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United States Civilian Nuclear Power Policy, 1954-1984: A Summary History

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The Department of Energy Organization Act of 1977 brought together for the first time in one department most of the Federal Government's energy programs. With these programs came a score of organizational entities, each with its own history and traditions, from a dozen departments and independent agencies. The History Division has prepared a series of pamphlets on *The Institutional Origins of the Department of Energy*. Each pamphlet explains the history, goals, and achievements of a predecessor agency or a major program of the Department of Energy.

The "United States Civilian Nuclear Power Policy, 1954-1984: A Summary History" written at the request of the Assistant Secretary for Nuclear Energy, traces the history of federal policy for developing commercial nuclear power from 1954 to 1984. From its inception commercial nuclear power policy has been the subject of a vigorous, and at times heated, public debate. In the 1950s the debate focused on the proper role of the government in encouraging commercial nuclear power. By the 1970s, the debate centered on the breeder reactor, the safety of commercial nuclear plants, and the disposal of nuclear wastes. This pamphlet describes the evolution of federal commercial nuclear power policy in the context of those debates. In addition, this history provides a brief overview of federal civilian nuclear power programs.

Jack M. Holl is Chief Historian of the Department of Energy. Roger Anders and Alice Buck are professional historians working in the History Division. Although the Assistant Secretary for Nuclear Energy's request established the topic and general goals of the study, the Chief Historian has ultimately determined its contents and conclusions. The authors wish to thank Prentice Dean for compiling the chronology and the charts for the study and Sheila Convis for her outstanding support in the overall production of this brief history.

It is our hope that this history of the United States Civilian Nuclear Power Policy will prove useful both to Departmental personnel and the public.

Jack M. Holl
Chief Historian

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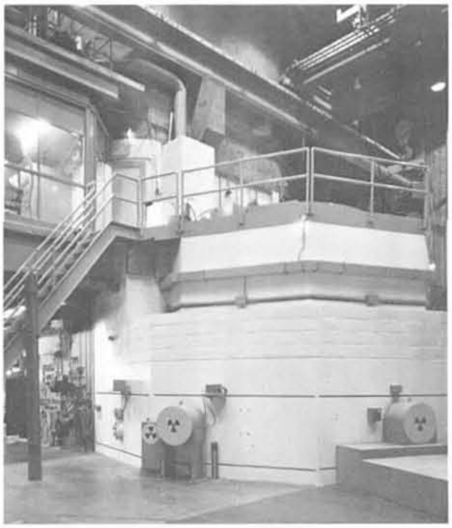
Atoms for Peace

President Eisenhower, at his desk, August 30, 1954, signs the Atomic Energy Act which created a private power industry and permitted greater atomic cooperation with American allies. Seated: President Eisenhower, Rep. Sterling Cole, AEC Chairman Lewis Strauss. Back: MLC Chairman Herbert B. Loper, Sen. Edwin C. Johnson, Rep. Carl Hinshaw, Rep. James E. Van Zandt, Rep. Melvin Price, Rep. Carl T. Durham, and Commissioner Thomas Murray.

President Eisenhower initiating the ground breaking at Shippingport Atomic Power Station, September 6, 1954. By passing a neutron wand over a neutron counter an electronic signal started a bulldozer 1200 miles away at the Shippingport site in Pennsylvania.

The origins of the United States' nuclear power policy are generally traced to President Dwight D. Eisenhower's famous Atoms-for-Peace speech delivered to the United Nations in New York on December 8, 1953. The President, who was anxious to break the deadlock in the stalled disarmament talks proposed establishing an international pool of fissionable nuclear material to be placed under the control of an international atomic energy agency under the aegis of the United Nations. Eisenhower hoped that an international pool of fissionable material would not only decrease stockpiles of uranium designated for weapons, but also would provide the impetus for the development of peaceful uses of the atom, especially nuclear power reactors. Indeed, the Eisenhower Administration perceived that the development of a domestic nuclear power industry initially would be closely tied to the growth of nuclear power in Europe and other areas.[1]

In order for the United States either to foster international cooperation in the peaceful uses of atomic energy, or to launch a civilian nuclear power policy, however, it was necessary for Congress to amend the original Atomic Energy Act of 1946. Under the law, the civilian Atomic Energy Commission monopolized all nuclear sciences including reactor technology. Between 1946 and 1952, the United States devoted virtually all of its atomic energy resources to building up the West's nuclear defenses. Limited stocks of uranium had precluded the development of civilian power reactors. Nonetheless, the commission's activities in developing plutonium production reactors, its limited power reactor experiments, and its success



Experimental Breeder Reactor-I (EBR-I), first reactor to go into operation at the National Reactor Testing Station, in 1951 generated first useful amounts of electricity from the atom and later proved the feasibility of breeding in a fast reactor. The reactor was shutdown in 1964.

in building military propulsion reactors had demonstrated the feasibility of nuclear power. As early as the fall of 1952, the Joint Committee on Atomic Energy published *Atomic Power and Private Enterprise*. The Joint Committee report, which indicated broad interest in nuclear power, conluded that the development of nuclear power would require administrative and financial arrangements not possible under the existing Atomic Energy Act.[2]

President Eisenhower endorsed amendment of the Atomic Energy Act as the first step toward encouraging private industry to undertake power reactor projects. Although the President doubted that industry would participate without large government subsidies, he also believed that nuclear power development would come more quickly with industrial participation. On March 31, 1953, the National Security Council adopted the Eisenhower Administration's policy on nuclear power development. The National Security Council affirmed that "the attainment of economically competitive nuclear power [was] a goal of national importance." But even with legislation permitting the private ownership and operation of power stations, the government would have to continue to shoulder the burden of long-term research and development. The NSC also envisioned that state authorities would "assume increasing responsibility for safety aspects of reactor operation," while financial risks would be assigned to the owners, "in keeping with normal industrial practice."[3]

For more than thirty years, Atoms for Peace served as the cornerstone for America's domestic and foreign policy relating to the peaceful uses of atomic energy. Eisenhower understood that American nuclear science and technology were "wasting assets"; that is, he knew that in time other nations would acquire nuclear capability through their own efforts. While the United States was still the dominant nuclear power, the President sought to further the Nation's political, commercial, and defense interests throughout the world. As one official explained to Nelson Rockefeller, special assistant to the president, the development of international atomic energy under the leadership of American government and industry would provide an "Atomic Marshall Plan" for the world.[4]

The Eisenhower Administration was committed to promoting nuclear power for civilian purposes, but its economic and budgetary policies did not allow for large expenditures for that purpose. When the Administration also decided not to build an aircraft carrier propulsion reactor because it would be too expensive, the Atomic Energy Commission saw a real possibility of converting the carrier reactor into a nuclear power project. Although the Commission supported industrial participation, like the NSC it did not believe private industry would invest heavily in long-term research necessary to achieve civilian power, even if the legal obstacles were removed Eisenhower agreed, and endorsed the idea of stripping the naval features from the carrier propulsion project which Westinghouse had already started at Bettis, the Commission's Atomic Power Laboratory in Pennsylvania, and developing instead a central station nuclear power plant.[5]

The Five-Year Program—1954

Despite enthusiasm to exploit commercial nuclear power, in 1954 the United States had no viable civilian power projects. At the insistence of the Joint Committee on Atomic Energy, the Commission proposed a five-year program consisting of specific research and development projects. The Commission's reactor development program was already heavily committed to military propulsion reactors for the Navy and Air Force. The military projects preempted so much of the budget, staff, and laboratory facilities that all the rest of the Commission's reactor development projects were simply referred to as the "civilian power program." Nevertheless some progress had been made. On December 20, 1951, the Experimental Breeder Reactor (EBR-1) built by Argonne National Laboratory in Idaho had produced small amounts of electricity. The Commission's Materials Testing Reactor (MTR), also built in Idaho, went critical in March 1952, while the Navy's prototype Pressurized Water Reactor (SIW) for the Nautilus submarine was successfully tested a year later in March 1953. Argonne's boiling water reactor experiment (BORAX-1), the construction of the Experimental Breeder Reactor-2, and Oak Ridge Laboratory's Homogeneous Reactor Experiment-1 (HRE-1), rounded out the Commission's major reactor programs on the eve of the Atoms-for-Peace speech.[6] None promised significant civilian power within the decade.

The Commission's five-year program included three of the reactor experiments already completely under government control: the boiling water, fast breeder, and homogeneous reactor experiments. A small fourth project, the Sodium Reactor Experiment (SRE) built in California by North American Aviation, Incorporated, would be the only private program largely financed by the government. The fifth, and by far the largest project, the pressurized water reactor was wholly government-sponsored and directed, with the degree of private participation to be determined later.

Consequently, the pressurized water reactor salvaged from the demise of the carrier propulsion project would become the centerpiece of the Commission's five-year program. The quickest, and surest, way to build a full-scale nuclear power plant would be to put the project under the control of Admiral Hyman Rickover and his naval reactors staff. Although the Joint Committee believed that the five-year plan was sound and deserved support, there was some reservation about the wisdom of converting a navy project into a civilian one, and of building a full-scale plant when it had no chance of generating power at an economic cost. But most questions evaporated when the Duquesne Light Company of Pittsburgh offered to build the new plant on a site it owned on the Ohio River at Shippingport, Pennsylvania, approximately forty miles from Bettis. At no cost to the government, Duquesne offered to provide the site and the turbogenerator plant, and to operate and maintain the facility. The company would also contribute to the cost of developing and building the reactor, which Westinghouse would design and the government would own. Duquesne also offered to buy the power from the Commission at rates favorable to the government. As the Commission reported to the Joint Committee, the Duquesne offer was almost too good to believe.[7]

Atomic Energy Act of 1954

AEC Chairman Gordon Dean (1950-1953)

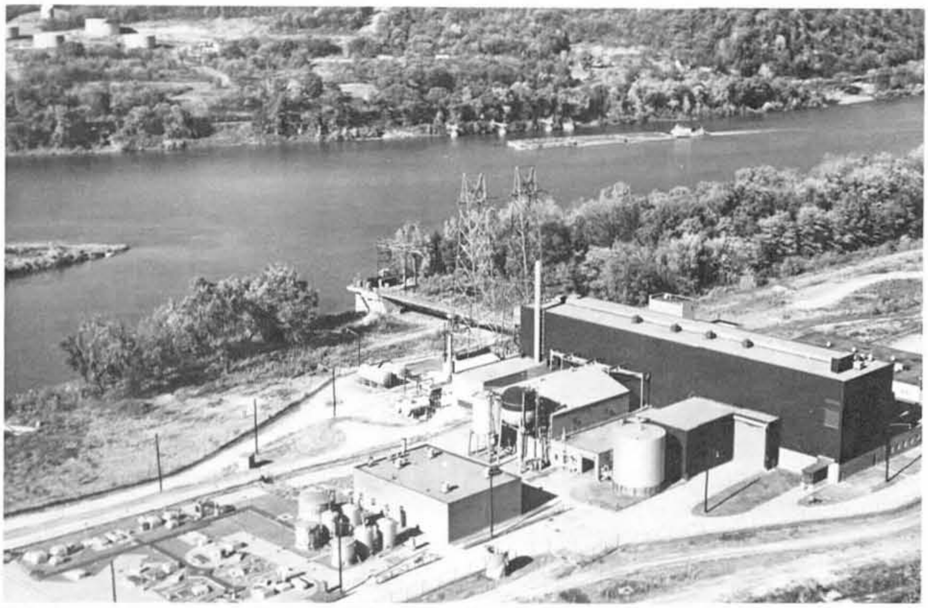
The virtual exclusion of private industry from the Commission's five-year plan underscored the need to amend the Atomic Energy Act. The Joint Committee assumed the initiative for drafting an entirely new statute rather than trying to amend the old law piecemeal. During the hearings when the proposed Dixon-Yates contract became public knowledge, old animosities surfaced over the issue of private-versus-public power. Under the proposed Dixon-Yates contract, the Commission would purchase power from a consortium of electric utilities planning to build a coal-fired plant on the Mississippi River. The purchase of power from private utilities, of course, would offset power the Commission would otherwise buy from the Tennessee Valley Authority. Congressional Democrats suspected that the Administration was using the Commission in this way to undermine the TVA.

In the subsequent debates over the Atomic Energy Act, Republicans and spokemen for private industry advocated provisions which would allow private ownership of plants producing or using fissionable material (ownership of fissionable material would remain with the government); authorize the Commission to declassifty restricted data for peaceful uses; establish licensing procedures for the distribution and use of fissionable and radioactive materials, and for the operation of nuclear facilities; liberalize patent provisions; and permit international exchange of technical information.

The Democrats countered that the United States could only maintain world leadership in nuclear energy by supporting a strong government program in reactor development. Along with public power advocates, the Democrats feared the new legislation would "give away" to private interests nuclear technology developed at public expense. After more than six months of bitter debate, including one of the longest Senate filibusters in history, Congress passed the legislation which the President signed into law on August 30, 1954.[8]

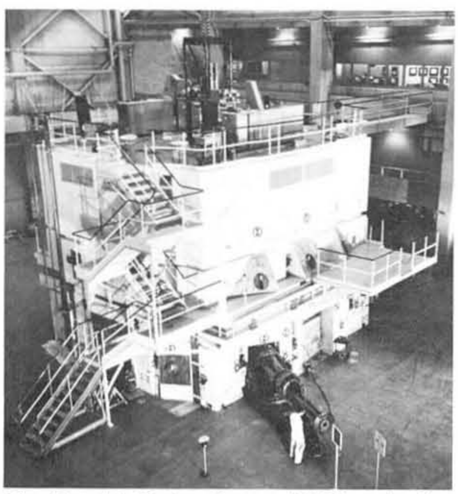
The President and his party had won a significant victory in establishing legislation which would allow the Federal Government and private industry to develop and promote nuclear power in partnership. The partisan legacy from the private-versus-public power debate, however, would continue to haunt the relationship between the Commission and the Joint Committee when the Democrats regained control of Congress after the November 1954 elections.

The Power Demonstration Reactor Program



Shippingport Atomic Power Station at Shippingport, Pa., which began operation in 1957, was the Nation's first full-scale nuclear generating station.

Just one month after the 1954 elections, the Atomic Energy Commission announced the establishment of its Power Demonstration Reactor Program. The Commission hoped to advance beyond its five-year plan, which included only limited industrial participation and funding, as in the Shippingport project, with the Commission owning the reactor and bearing primary responsibility for the project. In the Power Demonstration Reactor Program, private industry would own, design, construct, and operate the power reactor. The Commission would provide funding and other assistance as required, but industry would have overall responsibility for the project. Because of the high cost of purchasing fuel to load reactors, the Commission offered to loan the fuel, charging only for the fuel actually burned. Commission laboratories would also be made available for research and development. In addition, the Commision would assist in paying the costs for development, fabrication, and experimental operation of the plants. In its invitation, the Commission stressed the importance of advancing the state of the art toward economically competitive nuclear power while minimizing the costs to the government. Unfortunately, the broad selection criteria outlined in the Commission's invitation did not provide sufficient guidance for the industry proposals. Of the four proposals received by the Commission, none strictly followed the selection criteria. Two applicants even went so far as to propose government projects with industrial participation, rather than being private efforts with government support.[9]



The Materials Testing Reactor (MTR) at the National Reactor Testing Station in Idaho. The MTR was used primarily to study the effects of radiation on fuel, moderator and structural materials of interest to power reactor designers.

The government faced the fundamental problem of how to transfer a new technology from government control into the marketplace. The Commission had little confidence that private industry could make the proper decisions about the future of nuclear power, or had the resources to take the requisite risks. On the other hand, what were the limits to government investment in a technology destined for private exploitation? The Commission was caught in what might be called the Shippingport dilemma. The more the Commission provided needed assistance to stimulate growth of nuclear power, the more the power demonstration projects would become like Shippingport, government projects with industrial participation. Such partnership would defeat the basic purpose of the Power Demonstration Reactor Program by foreclosing private ownership and control of the reactor. On the other hand, as projects became increasingly independent of the Commission's support, the government would find it increasingly difficult to direct the course of nuclear power development.[10]

The Commission was pleased that all four power demonstration proposals would advance reactor development projects already sponsored by the five-year plan. Despite deep misgivings about government funding of research and development for private industry, the Commission also wanted the Power Demonstration Reactor Program to be a success. It seemed evident that in order to transfer nuclear technology from government control to the marketplace, the Federal Government would have to support projects which were more independent than Shippingport, but not yet fully private enterprises.[11]

The Commission approved the proposals of the Nuclear Power Group, headed by Commonwealth Edison, to build a boiling water reactor at Dresden, near Chicago, and of the Detroit Edison consortium to build a breeder reactor (the Enrico Fermi Atomic Power Plant) near Detroit. Proposals from the Yankee Atomic Electric Company of Boston to build a pressurized water reactor in western Massachusetts, and from the Consumer's Public Power District of Columbus, Nebraska to build a sodium graphite reactor were initially deferred, but later accepted.[12] (see Table 2.)

The results of the first round of the Power Demonstration Reactor Program were gratifying to the Commission, but did not stir great enthusiasm either in the White House or on Capitol Hill. Eisenhower, for example, hoped for a more dramatic project such as modifying the successful submarine reactor to power an "Atoms-for-Peace" surface ship. The National Security Council, on the other hand, believed the Commission should place greater emphasis on the development of small power reactors, which might be more competitive in foreign markets. While the Commission succeeded for the time being in postponing the President's project for an "Atoms-for-Peace" ship, it used the NSC's concerns to launch the second round in the power demonstration program.[13]

The second invitation, announced in September 1955, stressed small reactors and encouraged, for the first time, participation from public power groups. The response to the second round raised the total number of projects to seven (after the Nuclear Power Group withdrew from round one). In the second round the Commission took title to those portions of the reactor plant constructed with government funds, thus returning to the government-industry partnership adopted for the Shippingport project.[14] (See Table 2.)

The Gore-Holifield Bill

AEC Chairman Lewis L. Strauss (1953-1958)
Credit: Karah, Ottawa

The Atomic Energy Commission's five-year plan, and the first two rounds of the power demonstration reactor program left the Democrats on the Joint Committee dissatisfied with the government's leadership in developing civilian power reactors. The Commission had hoped that private industry could be induced to finance, build, and operate nuclear power plants incorporating each of the promising reactor designs, thus limiting the government's role in support of the new technology. Joint Committee Democrats, on the other hand, believed the Commission's reactor development program lacked the focus and resources necessary to achieve economical nuclear power. The Gore-Holifield Bill, introduced in the spring of 1956, would have dramatically enlarged the Federal Government's reactor development program by directing the Commission to construct six large-scale nuclear power projects in different regions of the country. The bill, sponsored by Senator Albert Gore of Tennessee and Representative Chet Holifield of California, received enthusiastic support from Senator Clinton Anderson of New Mexico, Chairman of the Joint Committee. Commission Chairman Lewis Strauss, suspecting that the Democrats wished to create an 'atomic TVA,' became the bill's intractable foe.

As hearings on the Gore-Holifield Bill got underway, the Democrats revealed their distrust of the Commission's enthusiasm for nuclear power, and of the private sector's commitment to build a nuclear industry. To some extent, the old public-versus-private power debate was rejoined. But Gore and other supporters of the bill also believed they were fighting a significant battle in the Cold War. To lose the race for nuclear power to the Soviet Union, Gore argued, would be "catastrophic." The United States had a "clear moral responsibility" to develop "this marvelous new source of energy ... to dispel Soviet progaganda that we are a Nation of warmongers." Significantly, Gore touched closely on the original theme of Eisenhower's Atoms-for-Peace speech.[15]

During the 1956 election campaigns, the Democrats did not criticize Eisenhower because his nuclear power program was environmentally reckless or socially dangerous. Rather, following the lead of Gore, Holifield, and Anderson, they chastized the Administration for not charging ahead far enough or fast enough. In May, hammering away at the Dixon-Yates theme while campaigning for the Democratic Presidential nomination, Senator Kefauver charged that the United States had "fallen woefully behind" the Soviet Union, the United Kingdom, and France because the Eisenhower Administration had insisted that private industry be the exclusive developer of commercial atomic energy. Kefauver repeated his accusations a month later, more stridently blaming "Republican Freebooters" for falling behind in the international development of nuclear power. At the Democratic National Convention in August 1956, the Commission was accused of being too slow, too secretive and too cautious. According to the Democrats, "lofty words and little action" characterized the administration's nuclear power program. While the Commission and private industry conferred, the United States was "lagging in the world race for nuclear power, prestige, and world markets."[16]

After bitter debate, and frequent amendment, the Gore-Holifield Bill, which had easily passed the Senate, was defeated in the House of Representatives by just twelve votes. A jubilant Strauss believed that the Eisenhower Administration had been vindicated. On the other hand, an embittered Senator Anderson was convinced that the Chairman of the Atomic Energy Commission was really opposed to nuclear power.[17] Anderson, and the Joint Committee Democrats, would bide their time.

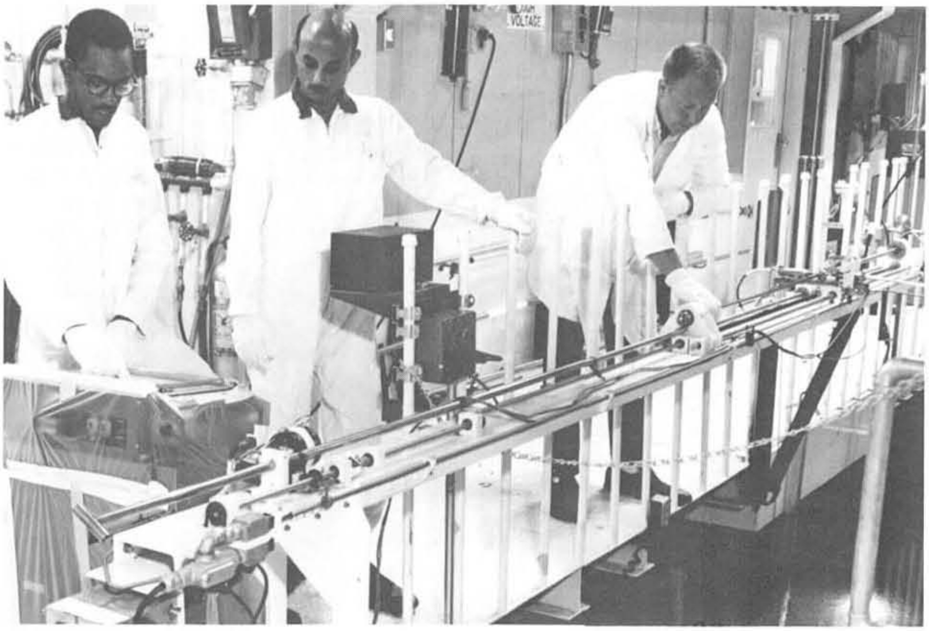
The Price-Anderson Act 1957

Anderson resolved to turn the Democratic defeats on atomic energy legislation in 1956 into solid victories in 1957. The Price-Anderson Act would become one of the most important pieces of atomic energy legislation passed after the Atomic Energy Act of 1954. In March Anderson warned Strauss that the insurance indemnity bill, which the nuclear manufacturers demanded, would be bottled up until the Administration showed more signs of cooperating with the Joint Committee on nuclear power legislation.[18]

Unexpectedly, Congressman Clarence Cannon, Chairman of the House Appropriations Committee, charged that the Power Demonstration Reactor Program was illegal because none of the projects had been specifically authorized by Congress as required by the 1954 Atomic Energy Act. Strictly speaking, Cannon was incorrect because the projects had been funded from the operating budget, and hence not subject to direct Congressional authorization. When Cannon demanded an amendment to the Act to provide Congressional oversight, Anderson seized the opportunity to suggest that the Joint Committee simply "cooperate" with the Commission by authorizing the projects, as Cannon requested, without having to amend the law. Although not happy about the compromise, the Commission acquiesced, thus providing Anderson and the Joint Committee their sought-after authority over the power reactor development program.[19]

Shortly thereafter, Congressman Melvin Price of Illinois and Senator Anderson introduced the insurance indemnity bill which quickly passed both houses of Congress. The act required nuclear power operators to carry the maximum insurance coverage offered by private companies. In addition, the licensees and their suppliers would be indemnified by the act for $500 million over the amount of private coverage available. Finally, public liability would be limited for each accident to the total amount of federal and private protection. Signed into law by President Eisenhower on September 2, 1957, the Price-Anderson Act would become controversial in the nuclear power debates of later decades.[20]

International Programs — Peaceful Bilaterals, the IAEA, and Euratom



Advanced training opportunities in the peaceful uses of atomic energy were offered to foreign nationals at AEC facilities. In this photo, two Battelle-Northwest research scientists describe the use of a fuel rod profilometer at the Pacific Northwest Laboratory to Jaguish K. Pahl (center), Bhubba Atomic Research Center exchange scientist, Bombay, India. Credit: Battelle-Northwest

Although Eisenhower's nuclear power program became embroiled in domestic politics between the Atomic Energy Commission and the Democratically controlled Joint Committee on Atomic Energy, Atoms for Peace remained a major part of United States' foreign policy relating to arms control and disarmament, the international control of nuclear energy and related technology, and post-World War II European recovery. American defense needs would always come first. By 1954, however, the United States had enough uranium so that it could promote international peaceful uses without depleting its own military stockpile. By sponsoring the Geneva Conference on Peaceful Uses of Atomic Energy in 1955, and the creation of the International Atomic Energy Agency (IAEA), the United States hoped to establish forums through which it could secure its role as an international manager of atomic energy. At the same time, through bilateral agreements which transferred nuclear technology and materials to foreign countries, Eisenhower hoped to strengthen American economic and military ties to its allies and other foreign nations.

The bilateral agreements provided fuel and technology for power reactors as well as research reactors and isotopes for nuclear medicine, agriculture and other research purposes. To some degree, however, the Commission preferred bilateral power and research agreements over cooperative programs through an international agency, since the bilaterals provided the United States greater economic and political leverage and maximum management of foreign activities. By 1961 the United States had negotiated fourteen power bilaterals and thirty-eight research bilaterals with thirty-seven participating countries and the city of West Berlin.

Even the numerous bilateral agreements of cooperation, however, did not reveal the main thrust of America's peaceful atomic diplomacy. In reality, under directions from President Eisenhower, the United States placed its greatest support behind Euratom, the European nuclear cooperative embracing France, West Germany, Italy, the Netherlands, Belgium and Luxembourg. As envisioned in 1956, Euratom would establish an integrated program for developing an atomic energy industry in Europe similar to the European Coal and Steel Community. Although Euratom would finance and coordinate research and development, it was primarily designed to generate electrical power for industrial uses. With European coal production on the decline and the best of the hydroelectric sites already exploited, nuclear energy seemed to offer Europe its only long-term indigenous source of industrial power. Even this source was somewhat limited by Europe's uranium resources, unless supplemented by the United States. Of course, the Administration also expected American industry to profit from the sale of nuclear hardware to the Euratom group. Although Chairman Strauss was somewhat concerned about the socialistic aspect of Euratom, the debate over public versus private power, waged so bitterly in the United States, did not seriously jeopardize the Atoms-for-Peace initiative.

Safeguards and security remained a persistent problem for exporting American nuclear technology and materials abroad, however. Each of the peaceful bilaterals included safeguards provisions satisfactory to the Commission, as did the Euratom agreement. In addition to the 1954 Atomic Energy Act, the United States looked to the Statutes of the International Atomic Energy Agency to provide the principal guidelines for safeguards procedures. Protracted negotiations with the Russians over establishment of the IAEA focused on these very issues. Even after the Soviet Union ratified the IAEA treaty in May 1957, the Senate moved slowly to approve United States' participation in the international organization. Senate opposition to the IAEA treaty sprang from a complex crosscurrent of isolationist, anti-foreign aid, anti-communist, and military secrecy sentiments mixed with suspicion of the Administration's domestic power reactor program. Although the treaty was never in any serious trouble, in the end the Senate amended it to require Congressional approval of all transfers of nuclear materials to the IAEA. The amendment did not cripple Eisenhower's Atoms-for-Peace program, but it reflected somewhat less than full confidence in the IAEA and international multilateral cooperation.[21]

International rivalry and safeguards were not alone in frustrating accelerated development of the peaceful atom. By 1960, increased European coal production and inexpensive Middle Eastern oil had dealt a severe economic blow to the hopes of establishing a competitive nuclear power industry. Euratom had consequently fallen short of expectations as the urgency for nuclear power lessened. Euratom remained confident that nuclear power, in the long run, would be important to Europe, but estimates from projected installed nuclear capacity by the 1970s were revised downward. With Euratom and other international nuclear programs facing economic uncertainty, stretch-outs and modifications were required for most development projects, while the prospects for competitive nuclear power in the United States continued uncertain.[22]

The Ten-Year Plan

In July 1958 John A. McCone succeeded Lewis Strauss as chairman of the Commission. McCone was an engineer, who took a pragmatic, rather than political, approach to issues. He moved quickly to build a good working relationship with Anderson and Holifield so that nuclear power policy would be formulated in coordination with the Joint Committee. Both McCone and the Joint Committee, however, would have to work within the budgetary limits set by the Eisenhower Administration. Realizing that power reactor technology was still in the early stages of development, McCone subjected every Commission reactor project to searching

Former AEC Chairman Lewis Strauss congratulating new Chairman John A. McCone, July 14, 1958.

technical scrutiny. Intending to formulate a "constructive program," he did not want to proceed with anything that was "unsound."[23] McCone's two years as chairman would give the Commission a time to pause and regroup after the hectic battles of the previous few years.

The Joint Committee, meanwhile, not satisfied with the Commission's civilian program, drafted its own *Proposed Expanded Civilian Nuclear Power Program.* Although concluding that nuclear power could one day supplement dwindling supplies of fossil fuels, the Committee saw urgency only in the need to maintain the American international lead in the peaceful applications of atomic energy. The Committee thought that economic nuclear power could be demonstrated in the United States by 1970 if the Commission provided "positive direction" to the course and speed of nuclear power development. Outlining its own program, the Joint Committee envisioned the construction of twenty-one reactors of various types over the next five to seven years.[24]

McCone asked Commission staff to analyze the Joint Committee's proposed program while he undertook his own review of power policy and programs. For over a year Commission laboratories and contractors reviewed reactor projects and concepts, with the ultimate goal of devising a plan for the development of commercially competitive nuclear power. Falling in line with the Joint Committee, the Commission concluded nuclear power could become economically competitive by 1968, or about ten years after McCone launched his policy review. The study, known as the Commission's ten-year plan, was published in February 1960.[25]

The Commission described the new plan as "the first phase" of its long-range program to make nuclear power "competitive with power from fossil fuels in high-energy cost areas of [the] country within ten years." Recognizing the bleak picture for nuclear power in Europe, the Commission nevertheless promised to maintain American leadership by assisting other nations to reduce the cost of nuclear power. The Commission recognized the need to develop breeder reactors which would use plentiful uranium 238 and thorium during power generation to create plutonium and uranium 233, which could then serve as reactor fuel. Light water reactors also produced some plutonium during operation but not at the same rate as breeders. Plentiful ore and the ability to produce new fuel meant that breeder reactors promised an almost unlimited supply of energy. The Commission refused, however, to predict when shortages of uranium 235 might make the use of breeder reactors vital and clearly saw their development as a long-term project.

To carry out the ten-year plan, the Commission devised a "three-phase sequence" for the development of commercial power reactors. First, the Commission would continue its experimental reactor projects. (See Table 3.) Next, in partnership with private industry the Commission would build prototypes of the most promising expermental types under provisions of the Power Reactor Demonstration Program. Finally, the Commission would work cooperatively with reactor manufacturers and utilities to produce full size power reactors.

Confident that light water reactors would soon become competitive, the Commission hoped that other reactors, such as organic or sodium cooled reactors, might also achieve competitive power in high fuel cost areas. In addition to the reactor developmental plans, the Commission saw the need to develop a variety of reactor fuels, components, and materials to devise methods of reprocessing commercial reactor fuels, and to establish "practical systems for the safe handling and disposal" of radioactive wastes. Noting also that the increasing number and diversity of new reactors would "intensify" problems in reactor safety, the Commission promised to continue the "experimental and analytical work" required to provide the technical basis for designing safe reactors.[26]

The Commission's ten-year plan was more of an extension of earlier proposals than a departure from either the Five-Year Program or the Power Reactor Demonstration Program.[27] The ten-year plan underscored the importance of integrating the various reactor projects and designs into a comprehensive plan for the introduction of commercial nuclear power. The plan also acknowledged in 1958 that the outlook for commercial nuclear power appeared somewhat better in the United States than in Europe. The Commission retained its role in developing commercial power while moving the technology into commerical production by 1968. But John F. Kennedy's victory in the 1960 Presidential election promised a new Administration and a new look at nuclear power.

A New Civilian Power Policy — The Kennedy Administration

President Kennedy's visit to Germantown, February 1961. Commissioner Graham, Chairman Seaborg, President Kennedy, Commissioners Wilson and Olson.

President Kennedy appointed Glenn T. Seaborg, Nobel Prize winning chemist and chancellor of the University of California, to be chairman of the Atomic Energy Commission. A distinguished chemist who had discovered plutonium, Seaborg was also an enthusiastic supporter of the peaceful applications of atomic energy. With Kennedy in the Presidency and Seaborg chairing the Commission, Senator Anderson and Representative Holifield of the Joint Committee on Atomic Energy looked forward to a vigorous civilian power program under strong federal leadership. The Joint Committee soon discovered, however, that the Kennedy Administration had different priorities, which included a "crash" space program, but not an equally vigorous civilian nuclear power program. The decline in federal outlays for demonstration reactor programs, which had begun in Eisenhower's second term, continued in the Kennedy Administration.[28]

Under Seaborg, the Commission announced a modified third round of the Power Demonstration Reactor Program. The additional third round essentially carried forward existing programs while the new Administration devised its own civilian nuclear power policy. Inviting industry to submit proposals for "the design, construction, and operation of a large all-nuclear power plant," capable of producing at least 400 megawatts of electricity, the Commission set a maximum amount for its financial contributions, expecting private industry to bear the remaining design and construction costs. The Commission hoped the modified third round projects, announced on August 23, 1962, would demonstrate the reliability of large nuclear plants for power production. Although the Commission believed industry capable of bearing a greater share of design and construction costs, it added an incentive by offering the possible waiver of reactor fuel use charges. Eventually the modified third round produced three projects, the city of Los Angeles Department of Water and Power's Malibu Plant, the Southern California Edison's San Onofre Nuclear Generating Station, and the Connecticut Yankee Atomic Power Company's Connecticut Yankee Plant. All three were pressurized water reactors.[29]

The 1962 Report to the President

Even before the opening of modified round three, the Joint Committee sought to build political and fiscal support for atomic power by encouraging the Commission to seek Administrative support for a strong civilian reactor program. With the assistance of the Bureau of the Budget, Seaborg drafted a letter which President Kennedy agreed to send to the Commission. In the letter the President requested the Commission, in cooperation with the Federal Power Commission and the Department of the Interior, to take "a new and hard look at the role of nuclear power" by identifying the requirements for a power program in light of the Nation's prospective energy needs and resources. Significantly, Kennedy wanted the study conducted in the context of total energy projections and resources. The President expected that nuclear power would help meet the Nation's continually growing demands for energy, and anticipated that operational powerplants would provide experience on which to base forecasts of the future of commercial nuclear power. But he made no specific commitments to a nuclear power program and his science advisor Jerome Wiesner remained skeptical about the study.[30]

Chairman Seaborg submitted *Civilian Nuclear Power...A Report to the President - 1962* to the White House on November 20, 1962. Concluding that government had paid too much attention to short-term goals in the past, the Commission focused on the long-range prospects of nuclear power. Admitting that programs of the 1950s had fostered an "over-capitalized and under-used" nuclear power industry, the Commission, nevertheless, believed that light water reactors were "on the threshold of economic competitiveness" in America. With only moderate government assistance they could cross the economic threshold into "widespread acceptance by the utility industry."[31]

Nevertheless, the Commission was concerned about the long-term outlook for the nuclear power industry. Because uranium 235 constituted only .7% of naturally occurring uranium ore, the capacity of light water reactors to meet future demands for electric power was severely limited. If, on the other hand, supplies of uranium 238 (99% of naturally occurring ores) and thorium could be used in breeder reactors, supplies of fuel would be "almost limitless." "Only by the use of breeders," the Commission declared, could America "really solve the problem of adequate energy supply for future generations."[32]

The Commission worked with the Federal Power Commission to develop the estimates of American power demand which made breeder reactors seem so attractive. Expecting American energy consumption to double by 1990, the Commission estimated that the nation would exhaust "low-cost fossil fuels" within 100 years and all fossil fuels in 150 to 200 years. The Commission believed nuclear energy, however, could supplement fossil fuels and conserve supplies. Immediately, nuclear energy could begin to replace fossil fuels in electric power generation. By the year 2000 nuclear power plants could generate as much as two-thirds of the Nation's electric power, although this was an optimistic estimate, the Commission cautioned.

Given the Commission's estimates, emphasis on breeder reactors was inevitable. The Commission described two types of breeder reactors; fast breeders which used the uranium-plutonium fuel cycle and thermal breeders which used the thorium-uranium 233 fuel cycle. Both breeders required extensive research and development before economic, commercial reactors would be a reality.

Until breeders were proven, however, the Commission expected to develop both breeder reactors and advanced converter reactors. (Converter reactors were any reactors which produced less fissionable material than they consumed. Advanced converters used fuel more efficiently than light water reactors.) The Commission would support advanced converter projects designed to improve unit power cost, to increase fuel efficiency, or to contribute to breeder reactor technology. Over the next twelve years, the Commission hoped to build three advanced converters and three breeders for which it would bear project costs. During the same period, the Commission anticipated sharing costs with industry on at least ten full-scale converter reactor projects. Prospective projects included organic cooled and moderated reactors, heavy water reactors, the "spectralshift" reactor, the sodium graphite reactor, and gas-cooled reactors.

The Commission reiterated that light water reactors had "definitely 'arrived'" and were "reliable and safe." Because light water reactors were declared to be economically competitive in high-fuel cost areas, the Commission planned no further government sponsored development programs for them. Rather it only foresaw programs for light water reactor fuel and component development.

Rounding out its review of nuclear power, the Commission described several supporting programs essential to the development of nuclear power. Research had to be continued on reactor fuel systems, moderators, and coolants. A vigorous effort was required "to maximize the inherent safety of reactor installations." The Commission also had to devise methods to dispose of the "low-activity" and "high-level" wastes which would be generated by commercial reactors. Finally, the Commission listed a number of policy areas, among them the efficient licensing of nuclear power plants, which would contribute to the commercial acceptance of nuclear power.[33]

Whether the Commission's report seemed to promote rather than to take a "hard look" at nuclear power, Anderson and Holifield generally were satisfied, but they were concerned that the Administration would not implement the report. Justifying their concern, President Kennedy failed to endorse the report and McGeorge Bundy, his national security advisor, argued that it failed to consider nuclear energy in the total context of American energy supply and demand. Philip Sporn, an influential member of the utility industry, thought the report placed too much urgency on the need to develop breeder reactors.[34] With the President and his advisors seeing no urgent need to develop civilian nuclear power, it was unlikely the Commission would win bigger budgets for civilian power programs.

The 1962 report to the President, however, was a landmark policy statement. In the report the Commission declared that the first phase of the commercialization of nuclear power was virtually over and set its sights on phase two. Basing its strategy on estimates of future electric power needs, the Commission believed it essential to promote breeder reactors through an overall plan for their development. But the 1962 plan, based on assumptions about growing power demands and the commercial readiness of light water technology, captured little immediate support in the White House.

Emergence of A Commercial Power Industry

Consumers Power Company's Big Rock Point nuclear electric generating station at Charlevoix, on Lake Michigan, at the northwest tip of Michigan's Lower Peninsula. The plant includes a high-power density, boiling water reactor. Initial criticality took place in September 1962, with first power production in December that year.
In June 1964, the plant attained an uprated power output of 75,000 kilowatts after some months of operating at various capacities up to 50,000 kilowatts. In 1969 Consumers Power Company provided electric service to more than 900,000 customers.
Credit: Consumers Power Company.

The Commission's optimism about nuclear power doubtlessly reflected the current state of the civilian power industry. In 1962 fifty-three power reactors of all types were being designed or under construction in the United States. Six large central-station nuclear plants were in operation, the largest being the 255 megawatt (electrical) Indian Point Unit-1. Although none were economically competitive, most reactor plants performed above expectations, were reliable, and often operated above normal power ratings. Both the Indian Point Plant and the Dresden Nuclear Power Station had been built entirely with private funds. Private industry had also made substantial technical and financial contributions to many of the other reactor projects.[35]

Within a year of the 1962 report to the President, private industry seemed to justify the Commission's assumption that light water reactors were on the verge of commercialization. On December 12, 1963, the Jersey Central Power and Light Company announced its decision to purchase a 515 megawatt plant from General Electric for construction at Oyster Creek, New Jersey, 40 miles north of Atlantic City. Jersey Central projected that within five years of its initial operation, scheduled for 1969, the nuclear plant would be more economical than a conventional plant. If these assumptions proved correct, the Oyster Creek plant would be the first nuclear power plant selected on purely economic grounds without government assistance and in direct competition with a fossil-fuel plant.[36] The Oyster Creek plant was called a "turnkey" plant, because General Electric had agreed to build the entire plant for a firm price, adjustable only for inflation. All Jersey Central had to do was "turn the key" and "open the door" to the completed plant. The fact that utilities soon bought eight more "turnkey" plants, all without government subsidies, reinforced the impression that the era of commercial nuclear power was at hand.

Meanwhile, with strong support from the Joint Committee on Atomic Energy, Congress passed legislation ending an eighteen-year mandatory government monopoly of special nuclear materials. Under the act, signed by President Johnson on August 26, 1964, enriched uranium for power reactor fuel would no longer have to be leased from the government. This proved to be an important step in encouraging commercial power while further reducing government involvement. The initial orders for "turnkey" plants were followed by orders for another generation of light water nuclear power plants purchased without firm price guarantees. A "boom" market developed and within four years of the Jersey Central announcement, utilities had ordered 75 central station nuclear power plants with a net total capacity of over 45,000 megawatts of electricity.[37]

Implementing Civilian Power Policy for the 1960s

President Johnson and Chairman Seaborg placing memorial plaque on the EBR-1 NRTS during the establishment of the EBR-1 as a national historical landmark, August 26, 1966. Experimental Breeder Reactor first produced small amounts of electricity on December 20, 1951.

As a commercial power industry based on light water technology grew, the Commission moved to implement the advance converter program. Because of budget limitations and competition with commercial power reactors and the breeder, however, the converter program never really got off the ground. In February 1964, the Commission requested proposals from industry for the joint exploration of several different types of advanced converter reactors. The Commission received four separate proposals, but accepted only two of them. Eventually only a high-temperature gas-cooled reactor proposed by the Colorado Public Service Company was built at Fort St. Vrain, Colorado. Within four years the advanced converter program had disappeared.[38]

The Commission also had established a modest program for developing breeder reactors. The Commission's Experimental Breeder Reactor No. 2 and the Power Reactor Development Company's Enrico Fermi fast breeder reactor were both operating at low power levels by 1964. The Commission planned to use both facilities as well as the planned Southwest Experimental Fast Oxide Reactor to test materials and components designed for the first generation of breeder reactors. To provide a more advanced test facility for breeder components, the Commission's Argonne laboratory planned to build a Fast Reactor Test Facility. Commission contractors simultaneously initiated studies for a breeder reactor suitable for use in a one-million electrical kilowatt plant.[39]

Commisioner James T. Ramey, former Executive Director of the Joint Committee, nonetheless argued that these efforts were too diffuse and lacked the urgency required to insure the prompt commercial introduction of breeder reactors. In November 1964, the Commission named Milton Shaw, from Admiral Rickover's Naval Reactors Program, director of reactor development. Shaw's assignment was to implement an agressive government-controlled reactor program. Shaw's mandate for reactor development was similar to the power development strategy the Joint Committee had urged on the Commission since the 1950's.[40]

In November 1965, after extensive review and debate, the Commission decided, at Shaw's urging, to give more priority and resources to fast breeder programs. In order to assure adequate facilities for testing materials for complex fast breeder reactors, the Commission cancelled Argonne's Fast Reactor Test Facility in favor of building a Fast Flux Test Facility (FFTF) under the highest priority. The Commission also decided, again at Shaw's insistence, to center breeder programs on the Liquid Metal Fast Breeder Reactor (LMFBR) concept. To insure rapid development of breeder reactors, the LMFBR project received highest priority among the Commission's reactor development programs.[41]

Because the Commission saw the breeder as a difficult, long-term project requiring heavy government participation, United States had developed beyond expectations" and noted this was primarily due to utility orders for light water reactors.

After describing power reactor programs, the Commission turned to support programs. The size of power reactors had increased markedly since 1962 and the Commission noted that results of reactor safety experiments neeeded to be applied to reactor design. Engineered safety features had to be "specifically designed to prevent accidents or to minimize their consequences." Listing safety features and systems being designed and tested for power reactors, the Commission also anticipated that operating experience would suggest further measures to improve reactor safety.

The Commission deemed it essential for the nuclear power industry to provide safe and economic management of wastes. Although the Commission anticipated few problems in handling the low-level wastes generated by power plants, nonetheless it encouraged practices which reduced the volume of high-level wastes requiring long term storage. Because methods of solidifying and disposing of high-level wastes had reached the field demonstration phase, the Commission expected them soon to be available to industry for use in the commercial reprocessing of reactor fuel.

The Commission supported continued research on reactor components and materials. It noted that the legislative change allowing private ownership of reactor fuel was "an important element" in the "surge of orders for nuclear power plants." Almost parenthetically the Commission recognized that the rapid growth of the nuclear power industry required measures to simplify the power plant licensing process. Although the Commission admitted that "inadequate depth in reactor design and engineering efforts" had led to "delays, increased costs, and in some cases cancellation of experimental and demonstration reactor projects," on the whole it saw few obstacles to the continued growth of nuclear power.[46]

By the end of the 1960s, most of the plants built under the Power Demonstration Reactor Program had several years' operating experience. A small number of reactors, among them the Consumers Power Company's Big Rock Nuclear Power Plant, the Elk River Rural Co-op Association's Elk River Reactor, the Puerto Rico Water Resource Authority's Boiling Nuclear Superheat Reactor, and the Dairyland Power Cooperative's La Crosse Boiling Water Reactor had been built during the decade under terms of the Power Demonstration Reactor Program. Of the three projects initiated under the modified third round, the Malibu plant had been cancelled, but both the San Onofre and the Connecticut Yankee plants began operation in 1967. No new projects were started under any round of the Power Demonstration Reactor Program after 1964.[47] Except for accumulating valuable operating experience and data, the Power Demonstration Reactor Program was over. (See Table 2.)

In some respects, the Commission's perception that the civilian power industry had grown "beyond expectations" was an understatement. By 1967 utilities were ordering power reactors ranging in size from 800 to 1100 megawatts. Yet the largest operating plant was the 255 megawatt Indian Point plant. The most recently constructed demonstration reactors, the San Onofre plant and the Connecticut Yankee plant produced only 450 and 575 megawatts respectively. Thus most of the plants being designed and built for the commercial power industry were based on assumptions and extrapolations about safety and reliability rather than operating experience.[48]

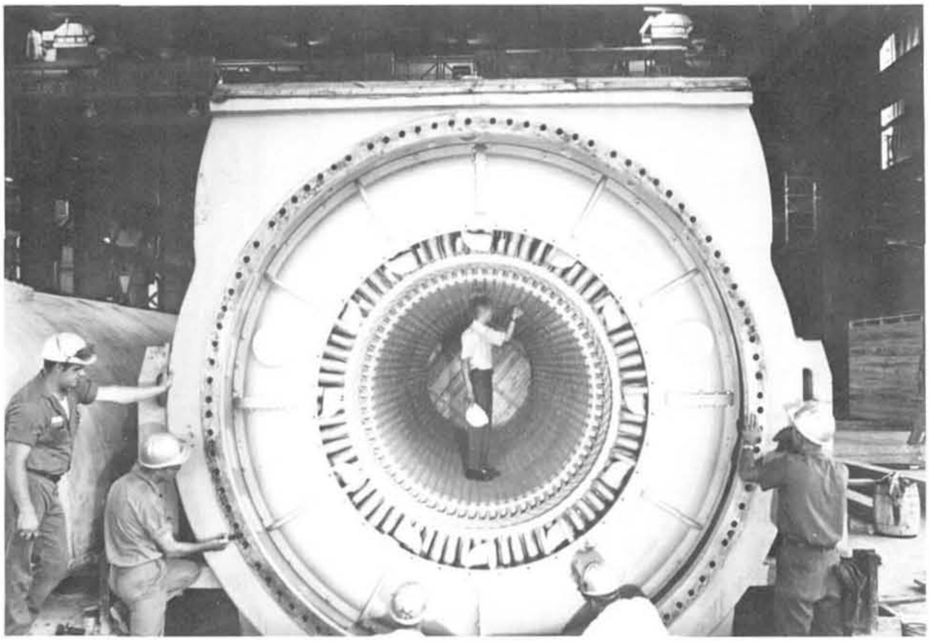
Agenda for the 1970s

In the 1970s the government's civilian reactor policy would be shaped by the problems of the commercial power industry as well as by Commission decisions and actions of the previous decade. Rising costs, the impact of the environmental movement, unresolved questions about reactor safety, and the collapse of the Commission's program for developing a high-level waste storage facility in Kansas would establish a new agenda for civilian power policymaking. Although the energy crisis made nuclear power appear more competitive with fossil fuels, the end of the Arab Oil Embargo would not mark the end of questions about reactor safety, reliability, or economic competitiveness. Increasingly, civilian nuclear power policy would focus on issues relating to the fast breeder reactor, the safety of commercial power reactors, and the disposal of power reactor wastes. Even before the decade's end previous estimates about the cost of nuclear power plants were proving overly optimistic. Projected costs would continue to rise at the opening of the 1970s, due partly to the increased complexity of power reactor licensing.

Seaborg and his associates decided to place tight management controls over the program. The Commission, with some participation by private industry, would take responsibility for guiding the technology from research and development through a demonstration plant. The Joint Committee on Atomic Energy approved both the high priority given the breeder and the Commission's plans for managing it. Indeed, for over ten years the Joint Committee had argued that civilian reactor development should be closely controlled and managed by the government. In effect, the LMFBR program could be called "a larger version of the Shippingport arrangement." Commission management of civilian reactor projects had come a full circle from the government controlled Shippingport project through the loose government/industry partnership of the Power Reactor Demonstration Program to commercial development and finally back to tight Federal control.[42]

The breeder program would face the same budgetary limitations as other civilian power programs. In November 1964, the Commission appealed successfully to President Kennedy's successor, Lyndon B. Johnson, to save the advanced converter program.[43] The growing war in Vietnam, however, would hardly leave the Johnson Administration time or money for civilian nuclear power. Making the breeder program a top priority gave it a significant advantage when competing against other reactor programs for limited resources.

Commission Civilian Power Programs — Late 1960's



Oconee Nuclear Station... A six-foot man fits almost exactly into the rotor tunnel of this giant generator designed to produce electric power for the first unit of Duke Power's Oconee Nuclear Station. The weight of the generator's stator (in which the man is standing) is 375 tons, and the rotor, which fits into the circular hole, weighs 188 tons. When installed and put into operation in 1973, the generator had a capacity of 886,600 kilowatts, enough electricity to supply a city of 750,000 people.

At the suggestion of the Joint Committee, the Commission updated the 1962 report on civilian power. *The 1967 Supplement to the 1962 Report to the President* contained no new civilian power policy; rather it reaffirmed the basic decisions and assumptions made five years earlier. Although it had reduced estimates of power demand somewhat, the Commission continued to give highest priority to fast breeder reactor programs. The Commission established the Liquid Metal Fast Breeder Reactor program office at Argonne which helped draft a comprehensive program plan which included the Fast Flux Test Facility and the Liquid Metal Fast Breeder Reactor demonstration plant. Meanwhile the Commission used Experimental Breeder Reactor-2 and the Southwest Experimental Fast Oxide Reactor to test materials for the breeder program.[44]

Simultaneously the Commission explored other breeder reactor concepts. Molten salt breeder reactors promised more efficient use of thorium reserves, and the Commission's Oak Ridge laboratory built and operated a Molten Salt Reactor Experiment. The Shippingport plant was converted into an experimental light water breeder reactor to explore the possibility of thorium breeding in light water reactors. In addition the Commission examined gas-cooled breeder reactors.[45]

The Commission still foresaw a role for advanced converters but worried that they faced "a severe test" in competing economically with light water reactors. The Commission reported that the "promise shown for nuclear power in the

The Calvert Cliffs Decision

The Calvert Cliffs decision of July 23, 1971, which required the Commission to assess environmental hazards beyond radiation effects, proved a landmark decision regarding nuclear power licensing. The decision grew out of a challenge by local intervenors in the licensing action on the Baltimore Gas and Electric Company's Calvert Cliffs nuclear power plant. Intervenors, led by Anthony Roisman, a Washington attorney, argued that the Commission's regulations, which held the Commission responsible only for potential radiological hazards to public health and safety, were inconsistent with the National Environmental Policy Act of 1969. Roisman believed that the Commission should also consider potential thermal pollution from power plants as well as other environmental issues in the licensing action. The courts ruled in favor of the intervenors. In his determination to mold a new image for the Commission, James R. Schlesinger, Seaborg's successor as chairman, decided not to appeal the ruling, but rather to make substantive changes in the Commission's environmental review and reactor licensing procedures. The *Calvert Cliffs* decision was a major, but not the only, factor in creating a large licensing backlog and in increasing the costs of licensing a nuclear power plant.[49]

Just as Schelsinger and his staff were adjusting to the *Calvert Cliffs* decision, the Commission opened hearings on acceptance criteria for power reactor emergency core cooling systems. To prevent the loss of cooling water around reactor fuel elements, and thereby prevent a major reactor accident, the Commission and reactor manufacturers had devised emergency core cooling systems which flooded reactor cores with water in the event of loss of primary coolant from around the fuel. Following loss of cooling experiments, the Commission learned in 1971 that emergency core cooling systems might not work as designed. The Commission immediately revised its standards for emergency core cooling systems and published "Interim Acceptance Criteria" for emergency core cooling systems. Critics challenged the new guidelines in rule-making hearings which dragged on for one and one-half years. The hearings dramatically focused public attention on nuclear reactor safety and awakened national concern about the safety of nuclear power.[50]

Simultaneously the Commission had to devise new plans for disposing of high-level wastes. The Nation's only commercial reprocessing plant located in West Valley, New York, shut down in 1972 just as the Commission had to abandon its studies to dispose of high-level wastes by storing them in underground salt mines in Kansas. Technical problems with salt mine disposal, opposition from local citizens and officials, and determined opposition from Representative Joe Skubitz of Kansas forced the Commission to abandon the project.[51] The Commission now had no program for disposing of high-level wastes and private industry had no capacity for reprocessing reactor fuel. Waste disposal and fuel reprocessing would be two major challenges of the new decade.

Reaffirmation of Breeder-Oriented Civilian Power Policy

Dr. Glenn T. Seaborg introduces his successor, AEC Chairman James R. Schlesinger, to Dr. C. Salvetti, Vice-President of the Italian National Committee on Nuclear Energy, following a session of the Fourth United Nations International Conference on Peaceful Uses of Atomic Energy. The Conference was held in Geneva, Switzerland in September 1971.

The "brownouts" of the late 1960s served as a warning to the Nation that the era of abundant energy supplies was coming to a close. When Richard M. Nixon took office in 1969 the signs of an energy emergency were even more evident. The winter of 1969-70 was the coldest in thirty years. Natural gas, heating oil and liquified petoleum were in short supply, and "brownouts" up and down the east coast in the summer of 1970 pointed to further difficulties for the coming winter.[52]

Although federal funding for energy research and development had increased enormously since World War II, the Federal Government still lacked a comprehensive national energy plan. While environmental and nuclear safety issues had begun to cast a shadow over the nuclear establishment, nuclear energy, nevertheless, had received by far the greater share of federal research and development funds and quite naturally held great promise as the answer to future energy needs.

Nixon's Energy Proposals

On July 4, 1971, in what he referred to as the first comprehensive energy message to Congress by a United States president, Nixon addressed the energy problem head on. Although for twenty years the United States had doubled energy consumption without exhausting the supply, the President warned that the Nation could no longer take energy supply for granted. Nixon called for the successful demonstration of the liquid metal fast breeder reactor by 1980. "Our best hope today for meeting the Nation's growing demand for economical clean energy lies with the fast breeder reactor," he asserted. Emphasizing environmental, as well as economic advantages of breeder technology, Nixon recommended an additional $500 million in federal funds for what became the Clinch River Breeder Reactor project at Oak Ridge, Tennessee. The President also recommended $16 million to modernize and expand uranium enrichment capacity.[53]

The President's support of the breeder reactor represented a major boost for the Atomic Energy Commission's high priority breeder reactor project, already in the advanced planning stages under Milton Shaw's direction. On the other hand, extended licensing procedures and increasing environmental considerations continued to lengthen the time necessary to bring nuclear power plants on line. As Commissioner William O. Doub informed the Atomic Industrial Forum in October 1971, the Atomic Energy Commission harbored no illusions as to the magnitude of the task of trying to match "the capabilities of a dynamic and complex technology to the urgent energy and environmental needs of the country."[54]

President Nixon's 1971 energy message to Congress had also included a proposal for a new energy agency. Citing the lack of an integrated national energy policy, Nixon proposed that all major energy programs be consolidated in a new Department of Natural Resources. Two years later, as the energy situation worsened, he presented a modified proposal that placed greater emphasis on policy and management. In addition to a Department of Energy and Natural Resources, the new proposal included two additional agencies to replace the existing Atomic Energy Commission: an Energy Research and Development Administration to develop fossil fuels, nuclear power and potential new forms of energy, and a Nuclear Regulatory Commission to assume all regulatory and licensing responsibilities of the Atomic Energy Commission.[55] The President's proposal reflected increasing public and congressional criticism of the Commission's dual role as regulator and promoter of nuclear power.

"The Nation's Energy Future" — The Ray Report

U.S. Atomic Energy Commission, December, 1973...(L to R) William A. Anders, Commissioner; Clarence E. Larson, Commissioner; Dr. Dixy Lee Ray, Chairman; William O. Doub, Commissioner; William E. Kriegsman, Commissioner.
Credit: J.E. Westcott, USAEC

In addition to presenting revised legislative proposals to Congress, in June 1973 Nixon also directed the chairman of the Atomic Energy Commission, Dixy Lee Ray, to review federal and private energy research and development activities in order to recommend an integrated program for the Nation. In "The Nation's Energy Future," Ray proposed that the Federal Government annually spend over $2 billion on energy research and development over the next five years while private industry would commit an estimated $12.5 billion during the same period. Ray envisioned that the Federal Government would principally fund medium-term and long-term energy projects, while private efforts would be concentrated on short-term projects. America's energy problems, Ray believed, resulted from the lack of a coordinated national energy research and development program over the past twenty years. Only nuclear power had received sustained support at adequate levels.

Nevertheless, the resources and technology were available and United States self-sufficiency could be attained with a properly directed, sustained national commitment. Ray also endorsed Nixon's proposed legislation for an Energy Research and Development Administration to plan and coordinate the government's overall energy program.[56]

More than $4 billion of the $10 billion budget recommended by Ray would be used to validate the nuclear option. Included in the Ray budget were research on reactor safety, uranium enrichment processes, the high-temperature gas reactor (HTGR), the light water breeder reactor, and the liquid metal fast breeder reactor. Again the highest priority would go to the breeder program, including the Liquid Metal Fast Breeder Reactor, the gas-cooled fast reactor and advanced technology. Ray projected that by 1985 the nuclear option would guarantee the previously projected supply of 7.1 million barrels/day of oil equivalent. The escalation of the energy emergency in late 1973, however, turned national attention away from long-term planning as set forth in the Ray report toward emergency measures to meet more immediate needs.[57]

The Oil Embargo of 1973 and "Project Independence"

Dr. Dixy Lee Ray, Chairman, USAEC. . . Named by President Nixon on February 6, 1973 to succeed Dr. James R. Schlesinger, Dr. Ray was the first woman chairman of the AEC as well as the first woman named to a full five-year term on the Commission.
Credit: Battelle-Northwest.

When war broke out in the Middle East on October 6, 1973, America's energy problem took on crisis proportions. As a result of an embargo by the Organization of Arab Petroleum Exporting Countries (OAPEC) on crude oil shipments to the United States, oil supplies sharply declined. On November 8 the President announced that the Nation was "heading toward the most acute shortages of energy since the Second World War." He asked Americans to take practical steps to conserve energy, and urged Congress to give the highest priority to his proposals for an Energy Research and Development Administration and a Nuclear Regulatory Commission. The new energy administration, Nixon hoped, would direct a $10 billion program aimed at achieving a national capacity for energy self-sufficiency by 1980. Although months of tension over Watergate, Vietnam and other issues caused a delay in the creation of Nixon's proposed energy agency, "Project Independence" soon became the responsibility of a new Federal Energy Office established on December 4, 1973, to coordinate the government's response to the oil embargo.[58]

The Federal Energy Administration, the successor to the Federal Energy Office, submitted a final "Project Independence" report in November 1974. A massive interagency undertaking, "Project Independence" projected nuclear power as one of the main answers to the energy needs of the United States, and called for atomic energy to provide thirty to forty percent of the Nation's electrical generating capability within ten or fifteen years, and more than fifty percent by the twenty-first century. Conservation and the development of shale oils, tar sands and gaseous liquids from coal were the other alternatives to be pursued in combination with nuclear power.[59]

The Energy Reorganization Act of 1974

President Gerald R. Ford signed the Energy Reorganization Act of 1974 at the White House October 11, 1974. (L to R) Rep. John W. Wydler (R-N.Y.); Sen. Charles H. Percy (R-Ill.); Sen. Abraham A. Ribicoff (D-Conn.); Rep. Chet Holifield (D-Cal.); Dr. Gilbert S. Omenn-White House Fellow (back row); Rep. Frank Horton (R-N.Y.); Jack Carlson, Assistant Secretary for Energy and Materials, Dept. of Interior (back row); Rep. Don Fugua (D-Fla.); Rep. John B. Anderson (R-Ill.); Rep. Clarence J. Brown (R-Ohio); Rogers Morton, Secretary of Interior.
Credit: AEC Photo by Westcott

On October 11, President Gerald R. Ford signed the Energy Reorganization Act of 1974. The Act abolished the Atomic Energy Commission and created three new federal entities: the Energy Research and Development Administration (ERDA), the Nuclear Regulatory Commission (NRC), and an Energy Resources Council with a mandate to develop a single national energy policy and program. Increasingly since 1960 observers had questioned the appropriateness of the Atomic Energy Commission's dual role of promoting and regulating the atom. Critics of the Commission had argued that it created an inherent conflict of interest when the Commission acted on reactor safety issues.

Although the energy crisis overshadowed Congressional debates on the Energy Reorganization Act, proponents of the bill believed the creation of an independent Nuclear Regulatory Commission would end the charge that conflict of interest prevented stringent regulation of the nuclear power industry.[60]

To direct the new Energy Research and Development Administration, Ford appointed Robert C. Seamans, former president of the National Academy of Engineering, and a recent participant in the Academy's 1974 study on "U.S. Energy Propects: An Engineering Viewpoint." With major energy research and development programs brought together for the first time in a single agency, Seamans would have an opportunity to pursue some of the study group's recommendations for closing the gap between current energy production and projected future energy requirements.[61]

Creating Energy Choices for the Future

On June 28, 1975, Seamans submitted to Congress a comprehensive national energy research and development plan, "Creating Energy Choices for the Future." The plan outlined short-term (to 1985), mid-term (1985-2000), and long-term (after 2000) programs for developing energy resources, and called for an early demonstration of the technical feasibility of new energy systems with built-in environmental and safety controls. Near-term projects would require an immediate effort to overcome the technical problems preventing an expansion of current major energy sources such as nuclear reactors and coal plants. Mid-term programs would include the establishment of a synthetic fuels industry and continued growth in electrification. Long-term results would require the development of technologies to unlock the potential of essentially inexhaustible sources of energy such as breeder reactors, fusion and solar electric.

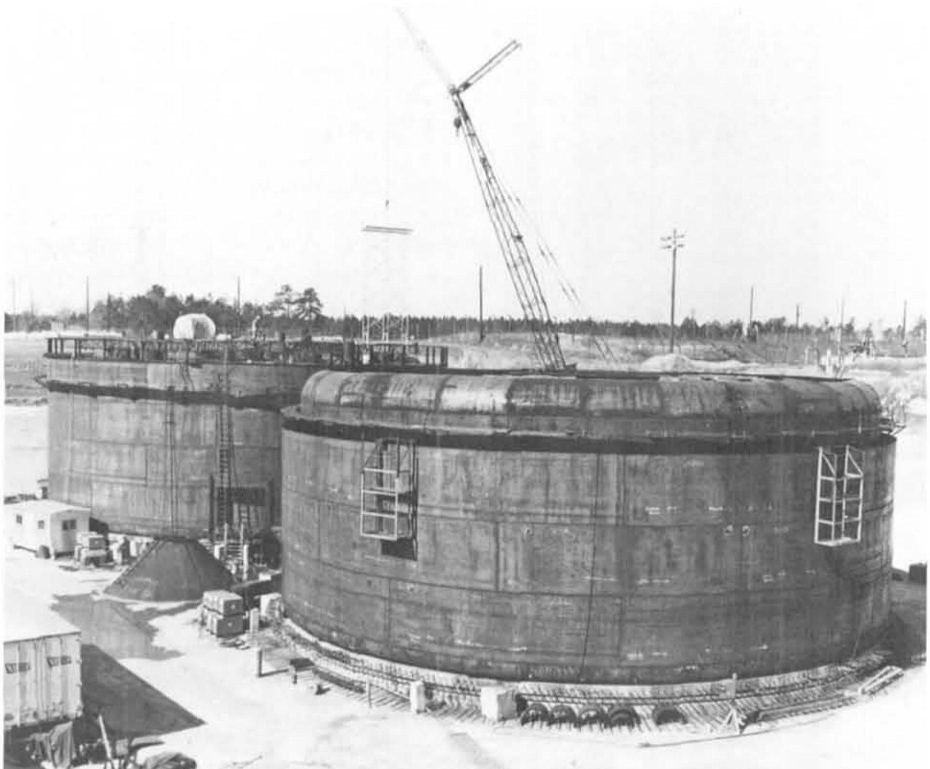
In the national energy plan submitted in the spring of 1976, Seamans gave highest priority to conservation, not nuclear power, as a means of providing time to develop new energy sources to replace dwindling supplies of oil and gas. Additional emphasis was given to the role of industry in the development of new energy technologies, and to federal programs that could assist industry in accelerating the commercialization of near-term technologies.[62]

The ERDA Nuclear Power Program

Seamans did not neglect nuclear energy, however. The Energy Research and Development Administration inherited from the Atomic Energy Commission two nuclear problems of major concern: the future of the liquid metal fast breeder reactor, and the handling and storage of nuclear wastes. Seamans organized special groups to study both issues.

The Energy Research and Development Administration affirmed the Commission's decision to build the liquid metal fast breeder demonstration plant on the Clinch River at Oak Ridge, Tennessee. Clinch River was to be a major step in the transition from the government's twenty-five-year development of liquid metal fast breeder reactor technology to large-scale demonstration of the fast breeder concept. ERDA assumed full responsibility for the Clinch River Reactor project in May 1976, with major construction scheduled to begin in 1978 and initial start-up targeted for 1984. Although the government would have to commit the larger share of the funding for the breeder program in the initial stages, it was hoped that by the early 1990s industry would assume most of the costs. In January 1976, the Joint Committee on Atomic Energy review of the Liquid Metal Fast Breeder Reactor program gave strong support for the breeder program and urged a vigorous pursuit of LMFBR development and an aggressive program of research and development on the safety and environmental impact of breeder commercialization.[63]

Nuclear Waste Disposal



High-level waste storage tanks. . . The 30 high-level radioactive waste storage tanks at the Atomic Energy Commission's Savannah River Plant in South Carolina were built of carbon steel, surrounded by concrete encasements two to three feet thick, set about 40 feet in the ground and back-covered with dirt. Each had a capacity of from 750,000 to 1,300,000 gallons. Most tanks were equipped with cooling coil assemblies to remove heat produced by radioactive decay of fission products in the waste. Pictured here are two steel tanks before concrete encasement. They consist of a tank within a tank. The outer liner on the tank in the background is finished. The rounded, inner primary steel liner is visible a the top of the tank in the foreground.

Probably the most difficult problem facing the Energy Research and Development Administration when it assumed responsibility for the Nation's nuclear program was what to do about "the back end" of the fuel cycle. Seamans appointed a task force to review the complete fuel cycle from the mining of uranium through processing, enrichment, fuel fabrication, and irradiation in power reactors. There was a break in the cycle at the point of spent fuel reprocessing. The ERDA task force accepted the Commission strategies for waste disposal, and acknowledged that extensive research had shown that both retrievable surface storage and permanent geologic deposit were technically feasible. The group noted, however, that neither technology had been demonstrated.

Seamans moved quickly to centralize waste management activities and transferred all operational responsibilities in both civilian and defense areas to an expanded Division of Nuclear Fuel Cycle and Production. Environmental control oversight was assigned to a new Division of Environmental Control Technology. The reorganization enabled the ERDA headquarters staff to develop a coherent policy on waste management.[64]

A comprehensive study prepared at the request of the Joint Committee on Atomic Energy in the spring of 1976 presented detailed descriptions of the options available for treating wastes from power reactors, reprocessing plants, and fuel fabricating facilities comprising the "back end of the fuel cycle." At the same time

ERDA developed a new concept of placing "multiple barriers" between high-level wastes and the environment. This would be achieved by converting liquid waste into a stable solid form which could then be sealed in a high-integrity container and transported to a terminal repository in a deep, stable geologic formation.[65]

In the summer of 1976 President Ford requested ERDA's deputy administrator Robert Fri to organize an interagency task force to review United States nuclear policy. The President's July 19 directive called for a comprehensive review of issues involved in "closing" the nuclear fuel cycle. Included were nuclear exports and safeguards, the reprocessing of spent fuel from commercial reactors, and the storage of nuclear wastes. President Ford's October 28 statement on nuclear policy, and his final energy message to Congress in January 1977, reflected recommendations made in the Fri task force report. For nearly a decade, Ford declared, the United States had not enjoyed a monopoly on nuclear technology. Proliferation, therefore, was an international problem, requiring an acceleration of United States diplomatic initiatives to control the spread of plutonium separating technologies.[66]

In January the President urged Congress to provide authority for ERDA to enter into cooperative agreements with United States firms wishing to build and own uranium enrichment plants. He also reminded Congress of his budget proposal for a four-fold increase in funding for the nuclear waste management program. ERDA's directive was to demonstrate all components of waste management technology by 1978 and provide a complete repository for such wastes by 1985.[67]

President Carter's 1977 Review of Nuclear Energy Policy

James R. Schlesinger, President Carter, Senator Henry Jackson. White House swearing in ceremony for Schlesinger, first Secretary of the Department of Energy, August 5, 1977.

On April 7, 1977, the new President, Jimmy Carter, announced a number of significant changes in United States nuclear energy policies and programs. First of all, the commercial reprocessing and recycling of plutonium produced in American civilian power reactors would be deferred indefinitely. Alternate fuel cycles and processes would be evaluated. The commercialization of the liquid metal fast breeder reactor would also be deferred indefinitely. Carter said that he would propose legislation necessary to permit the United States to offer nuclear fuel supply contracts, and guarantee delivery of such nuclear fuel to other countries. In addition, an embargo on exporting uranium enrichment and chemical reprocessing equipment or technology would be continued.[68]

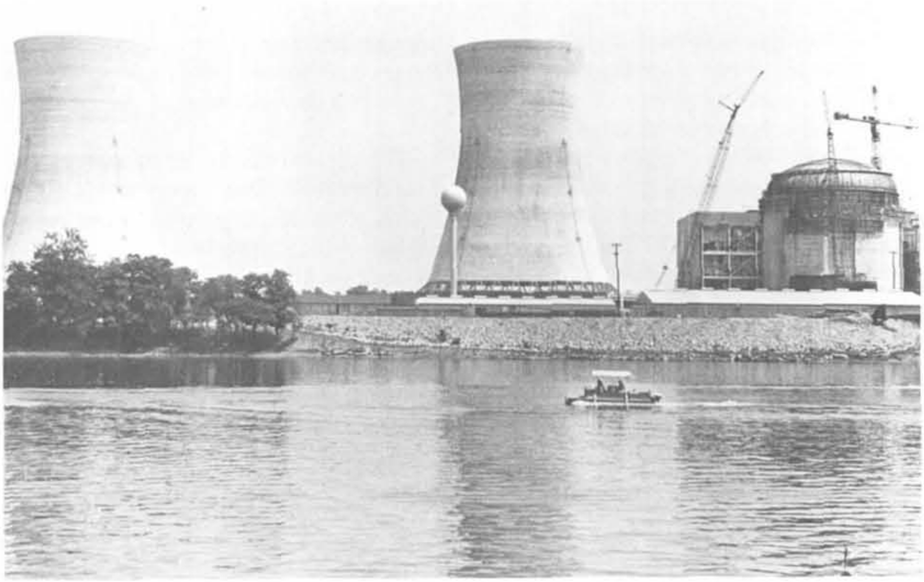
President Carter's announcements represented a major shift in United States nuclear energy policy. Based on a desire to reduce the proliferation of nuclear weapons, they were also in line with a recent Ford Foundation study, "Nuclear Power: Issues and Choices," which concluded that the immediate use of plutonium as a reactor fuel would needlessly enhance the risk of nuclear weapon proliferation.[69]

ERDA's 1977 Energy Plan

The third national energy research, development and demonstration plan, ERDA-77-1, presented to the President on June 23 by the ERDA administrator, again stressed conservation as having the greatest immediate impact on the Nation's energy system between 1977 and the year 2000. Robert Fri, who had succeeded Seamans as administrator in January, informed the President that the plan would provide the basis for the technological changes needed to weather the difficult period of transition from limited oil and natural gas to inexhaustible or renewable sources of energy. A successful conservation program, however, would require voluntary participation by the public, as well as economic incentives, regulatory actions and the development of more efficient technologies to use and produce energy.

The plan, which noted that nuclear power plants generated about 10% of America's electrical energy supply, affirmed that light water reactors played a significant role in reducing petroleum imports. In accordance with the President's policy of deferring the use of plutonium as a reactor fuel, the plan asserted a need to explore alternative breeder reactor systems.[70]

Public Concern for Reactor Safety



Three Mile Island Nuclear Plant on the Susquehanna River about ten miles south of Harrisburg, Pennsylvania. The plant was shut down following an accident in March 1979. Credit: Metropolitan Edison Co.

The Calvert Cliffs decision of July 1971, followed in 1972-73 by the eighteen-month-long "rule-making hearing" concerning the controversial emergency core cooling systems, had focused nationwide attention on the question of reactor safety. Heretofore public concerns had been limited to local areas and specific projects. Now the American public enjoined the nuclear establishment in what became known as the "great debate" over the safety of the light water reactors then on line or under construction. Two issues were of particular concern: the probability of an accident to an operating reactor, and the consequences of an accident if it did occur.

In August 1974 the Atomic Energy Commission had published the results of a comprehensive three-year study estimating the risks to the public from the operation of large commercial nuclear power plants similar to the ones being operated by the Commission. The huge report, WASH-1400, "An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," was prepared by a staff of 60 scientists and engineers under the direction of M.I.T. Professor Norman C. Rasmussen. A final version of the Rasmussen Report was released by the Nuclear Regulatory Commission in October 1975.

The basic conclusion of the Rasmussen Report was that risks to the public from potential nuclear accidents were small in comparison with other risks in a technological society. This conclusion was reached by using a statistical technique, "fault-tree analysis," developed by the aerospace industry to predict the effect of failures of small components in large, complex systems. After thousands of possible sequences in reactor failures were assessed by computer, the prediction was made that the "maximum credible" reactor accident would occur once in every ten million operating years. Nuclear critics claimed that the report underestimated the consequences of a potential accident, and that the study was unduly influenced by the AEC's desire to minimize the dangers of a reactor accident.[71] (See Appendix III.)

Another indication of public concern occurred in the summer of 1975 when opponents of nuclear power in California gathered enough signatures to initiate a state-wide voter referendum for the purpose of halting the construction of nuclear plants in the state. The following June the voters rejected "Proposition 15," as it was known because of its position on the ballot, by a two-to-one margin. A number of other states held similar referenda during the presidential election which were also defeated by about two-to-one. It was difficult to determine whether the vote represented approval of nuclear power by the American voters or an outstanding publicity campaign by the nuclear advocates.[72]

Commercial Power in Trouble

Dr. Robert C. Seamans, Jr. Administrator of the Energy Research and Development Administration 1975-1977

The promise of nuclear power reached its zenith in the early and mid-1970's. In spite of increasing public concern over safety and environmental issues, nuclear power was widely accepted in most industrialized countries as the world's principal new energy resource for the decades ahead. By the end of 1975, 157 nuclear power plants were operating in 19 countries, and many of the nations had additional reactors under construction or on order. Nuclear power, it seemed, had finally matured, and American "light-water" reactor technology completely dominated the world market. Nuclear advocates even saw the oil embargo of 1973 as providing a new mission and challenge for the nuclear industry.[73]

Why then did the situation change so dramatically by the end of the decade? Part of the difficulty resulted from the quadrupling of fossil fuel prices since the oil embargo of 1973 which in turn fueled inflation. The increases were felt by the nuclear industry as plant contruction costs continued to escalate. Also cost estimates were difficult to make because projections were based on extrapolations rather than operating data. As reactor components continued to increase in size and cost it was almost impossible for reactor manufacturers and purchasers to distinguish between fact and estimate.

The issue of reactor safety and reliability, combined with environmental concerns, continued to have a major effect on costs. While experts argued over the economics of nuclear power, rising costs forced the cancellation of orders for new plants. When Jimmy Carter became President in 1977 there was already a de facto national moratorium on the purchase of nuclear generating equipment in the United States, and downward revisions were being made on projections for future installed capacity in western oil-importing countries. (See Appendix IV.)

In the mid-1970's fuel reprocessing became an area of Presidential concern because of its international implications. In his October 1976 message on nuclear policy, President Ford had made it clear that fuel reprocessing might become unacceptable. Six months later President Carter ended government support for the recycling of plutonium and called on other nations to join the United States in deferring the use of plutonium for nuclear fuel.[74]

Department of Energy Established

Soon after his inauguration, President Carter had selected James R. Schlesinger, former Chairman of the Atomic Energy Commission, Secretary of Defense, and Director of the Central Intelligence Agency, to work with Congress to ease the natural gas shortage of 1976-1977 and to hammer out an energy policy and reorganization plan. On March 1, 1977, Carter presented to Congress his proposed legislation for a new Department of Energy. Citing the energy crisis as the Nation's greatest challenge, the President urged the speedy establishment of the Department of Energy as a means of accomplishing his energy goals. "Continued fragmentation of government authority and responsibility of our energy program for this Nation," he warned, "is both dangerous and unnecessary." On August 4, 1977 President Carter signed into law the bill creating the Department of Energy, and the following day named Schlesinger as the first Secretary of Energy.

The energy crisis continued throughout the Carter Administration. In 1979 Americans were again assaulted by energy shocks as the Iranian crisis brought fear of even greater oil shortages than those created by the 1973-74 embargo. A devastating blow to the nuclear establishment occurred on the morning of March 28, 1979, when the Nation learned of the unexpected accident at the Three Mile Island reactor in Pennsylvania. For two weeks scientists, engineers and technicians worked to shut down the plant. Though the crisis was contained, nuclear critics used the accident as example of the failure of nuclear technology. The accident was not so much a mechanical breakdown as a series of human choices that crippled a reactor and reduced public confidence in nuclear power.[75]

Following the accident at Three Mile Island, the government sponsored study groups to assess the causes and impact of the accident. Two of the most important were the President's Commission on the Accident at Three Mile Island headed by Dartmouth College President John Kemeny, and the Special Inquiry Group funded by the Nuclear Regulatory Commission. Pending their studies, the Nuclear Regulatory Commission suspended issuing operation and construction licenses. Both the Kemeny Commission and the Special Inquiry Group criticized the Nuclear Regulatory Commission on matters relating to reactor licensing and safety. The recommendations led to a reorganization within the Commission, which resumed issuing licenses for the operation of new plants in February 1980.[76]

The Reagan Energy Policy

Rancho Seco Nuclear Station. . . These twin hyperbolic cooling towers, 43 stories tall, are an integral part of the plant developed by the Bechtel Corporation at the 913-Mwe. Rancho Seco Nuclear Station in California. Located 25 miles southeast of Sacramento, the plant was constructed for the Sacramento Municipal Utility District. The natural draft evaporative towers dissipate waste heat by recircling the turbine condenser cooling water on a gigantic scale—a half million gallons per minute.
Credit: Bechtel Corporation

The election of President Ronald Reagan in 1980 signaled a major shift in the national energy policy. The Reagan Administration generally favored reducing the Federal Government's role in national energy management, especially when private industry and the free market could set energy priorities. The new strategy included ending government regulations and price controls which the Administration believed had inhibited domestic energy production, and encouraging private capital, not the Federal Government, to demonstrate the commercial viability of energy technologies. The Federal Government's proper role was to support long-term, high-risk energy research and development in which industry would not invest. As the new Secretary of Energy James B. Edwards emphasized, "only in areas where these market forces are not likely to bring about desirable new energy technologies and practices within a reasonable amount of time is there potential need for federal involvement."[77]

The Reagan Administration's national energy plan, *Securing America's Energy Future: The National Energy Policy Plan*, broke sharply with that of the previous administration. Reagan's National Energy Policy Plan was unified by two basic principles: (1) the Administration's overall economic recovery program, which reduced federal spending, taxes, and regulation, and (2) the Administration's confidence that national energy decisions and policy were best made by the free market. Conscious of the significant departure they were making from policies instituted in 1973-1974, the Administration's energy planners observed that "all Americans were involved in making energy policy. When individual choices are made with a maximum of personal understanding and a minimum of governmental restraints, the result is the most appropriate energy policy."[78]

While the nuclear power industry accepted the Reagan Administration's commitment to reduce federal involvement in the economy, many industry leaders believed that more, rather than less, federal involvement in the economy would be necessary to revive nuclear power as a viable energy option. The premise of the Eisenhower Administration in the 1950s, and of the Kennedy, Johnson and Nixon Administrations in the 1960s, had been that nuclear power was essentially the same as conventional power, subject only to federal regulation concerning nuclear safety. Government and industry in the 1960s both hoped that ultimately nuclear power plants could be planned, financed, built, and operated in the same way as conventional power plants.

Although private industry was able to buy into nuclear power, the Federal Government was never able to get out, because the management and control of nuclear energy became one of the most sensitive social and political issues of the twentieth century. Nuclear energy issues not only included safety and weapon proliferation, both well understood in the 1950s, but also national energy and environmental policy, issues which became more controversial after Eisenhower announced his Atoms-for-Peace policy. Furthermore, nuclear power technology involved two issues for which there were no analogies in the conventional power industry: the nuclear fuel cycle and long-term storage of high-level radioactive wastes. It would prove impossible to unscramble public and private responsibilities in these areas. As John F. Welch, Chairman of the Board at General Electric, advised the Reagan Administration, "It is inevitable that government action will continue to have an overwhelming impact on the future of the nuclear business."[79]

In October 1981, President Reagan announced new policy initiatives on nuclear energy. Couching nuclear power policy in terms of the Administration's economic recovery program, Reagan reaffirmed that nuclear power would be "one of the best potential sources of new electrical supplies in the coming decades." Importantly, the President, while endorsing the breeder program, also acknowledged the need to assist the light water reactor industry by streamlining nuclear regulatory and licensing procedures, by lifting the ban on commercial reprocessing, and by resolving problems associated with nuclear waste storage.[80]

The Office of Technology Assessment described the civilian nuclear power policy debate as a seven-sided coin involving utilities, nuclear safety regulators, critics of nuclear power, the public, the nuclear supply industry, investors and the financial community, and the state public utility commissions. Each of the seven consitituencies, representing slightly different interests, had contributed to the impasse in which the nuclear power industry faced an uncertain future.[81] Indeed, some fifty reactors had been lost from the pipeline, and there had been essentially no new orders since the mid-1970s. (See Appendix IV.) A decreased demand for electricity, which caused the cancelation and delay of coal-fired plants, also was a factor in nuclear cancelations.

Although President Reagan believed the completion of the Clinch River Breeder Reactor was "in the best interests of the Nation," on October 26, 1983 the Senate discontinued funding for the project. Congressional alarm over rising costs had resulted in a slow erosion of Congressional support. Consequently, Clinch River was committed to an orderly termination. A revised liquid metal fast breeder reactor program would focus on resolving the technological issues key to improved breeder economics and predictable, safe performance. In consonance with national energy research and development policy, the responsibility for commercialization of breeder reactor technology now would reside primarily with the private sector as the government would not take the lead in funding demonstration projects.[82]

Following the termination of Clinch River and the reorientation of the breeder project, the Reagan Administration reaffirmed its commitment to foster nuclear power as part of the national energy policy to secure an adequate supply of energy at reasonable costs. A principal objective was to create the political and institutional climate in which nuclear power could prosper. Passage of the Nuclear Waste Policy Act of 1982 offered hope that progress would be made in establishing a program for the long term management of the Nation's high-level radioactive wastes. To implement the act, the Department of Energy established the Civilian Radioactive Waste Management Office which by May 8, 1984 had issued the Nuclear Waste Management Mission Plan. The Administration also proposed a Nuclear Licensing Reform Act designed to reduce the time required for nuclear plant licensing to seven years, rather than twelve to fourteen years. In addition, the Administration hoped that licensing reform would promote improved safety in nuclear plants, encourage more effective public participation, and provide a stable and reliable licensing process. Finally, under Secretary of Energy Donald Paul Hodel's leadership, the Department of Energy revamped its uranium enrichment program to price the American product more competitively and recapture some of its lost world market.[83]

Like the Eisenhower Administration forty years before, the Reagan Administration recognized the link between a healthy nuclear power industry at home and America's ability to achieve its international objective for the control and management of nuclear energy. In addition to helping the United States meet its domestic energy needs, Secretary of Energy Hodel emphasized that a prosperous nuclear industry was necessary if the United States were to achieve its nonproliferation goals. A weakened domestic industry would limit the United States' influence in achieving satisfactory international safeguards and control of nuclear materials. Hodel also noted that the United States needed to maintain its nuclear capacity in order to compete successfully in international markets. Peaceful uses of nuclear energy would continue to serve the United States both economically and diplomatically around the world. Department of Energy research and development programs would include new and advanced technologies with a goal of developing and producing smaller and more passively safe reactors that would not require long years of lead time. All nuclear research and development would be conducted with the idea of transferring the technology to the private sector for demonstration and deployment as soon as feasible.[84]

As Atoms for Peace entered its fourth decade, questions asked about the future of nuclear power were significantly different from those asked only a few years before. Speculation on the economy and safety of the industry had given way to debate about the future of nuclear power based on historical data. Nonetheless, many in government and industry remained confident that sooner or later nuclear power would prove its inherent worth as a major energy source along with fossil fuels and other traditional energy sources. Others believed, however, that the so-called "nuclear imperative" might prove a cruel illusion unless both government and industry accepted responsibility for keeping the nuclear option alive. The "nuclear imperative" would not be self-fulfilling, but would only be an imperative of need. In 1984, government and industry would be required to build new bridges between the past and future in order to assure continuity between past and future nuclear power generations. This would mean not only developing the human and technological resources needed to build a viable nuclear industry, but also maintaining the institutional memory of successes and failures so that the basic lessons learned over four decades would not be forgotten.[85]

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Chronology

December 2, 1942	Chicago Pile 1 demonstrated the first self-sustaining nuclear fission chain reaction. Dismantled and rebuilt at Argonne as CP-2, the pile operated until 1954.
August 1, 1946	President Truman signed the Atomic Energy Act of 1946.
January 1, 1947	The AEC assumed control from Manhattan Engineer District of atomic energy facilities and programs.
June 1947	AEC established Reactor Safeguards Committee.
October 6, 1947	AEC appointed an Industrial Advisory Group under Chairman James W. Parker to investigate peaceful uses of atomic energy. Report issued on December 30, 1948.
March 1, 1949	AEC announced selection of a site in Idaho for the National Reactor Testing Station.
December 20, 1951	Experimental Breeder Reactor #1 (EBR-1) produced the first electric power from a nuclear reactor.
March 31, 1952	The Materials Testing Reactor (MTR) went critical at the NRTS.
March 30, 1953	The Navy prototype pressurized water reactor for the Nautilus went critical.
August 9, 1953	AEC established an Advisory Committee on Reactor Safeguards.
December 8, 1953	President Eisenhower delivered his "Atoms-for-Peace" speech before the United Nations and proposed an international agency to promote peaceful applications of atomic energy.
March 23, 1954	Joint Committee on Atomic Energy approved AEC Five-Year Program for reactor development.
August 30, 1954	President Eisenhower signed the new Atomic Energy Act of 1954, opening the way for the civilian power program.
November 11, 1954	E.H. Dixon and E.A. Yates of the Mississippi Valley Generating Company signed a contract with the AEC for power supply to AEC facilities.
January 10, 1955	AEC announced the first round of the Power Demonstration Reactor Program, under which the AEC and industry would cooperate in the construction and operation of experimental power reactors.
August 8-20, 1955	First United Nations International Conference on the Peaceful Uses of Atomic Energy held in Geneva, Switzerland.
September 21, 1955	AEC issued second round of invitations to private industry under the PDRP program.
February 22, 1956	At the direction of President Eisenhower, the AEC made available for sale or lease 20,000 kilograms of U-235 for use in power and research reactors abroad, and 20,000 kilograms for power reactors in the U.S.
Spring 1956	Senator Gore and Representative Holifield introduced legislation to enlarge the reactor development program. The legislation did not pass the House.
January 7, 1957	The AEC sponsored the third round of the PDRP for industry.

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July 12, 1957	Power produced by the Sodium Reactor Experiment (SRE), at Santa Susana, California marked the first use of power from a civilian reactor. Deactivation of the SRE announced on December 2, 1966.
September 2, 1957	President Eisenhower signed the Price-Anderson Act, giving financial protection to the public, AEC licensees, and contractors in the event of a major nuclear power plant accident.
October 1, 1957	International Atomic Energy Agency inaugurated in Vienna, Austria. AEC announced U.S. offer to make 5,000 kilograms of U-235 available to the agency.
December 2, 1957	The pressurized water reactor at Shippingport went critical. On December 23 the reactor reached full power rating of 60 MWe and was the first full-scale nuclear power plant in the United States.
May 22, 1958	Keel of the world's first nuclear powered merchant ship, N.S. *Savannah* laid at Camden, New Jersey. Ship launched on July 21, 1959, and mothballed in 1971.
October 15, 1959	The boiling water reactor at Dresden Nuclear Power Station, built by Commonwealth Edison Company (IL) went critical, but did not produce commercial power until June 1960.
February 16, 1960	AEC published a ten year plan of nuclear power development.
August 19, 1960	The Yankee Nuclear Power Station went critical, becoming the third reactor producing commercial power.
March 17, 1962	President Kennedy asked AEC to report on the role of nuclear power in the economy. The report was released November 20, 1962.
August 23, 1962	Modified Round Three of PDRP announced by AEC.
December 12, 1963	Jersey Central Power and Light Company announced the construction of a nuclear power plant at Oyster Creek, and estimated it would be more economical to operate than a conventional fueled power plant.
February 22, 1964	AEC solicited proposals for the advanced converter program.
August 26, 1964	President Johnson signed the Private Ownership of Special Nuclear Materials Act, allowing the power industry to own fuel for power reactors. After June 30, 1973, private ownership of fuels would be mandatory.
November 1965	AEC decided to give the Liquid Metal Fast Breeder (LMFBR) highest priority and to build the Fast Flux Test Facility (FFTF). The FFTF began operation in April 1982.
November 9, 1965	The first major power blackout covered the northeast U.S.
February 1967	AEC published its supplement to 1962 Report to the President.
January 1, 1969	National Environmental Policy Act signed by President Johnson.
August 18, 1969	AEC established the Atomic Safety and Licensing Appeal Board.
September 23, 1970	Electric power "brownouts" hit northeast during heat wave.
June 4, 1971	President Nixon announced as a national goal a commitment to complete LMFBR demonstration plant by 1980.

July 23, 1971	D.C. Court of Appeals ruled in the Calvert Cliffs decision that AEC incorporate wider environmental considerations in its regulatory procedures.
August 7, 1972	AEC announced cooperative agreement with industry to build LMFBR demonstration plant on the Clinch River in Tennessee.
June 29, 1973	President Nixon proposed creation of the Energy Research and Development Administration and the Nuclear Regulatory Commission to replace the AEC.
October 17, 1973	Organization of Arab Petroleum Exporting Countries embargo oil to the United States, sparking first "energy crisis." Embargo lasted until March 17, 1974.
December 1, 1973	AEC Chairman Ray issued report requested by President Nixon on *The Nation's Energy Future.*
October 11, 1974	Energy Reorganization Act signed by President Ford, abolished AEC and created ERDA and NRC.
November 1974	Federal Energy Administration released "Project Independence" report.
January 19, 1975	ERDA activated.
October 1975	The Rasmussen Report, a study of reactor safety, published by NRC.
May 1976	ERDA assumed responsibility for management of the Clinch River Breeder Reactor.
October 28, 1976	President Ford released his nuclear policy statement, emphasizing the fuel cycle, reprocessing and nonproliferation.
April 7, 1977	President Carter announced new policy of deferral of reprocessing of spent fuel from civilian reactors, and delay of the breeder reactor.
August 4, 1977	President Carter signed Energy Reorganization Act creating the Department of Energy, combining ERDA and FEA.
October 1, 1977	DOE activated.
March 28, 1979	Accident occurred at Three Mile Island nuclear power plant.
October 8, 1981	Reagan Administration announced nuclear energy policy which anticipated the establishment of a facility for the storage of high-level radioactive waste, and lifted the ban on commercial reprocessing of nuclear fuel.
January 7, 1983	President Reagan signed Nuclear Waste Policy Act of 1982 into law.
October 26, 1983	The Senate refused to continue funding the Clinch River Breeder Reactor, effectively terminating the project.
May 8, 1984	The Department of Energy established a Civilian Radioactive Waste Management Office.
May 8, 1984	Secretary of Energy Hodel gave the Nuclear Power Assembly his assessment of the state of the nuclear power industry.

Table 1

February 1954
AEC
Five-Year Power Program

Reactor Name	Location	Reactor Designer and Manufacturer	Completion Date	Cost	Electrical Output
Pressurized-Water Reactor (PWR)	Shippingport, Pennsylvania	Westinghouse	December, 1957	$55 million $5 million by Duquesne Light Company	60,000 kw
Experimental Boiling-Water Reactor (EBWR)	Argonne National Laboratory (near Chicago)	Argonne National Laboratory	December, 1956	$6.1 million	5,000 kw
Sodium Reactor Experiment (SRE)	Santa Susana, California	North American Aviation	April, 1957	$15.6 million $2.9 million by North American Aviation	6,500 kw
Homogeneous Reactor Experiment No. 2 (HRE No. 2)	Oak Ridge, Tennessee	Oak Ridge National Laboratory	Abandoned in 1957 after many technical difficulties	(unavailable)	designed for 5,000 kw
Experimental Breeder Reactor No. 2 (EBR No. 2)	Argonne National Laboratory	Argonne National Laboratory	November, 1957	$29.1 million	20,000 kw

U.S. Atomic Energy Commission, *Nineteenth Semi-Annual Report, 1956,* 40-45.

USAEC *Major Activities in the Atomic Energy Programs, January-June, 1957,* 49-53.

Table 2

Power Demonstration Reactor Program

Plant	Location	Reactor Type	Reactor Owner/Operator	Cap. Net MWe	Reactor Contractor	Start of Project	Init. Crit.	Commercial Operation	Status 1984
Round One 1/55									
Yankee Nuclear Power Station	Rowe, MA	Pressurized water	Yankee Atomic Electric Co.	175	Westinghouse Electric Corp.	CP 1957	8/19/60	7/61	Operating
Hallam Nuclear Power Facility	Hallam, NB	Sodium graphite	AEC/Consumers Public Power District of Nebraska	75	Atomics International	A 1960	8/25/62	2/64	Shutdown 9/64
Enrico Fermi Atomic Power Plant	Lagoona Beach, MI	Sodium-cooled fast breeder	Power Reactor Devel. Corporation	61	Atomic Power Devel. Association	CP 1957	8/23/63	Electricity produced 8/5/66	Partial meltdown 10/5/66 Decommissioned 11/29/72
Round Two 9/55									
Elk River Reactor	Elk River, MN	Boiling Water	AEC/ELK River Rual Co-op Power Assn.	22	Allis-Chalmers Manufacturing Co.	A 1959	11/19/62	6/65	Shutdown 2/68
Piqua Nuclear Power Facility	Piqua, OH	Organic cooled	AEC/City of Piqua, Ohio	11.4	Atomics International	A 1960	6/10/63	8/64	Shutdown for repairs 1/66 Op. contr. terminated 12/67
La Crosse Boiling Water Reactor	La Crosse, WI	Boiling water	AEC/Dairyland Power Co-operative	50	Allis-Chalmers Manufacturing Co.	A 1963	7/11/67	9/69	Operating
Boiling Nuclear Superheat Reactor (BONUS)	Punta Higuera, PR	Boiling water, nuclear superheat	AEC/Puerto Rico Water Resources Authority	16.5	General Nuclear Engineering Corp.	A 1960	4/13/64	Decommissioned 6/68	Dismantled 8/11/69
Round Three 1/57									
Big Rock Nuclear Power Plant	Big Rock Point, MI	Boiling water	Consumers Power Co.	72	General Electric Co.	CP 1960	9/27/62	9/63	Operating
Carolinas-Virginia Tube Reactor	Parr, SC	Heavy-water pressure tube	Carolinas-Virginia Nuclear Power Association	17	Westinghouse Electric Corp.	CP 1960	3/30/63	5/64	Shutdown 6/67
Pathfinder Atomic Power Plant	Sioux Falls, SD	Boiling water, nuclear superheat	Northern States Power Co.	58.5	Allis-Chalmers Manufacturing	CP 1960	3/24/64	Shutdown 10/67	
Peach Bottom Atomic Power Station #1	Peach Bottom, PA	Gas cooled	Philadelphia Electric Co.	40	General Atomic	CP 1962	3/3/66	6/67	Shutdown 11/74
Fort St. Vrain	Platteville, CO	Gas cooled	Public Service Co. of Colorado	330	General Atomic	CP 1968	1/31/74	1977	Operating
Modified Round Three 8/62									
San Onofre Nuclear Generating Station #1	San Clemente, CA	Pressurized water	Southern Cal. Edison & San Diego Gas & Electric Cos.	450	Westinghouse Electric Corp.	CP 1964	6/14/67	1/68	Operating
Malibu Nuclear Plant	Corral Canyon, CA	Pressurized water	Dept. of Water & Power of City of Los Angeles	—	Westinghouse Electric Corp.	(CP) 1964		Cancelled 1972	
Connecticut Yankee Atomic Power Station	Haddam Neck, CT	Pressurized water	CT Yankee Atomic Power Company	575	Westinghouse Electric Corp.	(CP) 1963	7/24/67	1/68	Operating

A - Project authorization
CP - Construction permit granted
(CP) - Construction permit filed

Table 3

Experimental Power-Reactors

Reactor	Location	Start-up	Shutdown
Experimental Breeder Reactor #1	Idaho National Engineering Lab. (INEL), formerly named National Reactor Testing Station	1951	1964
Homogeneous Reactor Experiment #1	Oak Ridge, TN	1952	1954
Boiling Reactor Experiment #1 (BORAX-1)	INEL, ID	1953	1954
Boiling Reactor Experiments (BORAX-2, 3, 4)	INEL, ID	1954	1958
Experimental Boiling Water Reactor*	Argonne, IL	1956	1967
Los Alamos Power Reactor Experiment #1	Los Alamos, NM	1956	1957
Homogeneous Reactor Experiment #2*	Oak Ridge, TN	1957	1957
Sodium Reactor Experiment (with So. Calif. Edison CO.)*	Santa Susana, CA	1957	1964
Organic Moderated Reactor Experiment	INEL, ID	1957	1963
Los Alamos Power Reactor Experiment #2	Los Alamos, NM	1959	1959
Plutonium Recycle Test Reactor	Richland, WA	1960	1969
Los Alamos Molten Plutonium Reactor Experiment	Los Alamos, NM	1961	1963
Boiling Reactor Experiment #5 (BORAX-5)	INEL, ID	1962	1964
Heavy Water Components Test Reactor	Savannah River	1962	1964
Experimental Breeder Reactor #2*	INEL, ID	1963	Operating
Molten Salt Reactor Experiment	Oak Ridge, TN	1965	1969
Experimental Beryllium Oxide Reactor	INEL	construction never completed	terminated in 1966
Experimental Gas Cooled Reactor	Oak Ridge, TN	construction never completed	terminated in 1966
Experimental Organic Cooled Reactor	INEL	construction never completed	terminated in 1962
Saxon Experimental**	Saxon, PA	1962	1972
Vallecitos** (G.E. & Pacific Gas & Elec. Co.)	Pleasanton, CA	1957	1963

*Part of AEC 1954 Five-Year Power Reactor Development Program

**Privately Financed Experiments and Prototypes

Table 4

Review of Commercial Nuclear Power Plants by Decade*

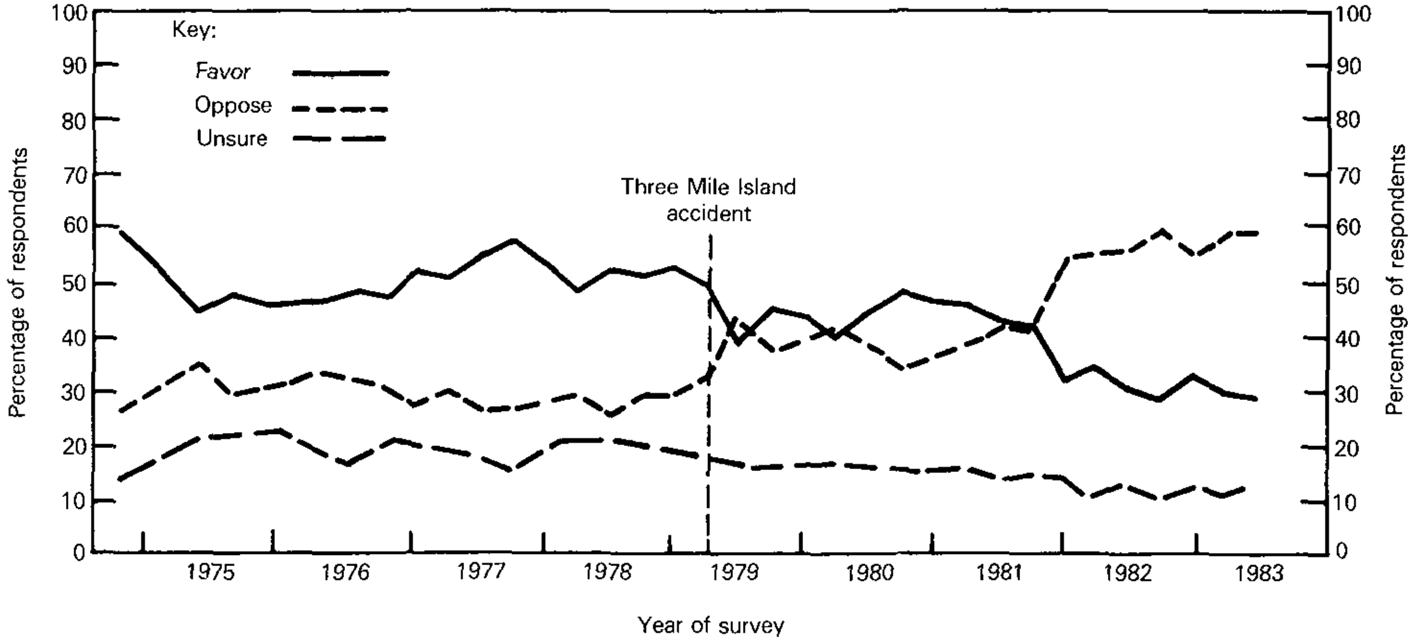
Reactor	Capacity in MWe	Operator	Startup
1960 (3)			
Shippingport Atomic Power Station (PA)	60	AEC/Duquesne Light Co.	1957
Dresden Nuclear Power Station #1 (IL)	110	Commonwealth Edison Co.	1959
Yankee Nuclear Power Station (MA)	175	Yankee Atomic Electric Co.	1960
1970 (19) including the 3 listed above			
Indian Point Station #1 (NY)	265	Consolidated Edison Co.	1962
Big Rock Point Nuclear Plant (MI)	72	Consumers Power Co.	1962
Humboldt Bay Power Plant (CA)	69	Pacific Gas & Electric Co.	1963
Peach Bottom Atomic Power Station #1 (PA)	40	Philadelphia Electric Co.	1966
Hanford-N (WA)	850	DOE-Dual Purpose Reactor	1966
La Crosse Boiling Water Reactor (WS)	50	Dairyland Power Coop. & AEC	1967
Haddam Neck Plant (CN)	582	CN Yankee Atomic Power Co.	1967
San Onofre Nuclear Generating Station #1 (CA)	436	Southern California Edison and San Diego Gas & Elec. Co.	1967
Oyster Creek Nuclear Power Plant #1 (NJ)	650	Jersey Central Power & Light Co.	1969
Nine Mile Point Nuclear Station #1 (NY)	620	Niagara Mohawk Power Corp.	1969
R.E. Ginna Nuclear Power Station (NY)	470	Rochester Gas & Elec. Co.	1969
Millstone Nuclear Power Station #1 (CN)	660	Millstone Point Co.	1970
Dresden Nuclear Power Station #2 (IL)	794	Commonwealth Edison Co.	1970
Monticello Nuclear Generating Plant (MN)	545	Northern States Power Co.	1970
H.B. Robinson S.E. Plant (SC)	700	Carolina Power & Light Co.	1970
Point Beach Nuclear Plant #1 (WI)	497	Wisconsin Electric Power Co.	1970
1980 (87) includes those listed above except for: - Shippingport-converted to LWBR in 1977 (separate listing this section) - Indian Point #1-idle since 1974, began to be decommissioned in 1980 - Peach Bottom #1-shutdown 1974			
Quad-Cities #1 (IL)	789	Commonwealth Edison Co.	1971
Dresden #3 (IL)	794	Commonwealth Edison Co.	1971
Palisades (MI)	805	Consumers Power Co.	1971
Pilgrim #1 (MA)	655	Boston Edison Co.	1972
Maine Yankee (MN)	825	Main Yankee Atomic Power Co.	1972

Vermont Yankee (VT)	514	VT Yankee Nuclear Power Corp.	1972
Quad-Cities #2 (IL)	789	Commonwealth Edison Co.	1972
Point Beach #2 (WI)	497	Wisconsin Electric Power Co.	1972
Turkey Point #3 (FL)	693	Florida Power and Light Co.	1972
Surry #1 (VA)	788	Virginia Electric & Power Co.	1972
Zion #1 (IL)	1040	Commonwealth Edison Co.	1973
Zion #2 (IL)	1040	Commonwealth Edison Co.	1973
Prairie Island #1 (MN)	530	Northern States Power Co.	1973
Fort Calhoun #1 (NB)	478	Omaha Public Power District	1973
Oconee #1 (SC)	887	Duke Power Co.	1973
Turkey Point #4 (FL)	693	Florida Power and Light Co.	1973
Surry #2 (VA)	788	Virginia Electric & Power Co.	1973
Indian Point #2 (NY)	873	Consolidated Edison Co.	1973
Peach Bottom #2 (PA)	1065	Philadelphia Electric Co.	1973
Oconee #2 (SC)	887	Duke Power Co.	1973
Browns Ferry #1 (AL)	1065	TVA	1973
Three Mile Island #1 (PA)	819	Metropolitan Edison Co.	1974
Peach Bottom #3 (PA)	1065	Philadelphia Electric Co.	1974
Duane Arnold (IA)	538	Iowa Elec. Power and Light Co.	1974
Cooper (NB)	778	Nebraska Public Power District	1974
Prairie Island #2 (MN)	530	Northern States Power Co.	1974
Kewaunee (WI)	535	WI Public Services Corp.	1974
Arkansas Nuclear One #1 (AK)	850	Arkansas Power & Light Co.	1974
Oconee #3 (SC)	887	Duke Power Co.	1974
James A. FitzPatrick (NY)	821	Power Authority of the State of NY	1974
Edwin I. Hatch #1 (GA)	777	Georgia Power Co.	1974
Browns Ferry #2 (AL)	1065	TVA	1974
Rancho Seco (CA)	918	Sacramento Municipal Utility District	1974
Fort St. Vrain (CO)	330	Public Service Co. of CO	1974
Calvert Cliffs #1 (MD)	845	Baltimore Gas & Elec. Co.	1975
Millstone #2 (CN)	870	Northeast Utilities	1975
Donald C. Cook #1 (MI)	1054	Indiana & Michigan Electric Co.	1975
Trojan (OR)	1130	Portland General Electric Co.	1975
Brunswick #2 (NC)	821	Carolina Power & Light Co.	1975
Indian Point #3 (NY)	965	Consolidated Edison	1976
St. Lucie #1 (FL)	830	Florida Power & Light Co.	1976
Beaver Valley #1 (PA)	833	Duquesne Light Co.	1976
Browns Ferry #3 (AL)	1065	TVA	1976
Salem #1 (NJ)	1090	Public Service Electric & Gas Co.	1977

Calvert Cliffs #2 (MD)	850	Baltimore Gas & Electric Co.	1977
Shippingport (PA)	60 (LWBR)	DOE and Duquesne Light Co.	1977
Davis-Besse #1 (OH)	906	Toledo Edison Co.	1977
Joseph M. Farley #1 (AL)	829	Alabama Power Co.	1977
Crystal River #3 (FL)	825	Florida Power Corp.	1977
Donald C. Cook #2 (MI)	1100	IN & MI Electric Co.	1978
North Anna #1 (VA)	907	Virginia Elec. & Power Co.	1978
Edwin I. Hatch #2 (GA)	784	Georgia Power Co.	1979
Arkansas Nuclear Two #2 (AK)	912	Arkansas Power & Light Co.	1980
North Anna #2 (VA)	907	Virginia Elec. & Power Co.	1980
Sequoyah #1 (TN)	1148	TVA	1981
Salem #2 (NJ)	1115	Public Service Electric & Gas Co.	1981
Joseph M. Farley #2 (AL)	829	Alabama Power Co.	1981
McGuire #1 (NC)	1180	Duke Power Co.	1981
Sequoyah #2 (TN)	1148	Tennessee Valley Authority	1982
LaSalle County #1 (IL)	1078	Commonwealth Edison Co.	1982
Virgil C. Summer #1 (SC)	900	South Carolina Electric & Gas Co.	1982
Susquehanna #1 (PA)	1050	Pennsylvania Power & Light Co.	1983
San Onofre #2 (CA)	1100	Southern California Edison	1983
St. Lucie #2 (FL)	810	Florida Power & Light Co.	1983
McGuire #2 (NC)	1180	Duke Power Co.	1983
San Onofre #3 (CA)	1100	Southern California Edison	1983
LaSalle County #2 (IL)	1078	Commonwealth Edison Co.	1984
Calloway (MO)	1171	Union Electric Co.	1984
WPPS #2 (WA)	1100	Washington Public Power Supply System	1984
Susquehanna #2 (PA)	1065	Pennsylvania Power and Light Co.	1984
Diablo Canyon #2 (CA)	1119	Pacific Gas and Electric Co.	1985

**Nuclear Power Plant Construction Activity 1984*, Energy Information Administration, U.S. Department of Energy (Washington, D.C.), July 1985.

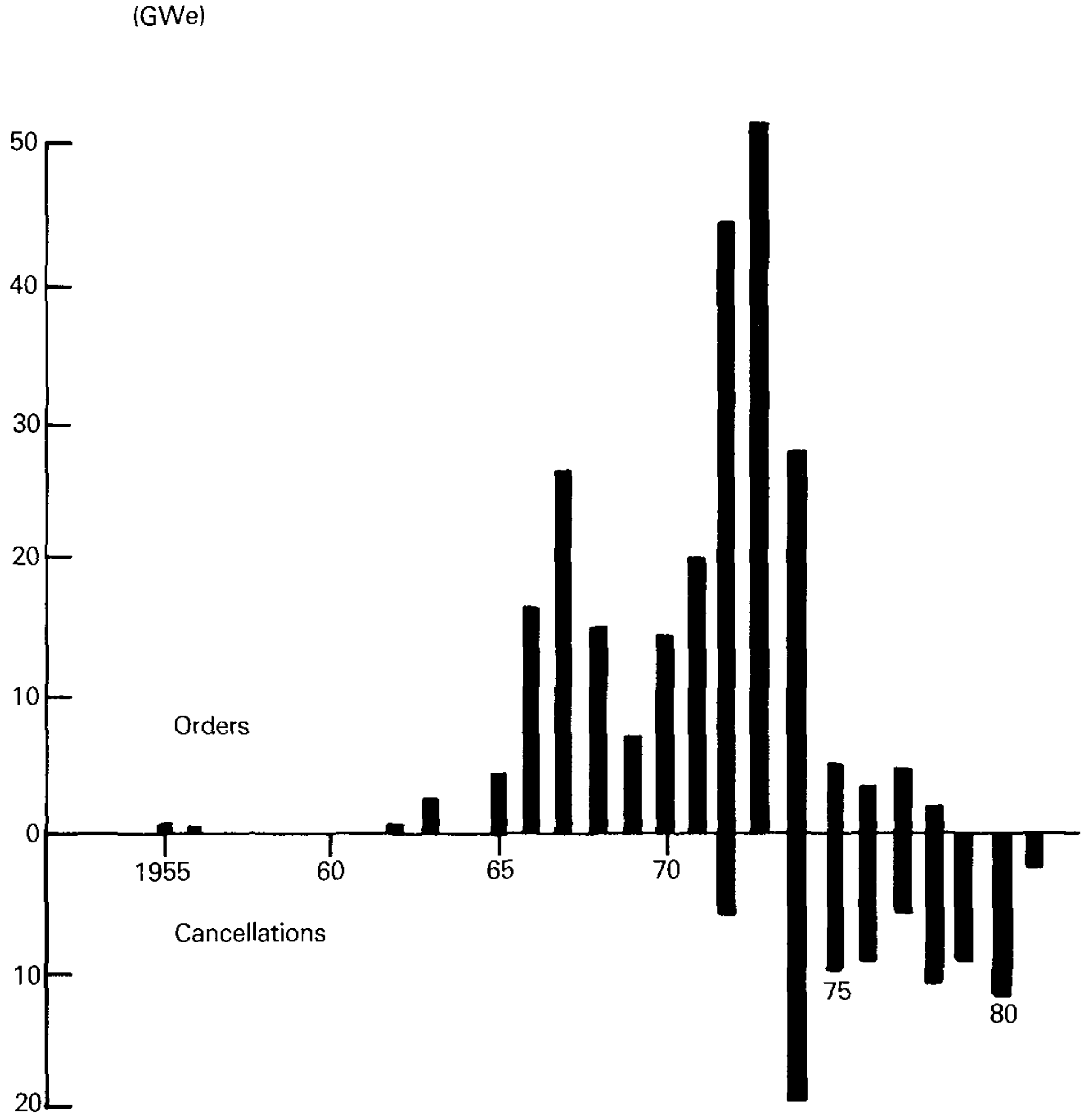
Trends in Public Opinion on Nuclear Power



Question asked: "Do you favor or oppose the construction of more nuclear powerplants?"
SOURCE: Cambridge Reports, Inc.

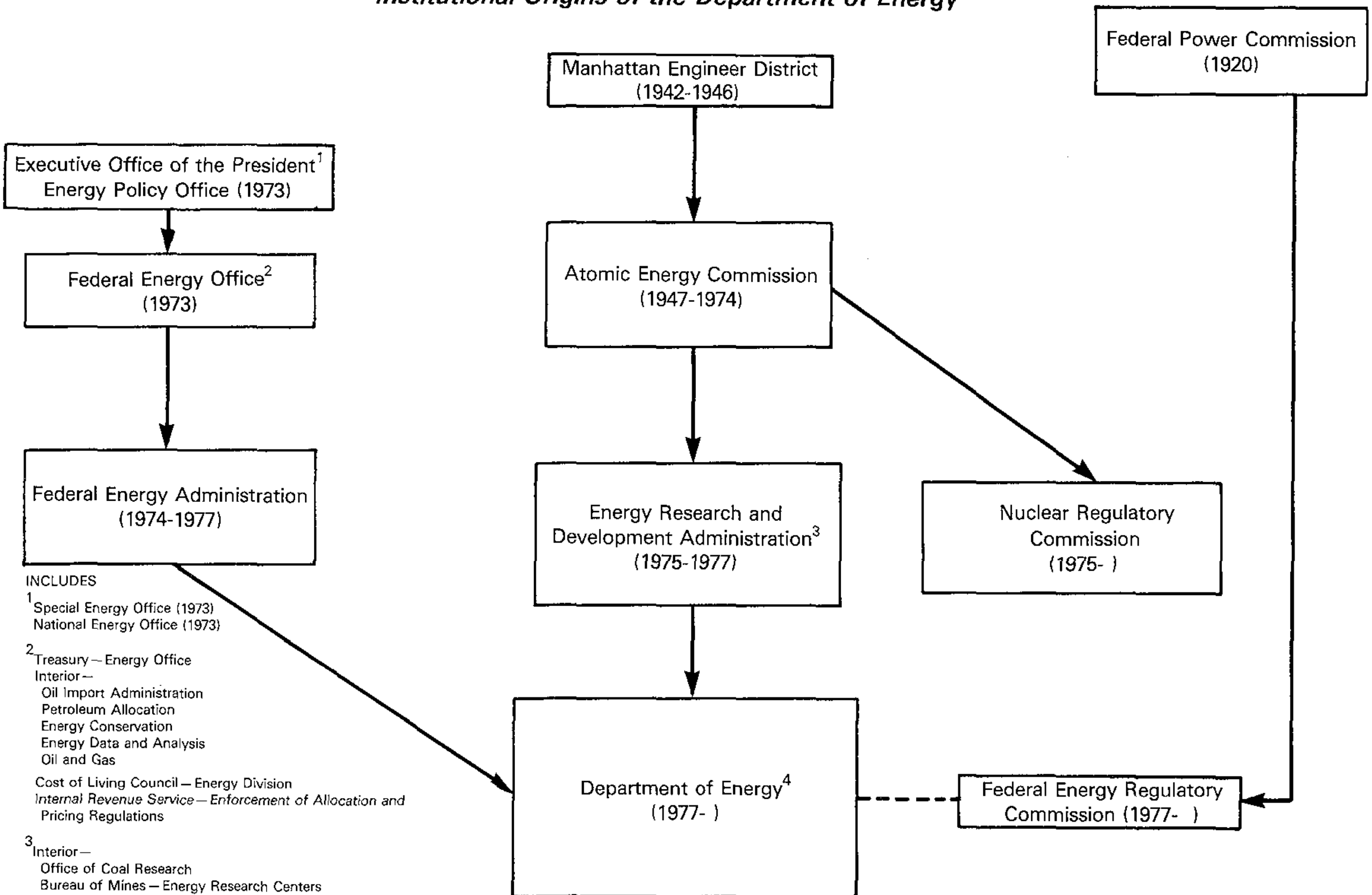
Nuclear Power in an Age of Uncertainty, Washington, D.C.: United States Congress, Office of Technology Assessment, OTA-E-216, February 1984, 211.

Domestic Nuclear Orders/Cancellations



Source: Kidder, Peabody & Co. (3/18/81)

Institutional Origins of the Department of Energy



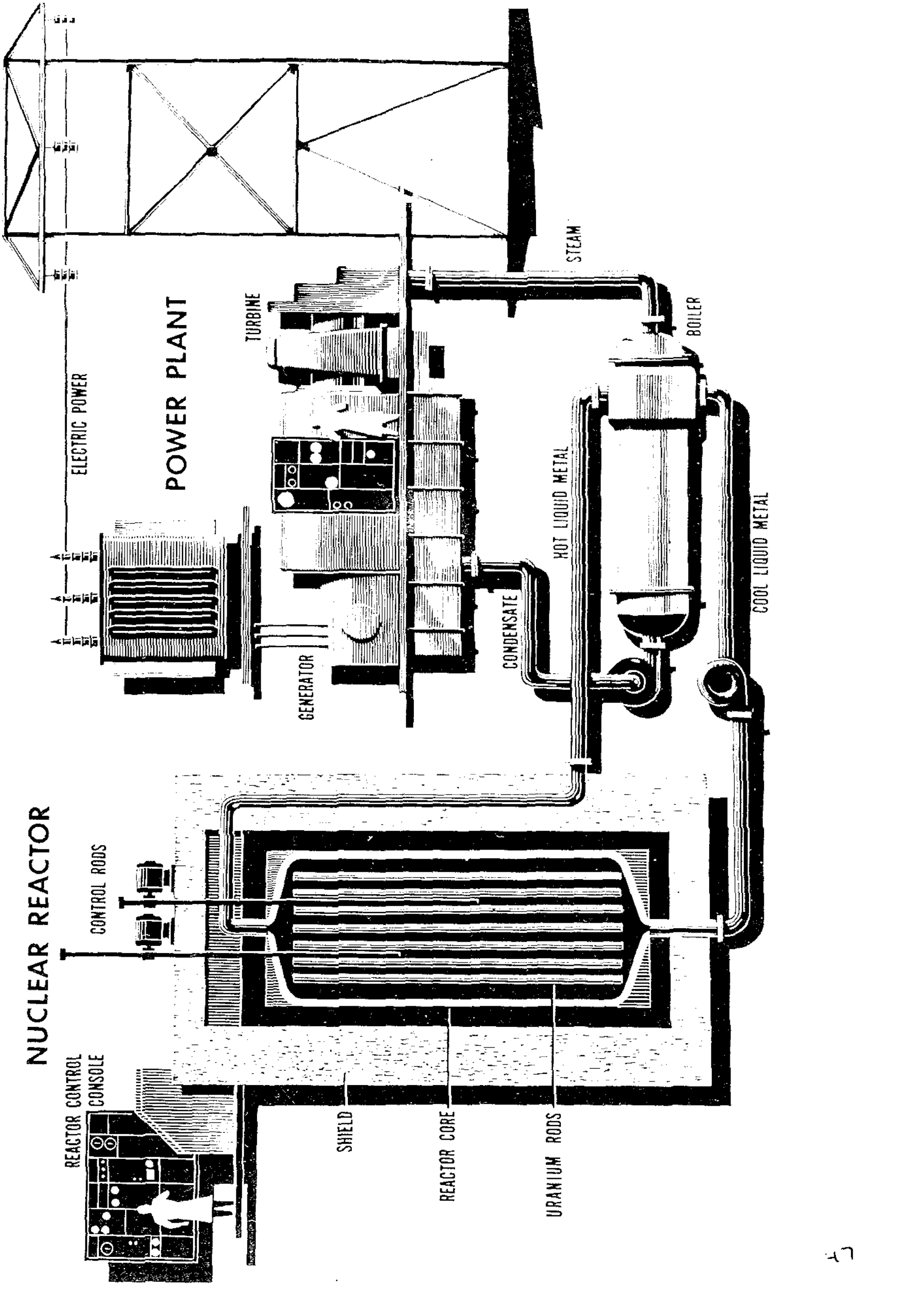
INCLUDES

[1] Special Energy Office (1973)
National Energy Office (1973)

[2] Treasury — Energy Office
Interior —
Oil Import Administration
Petroleum Allocation
Energy Conservation
Energy Data and Analysis
Oil and Gas
Cost of Living Council — Energy Division
Internal Revenue Service — Enforcement of Allocation and Pricing Regulations

[3] Interior —
Office of Coal Research
Bureau of Mines — Energy Research Centers
Environmental Protection Agency — Research, Development and Demonstration of Innovative Automotive Systems
National Science Foundation
Solar Heating and Cooling
Geothermal Power

[4] Agriculture — REA Loans
Commerce — Voluntary Industrial Conservation
Defense — Petroleum and Shale Reserves
Interstate Commerce Commission — Oil Pipeline Regulation
Securities and Exchange Commission — Electric Utility Merger
Department of Housing and Urban Development — Thermal Efficiency Standards
Department of Transportation — Fuel Efficiency Standards



*U.S. GOVERNMENT PRINTING OFFICE: 1986-491-176:20274