and summary reversal of the decision authorizing the LWA, but stayed construction under the LWA pending further consideration of alternative sites. On October 22, the Court of Appeals denied the utility's motion for a rehearing, and gave Florida Power and Light until November 8 in which to terminate construction activities. Consequently, work under the LWA ceased pending consideration of alternative sites. On April 19, 1977, the licensing board issued its initial decision resolving the alternate sites contention in favor of the St. Lucie site and authorized issuance of a construction permit. The Court of Appeals was advised of this action. Subsequently, the court dissolved its stay and dismissed petitioners' motions as moot. At the end of the report period, the Court of Appeals was holding proceedings in abeyance pending completion of administrative review.

Administration and Management



The day-to-day administrative and management operations essential to accomplish the NRC's primary statutory missions drew new levels of attention during fiscal year 1977. Congressional committees with new legislative jurisdiction or oversight responsibilities over NRC were briefed in considerable detail on NRC's internal management activities. Matters of particular interest included the personnel strength and distribution and funding statistics reflected in NRC budget requests, the Commission's dispersed physical locations, and equal employment opportunity programs. These and other related items of current or historical interest are described in this chapter.

PERSONNEL AND ORGANIZATION

As shown in the personnel and funding charts below, NRC's authorized strength for fiscal year 1977 was 2,499.* Approximately 70 percent of NRC employees are assigned to major program offices, about 20 percent in program direction and coordination, and approximately 10 percent at the Commission and Commission staff level, including the independent advisory and licensing bodies. More than half of all NRC employees are trained as scientists or engineers. Nearly 70 percent hold college degrees, including almost 30 percent with masters' and law degrees and close to 10 percent with doctorates.

New Commissioners and New Chairman

Major personnel changes during the period included the departures of Chairman Marcus A. Rowden and Commissioner Edward A. Mason, and the arrivals of Dr. Joseph M. Hendrie and Peter A. Bradford as Commissioners and Dr. Hendrie's appointment by the President to serve as Chairman of the NRC.

Dr. Hendrie had served as Deputy Director for Technical Review in the Office of Regulation of the former Atomic Energy Commission from 1972 to 1974 and came to the NRC from the

*The fiscal year 1977 authorized strength figure shown in the Annual Report for 1976 was 2,529. The Office of Management and Budget reduced that figure by 30.

Brookhaven National Laboratory. He was sworn in on August 9, 1977, and his term runs to June 30, 1981.

Mr. Bradford was a commissioner of the Maine Public Utilities Commission when named to the NRC; he had served as assistant to Governor Kenneth Curtis of Maine from 1968 to 1971, specializing in energy and the environment. He was sworn in on August 15, 1977, and his term runs to June 30, 1982.

The fifth Commissioner position remained unfilled at year's end.

Changes at the Program Office level included Dr. Clifford C. Smith replacing Kenneth R. Chapman as Director, Office of Nuclear Material Safety and Safeguards; Edson G. Case, named Acting Director, Office of Nuclear Reactor Regulation, following the departure of Benard C. Rusche; and Saul Levine who moved from Acting Director to Director, Office of Nuclear Regulatory Research.

OSS Abolished

The only significant organizational change during the period was the official deactivation of the Office of Special Studies whose work on statutorily assigned siting and security study projects had been completed during the latter part of the preceding year.

Supergrade Audit

At the end of July 1977, NRC signed a contract for review of existing and proposed supergrade positions, a project which grew out of a 1976 study by the Office of Management and Budget. The contractor review is scheduled to be completed by the end of the calendar year.

Union Agreement

NRC officials and representatives of the American Federation of Government Employees (AFGE) signed an agreement early in 1977 covering all NRC headquarters employees. The agreement designated AFGE as the exclusive bargaining agent for nonsupervisory NRC employees in headquarters offices. Effective for one year, the agreement will be automatically renewed each year unless either party serves notice to renegotiate or terminate it.

PHYSICAL FACILITIES

The Nuclear Regulatory Commission continued to house approximately 2,400 people in nine buildings located in the District of Columbia and in Bethesda, Silver Spring and Rockville, Maryland, at an estimated direct annual cost, for dispersal of functions and personnel alone, well in excess of $4 million. The Commission's experience under this dispersed arrangement has accentuated the need for consolidation. Heightened public and official interest in nuclear energy has had a multiplying effect on the number and frequency of meetings and discussions between NRC officials and members and committees of Congress, members and agencies of

NRC EMPLOYMENT PROFILE

	SEPTEMBER 30, 1976				SEPTEMBER 30, 1977			
	MEN		WOMEN		MEN		WOMEN	
	WHITE	MINORITY	WHITE	MINORITY	WHITE	MINORITY	WHITE	MINORITY
EXECUTIVE	18	0	0	0	10	1	0	0
GS-18	22	0	0	0	23	0	0	0
GS-17	49	3	1	0	53	3	0	0
GS-16	107	3	1	0	103	3	1	0
GS-15	424	15	5	0	436	13	6	0
GS-14	497	31	12	0	493	31	15	0
GS-13	229	20	14	2	244	30	18	4
GS-12	109	8	30	7	119	8	36	7
GS-11	23	0	35	3	51	6	46	10
GS-1 to 10	75	30	431	111	92	30	460	125
OTHER	41	10	1	0	17	11	1	0

Employees whose salaries are set by Wage Board, Health and Medical Group, or Administrative Determination

Ken Jackson, deputy director, EEO; Sam Woodard, a professor at Howard University; and Ed Tucker, director, EEO, view the exhibit displayed during NRC's observance of Black History Month. Dr. Woodard was the featured speaker on a special program held to commemorate the event.

the Executive Branch, public interest groups, and representatives of foreign countries. A consolidation of the agency in Washington would facilitate these relationships.

The Congress has shared the Commission's concern over the inefficiencies and high costs of this dispersal and has expressed it in several committee reports. To help resolve the problem, the General Services Administration (GSA) was directed to study the feasibility of consolidation and to present alternative solutions. GSA's response to this directive was a determination that NRC should be consolidated in facilities constructed on a suitable site in an urban renewal area in Washington. At the end of fiscal year 1977, the GSA report was under consideration in the Congress.*

EQUAL EMPLOYMENT OPPORTUNITY

Efforts continued during fiscal year 1977 to bring NRC closer to Federal Government goals for increasing the representation of minority and women employees. Although previously established goals for 1977 were not reached, considerable progress was made.

As of October 1, 1976, minorities made up 10.8 percent of the total NRC population. By September 30, 1977, the minority percentile was 11.7 percent, three-tenths of one percent short of the 1977 objective. As has been the case in many technical agencies, the most notable shortfall in minority representation is in grade levels GS-13 and higher; thus an intensified effort to recruit minority personnel for such positions continued through the year. Statistics for September 30, 1977 showed that at those senior and executive grades, only 6.4 percent (97 employees in a total of 1,509) were minority personnel. This was slightly higher than the Government average of 5.7 percent. A similar shortfall in representation of women was reflected in statistics showing women filling 28.5 percent of positions at the beginning of fiscal year 1977 and 28.9 percent at year's end. As contrasted to minorities, the proportion of women in the senior and supergrades at NRC was below the Government average of 5.4 percent, with only 3 percent of the total in those grades.

As noted in the previous annual report, however, equal employment programs initiated since the NRC's inception in 1975, have laid the groundwork for future increases in minority and female representation at higher grade levels. During fiscal year 1977, vigorous recruiting at colleges and universities graduating respectable numbers of women and minority scientists and engineers brought substantially greater numbers of such personnel into the NRC Intern and Cooperative Education programs. These newer, younger groups should have a pronounced effect on minority and women representations at higher grades in coming years, and will bring a cumulative impetus to agency-wide achievement of equal employment goals.

*On October 12, 1977, the Subcommittee on Buildings and Grounds of the House Committee on Public Works and Transportation unanimously passed a motion that the GSA report be adopted, and on October 20, 1977, the parent committee passed a similar motion. Further review and evaluation of GSA's Report of the Building Project Survey was underway in the Senate as this report went to press.

Highlights of EEO activity during the year included the formal establishment of a Spanish-Speaking Program within the Office of Equal Employment Opportunity under the direction of a Spanish-Speaking Program Coordinator. In addition, a quarterly publication was initiated for women employees—"NRC Federal Women's Program News"—under the auspices of the Federal Women's Program Coordinator. A wide range of special awareness programs, career seminars, group and individual counseling and training programs to prepare both managers and employees for greater minority and female participation and contribution to major NRC operations and functions marked 1977 as a year of new beginnings in the equal employment opportunity field.

Congressional interest in such programs was reflected in the introduction, as part of NRC's fiscal year 1978 authorization legislation (S. 1131), of an amendment to the Energy Reorganization Act of 1974 which would require a quarterly status report to the Congress, documenting, for grades GS-11 and above, the number of minority and women candidates hired, employees promoted and other actions attendant to EEO goals and accomplishments. The first such quarterly report would be submitted no later than January 31, 1978.

INSPECTION AND AUDIT

The Office of Inspector and Auditor's (OIA) audits, investigations and inspections provide the Commission with independent reviews and appraisals of NRC operations. Some of the more important OIA actions during fiscal year 1977 are summarized below:

Program for Licensing Standardized Nuclear Power Plants. A major audit which started as a broad survey of the licensing process was redirected to focus on NRC's proposed revisions to its policy for licensing of standardized plants following the Commission's expression of a desire to increase industry participation in the standardization program. A draft report summarizing industry and NRC staff views with regard to two standardization options—the reference design system and replication—was issued to the Executive Director for Operations for comment near the end of the fiscal year.

North Anna Power Plant Inspection Program. OIA investigated publicized allegations of faulty NRC inspection procedures at the Virginia Electric and Power Company's North Anna site. The results of this investigation were conveyed to the Commission in January 1977, together with five recommendations relating to and to be considered part of an ongoing evaluation of the reactor construction inspection program. Among the recommendations to be considered was the utilization of a resident inspector at a reactor site. NRC at the time of OIA's report had a pilot resident inspection program underway and now is implementing that program.

Nuclear Engineering Company. On May 12, 1977, the Nuclear Engineering Company, whose Beatty, Nevada, waste-burial operations, together with AEC and NRC inspections of the Beatty facility, were investigated in 1976 (NRC 1976 Annual Report, p. 224), entered a plea of *nolo contendere* to two counts of violating the Atomic Energy Act of 1954, as amended. The Corporation failed to confine the possession and use of radioactive waste to the location and for the purpose specified in its license.

Use of Consultants. On September 20, 1977, OIA issued an audit report which evaluates NRC's policies and procedures for obtaining, using, controlling, and paying its consultants. The report recommends modifications in NRC's policies and practices to obtain the most advantageous results from the use of its consultants and advisers. The audit was conducted as part of the ongoing review of the NRC's administration and program direction activities.

Processing ERDA Task Orders and Other Government Interagency Agreements. Based on recommendations contained in an OIA report issued in May 1977, NRC's policies and practices for processing and controlling ERDA (now Department of Energy—DOE) task orders ("task orders" are the financially binding instruments used by NRC to order research services at DOE laboratories) and other interagency agreements will be strengthened. This will be done by standardizing procedures for handling and processing interagency agreements and DOE task orders, and establishing centralized points of control for collection and overview of these instruments.

Sole-Source Procurement Activities. An OIA report issued in September 1977 assessed NRC's basis for awarding contracts on a sole-source basis, and recommended improvements in the process, such as earlier submission of requirements by NRC offices to the Division of Contracts; making more intensive searches for contract sources; publishing sole-source awards in the *Commerce Business Daily*; and developing a resource-capability listing to provide for more possible sources.

Materials Inspection Program. The draft report mentioned in the 1976 annual report on NRC's

materials inspection program was issued in final form on December 21, 1976. This report centers on the management and implementation of the materials inspection program at NRC headquarters and the five regional offices. To further evaluate some of the problems disclosed in the audit and to gain an insight into the views that regional office materials inspections staff hold concerning various aspects of the materials inspection program, the report also includes a questionnaire survey of 74 materials inspectors. Since the responses to the questionnaire indicated that as a group the NRC materials inspectors had genuine concerns about the Office of Inspection and Enforcement's materials inspection program, the report includes recommendations to IE concerning the merits and implications of some of the responses.

FUNDING AND BUDGET MATTERS

The charts on the next page show the apportionment of authorized personnel and funds to the various NRC activities carried out during fiscal year 1977 and projected for fiscal year 1978.

The indicated increase in personnel for fiscal year 1978 is mainly for the expanded safeguards inspection program and the fuel cycle and materials inspection program, and also for the stationing of Federal inspectors at operating reactor sites and at plants in late stages of construction.

The indicated increase in funds for fiscal year 1978 is mainly for regulatory research, with lesser increases in the areas of inspection and administration. The increase for research is required primarily to support water reactor research projects such as Semiscale, three-dimensional flow effects in a PWR core, and PWR blowdown heat transfer experiments. Increased funding also goes to loss of fluid (LOFT) and fuel behavior tests and to research in support of environmental and fuel cycle activities. Increases for inspection and administration are mainly to allow for more personnel.

The financial statements on the pages following are self-explanatory.

PROCUREMENT

Technical assistance in specialized areas of NRC activity is accomplished under a variety of contract arrangements administered by the Division of Contracts of NRC's Office of Administration. In fiscal year 1977 contract purchases of all kinds totaled more than $35 million, with about one fourth of that amount going to small business firms.

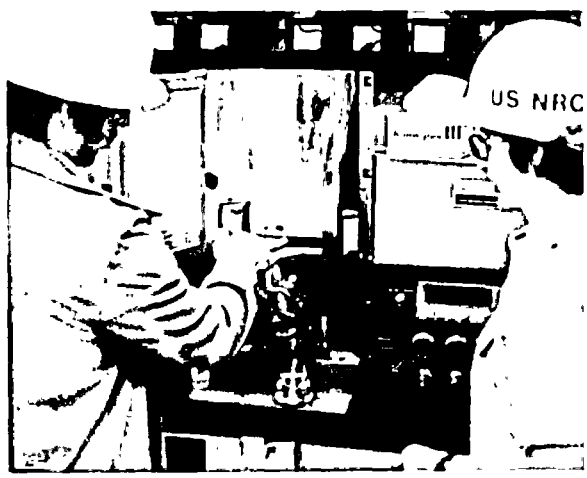
Considerable progress was made by the NRC contracting staff in its continuing work with minority business organizations. At year's end, as a result of these cooperative efforts, the development of procedures for implementing the minority business provisions of the Small Business Act was well under way.

NRC LICENSE FEES

From October 1968, when fee collections began, until mid-1974, NRC imposed annual fees on licensees in addition to those fees collected on applications and for issuance of construction permits and operating licenses. Based on a United States Supreme Court ruling in March 1974, NRC suspended the collection of annual fees and began refunding those previously collected. To date, $6.1 million of annual fees have been returned.

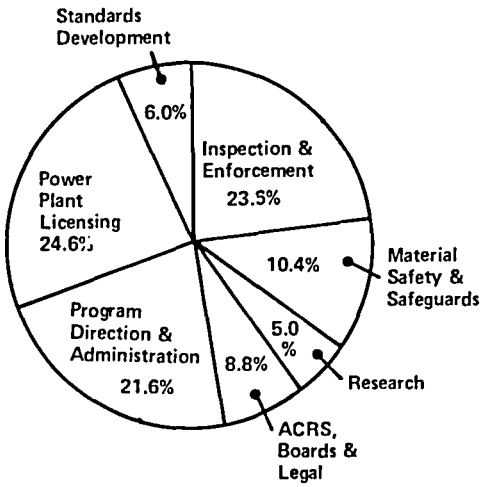
Fees of the other types mentioned amounted to $9.5 million in 1977. The total collected since October 1968 is $75.9 million.

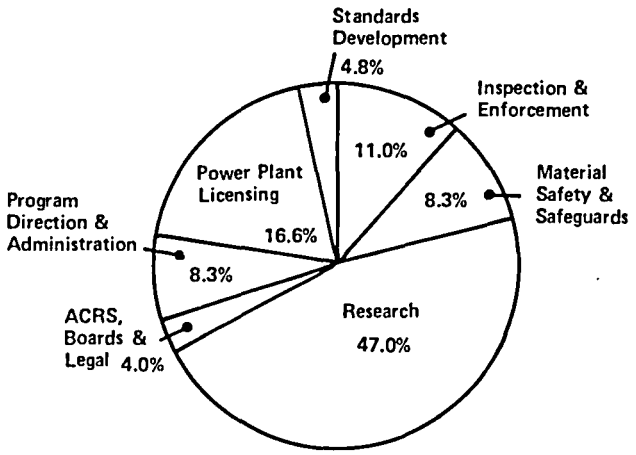
On May 2, 1977, NRC published for public comment a Notice of Proposed Rulemaking regarding revisions to its schedule of license fees. Some of the more important items included in the proposed revision are fees on (1) requests for standardized design approvals; (2) utility applications for use of such designs; (3) license amendments; (4) routine inspections; (5) special projects and reviews; (6) requests for approval of spent fuel casks and shipping containers; (7) requests for approval of sealed sources and devices containing or utilizing by-product, source or special nuclear material; and (8) licenses for receipt and storage of spent fuel.



A Radiation Specialist/Intern (right) participates in an inspection at the Diablo Canyon nuclear plant. The NRC's two-year intern program is designed to develop a source of highly qualified, broadly trained personnel who will be available for staffing professional and management positions throughout the NRC. During fiscal year 1977, 108 persons participated in the intern program, including 30 women and 21 minority employees. Most participants are college graduates just beginning their professional careers.

NRC RESOURCES
FY 1977

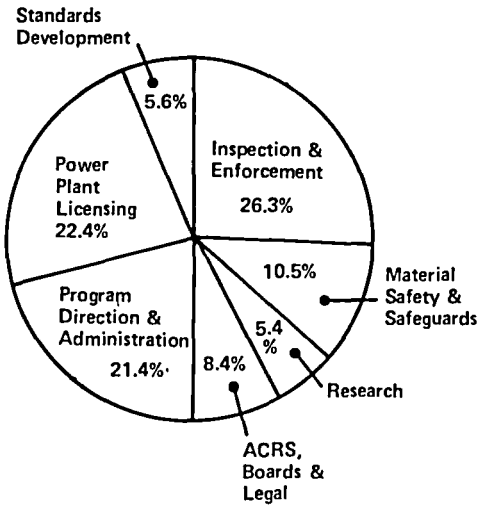


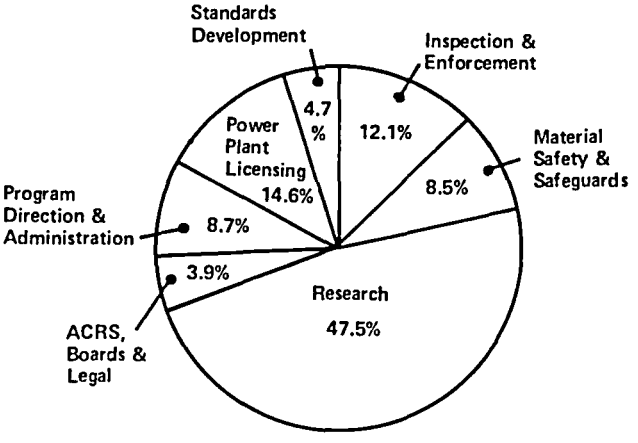


PERSONNEL — 2499

FUNDS — $254 MILLION

NRC RESOURCES
FY 1978





PERSONNEL — 2723

FUNDS — $295 MILLION

Fiscal Year 1977—NRC Financial Statements

Balance Sheet (in thousands)

ASSETS	September 30, 1977	September 30, 1976
Cash:		
Appropriated Funds in U.S. Treasury	$110,003	$ 91,782
Other*	6,204	5,482
	$116,207	$ 97,264
Accounts Receivable:		
Federal Agencies	$ 39	$ 42
Other	16	71
Miscellaneous Receipts**	367	602
	$ 422	$ 715
Plant:		
Completed Plant and Equipment***	$ 7,022	$ 11,668
Less—Accumulated Depreciation	1,663	1,161
	$ 5,359	$ 10,507
Advances and Prepayments:		
Federal Agencies	$ 230	$ 50
Other	634	486
	$ 864	$ 536
Total Assets	$122,852	$109,022

LIABILITIES AND NRC EQUITY	September 30, 1977	September 30, 1976
Liabilities:		
Funds held for Others*	$ 6,204	$ 5,483
Accounts Payable and Accrued Expenses:		
Federal Agencies	31,638	26,215
Other	11,253	8,464
Accrued annual leave of NRC employees	4,843	4,005
Total Liabilities	$ 53,938	$ 44,167
NRC Equity: October 1, 1976, Balance	64,855	26,507
Additions:		
Funds Appropriated—net	248,780	269,548
Non-reimbursable transfers from ERDA	1,233	99
	$314,868	$296,154
Deductions:		
Net Cost of Operations***	$233,220	$211,512
Funds returned to U.S. Treasury**	12,734	19,787
	$245,954	231,299
Total NRC Equity	$ 68,914	$ 64,855
Total Liabilities and NRC Equity	$122,852	$109,022

* Includes $4,954,692.82 of funds received under cooperative research agreements involving NRC, ERDA, the Federal Republic of Germany, the Japan Atomic Energy Research Institute, and Austria.

** These funds are not available for NRC use.

*** On March 11, 1977 NRC and ERDA (DOE) signed a policy agreement which stated that for all equipment purchased by NRC for use at ERDA/DOE facilities on NRC requested projects, title would rest with ERDA/DOE. This agreement was considered to be retroactive to January 19, 1975. Therefore, $7,213,512.77 in Plant and Equipment cost at September 30, 1976 associated with NRC projects being performed at ERDA/DOE facilities was transferred from the completed Plant & Equipment accounts and charged to Net Cost of Operations during Fiscal Year 1977.

Fiscal Year 1976/1977 Statement of Operations (in thousands)

	Fiscal Year 1977 (October 1, 1976, thru September 30, 1977)	Fiscal Year 1976 (July 1, 1975, thru September 30, 1976)
Personnel Compensation	$ 68,430	$ 70,177
Personnel Benefits	6,375	6,226
Program Support	133,808	132,243
Administrative Support	14,045	14,205
Travel of Persons	4,854	4,641
Training (Technical)	724	429
Equipment (Technical)*	6,016	—
Construction*	2,205	—
Taxes and Indemnities	7	—
Refunds to Licensees	473	2,754
Representational Funds	10	7
Reimbursable Work	170	120
Increase in Annual Leave Accrual	838	450
Depreciation Expense	521	398
Equipment Write-offs and Adjustments	200	155
Total Cost of Operations	$238,676	$231,805
Less Revenues:		
Reimbursable work for Other Federal Agencies	$ 170	$ 119
Fees (to be deposited in U.S. Treasury as Miscellaneous Receipts)**		
Indemnity	2,805	4,752
Material Licenses	159	209
Facility Licenses	9,321	15,149
Other	215	64
Total Revenue	$ 12,670	$ 20,293
Net Cost of Operations before prior Year Adjustment	$226,006	$211,512
Prior Year Adjustment***	7,214	—
Net Cost of Operations	$233,220	$211,512

U.S. Government Investment In The Nuclear Regulatory Commission (From January 19, 1975, Through September 30, 1977—in thousands)

Appropriation Expenditures:	
Fiscal Year 1975 (January 19, 1975, through June 30, 1975)	$ 52,792
Fiscal Year 1976 (July 1, 1975, through September 30, 1976)	226,248
Fiscal Year 1977 (October 1, 1976 through September 30, 1977)	230,559
	$509,599
Unexpended Balance of Appropriated Funds in U.S. Treasury, September 30, 1977	$110,003
Transfer of Refunds Receivable from Atomic Energy Commission, January 19, 1975	429
Total Funds Appropriated	$620,031
Less:	
Funds returned to U.S. Treasury**	$ 33,759
Assets and Liabilities transferred from Other Federal Agencies without Reimbursement	2,018
Net Cost of Operations from January 19, 1975, through September 30, 1977	515,340
Total Deductions	$551,117
NRC Equity at September 30, 1977, as shown on Balance Sheet	$ 68,914

* Represents current year cost of plant and equipment acquisitions for use at ERDA/DOE facilities.

** These funds are not available for NRC use.

*** On March 11, 1977 NRC and ERDA (DOE) signed a policy agreement which stated that for all equipment purchased by NRC for use at ERDA/DOE facilities on NRC requested projects, title would rest with ERDA/DOE. This agreement was considered to be retroactive to January 19, 1975. Therefore, $7,213,512.77 in Plant and Equipment cost at September 30, 1976 associated with NRC projects being performed at ERDA/DOE facilities was transferred from the completed Plant & Equipment accounts and charged to Net Cost of Operations during Fiscal Year 1977.

Appendix 1

NRC Organization

(As of September 30, 1977)

COMMISSIONERS

Joseph M. Hendrie, Chairman
Victor Gilinsky
Richard T. Kennedy
Peter A. Bradford

The Commission Staff

General Counsel, James L. Kelley, Acting
Office of Policy Evaluation, Kenneth S. Pedersen, Director
Office of Public Affairs, Joseph J. Fouchard, Director
Office of Congressional Affairs, Carlton C. Kammerer, Director
Office of Inspector and Auditor, Thomas J. McTiernan, Director
Secretary of the Commission, Samuel J. Chilk

Other Offices

Advisory Committee on Reactor Safeguards, Myer Bender, Chairman
Atomic Safety & Licensing Board Panel, James R. Yore, Chairman
Atomic Safety & Licensing Appeal Panel, Alan S. Rosenthal, Chairman

EXECUTIVE DIRECTOR FOR OPERATIONS

Executive Director for Operations, Lee V. Gossick
Assistant Executive Director for Operations, William J. Dircks
Technical Advisor, Stephen H. Hanauer

Program Offices

Office of Nuclear Reactor Regulation, Edson G. Case, Acting Director
Office of Nuclear Materal Safety and Safeguards, Clifford V. Smith, Jr., Director
Office of Nuclear Regulatory Research, Saul Levine, Director
Office of Standards Development, Robert B. Minogue, Director
Office of Inspection and Enforcement, Ernst Volgenau, Director

Staff Offices

Office of Administration, Daniel J. Donoghue, Director
Executive Legal Director, Howard K. Shapar
Controller, Learned W. Barry, Acting
Office of Equal Employment Opportunity, Edward E. Tucker, Director
Office of Planning and Analysis, Harold S. Bassett, Acting Director
Office of International Programs, James R. Shea, Director
Office of State Programs, Robert G. Ryan, Director
Office of Management Information and Program Control, William G. McDonald, Director

Regional Offices

Region I Philadelphia, Pa., Boyce H. Grier, Director
Region II Atlanta, Ga., James P. O'Reilly, Director
Region III Chicago, Ill., James G. Keppler, Director
Region IV Dallas, Texas, E. Morris Howard, Director
Region V San Francisco, Calif., Robert H. Engelken, Director

The Energy Reorganization Act of 1974 specified that, below the Commission level, there would be an Executive Director for Operations, and three regulatory or "line" offices: the Offices of Nuclear Reactor Regulation, Nuclear Material Safety and Safeguards, and Nuclear Regulatory Research. During the transition phase of the organization's development, NRC determined that two additional program offices were needed to perform functions not specifically mandated by the legislation (see organization chart in Chapter 1).

The Executive Director for Operations directs and coordinates the Commission's operational and administrative activities and the development of policy options for Commission consideration.

The Office of Nuclear Reactor Regulation licenses nuclear power, test and research reactors under a two phase process. A construction permit is granted before facility construction can begin and an operating license is issued before fuel can be loaded. NRR reviews license applications to assure that the proposed facility can be built and operated without undue risk to the health and safety of the public and with minimal impact on the environment. NRR monitors operating reactor facilities during their lifetime through decommissioning. NRR also reviews the financial responsibility of each applicant for a construction permit, confirms that each applicant is properly indemnified against accidents, and verifies that the applicant(s) is not in violation of antitrust laws.

The Office of Nuclear Material Safety and Safeguards is responsible for ensuring public health and safety, and protection of national security and environmental values in the licensing and regulation of facilities and materials associated with the processing, transport, and handling of nuclear materials. NMSS reviews and assesses safeguards against potential threats, thefts, and sabotage, and works closely with other NRC organizations in coordinating safety and safeguards programs and in recommending research, standards, and policy options necessary for their successful operation.

The Office of Nuclear Regulatory Research plans and implements research programs of nuclear regulatory research which are deemed necessary for the performance of the Commission's licensing and regulatory functions. Research programs cover reactor safety areas such as fuel behavior, site safety, systems engineering, and computer code development and verification. Research is also performed on safeguards, health effects associated with the nuclear fuel cycle, environmental impact of nuclear power, waste treatment and disposal, and transportation of radioactive materials.

The Office of Standards Development develops regulations, guides, and other standards needed for regulation of facilities and materials with respect to radiological health and safety and environmental protection, for materials safeguards and plant protection, and for antitrust review. The Office also coordinates NRC participation in national and international standards activities.

The Office of Inspection and Enforcement inspects nuclear facilities and materials licensees to determine whether facilities are constructed and operations are conducted in compliance with license provisions and Commission regulations, and to identify conditions that may adversely affect the protection of nuclear materials and facilities, the environment, or the health and safety of the public; inspects applicants and their facilities to provide a basis for recommending issuance or denial of licenses; investigates accidents, incidents, and allegations of improper actions that involve nuclear material and facilities; and enforces NRC regulations and license provisions. IE, on behalf of NRC, manages and directs the Commission's five regional offices, located in Philadelphia, Pa., Atlanta, Ga., Chicago, Ill., Dallas, Texas, and San Francisco, Calif.

The Commission Staff

The Office of the Secretary provides secretariat services for the conduct of Commission business and implementation of decisions, including planning meetings and recording deliberations, manages the staff paper system, monitors the status of actions, and maintains the Commission's official records. The office also processes institutional correspondence, controls the service of documents in adjudicatory and public proceedings, supervises the Washington, D.C. Public Document Room, administers the NRC historical program, and provides administrative support for the Commission.

The Office of General Counsel serves the Commission in a variety of legal capacities. The Office assists the Commission in the review of Appeal Board decisions, petitions seeking direct Commission relief, and rulemaking proceedings, and drafts legal documents necessary to carry out the Commission's decisions. The General Counsel provides a legal analysis of proposed legislation affecting the Commission's functions and assists in drafting legislation and preparing testimony. The General Counsel also represents the Commission in court proceedings, frequently in conjunction with the Department of Justice.

The Office of Policy Evaluation plans and manages activities involved in performance of an independent review of positions developed by the NRC staff which require policy determinations by the Commission. The Office also conducts analyses and projects which are either self-generated or requested by the Commission.

Office of the Inspector and Auditor investigates to ascertain the integrity of all NRC operations; investigates allegations of NRC employee misconduct, equal employment and civil rights complaints, and claims for personal property loss or damage; conducts the NRC's internal audit activities; and hears individual employee concerns regarding Commission activities under the agency's "Open Door" policy. The office develops policies governing the Commission's financial and management audit program, and is the agency contact with the General Accounting Office on this function. Refers criminal matters to the Department of Justice and maintains liaison with law enforcement agencies.

The Office of Public Affairs plans and administers NRC's program to inform the public of Commission policies, programs and activities and keeps NRC management informed of public affairs activities of interest to the Commission.

The Office of Congressional Affairs provides advice and assistance to the Commission and senior staff on congres-

sional matters, coordinates NRC's congressional relations activities, and maintains liaison for the Commission with congressional committees and members of Congress.

Support Staff

The Office of Administration directs the agency's programs for organization and personnel management; security and classification; technical information and document control; facilities and materials license fees; contracting and procurement; rules, proceedings and document services; data processing; management development and training; and other administrative housekeeping and special services.

The Office of the Controller develops and maintains the Commission's financial management program, including accounting, budgeting, pricing, contract finance, automatic data processing equipment acquisition, and accounting for capitalized property. Prepares reports necessary to the management of NRC funds. Maintains liaison with the General Accounting Office, Office of Management and Budget, Congressional Committees, other agencies, and industry. The Controller also prepares the NRC Five-Year Plan and performance resource evaluation studies.

The Office of the Executive Legal Director provides legal advice and services to the Executive Director for Operations and staff, including representation in administrative proceedings involving the licensing of nuclear facilities and materials, and the enforcement of license conditions and regulations; counseling with respect to safeguards matters, contracts, security, patents, administration, research, personnel, and the development of regulations to implement applicable Federal statutes.

The Office of Equal Employment Opportunity develops and recommends overall policy providing for equal employment opportunity, recommends improvements or corrections to achieve this goal, and monitors the agency's affirmative action program.

The Office of International Programs plans and implements programs of international cooperation; coordinates NRC export-import policies, issuing licenses as directed by the Commission; and establishes regulatory relationships with foreign nations and international organizations.

The Office of Management Information and Program Control provides integrated information and control systems for schedules, manpower, budget, and program performance by line offices; administers agency-wide manpower reporting systems and performance appraisal reports; and analyzes and reports on the operating experience of licensed facilities.

The Office of Planning and Analysis performs program assessment and management studies; conducts analyses to determine NRC progress in achieving objectives; develops and implements Commission policy on value/impact analyses; and identifies new agency policy objectives.

The Office of State Programs directs programs relating to regulatory relationships with State governments and organizations and interstate bodies; manages the NRC State Agreements program; and provides Federal agency leadership in assisting State and local governments in radiological emergency response planning.

Other Offices

Advisory Committee on Reactor Safeguards. A statutory committee of 15 scientists and engineers, advises the Commission on the safety aspects of proposed and existing nuclear facilities and the adequacy of proposed reactor safety standards, and performs such other duties as the Commission may request.

Atomic Safety and Licensing Board Panel. Three-member licensing boards drawn from the Panel—made up of lawyers and others with expertise in various technical fields—conduct public hearings and make such intermediate or final decisions as the Commission may authorize in proceedings to grant, suspend, revoke, or amend NRC licenses.

Atomic Safety and Licensing Appeal Panel. Three-member appeal boards selected from the Panel exercise the authority and perform the review functions which would otherwise be carried out by the Commission in licensing proceedings. ASLB decisions are reviewable by an appeal board, either in response to an appeal or on its own initiative. The appeal board's decision also is subject to review by the Commission on its initiative or in response to a petition for discretionary review.

Appendix 2

NRC Committees and Boards

Advisory Committee on Reactor Safeguards

The ACRS was made a statutory committee in 1957 by Section 29 of the Atomic Energy Act of 1954, as amended. The committee reviews safety studies and facility license applications referred to it in accordance with the Atomic Energy Act and the Energy Reorganization Act and makes reports thereon which are made part of the public record of the proceeding. The committee provides advice with respect to the hazards of new or existing nuclear facilities and the adequacy of related safety standards. The committee also performs such other additional duties as the Commission may request. The members are appointed for four-year terms by the Commission. The committee annually elects its own chairman and vice chairman. As of September 30, 1977, the members were:

MYER BENDER, *Chairman,* Director, Engineering Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.

DR. STEPHEN LAWROSKI, *Vice Chairman,* Senior Engineer, Chemical Engineering Division, Argonne National Laboratory, Argonne, Ill.

JOHN H. ARNOLD, Consultant, Air Products and Chemicals, Inc., Allentown, Pa.

DR. SPENCER H. BUSH, Senior Staff Consultant, Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Wash.

DR. MAX W. CARBON, Professor and Chairman of Nuclear Engineering Department, University of Wisconsin, Madison, Wis.

JESSE EBERSOLE, Retired Head Nuclear Engineer, Division of Engineering Design, Tennessee Valley Authority, Knoxville, Tenn.

HAROLD ETHERINGTON, Consulting Engineer (Mechanical Reactor Engineering), Jupiter, Fla.

DR. HERBERT S. ISBIN, Professor, Chemical Engineering, University of Minnesota, Minneapolis, Minn.

PROF. WILLIAM KERR, Professor of Nuclear Engineering, Director of Michigan Memorial-Phoenix Project, University of Michigan, Ann Arbor, Mich.

Dr. J. CARSON MARK, Retired Division Leader, Los Alamos Scientific Laboratory, Los Alamos, N.M.

Dr. DADE W. MOELLER, Professor of Engineering in Environmental Health, Chairman of Environmental Health Sciences Department and Associate Director, Kresge Center for Environmental Health, School of Public Health, Harvard University, Boston, Mass.

Dr. DAVID OKRENT, Professor, School of Engineering and Applied Science, University of California, Los Angeles, Calif.

Dr. MILTON S. PLESSET, Professor, Department of Engineering Science, California Institute of Technology, Pasadena, Calif.

Dr. PAUL G. SHEWMON, Professor, Chairman of Metallurgical Engineering Department, Ohio State University, Columbus, Ohio

Dr. CHESTER P. SIESS, Professor, Head of Civil Engineering Department, University of Illinois, Urbana, Ill.

Atomic Safety and Licensing Board Panel

Section 191 of the Atomic Energy Act of 1954 authorizes the Commission to establish one or more atomic safety and licensing boards, each comprised of three members, one of whom is to be qualified in the conduct of administrative proceedings and two of whom will have such technical or other qualifications as the Commission deems appropriate to the issues to be decided. The boards conduct such hearings as the Commission may direct and make such intermediate or final decisions as it may authorize in proceedings with respect to granting, suspending, revoking or amending licenses or authorizations. The Atomic Safety and Licensing Board Panel (ASLBP) Office—with a permanent chairman who coordinates and supervises the ASLBP activities—serves as spokesman for the panel, and makes policy recommendations to the Commission concerning conduct of hearings and hearing procedures. Pursuant to subsection 201(g)(1) of the Energy Reorganization Act of 1974, the functions performed by the licensing boards were specifically transferred to the Nuclear Regulatory Commission. As of September 30, 1977, the ASLBP was composed of the following members and professional staff ("*" denotes full-time ASLBP members and staff):

JAMES R. YORE, *Chairman, ASLBP,* Attorney, U.S. Nuclear Regulatory Commission, Bethesda, Md.*

Dr. GEORGE C. ANDERSON, Department of Oceanography, University of Washington, Seattle, Wash.

ELIZABETH S. BOWERS, ASLBP Attorney, Bethesda, Md.*

JOHN H. BREBBIA, Attorney with law firm of Alston, Miller & Gaines, Washington, D.C.

R. BEECHER BRIGGS, Retired Senior Research Engineer, Oak Ridge National Laboratory, Oak Ridge, Tenn.

GLENN O. BRIGHT, ASLBP Engineer, Bethesda, Md.*

Dr. A. DIXON CALLIHAN, Retired Physicist, Union Carbide Corporation, Oak Ridge, Tenn.

Dr. E. LEONARD CHEATUM, Retired Director of Institute of Natural Resources, University of Georgia, Watkinsville, Ga.

HUGH K. CLARK, Retired Attorney, E. I. duPont de Nemours & Company, Kennedyville, Md.
Dr. RICHARD F. COLE, ASLBP Environmental Scientist, Bethesda, Md.*
FREDERIC J. COUFAL, ASLBP Attorney, Bethesda, Md.*
Dr. FREDERICK P. COWAN, Retired Physicist, Brookhaven National Laboratory, Stuart, Fla.
Dr. FRANKLIN C. DAIBER, College of Marine Studies, University of Delaware, Newark, Del.
VALENTINE B. DEALE, Attorney at Law, Washington, D.C.
RALPH S. DECKER, Retired Engineer, U.S. Atomic Energy Commission, Cambridge, Md.
Dr. DONALD P. DE SYLVA, Professor, Biology and Living Resources, School of Marine and Atmospheric Science, University of Miami, Miami, Fla.
MICHAEL A. DUGGAN, College of Business Administration, University of Texas, Austin, Tex.
Dr. KENNETH G. ELZINGA, Department of Economics, University of Virginia, Charlottesville, Va.
Dr. GEORGE A. FERGUSON, Professor of Nuclear Engineering, Howard University, Washington, D.C.
Dr. HARRY FOREMEN, Director, Center for Population Studies, University of Minnesota, Minneapolis, Minn.
JOHN H. FRYE, III, ASLBP Legal Assistant, Bethesda, Md.*
JOHN M. FRYSIAK, ASLBP Attorney, Bethesda, Md.*
MICHAEL GLASER, Partner, law firm of Glaser and Fletcher, Washington, D.C.
ANDREW C. GOODHOPE, Retired Administrative Law Judge, Federal Trade Commission, Wheaton, Md.
Dr. DAVID B. HALL, Los Alamos Scientific Laboratory, Los Alamos, N.M.
Dr. CADET HAND, Director, Bodega Marine Laboratory, University of California, Bodega Bay, Calif.
Dr. DAVID L. HETRICK, Professor, Nuclear Engineering Department, University of Arizona, Tucson, Ariz.
ERNEST E. HILL, Engineer, Lawrence Livermore Laboratory, University of California, Livermore, Calif.
Dr. ROBERT L. HOLTON, School of Oceanography, Oregon State University, Corvallis, Ore.
Dr. FRANK F. HOOPER, Chairman, Resource Ecology Program, School of Natural Resources, University of Michigan, Ann Arbor, Mich.
SAMUEL W. JENSCH, Administrative Law Judge, U.S. Nuclear Regulatory Commission, Bethesda, Md.*
ELIZABETH B. JOHNSON, Engineer, Oak Ridge National Laboratory, Oak Ridge, Tenn.
Dr. WALTER H. JORDAN, Retired Senior Research Advisor & Physicist, Oak Ridge National Laboratory, Oak Ridge, Tenn.
LESTER KORNBLITH, Jr., ASLBP Engineer, Bethesda, Md.*
Dr. JAMES C. LAMB, III, Department of Environmental Sciences & Engineering, University of North Carolina, Chapel Hill, N.C.
MARGARET M. LAURENCE, Partner, law firm of Laurence, Stokes and Neilan, Arlington, Va.
ROBERT M. LAZO, ASLBP Executive Secretary, Bethesda, Md.*
Dr. J. V. LEEDS, Jr., Professor, Environmental and Electrical Engineering, Rice University, Houston, Tex.
GUSTAVE A. LINENBERGER, ASLBP Physicist, Bethesda, Md.*
Dr. LINDA W. LITTLE, Associate Professor, Department of Environmental Sciences & Engineering, University of North Carolina, Chapel Hill, N.C.
Dr. STANLEY LIVINGSTON, Retired Associate Director, Atomic Energy Commission National Accelerator Laboratory, Santa Fe, N.M.
Dr. EMMETH A. LUEBKE, ASLBP Physicist, Bethesda, Md.*
EDWARD LUTON, ASLBP Attorney, Bethesda, Md.*
Dr. JOHN R. LYMAN, Retired Professor of Oceanography, University of North Carolina, Chapel Hill, N.C.
Dr. MARVIN M. MANN, ASLBP Technical Advisor, Bethesda, Md.*
Dr. WILLIAM E. MARTIN, Senior Ecologist, Battelle Memorial Institute, Columbus, Ohio
Dr. KENNETH A. MCCOLLOM, Dean, Division of Engineering, Technology and Architecture, Oklahoma State University, Stillwater, Okla.
GARY L. MILHOLLIN, University of Wisconsin Law School, Madison, Wis.
MARSHALL E. MILLER, ASLBP Attorney, Bethesda, Md.*
Dr. OSCAR H. PARIS, ASLBP Environmental Scientist, Bethesda, Md.*
Dr. HUGH PAXTON, Los Alamos Scientific Laboratory, Los Alamos, N.M.
Dr. PAUL W. PURDOM, Director, Environmental Studies Institute, Drexel University, Philadelphia, Pa.
Dr. FORREST J. REMICK, Director, Institute of Science and Engineering, Pennsylvania State University, University Park, Pa.
Dr. ERNEST O. SALO, Professor, Fisheries Research Institute-WH-10, College of Fisheries, University of Washington, Seattle, Wash.
DAVID R. SCHINK, Department of Oceanography, Texas A&M University, College Station, Tex.
CARL W. SCHWARZ, Partner, law firm of Metzger, Noble, Schwarz & Kempler, Washington, D.C.
FREDERICK J. SHON, ASLBP Physicist, Bethesda, Md.*
IVAN W. SMITH, ASLBP Attorney, Bethesda, Md.*
Dr. MARTIN J. STEINDLER, Chemist, Argonne National Laboratory, Argonne, Ill.
Dr. QUENTIN J. STOBER, Research Associate Professor, Fisheries Research Institute, University of Washington, Seattle, Wash.
JOSEPH F. TUBRIDY, Attorney at Law, Washington, D.C.
JOHN F. WOLF, Attorney, law firm of Lamensdorf, Leonard & Moore, Washington, D.C.
SHELDON J. WOLFE, ASLBP Attorney, Bethesda, Md.*

Atomic Safety and Licensing Appeal Panel

An Atomic Safety and Licensing Appeal Board, established effective September 18; 1969, was delegated the authority to perform the review function which would otherwise be performed by the Commission in proceedings on applications for licenses or authorization in which the Commission had a direct financial interest, and in such other licensing proceedings as the Commission might specify.

In view of the increase in the number of proceedings subject to administrative appellate review, the Atomic Safety and Licensing Appeal Panel was established on October 25, 1972, from whose membership three-member

appeal boards could be designated for each proceeding in which the Commission had delegated its authority to an appeal board. At the same time, the Commission modified its rules to delegate authority to appeal boards in all proceedings involving the licensing of production and utilization facilities (for example, power reactors).

Pursuant to subsection 201(g)(1) of the Energy Reorganization Act of 1974, the functions performed by appeal boards were specifically transferred to the Nuclear Regulatory Commission. The Commission appoints members to the Appeal Panel, and the Chairman of the panel (or, in his absence, the Vice Chairman) designates a three-member appeal board for each proceeding. The Commission retains review authority over decisions and actions of appeal boards. The appeal board panel, on September 30, 1977, was composed of the following full-time members and professional staff:

ALAN S. ROSENTHAL, *Appeal Panel Chairman*, U.S. Nuclear Regulatory Commission, Bethesda, Md.
Dr. JOHN H. BUCK, *Appeal Panel Vice Chairman*, U.S. Nuclear Regulatory Commission, Bethesda, Md.
MICHAEL C. FARRAR, Appeal Panel Member, U.S. Nuclear Regulatory Commission, Bethesda, Md.
RICHARD S. SALZMAN, Appeal Panel Member, U.S. Nuclear Regulatory Commission, Bethesda, Md.
JEROME E. SHARFMAN, Appeal Panel Member, U.S. Nuclear Regulatory Commission, Bethesda, Md.
CHARLES BECHHOEFER, Counsel, Appeal Panel, U.S. Nuclear Regulatory Commission, Bethesda, Md.
CARDIS L. ALLEN, Technical Advisor, Appeal Panel, U.S. Nuclear Regulatory Commission, Bethesda, Md.
S. LORRAINE CROSS, Legal Intern, Appeal Panel, U.S. Nuclear Regulatory Commission, Bethesda, Md.
LENORE R. MAGIDA, Legal Intern, Appeal Panel, U.S. Nuclear Regulatory Commission, Bethesda, Md.

During fiscal year 1977, the Appeal Panel also included the following part-time members:

Dr. LAWRENCE R. QUARLES, Dean Emeritus, School of Engineering and Applied Science, University of Virginia, Charlottesville, Va.
DR. W. REED JOHNSON, Professor of Nuclear Engineering, University of Virginia, Charlottesville, Va.

Advisory Committee on Medical Uses of Isotopes

The Advisory Committee on Medical Uses of Isotopes was established in July 1958. The ACMI, composed of qualified physicians and scientists, considers medical questions referred to it by the NRC staff, and renders expert opinion regarding medical use of radioisotopes. The ACMI also advises the NRC staff, as requested, on matters of policy. Members are employed under yearly personal services contracts. The Deputy Directory, Division of Fuel Cycle and Material Safety, serves as Committee Chairman. As of September 30, 1977, the members were:

RICHARD E. CUNNINGHAM, *Chairman, ACMI*, Deputy Director, Division of Fuel Cycle and Material Safety, U.S. Nuclear Regulatory Commission, Silver Spring, Md.
Dr. FRANK H. DE LAND, Chief, Nuclear Medicine Department, Veterans' Administration Hospital, Lexington, Ky.
Dr. DAVID E. KUHL, Associate Director, Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles, Calif.
Dr. JAMES L. QUINN, III, Director, Nuclear Medicine Department, Northwestern Memorial Hospital, Chicago, Ill.
Dr. HENRY N. WAGNER, Jr., Professor, Radiology and Radiological Science, Johns Hopkins Medical Institution, Baltimore, Md.
Dr. EDWARD W. WEBSTER, Director, Department of Radiation Physics, Massachusetts General Hospital, Boston, Mass.
Dr. JOSEPH B. WORKMAN, Associate Professor of Radiology, Duke University Medical Center, Durham, N.C.

Appendix 3

Public Document Rooms

Most documents originated by NRC, or submitted to it for consideration, are placed in the Commission's Public Document Room at 1717 H Street, N.W., Washington, DC, for public inspection. In addition, documents relating to licensing proceedings or licensed operation of specific facilities are made available in local public document rooms established in the vicinity of each proposed or existing nuclear facility. The locations of these local PDRs as of December 1977, and the name of the facility for which documents are retained, are listed below. (NOTE: Due to changes in the location of local PDRs, an updated listing may be obtained by writing to the Local Public Document Room Branch, Division of Rules and Records, U.S. Nuclear Regulatory Commission, Washington, DC 20555.)

ALABAMA

- Mrs. Maude S. Miller
  Athens Public Library
  South and Forrest
  Athens, Ala. 35611
  Browns Ferry nuclear plant
- Mr. Wayne Love
  G. S. Houston Memorial Library
  212 W. Verdeshaw Street
  Dothan, Ala. 36301
  Farley nuclear plant
- Ms. Joanne Wyatt
  Clanton Public Library
  100 First Street
  Clanton, Ala. 35045
  Barton nuclear plant
- Mrs. Peggy McCutchen
  Scottsboro Public Library
  1002 South Broad Street
  Scottsboro, Ala. 35768
  Bellafonte nuclear plant

ARIZONA

- Mrs. Mary Carlson
  Phoenix Public Library
  Science and Industry Section
  12 East McDowell Road
  Phoenix, Ariz. 85004
  Palo Verde nuclear plant

ARKANSAS

- Mr. Vaughn
  Arkansas Polytechnic College
  Russelville, Ark. 72801
  Arkansas Nuclear One

CALIFORNIA

- Mr. C. Combs
  Kern County Library
  1315 Truxtun Avenue
  Bakersfield, Calif. 93301
  San Joaquin nuclear plant
- Mrs. Alice Rosenberger
  Palo Verde Valley District Library
  125 West Chanslorway
  Blythe, Calif. 92255
  Mr. William B. Rohan
  San Diego County Law Library
  1105 Front Street
  San Diego, Calif. 92101
  Sundesert nuclear plant
- Mrs. Lucille A. Martel
  Mission Viejo Branch Library
  24851 Chrisanta Drive
  Mission Viejo, Calif. 92676
  San Onofre nuclear plant
- Mrs. Patricia Clark
  San Luis Obispo County Free Library
  888 Morro Street
  San Luis Obispo, Calif. 93406
  Diablo Canyon nuclear plant
- Mrs. Judy Kapprott
  Humboldt County Library
  636 F Street
  Eureka, Calif. 95501
  Humboldt Bay nuclear plant
- Mrs. Dorothy Harvey
  Business & Municipal Department
  Sacramento City/County Library
  828 I Street
  Sacramento, Calif. 95814
  Rancho Seco nuclear plant
- Mr. Andrew La Mance
  Stanislaus County Free Library
  1500 I Street
  Modesto, Calif. 95345
  Stanislaus nuclear plant

COLORADO

- Miss Ester Fromm
  Greeley Public Library
  City Complex Building
  Greeley, Colo. 80631
  Fort St. Vrain nuclear plant

CONNECTICUT

- Mrs. Judy Liskov
  Waterford Public Library
  Rope Ferry Road—Route 156
  Waterford, Conn. 06385
  Millstone nuclear plant
- Mr. William Van Beynum
  Russell Library
  119 Broad Street
  Middletown, Conn. 06457
  Haddam Neck nuclear plant

DELAWARE

- Mrs. Yvonne Puffer
  Newark Free Library
  Elkton Road and Delaware Avenue
  Newark, Del. 19711
  Summit nuclear plant

FLORIDA

- Ms. Sally Litton
  Jacksonville Public Library
  122 North Ocean Street
  Jacksonville, Fla. 32204
  Offshore Power Systems manufacturing facility
- Mrs. R. Scott
  Indian River Junior College Library
  3209 Virginia Avenue
  Ft. Pierce, Fla. 33450
  St. Lucie nuclear plant

- Miss Elizabeth Peeler
  Environmental and Urban Affairs Library
  Florida International University
  Miami, Fla. 33199
  Turkey Point nuclear plant
- Mrs. Bonsall
  Crystal River Public Library
  668 N.W. First
  Crystal River, Fla. 32639
  Crystal River nuclear plant

GEORGIA

- Mrs. J. W. Borom
  Burke County Library
  Fourth Street
  Waynesboro, Ga. 30830
  Vogtle nuclear plant
- Ms. Annette Osborne
  Appling County Public Library
  Parker Street
  Baxley, Ga. 31513
  Hatch nuclear plant

ILLINOIS

- Mr. Ed Anderson
  Illinois Valley Community College
  Rural Route #1
  Oglesby, Ill. 16348
  La Salle nuclear plant
- Mrs. Pam Wilson
  Morris Public Library
  604 Liberty Street
  Morris, Ill. 60451
  Dresden nuclear plant
  Midwest fuel recovery plant
- Mrs. Marie Hoschied
  Moline Public Library
  504 17th Street
  Moline, Ill. 61250
  Quad Cities nuclear plant
- Ms. Jo Ann Ellingson
  Zion-Benton Public Library
  2600 Emmaus Avenue
  Zion, Ill. 60099
  Zion nuclear plant
- Mrs. M. Evans
  Vespasian Warner Public Library
  120 West Johnson Street
  Clinton, Ill. 61727
  Clinton nuclear plant
- Mrs. Penny O'Roarke
  Byron Public Library
  Third and Washington Streets
  Byron, Ill. 61010
  Byron nuclear plant
- Mr. Thomas Carter
  Wilmington Township Public Library
  201 S. Kankakee Street
  Wilmington, Ill. 60481
  Braidwood nuclear plant
- Savanna Township Public Library
  326 Third Street
  Savanna, Ill. 61074
  Carroll nuclear plant

INDIANA

- Mr. David Palmer
  West Chester Township Public Library
  125 South Second Street
  Chesterton, Ind. 46304
  Bailly nuclear plant
- Mr. Don C. Johnson
  Madison-Jefferson County Public Library
  420 West Main Street
  Madison, Ind. 47250
  Marble Hill nuclear plant

IOWA

- Miss Kay Burke
  Reference Service
  Cedar Rapids Public Library
  428 Third Avenue, S.E.
  Cedar Rapids, Iowa 52401
  Duane Arnold nuclear plant

KANSAS

- Mr. Jack Scott
  Coffey County Courthouse
  Burlington, Kans. 66839
  Wolf Creek nuclear plant

LOUISIANA

- Business & Science Division
  New Orleans Public Library
  219 Loyola Avenue
  New Orleans, La. 70140
  Offshore Power Systems manufacturing facility
- Mr. Ken Owen
  University of New Orleans Library
  Louisiana Collection, Lakefront
  New Orleans, La. 70122
  Waterford nuclear plant
- Miss Janie Videtto
  Audubon Library,
  West Feliciana Branch
  Ferdinand Street
  St. Francisville, La. 70775

  Mr. Jimmie H. Hoover
  Government Documents Department
  Louisiana State University
  Baton Rouge, La. 70803
  River Bend nuclear plant

MAINE

- Mrs. Barbara Shelton
  Wiscasset Public Library
  High Street
  Wiscasset, Me. 04578
  Maine Yankee nuclear plant

MARYLAND

- Mrs. Elizabeth Hart
  Charles County Library
  Garret and Charles Streets
  La Plata, Md. 20646
  Douglas Point nuclear plant
- Mrs. Marie Barrett
  Calvert County Library
  Prince Frederick, Md. 20678
  Calvert Cliffs nuclear plant
- Ms. Pamela R. Schott
  Harford Community College
  401 Thomas Run Road
  Bel Air, Md. 21014
  Perryman nuclear plant

MASSACHUSETTS

- Mrs. Margaret Howland
  Greenfield Community College
  One College Drive
  Greenfield, Mass. 01301
  Yankee Rowe nuclear plant
- Mr. Mark Titus
  Plymouth Public Library
  North Street
  Plymouth, Mass. 02360
  Pilgrim nuclear plant
- Ms. Sue SanSoucie
  The Carnegie Library
  Avenue A
  Turner Falls, Mass. 01376
  Montague nuclear plant

MICHIGAN

- Mrs. Diana Shamp
  Reference Department
  Kalamazoo Public Library
  315 South Rose Street
  Kalamazoo, Mich. 49006
  Palisades nuclear plant
- Mrs. Katherine Thomson
  St. Clair County Library
  210 McMorran Boulevard
  Port Huron, Mich. 48060
  Greenwood nuclear plant
- Mrs. M. B. Wallick
  Charlevoix Public Library
  107 Clinton Street
  Charlevoix, Mich. 49720
  Bic Rock Point nuclear plant
- Mrs. Alma FitzGibbons
  Grace Dow Memorial Library
  1710 West St. Andrews Road

Midland, Mich. 48640
Midland nuclear plant

- Ms. Ann Stobbe
Maude Preston Palenske Memorial Library
500 Market Street
St. Joseph, Mich. 49085
D. C. Cook nuclear plant

- Mrs. Marcia Learned
Reference Department
Monroe County Library System
3700 South Custer Road
Monroe, Mich. 48161
Fermi nuclear plant

MINNESOTA

- Mrs. Copeland
Environmental Conservation Library
Minneapolis Public Library
300 Nicollet Mall
Minneapolis, Minn. 55401
Monticello nuclear plant
Prarie Island nuclear plant

MISSOURI

- Mrs. Freida Mittwede
Fulton City Library
709 Market Street
Fulton, Mo. 65251

Mrs. Ranata Rotkowicz
Olin Library of Washington University
Skinker & Lindell Boulevard
St. Louis, Mo. 63130
Callaway nuclear plant

MISSISSIPPI

- Mrs. Stella Jennings
Clairborne County Chancery Clerk
Clairborne County Courthouse
Port Gibson, Miss. 39150
Grand Gulf nuclear plant

- Mr. William McMullin
Corinth Public Library
1023 Fillmore Street
Corinth, Miss. 38834
Yellow Creek nuclear plant

NEBRASKA

- Mrs. Leona Hansen
Blair Public Library
1665 Lincoln Street
Blair, Neb. 68008
Ft. Calhoun 1 nuclear plant

- Mr. Frank Gibson
W. Dale Clark Library
215 South 15th Street
Omaha, Neb. 68102
Ft. Calhoun 2 nuclear plant

- Loy Mowery
Auburn Public Library
118 15th Street
Auburn, Neb. 68305
Cooper nuclear plant

NEW HAMPSHIRE

- Miss Pamela Gjettum
Exeter Public Library
Front Street
Exeter, N.H. 03883
Seabrook nuclear plant

NEW JERSEY

- Mr. Arthur Flandreu, Director
Library Services
Stockton State College Library
Pomona, N.J. 08240
Offshore Power Systems manufacturing facility
Atlantic nuclear plant

- Miss Elizabeth Fogg
Salem Free Public Library
112 West Broadway
Salem, N.J. 08079
Salem nuclear plant
Hope Creek nuclear plant

- Mrs. Gail Colure
Ocean County Library
Brick Township Branch
401 Chambers Bridge Road
Brick Town, N.J. 08723
Oyster Creek nuclear plant
Forked River nuclear plant

NEW YORK

- Mr. Patrick Lozitto
Administrative Assistant
Oswego County Office Building
46 East Bridge Street
Oswego, N.Y. 13126
Nine Mile Point nuclear plant
Sterling nuclear plant
FitzPatrick nuclear plant

- Mrs. June Rogoff
Rochester Public Library
Business & Social Science Division
115 South Avenue
Rochester, N.Y. 14604
Ginna nuclear plant

- Mr. Oliver Swift
White Plains Public Library
100 Martine Avenue
White Plains, N.Y. 10601
Indian Point nuclear plant

- Mr. Richard Lusak
Comsewogue Public Library
170 Terryville Road
Port Jefferson, N.Y. 11776
Shoreham nuclear plant

- Mrs. E. Overton
Riverhead Free Library
330 Court Street
Riverhead, N.Y. 11901
Jamesport nuclear plant

- Mrs. Dorothy Augustine
Catskill Public Library
One Franklin Street
Catskill, N.Y. 12414
Greene County nuclear plant

- Mr. Stanley Zukowzki, Head
Science & Technology Department
Buffalo & Erie County Public Library
Lafayette Square
Buffalo, N.Y. 14203

Ms. Marsha Russell
Town of Concord Public Library
23 North Buffalo Street
Springville, N.Y. 14141

Mrs. Walter Baumann
Memorial Library of Little Valley
Main Street
Little Valley, N.Y. 14755
NFS fuel reprocessing plant and UF_6 facility

NORTH CAROLINA

- Mrs. Ruth Osborne
Public Library of Charlotte & Menklenburg County
310 North Tryon Street
Charlotte, N.C. 28202
McGuire nuclear plant

- Mr. Roy Dicks, Documents Librarian
Wake County Public Library
104 Fayetteville Street
Raleigh, N.C. 27601
Shearon Harris nuclear plant

- Mr. David G. Ferguson
Davie County Public Library
416 North Main Street
P.O. Box 158
Mocksville, N.C. 27028
Perkins nuclear plant

- Mr. Phillip Barton
Southport-Brunswick County Library
109 West Moore Street
Southport, N.C. 28461
Brunswick nuclear plant

- Mrs. Charlotte Ellis
Franklin County Library
1026 Justice Street
Louisburg, N.C. 27549
Gulf Youngsville fuel fabrication facility

OHIO

- Mrs. Betty Waltman
  Perry Public Library
  3753 Main Street
  Perry, Ohio 44081
  Perry nuclear plant
- Miss Diana Conner
  Clermont County Library
  Third and Broadway Streets
  Batavia, Ohio 45103
  Zimmer nuclear plant
- Mr. Donald Fought
  Ida Rupp Public Library
  310 Madison Street
  Port Clinton, Ohio 43452
  Davis-Besse nuclear plant
- Mrs. Esther Schedley
  Berlin Township Public Library
  Four East Main Street
  Berlin Heights, Ohio 44814
  Erie nuclear plant

OKLAHOMA

- Mrs. Linda Hill
  Tulsa City/County Library
  400 Civic Center
  Tulsa, Okla. 74102
  Black Fox nuclear plant
- Mrs. O. J. Grosclaude
  Librarian
  Sallisaw City Library
  111 North Elm
  Sallisaw, Okla. 74955
  Sequoyah UF_6 facility
- Ms. Hazel Nicholson
  Guthrie Public Library
  402 East Oklahoma Street
  Guthrie, Okla. 73044
  Cimarron Pu fabrication plant and uranium fuel facility

OREGON

- Mr. H. B. Allen
  City Hall, Records Office
  P.O. Box 356
  Arlington, Ore. 97812
  Pebble Springs nuclear plant
- Mr. Zimmer
  Columbia County Courthouse
  Law Library Circuit Court Room
  St. Helens, Ore. 97501
  Trojan nuclear plant

PENNSYLVANIA

- Reference Department
  Osterhout Free Library
  71 South Franklin Street
  Wilkes-Barre, Pa. 18701
  Susquehanna nuclear plant
- Mr. John Geschwindt
  Government Publications Section
  State Library of Pennsylvania
  Box 1601 (Education Building)
  Harrisburg, Pa. 17126
  Peach Bottom nuclear plant
  Three Mile Island nuclear plant
  Fulton nuclear plant
- Mrs. Gordon Bauerle
  Pottstown Public Library
  500 High Street
  Pottstown, Pa. 19464
  Limerick nuclear plant
- Apollo Memorial Library
  219 North Pennsylvania Avenue
  Apollo, Pa. 15613
  Apollo UF_6 and Pu facilities
- Mr. Anthony Martin
  Carnegie Library of Pittsburgh
  4400 Forbes Avenue
  Pittsburgh, Pa. 15213
  Cheswick Fuel Development Laboratories
- Mr. F. E. Virostek
  B. F. Jones Memorial Library
  663 Franklin Avenue
  Aliquippa, Pa. 15001
  Beaver Valley nuclear plant
  Shippingport Light Water Breeder Reactor

RHODE ISLAND

- Mrs. Ann Crawford
  Cross Mill Public Library
  Old Post Road
  Charlestown, R.I. 02831

  Mrs. Ann Shaw
  University of Rhode Island
  University Library
  Government Publications Office
  Kingston, R.I. 02881

  Mr. Philip Newbury
  Senior Nuclear Information Coordinator
  New England Power Company
  P.O. Box 600
  Charlestown, R.I. 02813
  New England nuclear plant

SOUTH CAROLINA

- Joe E. Garcia
  York County Library
  325 South Oakland Avenue
  Rockhill, S.C. 29730
  Catawba nuclear plant
- Reference Department
  Richland County Public Library
  1400 Sumter Street
  Columbia, S.C. 29201
  Summer nuclear plant
- Miss Louise Marcum
  Oconee County Library
  201 South Spring Street
  Walhalla, S.C. 29691
  Oconee nuclear plant
- Mrs. Allene Reep
  Hartsville Memorial Library
  Home and Fifth Avenues
  Hartsville, S.C. 29550
  H.B. Robinson nuclear plant
- Mr. David Lyon
  Cherokee County Library
  300 East Rutledge Avenue
  Gaffney, S.C. 29340
  Cherokee nuclear plant
- Mr. Fred Bodiford
  County Supervisor
  County Office Building, Room 105
  P.O. Box 443
  Barnwell, S.C. 29812
  Barnwell fuel plant
  UF_6 facility
  Barnwell fuel storage station
- Mr. Carl Stone
  Anderson County Library
  202 East Greenville Street
  Anderson, S.C. 29621
  Recycle fuel plant

TENNESSEE

- Mrs. A. A. Louderdale
  Fred A. Vought Library
  311 White Oak Street
  Hartsville, Tenn. 37074
  Hartsville nuclear plant
- Ms. Dorothy Dismuke
  Oak Ridge Public Library
  Civic Center
  Oak Ridge, Tenn. 37830

  Mrs. Patricia Rugg
  Lawson McGhee Public Library
  500 West Church Street
  Knoxville, Tenn. 37902
  Clinch River breeder plant
  Exxon nuclear fuel recovery center
  Fuel fabrication facility
- Mr. Wally Keasler
  Chattanooga-Hamilton County Bicentennial Library
  1001 Broad Street
  Chattanooga, Tenn. 37402
  Sequoyah nuclear plant
  Watts Bar nuclear plant

  Mr. T. Cal Hendrix
  Kingsport Public Library
  Broad and New Streets
  Kingsport, Tenn. 37660
  Phipps Bend nuclear plant

TEXAS

- Mrs. tim Whitworth
  Somervell County Public Library
  On The Square
  P.O. Box 417
  Glen Rose, Tex. 76403
  Comanche Peak nuclear plant
- Mrs. Rosie Hawthorne
  Newton County Library
  P.O. Box 657
  Newton, Tex. 77034
  Blue Hills nuclear plant
- Honorable Bert Huebner
  Judge, Matagorda County
  Matagorda County Courthouse
  Bay City, Tex. 77414
  South Texas nuclear plant
- Mrs. Kroesche
  Sealy Public Library
  415 Main Street
  Sealey, Tx. 77474
  Allens Creek nuclear plant

VERMONT

- Mrs. June Bryant
  Brooks Memorial Library
  224 Main Street
  Brattleboro, Vt. 05301
  Vermont Yankee nuclear plant

VIRGINIA

- Ms. Sandra Peterson
  Swem Library
  College of William & Mary
  Williamsburg, Va. 23185
  Surry nuclear plant
- Mr. Edward Kube
  Board of Supervisors
  Louisa County Courthouse
  P.O. Box 27
  Louisa, Va. 23093

Mr. Gregory Johnson
Alderman Library
Manuscripts Department
University of Virginia
Charlottesville, Va. 22901
North Anna nuclear plant

WASHINGTON

- Miss D. E. Roberts, City Librarian
  Richland Public Library
  Swift and Northgate Streets
  Richland, Wash. 99352
  WPPSS 1, 2, and 4 nuclear plants
  Exxon fuel plant
- Mrs. D. Stendal
  Chief Librarian
  Sedro Wooley Library
  802 Ball Avenue
  Sedro Wooley, Wash. 98294
  Skagit nuclear plant
- Ms. Selma Nielsen
  W. H. Abel Memorial Library
  125 Main Street South
  Montesano, Wash. 98563
  WPPSS 3 and 5 nuclear plants

WISCONSIN

- Mrs. Jan Radloff
  LaCrosse Public Library
  800 Main Street
  LaCrosse, Wis. 54601
  LaCrosse nuclear plant
- Mr. Arthur M. Fish
  Document Department, Library
  University of Wisconsin
  Stevens Point
  Stevens Point, Wis. 54481
  Point Beach nuclear plant
  Wood nuclear plant
- Mrs. M. Gates
  Dwight-Foster Public Library
  102 East Milwaukee Avenue
  Fort Atkinson, Wis. 53538

Ms. Ann Waidelich
Municipal Reference Service
Madison Public Library
Room 103-B
City County Building
Madison, Wis. 53709
Koshkonong nuclear plant

- Miss Sue Grossheuch
  Kewaunee Public Library
  833 Juneau Street
  Kewaunee, Wis. 54216
  Kewaunee nuclear plant
- Mr. John Jax
  Attention: Mr. Phil Sawin
  University of Wisconsin
  Stout Library
  Menomonie, Wis. 54751
  Tyrone nuclear plant
- Mrs. Frances Wendtland
  Mead Public Library
  710 North Eighth Street
  Sheboygan, Wis. 53081
  Haven nuclear plant

WYOMING

- Mrs. Carroll Highfill
  Converse County Library
  Douglas, Wyo. 82633
  Highland uranium mill
- Mrs. Margaret Baker
  Carbon County Public Library
  Courthouse
  Rawlins, Wyo. 82301
  Shirley Basin uranium mill

PUERTO RICO

- Mrs. Rosario Cabrera
  Public Library, City Hall
  Jose de Diego Avenue
  P.O. Box 1086
  Arecibo, P.R. 00612

  Mrs. Amalia Ruiz De Porras
  Etien Totti Public Library
  College of Engineers, Architects & Surveyors
  Urb Roosevelt Development
  Hato Rey, P.R. 00918
  North Coast nuclear plant

Appendix 4

Regulations

The regulations of the Nuclear Regulatory Commission are contained in Title 10, Chapter I, of the Code of Federal Regulations. Effective and proposed regulations concerning licensed activities, and certain policy statements relating thereto, which were published in the Federal Register during fiscal year 1977 are set forth below.

REGULATIONS AND AMENDMENTS PUT INTO EFFECT

Disclosure of Medical Records Under the Control of NRC—Part 9

On October 14, 1976, an amendment to Part 9 was published, effective immediately, which deleted §9.62(a), thereby permitting disclosure of medical records under the Commission's control directly to the requester.

Environmental Effects of the Uranium Fuel Cycle

On November 11, 1976, the Commission published a notice concluding that subject to limitations expressed in the notice, full power operating licenses, construction permits, and limited work authorizations may be issued in pending cases in advance of the adoption of an interim rule on the basis of the currently effective chemical reprocessing and waste storage values of Table S-3.

Exposure of Individuals to Concentrations of Radioactive Materials in Air in Restricted Areas—Part 20

On November 29, 1976, amendments to Part 20 were published, effective December 29, 1976, concerning control of internal occupational exposures to radioactive materials, including provision for use of respiratory protective equipment.

Special Procedures Applicable to Adjudicatory Proceedings Involving Restricted Data or Other National Security Information—Part 2

On December 6, 1976, amendments to Part 2 were published, effective January 5, 1977, concerning the use of Restricted Data and National Security Information in NRC proceedings.

Use of Depleted Uranium in Industrial Products or Devices—Part 40

On December 6, 1976, amendments to Part 40 were published, effective January 5, 1977, to issue a general license to receive, acquire, possess, use, or transfer depleted uranium in industrial products or devices for mass volume applications, to set out requirements for issuance of specific licenses to manufacture, import or transfer industrial products and devices for use under the proposed general license, and to define depleted uranium.

Codes and Standards for Nuclear Power Plants—Part 50

On December 6, 1976, amendments to Part 50 were published, effective January 5, 1977, which incorporate a new edition and new addenda of referenced national codes.

Privacy Act Regulations, Exemptions—Part 9

On December 20, 1976, an amendment to Part 9 was published, effective immediately, which exempts from certain requirements of the Privacy Act portions of the NRC systems of records NRC-1, "Appointment and Promotion Certificate Records—NRC."

Miscellaneous Amendments—Parts 7, 20, and 73

On December 23, 1976, amendments to Parts 7, 20, and 73 were published, effective immediately, which correct the address and phone number of the Region II office and change a reference to 10 CFR Part 9 in Part 7.

Group Licensing for Certain Medical Uses—Part 35

On December 27, 1976, an amendment to Part 35 was published, effective immediately, which adds the use of sulfur colloid for bone marrow imaging to the group of medical uses of byproduct material.

Implementation of Legislation Amending the Price-Anderson Act—Part 140

On January 3, 1977, amendments to Part 140 were published, effective August 1, 1977, which implement the provisions of the Price-Anderson Act (Pub. L. 94-197).

Seismic and Geologic Design Bases—Part 100

On January 10, 1977, an amendment to Part 100 was published, effective immediately, which states that the maximum historic earthquake could be exceeded in the determination of the safe shutdown where warranted.

Exemption of Persons Using Thorium in Personnel Neutron Dosimeters—Part 40

On February 3, 1977, an amendment to Part 40 was published, effective March 7, 1977, which will exempt

from licensing and regulatory requirements persons using personnel neutron dosimeters containing not more than 50 milligrams of thorium.

Requirements for the Physical Protection of Nuclear Power Plants—Parts 50 and 73

On February 24, 1977, amendments to Parts 50 and 73 were published, effective March 28, 1977, which, in the interest of common defense and security and the public health and safety, identify measures to be taken for the protection of nuclear power plants against industrial sabotage.

Rules Governing Public Attendance at Meetings of the Nuclear Regulatory Commission—Parts 2, 7, and 9

On March 7, 1977, amendments to Parts 2, 7, and 9 were published, effective March 12, 1977, to implement the open meeting requirements of the Government in the Sunshine Act of 1976 (Pub. L. 94-409).

Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management—Part 51

On March 14, 1977, amendments to Part 51 were published, effective immediately, so as to incorporate revised values, based on a new study of the available information, for the nuclear waste management and nuclear fuel reprocessing portions of the fuel cycle.

Export of Certain Byproduct Material to Other Than Schedule A Countries—Part 36

On March 28, 1977, an amendment to Part 36 was published, effective immediately, which clarifies the phrase in §36.21(a) "when contained in luminous safety devices installed in aircraft as generally licensed items pursuant to §31.7 of this chapter."

Group Licensing for Certain Medical Uses—Part 35

On March 31, 1977, an amendment to Part 35 was published, effective immediately, which adds indium-113m as chloride for blood pool imaging including placenta localization as a licensed medical use of radioisotopes.

Material Status Reports, Form NRC/ERDA-742, Reporting Date Change to March 31 and September 30 of Each Year—Part 70

On March 31, 1977, an amendment to Part 70 was published, effective immediately, which changes the reporting dates from December 31 and June 30 to March 31 and September 30 for Form NRC/ERDA-742.

Plans for Coping with Radiological Emergencies—Part 70

On March 31, 1977, amendments to Part 70 were published, effective immediately, which set forth (1) the requirement that an application for a license to process and use special nuclear material in fuel reprocessing and fuel fabrication plants contain plans for coping with emergencies and (2) the minimum information that applicants should include in these emergency plans.

Corrective and Minor Amendments—Parts 0, 20, and 50

On April 18, 1977, amendments to Parts 0, 20, and 50 were published, effective immediately, which were minor and corrective in nature.

Miscellaneous Amendments—Part 140

On April 18, 1977, amendments to Part 140 were published, effective May 1, 1977, to increase the level of the primary layer of financial protection required of certain indemnified licensees, and make certain other minor changes in indemnity agreement forms and in the facility form of nuclear liability insurance policy furnished as financial protection.

Addition to General License for In Vitro Diagnostic Products—Part 31 and 32

On April 28, 1977, amendments to Parts 31 and 32, were published, effective May 31, 1977, which add selenium-75 to the list of radionuclides in the general license for medical laboratory use.

Commission Review of Appeal Board Decisions and Procedure for Request for Stays—Part 2

On May 2, 1977, amendments to Part 2 were published, effective June 1, 1977, to provide procedures for parties to petition the Commission for a discretionary review of a decision or action of the Atomic Safety and Licensing Appeal Board. This rule also provides a procedure for parties to apply for stays of the decisions or actions of both presiding officers and the ASLAB.

Early Site Reviews and Limited Work Authorizations—Parts 2 and 50

On May 5, 1977, amendments to Parts 2 and 50 were published, effective June 6, 1977, which establish procedures for the early review of site suitability issues both separate from and in conjunction with the initiation of proceedings for the issuance of permits authorizing the construction of nuclear power and test reactors.

GAO Clearances, Reporting and Recordkeeping Requirements—Parts 20, 30, 31, 32, 33, 34, 35, 36, 40, 50, 55, 70, 71, 73, 140, and 150

On May 19, 1977, amendments to Parts 20, 30, 31, 32, 33, 34, 35, 36, 40, 50, 55, 70, 71, 73, 140, and 150 were published, effective immediately, which add the update notations, which state that the reporting or recordkeeping requirement has been approved by the General Accounting Office, and include the appropriate GAO approval number.

Addition to General License for In Vitro Diagnostic Products—Parts 31 and 32

On May 26, 1977, amendments to Parts 31 and 32 were published, effective June 27, 1977, which add mock iodine-125 to the list of radionuclides in the general license for medical laboratory use.

Reports to the Commission Concerning Defects and Noncompliance—Parts 2, 21, 31, 34, 35, 40, and 70

On June 6, 1977, amendments to Parts, 2, 21, 31, 34, 35, 40, and 70 were published, effective July 6, 1977, and January 6, 1978, which require directors and responsible officers of firms and organizations building, operating, or owning NRC-licensed facilities, or conducting NRC-licensed activities, to report failures to comply with regulatory requirements and defects in components which may result in a substantial safety hazard.

Employment and Financial Interest Statements—Part 0

On June 30 1977, amendments to Part O were published, effective immediately, which require employees to submit one copy of employment and financial interest statements to the appropriate reviewer instead of two copies.

Interpretation by the General Counsel of 10 CFR §73.55, Illumination and Physical Search Requirements—Part 8

On June 30, 1977, an amendment to Part 8 was published, effective immediately, which adds an interpretation by the General Counsel of the requirements for physical protection of licensed activities in nuclear power reactors against industrial sabotage.

Certain Reporting Dates Changed—Parts 30, 40, and 150

On June 30, 1977, amendments to Parts 30, 40, and 150 were published, effective immediately, which change reporting dates to correspond to the new Federal fiscal year.

Standardization of Nuclear Power Plants—General Statement of Policy

On July 5, 1977, the Commission issued a policy statement for comment on the continuing use of standardization of nuclear power plants.

Environmental Reports by Applicants for Materials Licenses—Part 51

On July 8, 1977, an amendment to Part 51 was published, effective August 4, 1977, which requires that 15 copies of the environmental report applicable to materials licenses be submitted to the NRC and that an additional 85 copies of the environmental report be retained by the applicant for distribution to Federal, state, and local officials in accordance with written instructions issued by the Director of Nuclear Material Safety and Safeguards.

Export of Small Quantities of SNM for Government-Sponsored Use—Part 70

On July 8, 1977, an amendment to Part 70 was published, effective immediately, which exempts U.S. Government agencies from the requirements for an export license for small quantities of special nuclear material intended for use in U.S. Government-sponsored or cooperative activities in foreign countries.

Petitions for Review of Director's Denial of Enforcement Requests—Part 2

On July 14, 1977, an amendment to Part 2 was published, effective August 15, 1977, which provides procedures under which the Commission may, on its own motion, review a Director's decision denying a request to institute enforcement proceedings in order to determine whether the Director has abused his discretion

Specific Licenses to Individual Physicians and Institutions—Part 35

On July 14, 1977, an amendment to Part 35 was published, effective August 15, 1977, which requires most medical institutions to be licensed for the use of radioactive material in the institution rather than the individual physician using the radioactive material.

Statement of Organization and General Information—Part I

On July 18, 1977, the Commission issued a statement of its organization and functions that sets out in codified form, effective immediately, a description of the major program and staff components of the agency and their functions, lists the location of NRC offices, and describes the NRC seal and flag.

Codes and Standards for Nuclear Power Plants—Part 50

On July 18, 1977, an amendment to Part 50 was published, effective August 17, 1977, which incorporates by reference new addenda to specified published national codes and standards for the design, fabrication, construction, testing, and inspection of reactor components and systems.

Outside Employment and Other Activity—Part O

On August 1, 1977, amendments to Part 0 were published, effective September 12, 1977, which specify in greater detail what constitutes a conflict of interest with respect to outside employment or other activities of NRC employees.

Quality Assurance Requirements for Transport Packages—Part 71

On August 4, 1977, amendments to Part 71 were published, effective October 18, 1977, which upgrade requirements for quality assurance in the design, fabrication, assembly, testing, use, and maintenance of packagings for shipping and transporting licensed radioactive material.

Revocation or Modification of Certain Reporting Requirements—Parts 50 and 140

On August 29, 1977, amendments to Parts 50 and 140 were published, effective immediately, which (1) revoke the requirement that if the construction or modification of a facility is completed before the earliest date specified in the construction permit, the holder of the construction permit shall promptly notify the Commission for the purpose of accelerating the final inspection; and (2) modify

the repetitive reporting requirements set out in special provisions applicable to licensees furnishing financial protection in whole or in part in the form of adequate resources.

Interim Exemption of Certain SNM Exports from Agreement for Cooperation Requirements—Part 70

On August 31, 1977, an interim amendment to Part 70 was published, effective immediately, to exempt exports of special nuclear material which is diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or is practicably irrecoverable, from the requirement that the export be subject to an agreement for cooperation. This interim rule will expire on March 1, 1978, unless extended by the Commission. The Commission expects to make a decision by March 1, 1978, on whether the interim rule should be made permanent. Interested persons were invited to submit comments by October 17, 1977.

Amendments to Revoke or Revise Certain Reporting Requirements—Parts 20, 32, 70, 73, and 150

On September 1, 1977, amendments to Parts 20, 32, 70, 73, and 150 were published, effective immediately, which revoke three reporting requirements, revise four reporting requirements to require telephone notification only, and revise two reporting requirements to increase the threshold for reporting damage to property.

Requirements for the Physical Protection of Nuclear Power Plants—Part 73

On September 29, 1977, an amendment to Part 73 was published, effective immediately, which delays the implementation of the physical search requirement for regular employees of a licensee at nuclear power reactor sites.

REGULATIONS AND AMENDMENTS PROPOSED

Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management—Part 51

On October 18, 1976, a proposed amendment to Part 51 was published for comment which would replace the existing Table S-3 in Part 51 with a new table. (Interim rule published in the *Federal Register* March 14, 1977.)

Standards for Combustible Gas Control Systems—Part 50

On October 21, 1976, proposed amendments to Part 50 were published for comment which would (1) clarify the Commission's original intent in regard to Appendix A, General Design Criterion 50, and (2) provide a new §50.44 to specify standards for combustible gas control systems.

Periodic Updating of Final Safety Analysis Reports—Part 50

On November 8, 1976, proposed amendments to Part 50 were published for comment which would require each applicant for or holder of a power reactor operating license which would be or was issued after January 1, 1963, to periodically submit to the Commission revised pages for its Final Safety Analysis Report that indicate changes made in the facility or the procedures for its operation and any analyses that are affected by these changes.

Financial Assistance to Participants in Commission Proceedings—Part 2

On November 18, 1976, the Commission published a statement of considerations terminating rulemaking. The notice also set up the framework for funding in the GESMO proceeding if Congress so authorizes and the Commission's planned study regarding possible relief from procedural burdens in other proceedings.

Distribution of Applications and Environmental Statements to Local Officials—Parts 2 and 51

On January 17, 1977, proposed amendments to Parts 2 and 51 were published for comment which would require applicants to distribute copies of draft environmental impact statements and environmental reports to appropriate local officials.

Guard Force Response to an Alarm—Part 73

On February 10, 1977, proposed amendments to Part 73 were published for comment which would clarify the responsibilities of the onsite guards for the protection of special nuclear material from theft and licensed plants from industrial sabotage and would assure uniformity in the application of regulatory requirements.

Proposed General License for Routine Use of Plutonium-238 Powered Cardiac Pacemakers—Part 70

On March 14, 1977, proposed amendments to Part 70 were published for comment which would establish (1) general licenses for the implantation, routine use, and recovery of plutonium-238 powered cardiac pacemakers that have been proved reliable and safe under investigational programs of actual use and (2) the requirements for issuance of specific licenses authorizing distribution of pacemakers for routine use under the general license.

Plutonium-238 Powered Cardiac Pacemakers—Part 150

On March 14, 1977, a proposed amendment to Part 150 was published for comment which would make the Commission the sole agency regulating the routine use under general license of plutonium-238 powered cardiac pacemakers and the distribution under specific license of pacemakers used under such general license.

Authority for Access to or Control Over Special Nuclear Material—Parts 11, 50, and 70

On March 17, 1977, proposed amendments to Parts 11, 50, and 70 were published for comment which would require certain individuals involved in the operation of licensed nuclear power reactors and fuel reprocessing plants, in the licensed use, processing, or storage of certain quantities of special nuclear materials, and in the transportation by the private sector of certain quantities

of special nuclear material, to receive authorization from the Commission for access to or control over special nuclear material.

Waiver or Reduction of Fees for Searching and Reproduction of Records—Part 9

On March 31, 1977, proposed amendments to Part 9 were published for comment which would reflect the requirements of the FOIA that documents shall be furnished without charge or at a reduced charge where an agency determines that waiver or reduction of the fee for searching and reproduction of records is in the public interest because furnishing the information can be considered as primarily benefiting the general public.

Codes and Standards for Nuclear Power Plants—Part 50

On March 31, 1977, proposed amendments to Part 50 were published for comment which would incorporate by reference new addenda to specified published national codes and would clarify provisions in §50.55a and Appendix G to Part 50.

Proposed Revision of License Fee Schedules—Part 170

On May 2, 1977, proposed amendments to Part 170 were published for comment which would revise the schedule of fees for facilities and materials applications and licenses.

Miscellaneous Amendments—Part 2

On May 2, 1977, proposed amendments to Part 2 were published for comment which would facilitate public participation in the facility license application review and hearing process, to improve coordination with states, counties, and municipalities, and to make certain other improvements.

Human Uses of Teletherapy Units—Part 35

On May 19, 1977, proposed amendments to Part 35 were published for comment regarding human uses of byproduct (i.e., reactor produced) material in teletherapy units and to ensure that teletherapy units are properly calibrated.

License Safeguards Contingency Plans—Parts 50, 70, and 73

On May 19, 1977, proposed amendments to Parts 50, 70, and 73 were published for comment which would require licensees authorized to operate a nuclear reactor (other than certain research and test reactors) and those authorized to possess strategic quantities of plutonium or uranium-235 to develop and implement acceptable plans for responding to threats, thefts, and sabotage of licensed nuclear materials and facilities.

Export and Import of Nuclear Facilities and Materials—Parts 2, 30, 31, 32, 33, 36, 40, 50, 70, and 110

On June 30, 1977, proposed amendments to Parts 2, 30, 31, 32, 33, 36, 40, 50, 70, and 110 were published to provide for standards, procedures, and rules of practice for licensing the export and import of utilization facilities, source, byproduct, and special nuclear materials.

Performance Oriented Safeguards Requirements—Parts 70 and 73

On July 5, 1977, proposed amendments to Parts 70 and 73 were published for comment which include performance oriented safeguards requirements for strengthened physical protection for strategic special nuclear material and for certain fuel cycle facilities, associated transportation and other activities involving significant quantities of strategic special nuclear materials.

Upgraded Guard Qualification Training and Equipment Requirements—Part 73

On July 5, 1977, proposed amendments to Part 73 were published for comment to require upgraded guard qualification training and equipping requirements for security personnel protecting against theft of special nuclear material and industrial sabotage of nuclear facilities or nuclear shipments.

Removal or Defacing of Radioactive Materials Labels on Empty Containers—Part 20

On July 14, 1977, a proposed amendment to Part 20 was published for comment to require the removal, defacing, or otherwise rendering unidentifiable radioactive materials labels on empty containers prior to disposal.

Maintaining Integrity of Structures, Systems, and Components Important to Safety During Construction at Multi-Unit Sites—Part 50

On July 14, 1977, proposed amendments to Part 50 were published for comment to require that, for multi-unit sites, applicants for construction permits and operating licenses take proper precautions to assure the integrity of structures, systems, and components important to the safety of the operating unit during all construction activities.

Burden of Proof in Enforcement Proceedings—Part 2

On July 21, 1977, a proposed amendment to Part 2 was published for comment to provide generally that the proponent of an order in an enforcement action has the burden of proof.

General License for Government Agencies' Operational Use of Small Quantities of Source Material—Part 40

On September 1, 1977, a proposed amendment to Part 40 was published for comment, which includes Federal, state, and local government agencies' research, development, educational, or operational use of small quantities of source materal in the general license which authorizes certain persons to use small quantities of source material.

Appendix 5

Regulatory Guides

Regulatory guides describe and make available to the public methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations and, in some cases, describe techniques used by the staff in evaluating specific problems or postulated accidents. Guides also may provide guidance to applicants concerning information needed by the staff in its review of applications for permits and licenses.

Comments and suggestions for improvements in guides are encouraged at all times, and guides will be revised as appropriate, to accommodate comments and to reflect new information or experience. Regulatory guides may also be withdrawn when they are superseded by the Commission's regulations, when equivalent recommendations have been incorporated in applicable approved codes and standards, or when changes in methods and techniques have made them obsolete.

When guides are issued, revised, or withdrawn, a notice is placed in the *Federal Register* and a public announcement is made. Single copies of guides may be obtained by writing to the Director, Division of Document Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. The following guides were issued or revised (or withdrawn as noted) during the period October 1, 1976, to September 30, 1977.

Division 1—Power Reactor Guides

1.7 Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident (Revision 1)

1.8 Personnel Selection and Training (Revision 1-R)

1.31 Control of Ferrite Content in Stainless Steel Weld Metal (Revision 2)

1.32 Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants (Revision 2)

1.33 Quality Assurance Program Requirements (Operation) (Revision 1)

1.38 Quality Assurance Requirements for Packaging, Shipping, Receiving, Storage, and Handling of Items for Water-Cooled Nuclear Power Plants (Revisions 1 and 2)

1.39 Housekeeping Requirements for Water-Cooled Nuclear Power Plants (Revision 1 and Revision 2)

1.59 Design Basis Floods for Nuclear Power Plants (Revision 2)

1.63 Electric Penetration Assemblies in Containment Structures for Light-Water-Cooled Nuclear Power Plants (Revision 1)

1.66 WITHDRAWN—Nondestructive Examination of Tubular Products

1.68 Initial Test Programs for Water-Cooled Reactor Power Plants (Revision 1)

1.68.1 Preoperational and Initial Startup Testing of Feedwater and Condensate Systems for Boiling Water Reactor Power Plants (Revision 1)

1.68.2 Initial Startup Test Program to Demonstrate Remote Shutdown Capacity for Water-Cooled Nuclear Power Plants

1.84 Code Case Acceptability—ASME Section III Design and Fabrication (Revisions 8, 9, and 10)

1.85 Code Case Acceptability—ASME Section III Materials (Revisions 8, 9, and 10)

1.88 Collection, Storage, and Maintenance of Nuclear Power Plant Quality Assurance Records (Revision 2)

1.90 Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons (Revision 1)

1.95 Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release (Revision 1)

1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident (Revision 1)

1.99 Effects of Residual Elements on Predicted Radiation Damage to Reactor Vessel Materials (Revision 1)

1.100 Seismic Qualification of Electric Equipment for Nuclear Power Plants (Revision 1)

1.101 Emergency Planning for Nuclear Power Plants (Revision 1)

1.103 Post-Tensioned Prestressing Systems for Concrete Reactor Vessels and Containments (Revision 1)

1.105 Instrument Setpoints (Revision 1)

1.106 Thermal Overload Protection for Electric Motors on Motor-Operated Valves (Revision 1)

1.107 Qualifications for Cement Grouting for Prestressing Tendons in Containment Structures (Revision 1)

1.108 Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants (Revision 1)

1.111 Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in

Routine Releases from Light-Water-Cooled Reactors (Revision 1)

1.112 Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors (Revision O-R)

1.113 Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I (Revision 1)

1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant (Revision 1)

1.115 Protection Against Low-Trajectory Turbine Missiles (Revision 1)

1.116 Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems (Revision O-R)

1.119 WITHDRAWN—Surveillance Program for New Fuel Assembly Designs

1.123 Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants (Initial Issue and Revision 1)

1.124 Design Limits and Loading Combinations for Class 1 Linear-Type Component Supports

1.125 Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants

1.126 An Acceptable Model and Related Statistical Methods for the Analysis of Fuel Densification

1.127 Inspection of Water-Control Structures Associated with Nuclear Power Plants

1.128 Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants

1.129 Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Nuclear Power Plants

1.130 Design Limits and Loading Combinations for Class 1 Plate-And-Shell-Type Component Supports

1.131 Qualification Tests of Electric Cables, Field Splices, and Connections for Light-Water-Cooled Nuclear Power Plants

1.132 Site Investigations for Foundations of Nuclear Power Plants

1.133 Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors

1.134 Medical Certification and Monitoring of Personnel Requiring Operator Licenses

1.135 Normal Water Level and Discharge at Nuclear Power Plants

Division 2—Research and Test Reactor Guides

2.4 Review of Experiments for Research Reactors (Revision O-R)

2.5 Quality Assurance Program Requirements for Research Reactors

Division 3—Fuels and Materials Facilities Guides

3.4 Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors (Revision 1)

3.11 Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills (Revision 1)

3.27 Nondestructive Examination of Welds in the Liners of Concrete Barriers in Fuel Reprocessing Plants (Revision 1)

3.30 Selection, Application, and Inspection of Protective Coatings (Paints) for Fuel Reprocessing Plants (Revision O-R)

3.31 Emergency Water Supply Systems for Fuel Reprocessing Plants (Revision O-R)

3.33 Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant

3.34 Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Uranium Fuel Fabrication Plant

3.35 Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Plutonium Processing and Fuel Fabrication Plant

3.40 Design Basis for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants

3.41 Validation of Calculational Methods for Nuclear Criticality Safety (Revision 1)

3.42 Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70

Division 4—Environmental and Siting Guides

4.3 WITHDRAWN—Measurements of Radionuclides in the Environment, Analysis of I-131 in Milk

4.11 Terrestrial Environmental Studies for Nuclear Power Stations (Revision 1)

4.13 Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications (Initial issue and Revision 1)

4.14 Measuring, Evaluating, and Reporting Radioactivity in Releases of Radioactive Materials in Liquid and Airborne Effluents from Uranium Mills

Division 5—Materials and Plant Protection Guides

5.35 WITHDRAWN—Calorimetric Assay of Plutonium

Division 6—Product Guides

None

Division 7—Transportation Guides

7.5 Administrative Guide for Obtaining Exemptions from Certain NRC Requirements Over Radioactive Material Shipments (Revision O-R)

7.6 Stress Allowables for the Design of Shipping Cask Containment Vessels

7.7 Administrative Guide for Verifying Compliance with Packaging Requirements for Shipments of Radioactive Materials

7.8 Load Combinations for the Structural Analysis of Shipping Casks

Division 8—Occupational Health Guides

8.8 Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable (Revision 2)

8.10 Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable (Revision 1-R)

8.14 Personnel Neutron Dosimeters (Revision 1)

8.15 Acceptable Programs for Respiratory Protection

Division 9—Antitrust Guides

None

Division 10—General Guides

10.1 Compilation of Reporting Requirements for Persons Subject to NRC Regulations (Revison 3)

10.2 Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope (Revision 1)

10.3 Guide for the Preparation of Applications for Special Nuclear Material Licenses of Less Than Critical Mass Quantities (Revision 1)

10.4 Guide for the Preparation of Applications for Licenses to Process Source Material (Revison 1)

10.7 Guide for the Preparation of Applications for Licenses for Laboratory Use of Small Quantities of Byproduct Material

Appendix 6

Nuclear Electric Generating Units In Operation, Under Construction or Planned

(As of September 30, 1977)

The following listing includes 230 nuclear power reactor electrical generating units which were in operation, under NRC review for construction permits, and ordered or announced by utilities in the United States at the end of September 1977, representing a total capacity of approximately 230,000 MWe. TYPE is indicated by: BWR—boiling water reactor, PWR—pressurized water reactor, HTGR—high temperature gas-cooled reactor, and LMFBR—liquid metal cooled fast breeder reactor. STATUS is indicated by: OL—has operating license, CP—has construction permit, UR—under review for construction permit, A/O—announced or ordered by the utility but application for construction not yet docketed by the NRC for review. The dates for commercial operation are either actual or those scheduled by the utilities.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
ALABAMA						
Clanton	Alan R. Barton Nuclear Plant Unit 1	1,159	BWR	UR	Alabama Power Co.	Indef.
Clanton	Alan R. Barton Nuclear Plant Unit 2	1,159	BWR	UR	Alabama Power Co.	Indef.
Decatur	Browns Ferry Nuclear Power Plant Unit 1	1,065	BWR	OL 1973	Tennessee Valley Authority	1974
Decatur	Browns Ferry Nuclear Power Plant Unit 2	1,065	BWR	OL 1974	Tennessee Valley Authority	1975
Decatur	Browns Ferry Nuclear Power Plant Unit 3	1,065	BWR	OL 1976	Tennessee Valley Authority	1977
Dothan	Joseph M. Farley Nuclear Plant Unit 1	829	BWR	OL 1977	Alabama Power Co.	1978
Dothan	Joseph M. Farley Nuclear Plant Unit 2	829	PWR	CP 1972	Alabama Power Co.	1979
Scottsboro	Bellefonte Nuclear Plant Unit 1	1,213	PWR	CP 1974	Tennessee Valley Authority	1980
Scottsboro	Bellefonte Nuclear Plant Unit 2	1,213	PWR	CP 1974	Tennessee Valley Authority	1981
ARIZONA						
Winterburg	Palo Verde Nuclear Generating Station Unit 1	1,238	PWR	CP 1976	Arizona Public Service Co.	1983
Winterburg	Palo Verde Nuclear Generating Station Unit 2	1,238	PWR	CP 1976	Arizona Public Service Co.	1984
Winterburg	Palo Verde Nuclear Generating Station Unit 3	1,238	PWR	CP 1976	Arizona Public Service Co.	1986

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
Winterburg	Palo Verde Nuclear Generating Station Unit 4	1,238	PWR	A/O	Arizona Public Service Co.	1988
Winterburg	Palo Verde Nuclear Generating Station Unit 5	1,238	PWR	A/O	Arizona Public Service Co.	1990
ARKANSAS						
Russelville	Arkansas Nuclear One Unit 1	850	PWR	OL 1974	Arkansas Power & Light Co.	1974
Russelville	Arkansas Nuclear One Unit 2	912	PWR	CP 1972	Arkansas Power & Light Co.	1978
CALIFORNIA						
Eureka	Humboldt Bay Power Plant Unit 3	63	BWR	OL 1962	Pacific Gas & Electric Co.	1963
San Clemente	San Onofre Nuclear Generating Station Unit 1	430	PWR	OL 1967	So. Calif. Ed. & San Diego Gas & Electric Co.	1968
San Clemente	San Onofre Nuclear Generating Station Unit 2	1,100	PWR	CP 1973	So. Calif. Ed. & San Diego Gas & Electric Co.	1980
San Clemente	San Onofre Nuclear Generating Station Unit 3	1,100	PWR	CP 1973	So. Calif. Ed. & San Diego Gas & Electric Co.	1981
Diablo Canyon	Diablo Canyon Nuclear Power Plant Unit 1	1,084	PWR	CP 1968	Pacific Gas & Elec. Co.	1977
Diablo Canyon	Diablo Canyon Nuclear Power Plant Unit 2	1,106	PWR	CP 1970	Pacific Gas & Elec. Co.	1978
Clay Station	Rancho Seco Nuclear Generating Station Unit 1	918	PWR	OL 1974	Sacramento Municipal Utility District	1975
*	Stanislaus Unit 1	1,200	BWR	A/O	Pacific Gas & Elec. Co.	Indef.
*	Stanislaus Unit 2	1,200	BWR	A/O	Pacific Gas & Elec. Co.	Indef.
*	San Joaquin Nuclear Project 1	1,300		A/O	L.A. Dept. of Water, PG&E, SCE, CDWR	N/S
*	San Joaquin Nuclear Project 2	1,300		A/O	L.A. Dept. of Water, PG&E, SCE, CDWR	N/S
*	San Joaquin Nuclear Project 3	1,300		A/O	L.A. Dept. of Water, PG&E, SCE, CDWR	Indef.
*	San Joaquin Nuclear Project 4	1,300		A)O	L.A. Dept. of Water, PG&E, SCE, CDWR	Indef.
Clay Station	Rancho Seco Nuclear Generating Station Unit 2	1,100		A/O	Sacramento Municipal Utility District	Indef.
*	Sundesert 1	974	PWR	UR	San Diego Gas & Elec. Co.	1984
*	Sundesert 2	974	PWR	UR	San Diego Gas & Elec. Co.	1986

*Site not selected.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
COLORADO						
Platteville	Fort St. Vrain Nuclear Generating Station	330	HTGR	OL 1973	Public Service Co. of Colorado	1978
CONNECTICUT						
Haddam Neck	Haddam Neck Generating Station	575	PWR	OL 1967	Conn. Yankee Atomic Power Co.	1968
Waterford	Millstone Nuclear Power Station Unit 1	660	BWR	OL 1970	Northeast Nuclear Energy Co.	1971
Waterford	Millstone Nuclear Power Station Unit 2	830	PWR	OL 1975	Northeast Nuclear Energy Co.	1975
Waterford	Millstone Nuclear Power Station Unit 3	1,156	PWR	CP 1974	Northeast Nuclear Energy Co.	1986
DELAWARE						
Summit	Summit Power Station Unit 1	1,200		UR**	Delmarva Power &	N/S
FLORIDA						
Florida City	Turkey Point Station Unit 3	693	PWR	OL 1972	Florida Power & Light Co.	1972
Florida City	Turkey Point Station Unit 4	693	PWR	OL 1973	Florida Power & Light Co.	1973
Red Level	Crystal River Plant Unit 3	825	PWR	OL 1976	Florida Power Corp. Light Co.	1977
Ft. Pierce	St. Lucie Plant Unit 1	802	PWR	OL 1976	Florida Power Corp. Light Co.	1976
Ft. Pierce	St. Lucie Plant Unit 2	810	PWR	CP 1977	Florida Power Corp. Light Co.	1983
GEORGIA						
Baxley	Edwin I. Hatch Plant Unit 1	786	BWR	OL 1974	Georgia Power Co.	1975
Baxley	Edwin I. Hatch Plant Unit 2	795	BWR	CP 1972	Georgia Power Co.	1978
Waynesboro	Alvin W. Vogtle, Jr. Plant Unit 1	1,113	PWR	CP 1974	Georgia Power Co.	1985
Waynesboro	Alvin W. Vogtle, Jr. Plant Unit 2	1,113	PWR	CP 1974	Georgia Power Co.	1986
ILLINOIS						
Morris	Dresden Nuclear Power Station Unit 1	200	BWR	OL 1959	Commonwealth Edison Co.	1960
Morris	Dresden Nuclear Power Station Unit 2	794	BWR	OL 1969	Commonwealth Edison Co.	1970

**Limited work authorization issued.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
Morris	Dresden Nuclear Power Station Unit 3	794	BWR	OL 1971	Commonwealth Edison Co.	1971
Zion	Zion Nuclear Plant Unit 1	1,040	PWR	OL 1973	Commonwealth Edison Co.	1973
Zion	Zion Nuclear Plant Unit 2	1,040	PWR	OL 1973	Commonwealth Edison Co.	1974
Cordova	Quad-Cities Station Unit 1	789	BWR	OL 1971	Comm. Ed. Co.-Iowa-Ill. Gas & Elec. Co.	1973
Cordova	Quad-Cities Station Unit 2	789	BWR	OL 1972	Comm. Ed. Co.-Iowa-Ill. Gas & Elec. Co.	1973
Seneca	LaSalle County Nuclear Station Unit 1	1,078	BWR	CP 1973	Commonwealth Edison Co.	1979
Seneca	LaSalle County Nuclear Station Unit 2	1,078	BWR	CP 1973	Commonwealth Edison Co.	1980
Byron	Byron Station Unit 1	1,120	PWR	CP 1975	Commonwealth Edison Co.	1981
Byron	Byron Station Unit 2	1,120	PWR	CP 1975	Commonwealth Edison Co.	1982
Braidwood	Braidwood Unit 1	1,120	PWR	CP 1975	Commonwealth Edison Co.	1981
Braidwood	Braidwood Unit 2	1,120	PWR	CP 1975	Commonwealth Edison Co.	1982
Clinton	Clinton Nuclear Power Plant Unit 1	933	BWR	CP 1976	Illinois Power Co.	1981
Clinton	Clinton Nuclear Power Plant Unit 2	933	BWR	CP 1976	Illinois Power Co.	1988
Savannah	Carroll County Station Unit 1	1,120		A/O	Commonwealth Edison Co.	1984
Savannah	Carroll County Station Unit 2	1,120		A/O	Commonwealth Edison Co.	1985
INDIANA						
Westchester Town	Bailly Generating Station	645	BWR	CP 1974	Northern Indiana Public Service Co.	1983
Madison	Marble Hill Unit 1	1,130	PWR	UR**	Public Service of Indiana	1982
Madison	Marble Hill Unit 2	1,130	PWR	UR**	Public Service of Indiana	1984
IOWA						
Pala	Duane Arnold Energy Center Unit 1	538	BWR	OL 1974	Iowa Elec. Light & Power Co.	1975
Vandalia	Iowa Power Unit 1	1,270	BWR	A/O	Iowa Po. & Lt. Co.	N/S
KANSAS						
Burlington	Wolf Creek	1,150	PWR	CP 1977	Kansas Gas & Elec. Co.	1983

**Limited work authorization issued.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
LOUISIANA						
Taft	Waterford Steam Electric Station Unit 3	1,113	PWR	CP 1974	Louisiana Power & Light Co.	1981
St. Francisville	River Bend Station Unit 1	934	BWR	CP 1977	GulfStates Utilities Co.	1983
St. Francisville	River Bend Station Unit 2	934	BWR	CP 1977	Gulf States Utilities Co.	N/S
MAINE						
Wicasset	Maine Yankee Atomic Power Plant	790	PWR	OL 1972	Maine Yankee Atomic Power Co.	1972
MARYLAND						
Lusby	Calvert Cliffs Nuclear Power Plant Unit 1	845	PWR	OL 1974	Baltimore Gas & Elec. Co.	1975
Lusby	Calvert Cliffs Nuclear Power Plant Unit 2	845	PWR	OL 1976	Baltimore Gas & Elec. Co.	1977
Douglas Point	Douglas Point Generating Station Unit 1	1,178	BWR	UR	Potomac Electric Power Co.	Indef.
Douglas Point	Douglas Point Generating Station Unit 2	1,178	BWR	UR	Potomac Electric Power Co.	Indef.
MASSACHUSETTS						
Rowe	Yankee Nuclear Power Station	175	PWR	OL 1960	Yankee Atomic Elec. Co.	1961
Plymouth	Pilgrim Station Unit 1	655	BWR	OL 1972	Boston Edison Co.	1972
Plymouth	Pilgrim Station Unit 2	1,180	PWR	UR	Boston Edison Co.	1984
Turners Falls	Montague Unit 1	1,150	BWR	UR	Northeast Nuclear Energy Co.	1986
Turners Falls	Montague Unit 2	1,150	BWR	UR	Northeast Nuclear Energy Co.	1988
MICHIGAN						
Big Rock Point	Big Rock Point Nuclear Plant	72	BWR	OL 1962	Consumers Power Co.	1963
South Haven	Palisades Nuclear Power Station	688	PWR	OL 1971	Consumers Power Co.	1971
Lagoona Beach	Enrico Fermi Atomic Power Plant Unit 2	1,093	BWR	CP 1972	Detroit Power Co.	1980
Bridgman	Donald C. Cook Plant Unit 1	1,054	PWR	OL 1974	Indiana & Michigan Elec. Co.	1975
Bridgman	Donald C. Cook Plant Unit 2	1,060	PWR	CP 1969	Indiana & Michigan Elec. Co.	1978
Midland	Midland Nuclear Power Plant Unit 1	460	PWR	CP 1972	Consumers Power Co.	1982
Midland	Midland Nuclear Power Plant Unit 2	811	PWR	CP 1972	Consumers Power Co.	1981

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
St. Clair County	Greenwood Energy Center Unit 2	1,200	PWR	UR	Detroit Edison Co.	N/S
St. Clair County	Greenwood Energy Center Unit 3	1,200	PWR	UR	Detroit Edison Co.	N/S
MINNESOTA						
Monticello	Monticello Nuclear Generating Plant	545	BWR	OL 1970	Northern States Power Co.	1971
Red Wing	Prairie Island Nuclear Generating Plant Unit 1	530	PWR	OL 1973	Northern States Power Co.	1973
Red Wing	Prairie Island Nuclear Generating Plant Unit 2	530	PWR	OL 1974	Northern States Power Co.	1974
MISSOURI						
Fulton	Callaway Plant Unit 1	1,120	PWR	CP 1976	Union Elec. Co.	1982
Fulton	Callaway Plant Unit 2	1,120	PWR	CP 1976	Union Elec. Co.	1987
MISSISSIPPI						
Port Gibson	Grand Gulf Nuclear Station Unit 1	1,250	BWR	CP 1974	Mississippi Power & Light Co.	1981
Port Gibson	Grand GulfNuclear Station Unit 2	1,250	BWR	CP 1974	Mississippi Power & Light Co.	1984
Yellow Creek	Yellow Creek Unit 1	1,285	PWR	UR	Tennessee Valley Authority	1985
Yellow Creek	Yellow Creek Unit 2	1,285	PWR	UR	Tennessee Valley Authority	1986
NEBRASKA						
Fort Calhoun	Fort Calhoun Station Unit 1	457	PWR	OL 1973	Omaha Public Power District	1973
Fort Calhoun	Fort Calhoun Station Unit 2	1,136	PWR	UR	Omaha Public Power District	N/S
Brownville	Cooper Nuclear Station	778	BWR	OL	Nebraska Public Power District	1974
*	NPPD-2	1,100	—	A/O	Nebraska Public Power District	N/S
NEW HAMPSHIRE						
Seabrook	Seabrook Nuclear Station Unit 1	1,200	PWR	CP 1976	Public Service of N.H.	1983
Seabrook	Seabrook Nuclear Station Unit 2	1,200	PWR	CP 1976	Public Service of N.H.	1985

*Site not selected.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
NEW JERSEY						
Toms River	Oyster Creek Nuclear Power Plant Unit 1	650	BWR	OL 1969	Jersey Central Power & Light Co.	1969
Forked River	Forked River Generating Station Unit 1	1,070	PWR	CP 1973	Jersey Central Power & Light Co.	1982
Salem	Salem Nuclear Generating Station Unit 1	1,090	PWR	OL 1976	Public Service Elec. & Gas Co.	1977
Salem	Salem Nuclear Generating Station Unit 2	1,115	PWR	CP 1968	Public Service Elec. & Gas Co.	1979
Salem	Hope Creek Generating Station Unit 1	1,067	BWR	CP 1974	Public Service Elec. & Gas Co.	1984
Salem	Hope Creek Generating Station Unit 2	1,067	BWR	CP 1974	Public Service Elec. & Gas Co.	1986
Little Egg Inlet	Atlantic Generating Station Unit 1	1,150	PWR	UR	Public Service Elec. & Gas Co.	1985
Little Egg Inlet	Atlantic Generating Station Unit 2	1,150	PWR	UR	Public Service Elec. & Gas Co.	1987
*	Atlantic Generating Station Unit 3	1,150	PWR	A/O	Public Service Elec. & Gas Co.	1990
*	Atlantic Generating Station Unit 4	1,150	PWR	A/O	Public Service Elec. & Gas Co.	1992
NEW YORK						
Indian Point	Indian Point Station Unit 1	265	PWR	OL 1962	Consolidated Edison Co.	1962
Indian Point	Indian Point Station Unit 2	873	PWR	OL 1971	Consolidated Edison Co.	1973
Indian Point	Indian Point Station Unit 3	873	PWR	OL 1975	Consolidated Edison Co.	1976
Scriba	Nine Mile Point Nuclear Station Unit 1	610	BWR	OL 1969	Niagara Mohawk Power Co.	1969
Scriba	Nine Mile Point Nuclear Station Unit 2	1,100	BWR	CP 1974	Niagara Mohawk Power Co.	1982
Ontario	R. E. Ginna Nuclear Power Plant Unit 1	490	PWR	OL 1969	Rochester Gas & Elec. Co.	1970
Brookhaven	Shoreham Nuclear Power Station	819	BWR	CP 1973	Long Island Lighting Co.	1980
Scriba	James A. FitzPatrick Nuclear Power Plant	821	BWR	OL 1974	Power Authority of State of N.Y.	1975
Long Island	Jamesport Unit 1	1,150	PWR	UR	Long Island Lighting Co.	1984
Long Island	Jamesport Unit 2	1,150	PWR	UR	Long Island Lighting Co.	1986
*	Unnamed Unit 1	1,250	PWR	A/O	N.Y. State Elec. & Gas Co.	Indef.
*	Unnamed Unit 2	1,250	PWR	A/O	N.Y. State Elec. & Gas Co.	Indef.
Sterling	Sterling Power Project Unit 1	1,150	PWR	CP	Rochester Gas & Elec. Co.	1984

*Site not selected.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
Cementon	Greene County Nuclear Power Plant	1,191	PWR	UR	Power Authority of State of N.Y.	1984
*	Mid-Hudson East 1	1,300		A/O	Empire State Power Resources	1987
*	Mid-Hudson East 2	1,300		A/O	Empire State Power Resources	1989
*	Mid-Hudson West 1	1,300		A/O	Empire State Power Resources	1990
*	Shoreham West 1	1,300		A/O	Empire State Power Resources	1987
*	Shoreham West 2	1,300		A/O	Empire State Power Resources	1989
*	St. Lawrence 1	1,300		A/O	Empire State Power Resources	1988
*	St. Lawrence 2	1,300		A/O	Empire State Power Resources	1990

NORTH CAROLINA

Southport	Brunswick Steam Electric Plant Unit 2	821	BWR	OL 1974	Carolina Power & Light Co.	1975
Southport	Brunswick Steam Electric Plant Unit 1	821	BWR	OL 1976	Carolina Power & Light Co.	1977
Cowans Ford Dam	Wm. B. McGuire Nuclear Station Unit 1	1,180	PWR	CP 1973	Duke Power Co.	1979
Cowans Ford Dam	Wm. B. McGuire Nuclear Station Unit 2	1,180	PWR	CP 1973	Duke Power Co.	1981
Bonsal	Shearon Harris Plant Unit 1	900	PWR	UR †	Carolina Power & Light Co.	1983
Bonsal	Shearon Harris Plant Unit 2	900	PWR	UR †	Carolina Power & Light Co.	1986
Bonsal	Shearon Harris Plant Unit 3	900	PWR	UR †	Carolina Power & Light Co.	1990
Bonsal	Shearon Harris Plant Unit 4	900	PWR	UR †	Carolina Power & Light Co.	1987
Davie Co.	Perkins Nuclear Station Unit 1	1,280	PWR	UR	Duke Power Co.	1985
Davie Co.	Perkins Nuclear Station Unit 2	1,280	PWR	UR	Duke Power Co.	1987
Davie Co.	Perkins Nuclear Station Unit 3	1,280	PWR	UR	Duke Power Co.	1990
*	Carolina P&L Unit 8	1,150	PWR	A/O	Carolina Power & Light Co.	—
*	Carolina P&L Unit 9	1,150	PWR	A/O	Carolina Power & Light Co.	—
*	Carolina P&L Unit 10	1,150	PWR	A/O	Carolina Power & Light Co.	—

*Site not selected.
†Exemption granted to allow some early work at site.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
OHIO						
Oak Harbor	Davis-Besse Nuclear Power Station Unit 1	906	PWR	OL 1977	Toledo Edison-Cleveland Elec. Illum. Co.	1977
Oak Harbor	Davis-Besse Nuclear Power Station Unit 2	906	PWR	UR**	Toledo Edison-Cleveland Elec. Illum. Co.	1985
Oak Harbor	Davis-Besse Nuclear Power Station Unit 3	906	PWR	UR**	Toledo Edison-Cleveland Elec. Illum. Co.	1987
Perry	Perry Nuclear Power Plant Unit 1	1,205	BWR	CP 1977	Cleveland Elec. Illum. Co.	1981
Perry	Perry Nuclear Power Plant Unit 2	1,205	BWR	CP 1977	Cleveland Elec. Illum. Co.	1983
Moscow	Wm. H. Zimmer Nuclear Power Station Unit 1	810	BWR	CP 1972	Cincinnati Gas & Elec. Co.	1979
Moscow	Wm. H. Zimmer Nuclear Power Station Unit 2	1,170	BWR	A/O	Cincinnati Gas & Elec. Co.	N/S
Berlin Hgts.	Erie Unit 1	1,260	PWR	UR	Ohio Edison Co.	1986
Berlin Hgts.	Erie Unit 2	1,260	PWR	UR	Ohio Edison Co.	1988
OKLAHOMA						
Inola	Black Fox Unit 1	1,150	BWR	UR	Public Service Co. of Oklahoma	1983
Inola	Black Fox Unit 2	1,150	BWR	UR	Public Service Co. of Oklahoma	1985
OREGON						
Prescott	Trojan Nuclear Plant Unit 1	1,130	PWR	OL 1975	Portland General Elec. Co.	1976
Arlington	Pebble Springs Unit 1	1,260	PWR	UR	Portland General Elec. Co.	1985
Arlington	Pebble Springs Unit 2	1,260	PWR	UR	Portland General Elec. Co.	1988
PENNSYLVANIA						
Peach Bottom	Peach Bottom Atomic Power Station Unit 2	1,065	BWR	OL 1973	Philadelphia Elec. Co.	1974
Peach Bottom	Peach Bottom Atomic Power Station Unit 3	1,065	BWR	OL 1974	Philadelphia Elec. Co.	1974
Pottstown	Limerick Generating Station Unit 1	1,065	BWR	CP 1974	Philadelphia Elec. Co.	1983
Pottstown	Limerick Generating Station Unit 2	1,065	BWR	CP 1974	Philadelphia Elec. Co.	1985
Shippingport	Shippingport Atomic Power Station Unit 1	90	PWR	—	Duquesne Light Co. & ERDA	NA

[1]Operable but OL not required.
**Limited work authorization issued.

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
Shippingport	Beaver Valley Power Station Unit 1	852	PWR	OL 1976	Duquesne Light Co. Ohio Edison Co.	1976
Shippingport	Beaver Valley Power Station Unit 2	852	PWR	CP 1974	Duquesne Light Co. Ohio Edison Co.	1982
Goldsboro	Three Mile Island Nuclear Station Unit 1	819	PWR	OL 1974	Metropolitan Edison Co.	1974
Goldsboro	Three Mile Island Nuclear Station Unit 2	906	PWR	CP 1969	Metropolitan Edison Co.	1978
Berwick	Susquehanna Steam Electric Station Unit 1	1,050	BWR	CP 1973	Pennsylvania Power & Light Co.	1980
Berwick	Susquehanna Steam Electric Station Unit 2	1,050	BWR	CP 1973	Pennsylvania Power & Light Co.	1982
Fulton	Fulton Generating Station Unit 1	1,160		UR	Philadelphia Elec. Co.	N/S
Fulton	Fulton Generating Station Unit 2	1,160		UR	Philadelphia Elec. Co.	N/S
RHODE ISLAND						
No. Kingston	New England Unit 1	1,150	PWR	UR	New England Power Co.	1984
No. Kingston	New England Unit 2	1,150	PWR	UR	New England Power Co.	1986
SOUTH CAROLINA						
Hartsville	H. B. Robinson S.E. Plant Unit 2	712	PWR	OL 1970	Carolina Power & Light Co.	1971
Seneca	Oconee Nuclear Station Unit 1	887	PWR	OL 1973	Duke Power Co.	1973
Seneca	Oconee Nuclear Station Unit 2	887	PWR	OL 1973	Duke Power Co.	1974
Seneca	Oconee Nuclear Station Unit 3	887	PWR	OL 1974	Duke Power Co.	1974
Broad River	Virgil C. Summer Nuclear Station Unit 1	900	PWR	CP 1973	So. Carolina Elec. & Gas Co.	1980
Lake Wylie	Catawba Nuclear Station Unit 1	1,145	PWR	CP 1975	Duke Power Co.	1981
Lake Wylie	Catawba Nuclear Station Unit 2	1,145	PWR	CP 1975	Duke Power Co.	1983
Cherokee County	Cherokee Nuclear Station Unit 1	1,280	PWR	UR**	Duke Power Co.	1983
Cherokee County	Cherokee Nuclear Station Unit 2	1,280	PWR	UR**	Duke Power Co.	1985
Cherokee County	Cherokee Nuclear Station Unit 3	1,280	PWR	UR**	Duke Power Co.	1988
TENNESSEE						
Daisy	Sequoyah Nuclear Power Plant Unit 1	1,148	PWR	CP 1970	Tennessee Valley Authority	1978

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Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
Daisy	Sequoyah Nuclear Power Plant Unit 2	1,148	PWR	CP 1970	Tennessee Valley Authority	1979
Spring City	Watts Bar Nuclear Unit 1	1,177	PWR	CP 1973	Tennessee Valley Authority	1979
Spring City	Watts Bar Nuclear Plant Unit 1	1,177	PWR	CP 1973	Tennessee Valley Authority	1980
Oak Ridge	Clinch River Breeder Reactor Plant	350	LMFBR	UR	U.S. Government	Indef.
Hartsville	Hartsville Nuclear Plant A, Unit 1	1,233	BWR	CP 1977	Tennessee Valley Authority	1982
Hartsville	Hartsville Nuclear Plant A, Unit 2	1,233	BWR	CP 1977	Tennessee Valley Authority	1983
Hartsville	Hartsville Nuclear Plant B, Unit 1	1,233	BWR	CP 1977	Tennessee Valley Authority	1983
Hartsville	Hartsville Nuclear Plant B, Unit 2	1,233	BWR	CP 1977	Tennessee Valley Authority	1984
Phipps Bend	Phipps Bend Unit 1	1,233	BWR	UR	Tennessee Valley Authority	1984
Phipps Bend	Phipps Bend Unit 2	1,233	BWR	UR	Tennessee Valley Authority	1985
TEXAS						
Glen Rose	Comanche Peak Steam Electric Station Unit 1	1,150	PWR	CP 1974	Texas P&L, Dallas P&L, Texas Elec. Service	1981
Glen Rose	Comanche Peak Steam Electric Station Unit 2	1,150	PWR	CP 1974	Texas P&L, Dallas P&L, Texas Elec. Service	1983
Jasper	Blue Hills Station Unit 1	918	PWR	UR	Gulf States Utilities Co.	Indef.
Jasper	Blue Hills Station Unit 2	918	PWR	UR	Gulf States Utilities Co.	Indef.
Wallis	Allens Creek Unit 1	1,150	BWR	UR	Houston Lighting & Power Co.	1985
Bay City	South Texas Nuclear Project Unit 1	1,250	PWR	CP 1975	Houston Lighting & Power Co.	1980
Bay City	South Texas Nuclear Project Unit 2	1,250	PWR	CP 1975	Houston Lighting & Power Co.	1982
VERMONT						
Vernon	Vermont Yankee Generating Station	514	BWR	OL 1972	Vermont Yankee Nuclear Power Corp.	1972
VIRGINIA						
Gravel Neck	Surry Power Station Unit 1	822	PWR	OL 1972	Va. Electric & Power Co.	1972
Gravel Neck	Surry Power Station Unit 2	822	PWR	OL 1973	Va. Electric & Power Co.	1973
Mineral	North Anna Power Station Unit 1	907	PWR	CP 1971	Va. Electric & Power Co.	1978
Mineral	North Anna Power Station Unit 2	907	PWR	CP 1971	Va. Electric & Power Co.	1979
Mineral	North Anna Power Station Unit 3	907	PWR	CP 1974	Va. Electric & Power Co.	1982
Mineral	North Anna Power Station Unit 4	907	PWR	CP 1974	Va. Electric & Power	1983

Site	Plant Name	Capacity (Net MWe)	Type	Status	Utility	Commercial Operation
WASHINGTON						
Richland	N-Reactor/WPPSS Steam	850	GR	—	Wash. Public Power Supply System	—
Richland	WPPSS No. 1 (Hanford)	1,218	PWR	CP 1975	Wash. Public Power Supply System	1982
Richland	WPPSS No. 2 (Hanford)	1,100	BWR	CP 1973	Wash. Public Power Supply System	1980
Satsop	WPPSS No. 3	1,242	PWR	UR**	Wash. Public Power Supply System	1983
Richland	WPPSS No. 4	1,218	PWR	UR**	Wash. Public Power Supply System	1984
Satsop	WPPSS No. 5	1,242	PWR	UR**	Wash. Public Power Supply System	1985
Sedro Wooley	Skagit Nuclear Power Project Unit 1	1,277	BWR	UR	Puget Sound Power & Light Co.	1983
Sedro Wooley	Skagit Nuclear Power Project Unit 2	1,277	BWR	UR	Puget Sound Power & Light Co.	1986
WISCONSIN						
Genoa	LaCrosse Nuclear 'Generating Station	50	BWR	OL 1967	Dairyland Power Coop.	1969
Two Creeks	Point Beach Nuclear Plant Unit 1	497	PWR	OL 1970	Wisconsin Michigan Power Co.	1970
Two Creeks	Point Beach Nuclear Plant Unit 2	497	PWR	OL 1971	Wisconsin Michigan Power Co.	1972
Carlton	KewauneeNuclear Power Plant Unit 1	535	PWR	OL 1973	Wisconsin Elec. Power Co.	1974
Durand	Tyrone Energy Park Unit 1	1,150	PWR	UR	Northern States Power Co.	1984
Sheboygan	Haven Nuclear Plant Unit 1	900	PWR	UR	Wisconsin Elec. Power Co.	1987
Sheboygan	Haven Nuclear Plant Unit 2	900	PWR	UR	Wisconsin Elec. Power Co.	1989
PUERTO RICO						
Arecibo	North Coast Nuclear Plant Unit 1	583	PWR	UR	Puerto Rico Water Resources Authority	Indef.

[1]Operable but OL not required.
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Index

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