The period from the late 1950s through the early 1970s was a time of difficult transition at both Savannah River and Hanford. At both sites the production reactors had been built and power levels increased under the urgent demands of wartime schedules, whether those of World War II, the early Cold War, or the intensified crisis atmosphere of the nuclear arms race. With the end of the Korean War in 1953 and the change of emphasis to peaceful use of atomic energy, the world of nuclear reactors had altered. Over the next decade and a half, decisions affecting reactor technology, reactor operation, and the very survival of the family of production reactors moved from behind closed doors into the open.

When the reactors had been built in World War II, the American public had no knowledge of their existence. Postwar upgrades and new reactors drew little notice. When new reactor construction sites were chosen, a few representatives of potential sites expressed interest, but the short flurry of public attention died out after Savannah River was selected in 1950. The AEC inherited from the Manhattan Engineer District both the formal and informal side of secrecy. On the formal side, the rules of classification, chainlink fences, an elaborate badging system, and controlled access to information and facilities all served to limit public awareness. On the informal side, the habit and tradition of providing no more information than was absolutely required meant that knowledge about production reactors remained limited. For such reasons, the myriad specific choices and broader policy decisions that shaped production reactor technology did not receive public exposure in the period 1942–52.
The Sixties: An Age of Transformations

Through the mid 1950s, President Eisenhower’s commitment to converting reactor technology to peaceful purposes soon brought reactor concerns into a somewhat more public forum. With the construction of N reactor, quite suddenly some aspects of production reactor technology had become the center of overlapping political conflicts.

New developments in the early 1960s exposed further aspects of production reactor policy to the public. The original production reactors approached the end of their life spans. Safety evaluators within the AEC continued to have reservations about reactors that had been modified, repaired, rebuilt, and upgraded. With N reactor coming on-line and with the accumulation of plutonium nearing long-term weapons requirements, the need to keep alive the oldest reactors for the production of plutonium diminished. The Commission then had to face the issue of which ones to close first. The simplest but not necessarily the most scientific way to rank the reactors by risk was to regard the oldest as the most unsafe. Once reactors had been scheduled for closure, the Commission needed to deal with how to minimize the economic impact of the closures and to search for alternative ways to employ the facilities and the personnel to soften the impact. Thus, in the 1960s the dilemma of an excess production reactor population generated new issues about risk, closure scheduling, and diversification of the tasks at Hanford and Savannah River. Increasingly, such issues crept into a more open, and a more complex, forum. Decisions on each issue could no longer be made entirely behind the fences, insulated from public participation.

The sources of the transition from the closed-room style of internal decision-making to the more open process are diverse. From the end of the Eisenhower administration through the Kennedy and Johnson years, the United States underwent a deep cultural and political transformation. Values and ideas that had been part of the national consensus in the war and postwar years started to erode; old assumptions no longer seemed valid. In areas of life ranging from popular support for American foreign policy to trust in government and acceptance of corporate and academic leadership, profound changes were afoot. Some of the causes were international, such as the coming of age of a generation born since World War II; other causes seemed rooted in peculiarly American experiences, such as the discrediting of extreme anticommunism in the political career of Sen. Joseph McCarthy. Still other factors involved long-range trends, such as the proliferation of commercial television, the disruption of the traditional family, and deep-
seated and unresolved social tensions over race and gender. The nuclear weapons complex, although insulated and isolated from the mainstream of American life by a curtain of classification, by a degree of geographic remoteness, and by the tradition of quiet decision making, could not be entirely immune to the underlying social changes of the 1960s. The transition to public involvement can be seen as an example of this broader transformation of American culture to a greater degree of participatory governance and as evidence of the declining popular trust in experts and scientists.

The specific case of transfer of production reactor decisions from government experts to a more public forum reflected unique and distinctive issues. Changing perceptions of risk and conflicts between national defense priorities and the economic interests of localities took the debate in particular, sometimes unpredictable directions. Actions by the Atomic Energy Commission itself contributed to the growing cynicism about government and distrust in decisions reached privately by leaders and experts. Some decision makers were shocked and irritated by the contrast between that new public cynicism and the euphoric patriotism of the early postwar years.

Bland statements from the AEC minimizing the risk of fallout from weapons testing inspired doubt rather than faith as contradictory evidence mounted. The exposure and consequent illness of Japanese fishermen aboard the fishing boat Lucky Dragon and of Marshall Islanders and American servicemen as a result of 1954 testing at Enewetak contributed to public doubts, as did congressional hearings on weapons fallout in 1957 and 1959. Hearings on AEC rule-making regarding the risk of reactor meltdown attracted some further public notice in 1959. Then, in the early 1960s, separate local grassroots groups objected to a proposed commercial reactor at Bodega Bay in California and to other reactors sited near Detroit and on Long Island, New York, because of the risks involved. In California, the opposition focused on the willingness of a public utility to despoil a scenic coastline and build near an earthquake fault. In Michigan and New York, the proximity of the planned reactors to population centers raised concerns about evacuation in the event of a catastrophe. Power companies preferred to site their reactors close to their heaviest consumer markets in metropolitan areas in order to minimize the loss of power over long-distance transmission lines. If the reactors were sited near cities, suburbanites feared their proximity; if sited remotely, nature-lovers raised an outcry. In these early and widely separated first protests lay hints and origins of what became a nationwide movement a decade later.¹
In 1963–64, the AEC’s assurances regarding the danger of radioactive exposure, reactor risk, and general issues of nuclear energy were no longer universally accepted, yet polls and votes on antinuclear propositions indicated that the majority of Americans still supported the concept of nuclear power development. The AEC tried to respond promptly to the new emphases on peace, safety, and public benefit, but the linkages between atomic energy and war, danger, and closely held secrets had been established. In the area of nuclear politics, as in other phases of American life, the decade following 1963 was one of difficult cultural adjustment.

At the heart of the adjustment was the issue of nuclear reactor risk. When and if a reactor had a major failure, its consequences could be disastrous. Even before the first Hanford production reactors had been built in 1943–44, the small knowledgeable circle of scientists and military men anticipated the potential dangers of reactors. It was for exactly that reason that one of the criteria for the selection of the site at Hanford had been geographic isolation. Even the Savannah River site, though in the heavily populated eastern United States, had been chosen in part for its relative isolation. But as the AEC sought to encourage power reactor development, a host of issues needed resolution, including how to compare the risk of reactors, how reactor risk increased as the reactors aged, and how various safety features should be evaluated. In the choice of alternate designs, some objective method of determining the safest system was desirable. The population of reactors was so small, and the consequences of an accident potentially so great, that it was impossible to apply the usual statistical measures of safety used on systems with more numerous individual cases of total failure, such as steam engines and automobiles.²

All of the production reactors except N reactor had been built before the movement to promote commercial reactors got under way. The early piles at Hanford had been shielded, but not “confined” or “contained,” while the confinement structures at Savannah River would not meet commercial reactor standards. Protection against the dangers of meltdown derived from isolation; if a graphite reactor at Hanford caught fire, or a heavy-water reactor at Savannah River suffered a major pipe break, the intervening miles of uninhabited land between the site and the nearest residence offered some public protection. Yet winds and streams could carry radioactive smoke or liquid effluent for hundreds of miles, so the risk remained. As commercial reactors were planned for less isolated spots and as containment structures were designed to protect against public exposure, the dangers of the older
reactors became more obvious by contrast. Public debates over the emerging regime of regulations and designs for commercial reactors that would minimize risk, reduce effluent, and protect worker safety became quite strident through the late 1960s and early 1970s. The older generation of production reactor cousins, ignored by the public when they had been created, simply did not conform to the evolving modern standards. If the AEC closed production reactors, it would resolve both the safety and the excess capacity issues. Yet reactor closure brought other public issues to the fore.

In this period, most of the people living near Savannah River and Hanford viewed closure of production reactors not as an environmental blessing but as a potential economic disaster. In both locations, the employment of thousands of technical workers had transformed the local economies. That effect was more pronounced in Washington State than in South Carolina, simply because the economic impact of Hanford was proportionally greater. Eastern Washington had been an arid, lightly settled region with an emerging agriculture based on irrigation; Hanford was the largest employer in the state for the whole region east of the Cascade Mountains. Furthermore, the three nearby towns in which Hanford workers lived all depended upon the government contract payroll. By 1964 there were nine production reactors at Hanford; those machines alone employed over 3,000 workers. At Savannah River, the population working at the site resided in a more dispersed fashion in surrounding counties, rather than being concentrated in specific neighboring communities. In both areas, however, representatives, senators, and state governors were sensitive to the impact of planning upon their constituents and worked to diversify employment opportunities.

By the time the AEC announced plans to close some of its production reactors, an intricate politics had already started to emerge in the related but distinct area of debates over commercial power reactors. Slowly, antinuclear sentiment became organized, at first in the widely dispersed local actions in California, Michigan, and New York. The issue of civilian power reactors may have served as a surrogate for opposition to or concerns about nuclear weapons. By opposing the vulnerable civilian reactors, concerned activists and members of the public more generally could express their hostility to nuclear weaponry. Eventually that organized hostility could affect the weapons programs. As the attacks against civilian power reactors mounted and as knowledge of the risks associated with them became more widespread, organizational hostility transferred to production reactors themselves.3

One of the sources of distrust of the Atomic Energy Commission was its
own handling of the issue of radioactive fallout from atmospheric nuclear testing in the late 1950s and early 1960s. The Commission, with its tradition of expert guidance in decision making and controlled access to information, had no experience in or mechanisms for dealing frankly and openly with a potentially critical public. That institutional culture gradually spawned local, then national groups objecting to the risks at both the testing sites and at the reactor site at Hanford. The AEC’s response of denial, dismissal of whistle-blowers, and resistance to outside investigation continued to exacerbate such fears and legitimate concerns over the 1960s and 1970s.  

Groups opposed to particular commercial reactors appealed for followers with the separate but related issues of risk to local real estate, concern for the natural environment, disarmament, nuclear safety, and participatory government. In the late 1960s, as utilities across the country placed orders for power reactors, concerned reactor neighbors in state after state took an interest in the issues. Gradually, the antinuclear movement coalesced.

Yet the engineers and industry spokesmen who sought to build more commercial nuclear power plants also expressed concern with international peace, with limiting reactor risk, and with controlling radioactive emissions. Pronuclear advocates claimed, with good evidence, that nuclear power was far cleaner than coal in the production of electricity and far safer to workers than the other energy systems based on coal or oil fuel. As the lines of argument and the advocates from the commercial reactor debate influenced production reactor issues, complexities and cross-currents abounded. For example, even advocates of various local nuclear reactor projects at Hanford and Savannah River, while very pronuclear in tone, grew suspicious of the AEC’s closed decision-making process. Thus, pronuclear activists also began to demand more information as well as more participation in decisions. Risk, local economic impact, peaceful uses of the atom, and plutonium oversupply all became hot topics as production reactor debates moved into the open.

**Land Use on Wahluke Slope**

The low public perception of reactor risk in the 1950s is illustrated by a protest at Hanford over access to agricultural lands. During World War II, the Manhattan Engineer District had restricted access to land on the northern and eastern bank of the Columbia River, across from the Hanford reservation, in an area known as Wahluke Slope. This land provided a safety zone between the reactor areas and civilian populations. In response to postwar
claims that the continued restriction of this land imposed “considerable hardship” on the landowners, in 1948 the AEC lifted some wartime restrictions, though it still did not permit extension to Wahluke Slope of any irrigation projects that the Department of the Interior sponsored elsewhere in the immediate area.5

As time passed without a major reactor accident, the Commission felt more confident about opening land on the Wahluke Slope to irrigation and development. In January 1952, under advice from the Reactor Safeguard Committee and a specially appointed Industrial Committee on Reactor Location Problems, the AEC released approximately 87,000 acres of a “secondary zone” on Wahluke Slope to irrigation works that included the Interior Department’s Columbia River Basin project. At the same time, however, the Commission retained an area of the secondary zone that remained restricted from development, as well as a central zone directly across the river from the reactors to which all access was prohibited. As a precaution, the AEC directed its Hanford Operations Office to establish a warning system for slope residents in case of a reactor disaster. It also developed a public education campaign to inform residents of potential hazards associated with production reactors.6

Local residents remained unsatisfied with the slow release of land to farming and, during this period, unconcerned with reactor risk. Glenn Lee, editor of the area’s Tri-City Herald, argued in May 1954 that the slope question was more an issue of the AEC’s wish for the “power of a dictatorship” than the reality of a catastrophe at Hanford. Lee did not think the “thousands and thousands of beautiful acres” should remain “locked up” simply for use by the federal government. Eventually the AEC agreed, withdrawing its objection to irrigation development within the entire secondary zone of Wahluke Slope in December 1958 and allowing normal use to begin. The Commission justified its action on the basis that General Electric had installed more safety devices in the reactors, including confinement systems.7

Glenn Lee’s positions in this dispute show how in the particular situation at Hanford, one could be a local booster and comfortably pronuclear and at the same time also be pro-environmental, pro-participatory democracy, and anti-AEC.

These early debates over the use of Wahluke Slope reveal that in the 1950s, some residents near federal nuclear facilities feared government encroachment on their economic and property rights far more than they feared radioactivity. Even 10 years later, after reactor risk had become a politicized
issue, it remained possible to find organized political groups at Hanford who regarded the loss of livelihood as a more dangerous prospect than radioactive hazards from reactors. To an extent, the early Wahluke Slope debates show very clearly how little the public near Hanford perceived nuclear facilities as risky up through 1959; indeed, the AEC was more concerned about such risks than the local activists thought appropriate. Such a contrast was not unusual, however, in isolated one-industry mining or timbering regions where local residents feared that zealous government inspectors might attack their central means of livelihood.8

As employees living downwind of the reactors began to associate frequent cancers and birth defects with their residence in the path of winds blowing past the reactors, they sometimes found themselves highly ambivalent about the conflict between their own loyalty to the nuclear establishment and to the national government which it served. Those institutions’ apparent unconcern for public health and for their own personal distress was tough to take, difficult to understand. Several poignant and tragic stories of the “downwinders,” victims of cancers and other diseases presumed to derive from radiation exposure, drew the attention of local and regional journalists.9

**Reactor Risk: Theories and Practices**

In the 1960s, when public concern about the risk of reactors increased, technical approaches to the study of such risk underwent a change. The older method, using “deterministic logic,” served as the basis for design and early operation of the Hanford reactors and had characterized early safety planning at Savannah River. In this system, a possible worst-case accident was visualized, and then both design and operation were planned around methods of forestalling cause-event sequences that would lead to, or determine, such an outcome or accident. At Savannah River, a possible catastrophic accident received close attention through examination of various event sequences in worst-case scenarios. One Du Pont report studied the measures taken prior to Savannah River startup to prevent escape of radioactive materials to the environment. As part of the analysis of the risks involved, the reactors were described in great detail. The report spelled out the scram and control processes and reviewed a possible boiling accident, outlining a worst-case scenario.10

A 1953 Savannah River study focused on the consequences of the assumed failure of certain major systems—in this case, the failure of the six heavy-water recirculation pumps. This deterministic method—a “design basis
accident approach”—did not consider unlikely combinations of unlikely minor problems that could combine in various ways into serious events; such extreme cases were not explored because they could be regarded as “non-credible.” Instead, the 1953 report estimated the time taken by each step in one catastrophic accident that was presumed possible, showing that a scram had to be achieved in 81 seconds at the 300-MW level, and more quickly at higher power levels, to prevent the lithium-aluminum control rods from melting and producing a catastrophic accident.\textsuperscript{11} Such calculations allowed designers to anticipate exactly how fast a scram had to take place at each level of power upgrade and to design accordingly. It was in just this fashion that deterministic risk analysis contributed to reactor design in the 1940s and 1950s.

By the 1960s, a new method of evaluating the risk of reactors began to emerge in the wider community of commercial power nuclear engineers. General Electric, with its growing experience in the power reactor manufacturing business, had more exposure to this new set of ideas than did the Du Pont operators at Savannah River. Some of the origins of the new method, called “probabilistic risk assessment,” could be found in the academic education of the newly emerging profession of nuclear engineering. Ernst Frankel, who wrote a textbook for a course in systems reliability at the Massachusetts Institute of Technology (MIT), which he taught through the 1960s, drew on a number of works published in the period 1957–61 that gave mathematical models for assessing the reliability of complex systems and evaluating the probability of their failure.\textsuperscript{12}

Frankel showed how, in the traditional deterministic approach to complex systems, engineers anticipated the physical causes of system failure and prevented them by redundancy (that is, duplication of crucial system elements), design, and maintenance. Under the probabilistic approach, engineers were able to estimate the numerical likelihood of failure of a system or subsystem with a given design and maintenance program. The two approaches were not incompatible even though their theoretical viewpoints were very different: with deterministic engineering, one looked to physical problems and their remedies; with probabilism, one assessed the system’s reliability by examining the probability of failure of crucial components. The probabilistic approach was more likely to focus on the combined effect of multiple failures of subsystems. It was precisely this new method that General Electric engineers at Hanford employed in trying to convince the Advisory Committee on Reactor Safeguards (ACRS) that the risk of the
combined failure of multiple subsystems at N reactor was in the one-in-one-million range. If three subsystems had to fail simultaneously, and the chance of each failing was less than one time in a hundred years of operation, the probability of all three at once was, for all practical purposes, nil. Douglas United Nuclear, which took over operation of N reactor in 1967, concurred that such a one-in-a-million, “postulated accident” could not happen.\textsuperscript{13}

The different approaches, although theoretically complementary or compatible, could lead to somewhat different practical conclusions about how to improve the reliability of a system. Using determinism, a worst-case failure would be examined and the system designed to prevent the accident or to ameliorate its effects. Using probabilism, the reliability of a great variety of subsystems could be calculated and an overall, quantified judgment made about the total system; such an approach could generate a focus on design improvements on small but crucial parts of the total system. The increasing use of computers made easier the vast number of calculations required under the probabilistic approach. Furthermore, by calculating the minute likelihood of simultaneous or sequential failure of multiple safety systems, one might reasonably demonstrate that the likelihood of a meltdown accident was not believable—that it was “not credible.”

In the late 1960s, several published papers brought probabilistic thinking more fully to the attention of nuclear engineers. One of these was a 1967 paper delivered at a Vienna conference of the International Atomic Energy Agency, F. R. Farmer’s “Reactor Safety and Siting: A Proposed Risk Criterion.” Farmer argued that risk could be measured by estimating the probability of a system’s failure, and he made a distinction between acceptable and unacceptable risks.\textsuperscript{14}

The growth of probabilistic risk assessment (PRA), as it came to be called in nuclear engineering, resembled in several respects the paradigm shift of a major scientific revolution. Some engineers who had been trained to use existing deterministic methods remained skeptical of the new system, warning particularly that it could lead to an unjustified reliance on numbers, many of which derived from guesses. The harshest critics thought it little more than an exercise in numerology. Practitioners of the new system showed that it addressed several difficulties not handled by the old, particularly the issue of combinations of minor causes into major consequences. That focus on the ability of the new system to deal with elements not adequately handled in the old system was similar in some ways to the pattern in scientific revolutions in which anomalies not explainable by the previous
scientific theory could be explained by the new. As in better-known “para-
digm shifts” or scientific revolutions, the development of probabilism in nu-
clear engineering was accompanied by heated controversy within the com-
munity of specialists.15

The contentious shift in risk analysis from determinism to probabilism
proceeded among a rather restricted community of technical experts, in-
cluding reactor designers and planners, mostly outside of any wide public
notice. As such, it might be called a technological minirevolution, requir-
ing a revolutionary change in viewpoint and practice among a very select
group of technical experts. Although the minirevolution produced rethink-
ing among such specialists, it was not the sort of world-shaking paradigm-
shift associated with full-scale scientific revolutions. Nevertheless, the change
in thinking about risk among the experts did have some long-range impacts
on public perceptions, creating echoes in the press.16

PRA practitioners insisted that their method was supplementary to the
ever earlier method; they saw no conflict with the earlier method, even though
some engineers continued to resist probabilistic approaches as mere num-
bers games. It is reflective of the different engineering approaches at Han-
ford and Savannah River that Hanford’s GE engineers, with their emphasis
on systems planning, used early forms of PRA methods in planning N re-
actor in the 1960s, whereas Du Pont engineers at Savannah River did not take
training in the newer methods and begin a probabilistic risk analysis of the
Savannah reactors until the 1980s.

Although PRA emerged as a new way of evaluating the risk associated
with nuclear reactors in the 1960s, concern for safety had always been an el-
ement in both design and operations. Du Pont was concerned about safety
from its first days of running the Savannah River reactors, both in terms of
industrial safety for workers and in terms of releases to the environment,
and it applied its existing safety procedures. As a chemicals company work-
ing with highly dangerous substances, Du Pont had a long tradition of en-
suring plant safety. Rather than assigning responsibility for safety to a sep-
arate office, Du Pont insisted that all line officers be personally responsible
for the safety of the divisions under them as part of their central manage-
ment mission. That corporate approach required considerable internal mon-
itoring and reporting.17

In response to a request in 1962 by the AEC’s local Savannah River Op-
erations Office, Du Pont began submitting semiannual reports on incidents
and a safety audit of performance at the Savannah River reactors. This doc-
umentation summarized problems every 6 months; earlier problems had been reported individually as reactor incidents (RIs). The semiannual reports to the Commission, focusing on trends, bore a more positive tone than the RIs, which had focused only on single incidents. In the semiannual reports, even a failure to reduce the number of incidents from one 6-month period to the next was presented as a measure of continued vigilance and a consistent level of performance in the face of changes and in view of the fact that the plant grew steadily older. Du Pont also addressed safety issues by improving reactor containment, power monitors, and internal radiation monitors.¹⁸

As the Commission’s concern with reactor safety increased with the licensing and construction of less remote power reactors, operators at Savannah River examined even more closely some of the worst-case scenarios, continuing to use deterministic approaches. In 1965, in response to an expected ruling from the ACRS, the Atomic Energy Commission asked the contractors at both Hanford and Savannah River to begin planning to bring the production reactors into conformity with standards for commercial power reactors. Their responses to the Commission request showed the slight difference in how Du Pont’s determinism and General Electric’s probabilism worked out in practice.

The AEC evaluated the two sites in light of a Code of Federal Regulations rule regarding radiation protection standards and emissions (10 CFR 20) and another regarding reactor site criteria in case of meltdowns (10 CFR 100). Savannah River met the 10 CFR 20 standard on radioactive emissions to streams and the 10 CFR 100 site requirement regarding partial, but not extensive, meltdowns. In effect, Du Pont admitted that in the case of a worst-case accident, Savannah River did not meet the site standard. Hanford had only a narrow margin on release to streams; however, on 10 CFR 100, Hanford’s explanation of the unlikely combination of events necessary to generate fuel melting made such an accident “incredible.” By those probabilistic grounds, General Electric argued that Hanford met the 10 CFR 100 rule. Du Pont made no effort to argue that the worst case could not happen; General Electric could use its calculations to show that the worst case was beyond likelihood.¹⁹

In a 1967 safety report, a Du Pont safety officer at Savannah River asserted that the motivation for Du Pont to guard against a catastrophic accident was even higher than any measure of real public risk would suggest, because relatively minor effects could bring adverse publicity to the corpo-
ration. In an internal report, he drew particular attention to 20 incidents, criticizing, one by one, the assessment of the incidents as of minor significance. This unpublished report showed that some of Du Pont’s own experts disagreed, sometimes heatedly, on how to assess, report, and respond to problems of control and radiation release. But even so, Du Pont personnel in this period regarded such issues as properly handled inside the company, seeking to avoid public misunderstanding or misapprehension.20

Through the 1950s and 1960s, Du Pont continued to operate the Savannah River reactors with a strict system of administrative controls that followed the contractor’s own standard and methods for safety at its chemical plants. Du Pont’s view was that a series of tried-and-true institutional mechanisms enforced safety: these included safety analysis reports, technical manuals, technical standards, mechanical standards, standard operating procedures, emergency procedures, test authorizations, reactor technology memoranda, facilities and equipment instructions, job plans, and maintenance procedures. For each of these institutional or procedural mechanisms, specific definitions, specific rules for issuance or modification, and specific responsibilities for implementation or authorization were all documented. This essentially Weberian bureaucratic method was detailed to the last step, reflecting Du Pont’s institutional resistance to the revolution in risk assessment. The concept was that any alteration in procedures that might reduce safety would be thoroughly reviewed; mechanical or operational factors that might determine a bad outcome would be forestalled by good management.21

Both Du Pont and General Electric remained sensitive to charges that the reactors they operated were unsafe, either in terms of gradual radioactive or thermal pollution of streams or in terms of the risk of a major sudden incident or meltdown. But they were caught in a difficult position. In order to meet Production Division orders for material production, they had to keep the reactors running; all reactors involved risk, and most had some degree of accidental radioactive emission. Any explanations issued by the contractor of technical procedures designed to mitigate pollution or risk were difficult to express in classic public relations terms. Because such explanations were issued by the firm responsible for the equipment and its possible failure, almost any such statement appeared self-serving, especially if it was couched in general and nonspecific terms. On the other hand, detailed technical explanations could be so difficult for a layman to follow that they could have the unintended psychological effect of drawing attention
to the risk itself, rather than to the complex methods used to reduce the risk. Yet, when the public or the ACRS expected explanations, the contractors had to make statements. Their position became increasingly difficult as public interest in the issues mounted.  

The problem of dealing with public perceptions of reactor risk had hardly existed in 1959; by the middle and late 1960s it had become an increasing administrative burden to both Du Pont and General Electric, as the issue moved into the open forum of the press and electronic media owing to contemporary expansion of commercial power reactors. Business leaders in the growing nuclear industry were troubled by exactly this “public perception” problem. At a panel presented in 1963 at the Atomic Industrial Forum, the new association of nucleonics firms, dominated by electrical engineers, several of the speakers noted the issue. C. Rogers McCullogh, former chairman of the ACRS and now vice president of a private nuclear firm, called it “a rising tide of criticism” of atomic energy. He felt the criticism was unfair and somehow politically motivated, since the nuclear industry was more concerned with safety and with explaining safety than were other industries.

**Peaceful Uses of Atomic Energy**

Safety and risk were only one side of the public relations problem. With the growing emphasis on peaceful uses of the atom, and with the attempt through the presidencies of Lyndon Johnson and Richard Nixon to maintain détente, the production reactors and the whole nuclear weapons complex remained uncomfortable reminders of the fact that the United States was engaged in a nuclear arms race with the Soviet Union. Although the primary function of both Hanford and Savannah River remained the production of materials for nuclear weapons, Du Pont, for one, sought to characterize a variety of design changes as reflective of more peace-oriented research and development. This “R&D” emphasis, which included efforts to produce a number of experimental isotopes at Savannah River, was at first presented as evidence of the meeting of scientific challenges and of adapting to the new emphasis on peaceful uses of atomic energy. In 1964 AEC manager G. W. Bloch informed the Joint Committee on Atomic Energy that Savannah River was working on a plan to irradiate weapons-grade plutonium, transforming it by steps into americium and finally curium-244. Even though curium-244 was 300 times more toxic than plutonium-239, the Commission hoped to find a market for the isotope in Space Nuclear Auxiliary Power (SNAP) applications. The project was pre-
It soon became clear that the idea of simply operating the reactors, year in and year out, to produce the same weapons-related products without product improvement or an experimental program was difficult and uncomfortable for Du Pont and its technical staff. People with scientific training went to work for Du Pont, not to be machine operators, but to engage in research and development and to make “better things for better living,” as the company proclaimed on the bottom of every piece of stationery. Operating a weapons-material production reactor on a routine basis, for quantity production, hardly met the official corporate ideal or the real professional needs of the employees, let alone the emerging ethos of Atoms for Peace, nor did it fit comfortably into the Du Pont culture, in which the pursuit of new products led to career advancement for executives. Du Pont sought visible and tangible connections between its weapons-material production efforts and peacetime applications. Production of curium-244 was only one such proposal among many to introduce variety and peaceful purposes into the Savannah River operation.

With the growth of commercial reactors and with the AEC’s continued emphasis on peaceful uses of the atom, Savannah River reflected the broader cultural shift. Difficult as it was, both the government and the contractor attempted to present production reactors and production facilities, all built for and dedicated to weapons manufacture, as somehow linked to, or convertible to, peaceful purposes. Efforts to produce isotopes, to harness the heavy-water design to power production, and to support power reactor work in other ways all became regular features of Du Pont and AEC public relations documents in the 1960s.

Du Pont participated from 1957 through 1962 in the commercial reactor development program, submitting a number of reports outlining how heavy-water reactors the company ran for weapons material production might be made into or designed for electrical power generation. The AEC requested that Du Pont prepare cost evaluations of heavy-water (HW) reactors at both the 500- and 1,000-MW scale, developing cost comparisons of heavy-water reactors with other types, including gas-cooled and light-water-cooled reactors. Du Pont did not wholeheartedly jump aboard the power reactor bandwagon, however. After thorough study of one type of heavy-water reactor, a boiling heavy-water-cooled pressure-tube reactor, Du Pont concluded that “large capacity reactors of this type are
not competitive with conventional fossil fuel plants at this time in the USA.”

Central to the heavy-water power projects was the Heavy-Water Components Test Reactor (HWCTR), which had been proposed in 1956 to help commercial manufacturers evaluate various components to be used in possible heavy-water reactors built for generation of electricity. Over the period 1956–63, the test reactor was conceived, designed, and constructed by Du Pont at Savannah River at an approximate cost of $8 million. On this AEC-initiated project, Du Pont had neither the urgency that had characterized the building of the production reactors nor the free hand that it had enjoyed in building those reactors. Company officials suggested that the 7-year span from conception to operation did not meet their corporate standard for getting things built in a timely fashion. Du Pont remained uncomfortable with the total systems design style of reactor building so readily followed by General Electric. The HWCTR delays and the planning imposed by the commission simply did not match Du Pont’s methods of plant design.

About a year after completion of the HWCTR, the AEC informed the Joint Committee on Atomic Energy that the program had become a dead issue. By the time of completion of the HWCTR, Westinghouse and General Electric had begun marketing of light-water reactors for power generation in earnest. The Commission’s general manager explored, without success, whether NASA or a European agency would be interested in sharing continued operating expenses of the HWCTR. This short-lived program was an early example of the many setbacks and disappointments in the effort to develop peaceful programs at Hanford and Savannah River.

Nevertheless, the overall tone taken by the Savannah River operation in the early 1960s was quite upbeat, conveying an emphasis on the possible future conversion of Savannah River from a Cold War arsenal to a locale for civilian and peacetime research. The need to move to such a conversion soon became quite pressing.

**Reactor Closings**

As Du Pont and General Electric began addressing increased safety concerns in the 1960s, they faced a new challenge to their operations that spelled doom for members of the production reactor family and precipitated much greater public and political concern. Gordon Dean’s 1952 prediction of a surplus of plutonium by the mid-1960s had been quite accurate. In fact, the intensive effort to increase production reactor power ratings in response to the per-
Table 5. Power level upgrades of production reactors

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<td>Hanford D</td>
<td>1945: 250</td>
<td>1951: 435</td>
<td>1963: 2,005</td>
</tr>
<tr>
<td>Hanford DR</td>
<td>1949: 250</td>
<td>1951: 500+</td>
<td>1963: 1,925</td>
</tr>
<tr>
<td>Hanford H</td>
<td>1950: 250</td>
<td>1951: 500+</td>
<td>1963: 1,955</td>
</tr>
<tr>
<td>Hanford C</td>
<td>1952: 750</td>
<td>1963: 2,310</td>
<td></td>
</tr>
<tr>
<td>Savannah R</td>
<td>1953: 383</td>
<td>1963: 2,300–2,600</td>
<td></td>
</tr>
<tr>
<td>Savannah P</td>
<td>1954: 383</td>
<td>1963: 2,300–2,600</td>
<td></td>
</tr>
<tr>
<td>Savannah L</td>
<td>1954: 383</td>
<td>1963: 2,300–2,600</td>
<td></td>
</tr>
<tr>
<td>Savannah K</td>
<td>1954: 383</td>
<td>1963: 2,300–2,600</td>
<td></td>
</tr>
<tr>
<td>Savannah C</td>
<td>1955: 383</td>
<td>1963: 2,300–2,600</td>
<td></td>
</tr>
<tr>
<td>Hanford KW</td>
<td>1955: 1,800</td>
<td>1963: 4,400</td>
<td></td>
</tr>
<tr>
<td>Hanford KE</td>
<td>1955: 1,800</td>
<td>1963: 4,400</td>
<td></td>
</tr>
<tr>
<td>Hanford N</td>
<td>1964: 3,950</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total capacity (low estimate), 1964</strong></td>
<td></td>
<td></td>
<td><strong>36,300</strong></td>
</tr>
</tbody>
</table>


...received immediate arms threat from the Soviet Union during the early 1950s advanced the date of plutonium surplus or glut. The weapons complex achieved a saturated market for plutonium by 1963, partly as a consequence of the steady upgrades in power over the preceding decade. Table 5 presents a cross section of the power ratings of the various production reactors up through the eve of the decision to close them.

In response to the plutonium supply levels, the AEC planned the retirement, first of the older plutonium-producing reactors at Hanford, with a cutback in enriched uranium production, and then of some of the dual-purpose, plutonium-tritium producers at Savannah River. As will be seen, the cutbacks were announced and carried out in a piecemeal fashion, with closure of a few major facilities at a time, over a period of 6 years. The Commission hoped to mitigate the economic impact by spacing out the shutdowns. However, the Commission did not announce its policy openly. Rather, a few reactors would be closed with an announcement that production needs could be met with the remainder, and then, a year or two later, another round of closings would be announced, a process that only heightened, rather than quieted, the resultant political outcry.
On 8 January 1964, President Johnson announced the first reduction in plutonium and enriched uranium production in his State of the Union message. The AEC scheduled four reactors for closure: F, DR, and H at Hanford, and R at Savannah River. These closings were scheduled through 1964 and 1965; the reactors were selected on the basis of being among the oldest and in the worst physical condition of all the members of the family.

While the reason for closing the production reactors was that American plutonium requirements had been met, Johnson used the impending shutdowns as a gesture of international goodwill. On 21 January 1964, in his message to an 18-nation disarmament conference, Johnson announced that the United States was prepared to accept appropriate verification of scheduled reactor shutdowns, implicitly suggesting that the Soviet Union follow the American example. The AEC then undertook the development of a verification system for international use to ensure that a production reactor had not been operated between verification visits. The closures, their relationship to disarmament, and the verification scheme were all given prominent mention in AEC publicity releases and in the Commission’s annual reports.

Commenting on the cutbacks in April 1964, President Johnson characterized them as reflecting “our desire to reduce tensions, and our unwillingness to risk weakness.” Despite the effort to style the closures as a peace gesture, he also stated somewhat more frankly that he was “bringing production in line with need” and said that he anticipated that Soviet Premier Nikita Khrushchev would respond with similar cutbacks. However, at no time in the public statements about the closing of plutonium production reactors did the AEC attempt to make clear that a permanent plutonium surplus had been achieved; placing some of the reactors on “standby” left a public impression that the closures might even be temporary. Eventually, when no “nonproduction” use for a reactor was found, its status would be altered to “permanent shutdown.”

Further closings in the mid-1960s continued to reflect the combined effects of oversupply, obsolescence, and détente. While the glut of plutonium and the obsolescence of the equipment made closures essential, the AEC continued to stress the implications for international peace: the closures were evidence of “restraint” in the weapons program and were “consistent with U.S. proposals in international disarmament discussions.”

Despite such high-minded implications, operators and local citizens at Savannah River and Hanford sought ways to keep their livelihoods. In 1964, regional power companies explored the idea of converting the Savannah
River reactors to generation of electricity. Private power companies lined up to support the idea, with 12 power companies writing to AEC chairman Glenn Seaborg that they would undertake and fund a study on converting a Savannah River reactor to power. The group evaluated the possible conversion of R reactor at Savannah River to power use, outlining the specific modifications required. Their report concluded, however, that while such a conversion would be technically feasible, it would be too expensive. The AEC operations office was apparently less than enthusiastic about the concept, for even before the power companies submitted their final report, it ordered R reactor closed. R was then cannibalized for parts useful for the surviving reactors at Savannah River.

In another attempt to keep the reactors and the local economies running, Savannah River managers continued to argue for conversion of production reactors to the production of a variety of isotopes, claiming there was some need for them at NASA and in experimental science. In 1966, the AEC acknowledged the idea in stilted language: “Previously determined reductions in weapons requirements have permitted the shutdown of four production reactors[,] and future requirements, while still uncertain, may permit utilization of production reactor capacity for non-weapons products.” The cold phrasing reflected the fact that isotope production at Savannah, while touted locally, received mixed reactions from headquarters.

As the planned shutdowns at Savannah River and Hanford became realities, members of Congress from South Carolina and Washington State sought ways of addressing the complaints about employee layoffs from their constituents. In South Carolina, Gov. Donald Russell worked with community leaders and congressional delegations from both South Carolina and Georgia to lobby for further peaceful uses of the Savannah River reactors. Russell knew that South Carolina could not claim that it had a specially built town like Richland, Oak Ridge, or Los Alamos. Those towns might argue that the government that had created them owed them special consideration; such a situation did not prevail at Savannah River. Nevertheless, Governor Russell felt that fact did “not mitigate in any way similar problems in plutonium cutbacks at the Savannah River plant.” The effect would be felt in “quite a number of communities and counties in South Carolina and Georgia, with an impact on the Southeast in general.”

In 1967, the AEC announced plans to close another Hanford reactor, stating that “currently projected requirements for national defense can be met with the reactors remaining in operation.” A year later, in January 1968,
Glenn Seaborg blandly explained that one more reactor at Savannah River and one more at Hanford would be shut down and placed on standby. Once again, a similar statement was given: “AEC review of currently projected requirements for reactor products in defense and civilian programs has indicated that the requirements can be met with fewer reactors than are now operating.” That decision reduced the total number to seven reactors: four at Hanford, three at Savannah River. Each statement could be read to mean that the announced closures were final. When followed shortly by yet another announcement, the cumulative effect increasingly frustrated the politicians who tried to satisfy voters in the affected areas. Through this period, local politicians and their constituents overwhelmingly resisted closures due to the prospect of lost employment. Despite growing complaints of “downwinders” about health hazards, those closest to the sites tended to be dependent on employment and most pro-reactor.

The AEC did not close reactors on the basis of the oldest first, or even on the basis of selecting the ones with the most physical problems. In 1968, for example, the Commission selected Savannah River’s L reactor for closure, over the more troublesome C reactor. Although L was slightly older than C, C had developed a history of minute heavy water-leaks, adding up to 50 to 100 liters per day. In support of the choice of L for closing, R. E. Hollingsworth of the AEC explained to an increasingly skeptical Joint Committee that despite the history of leakage at C—leaks now assumed to be “dormant”—other factors required that L rather than C be chosen for shutdown, including the relative production efficiencies of the two reactors when it came to tritium and a cost comparison of the maintenance and reconditioning requirements of the two reactors. C reactor continued to leak until its closure in 1987. In effect, it was cheaper to keep Savannah River C reactor in production of tritium than to reconfigure L reactor for that product alone.

The AEC surprised its political allies further in 1969 when, under pressure to cut the budget, it announced still another group of closures at Hanford. As the closures and the layoffs continued, the local community became a bit jaded about reassurances from Washington. Local representatives, with newspaperman Glenn Lee as spokesman, complained bitterly to Commission chairman Glenn Seaborg in January 1969. The announcement of the closure of more reactors at Hanford had “shaken the community more severely, and done more psychological damage than anything which has happened in the last five years’ time.” Both Senators Warren Magnuson and Henry Jackson had been assured by the AEC within the previous month.
that there were to be no more cutbacks; Lee and the senators regarded the planned cutback as a betrayal. With no notice or opportunity for reconsideration, the reactors built in the 1950s—Hanford’s C, KE, and KW—would be shut down.

By 1971, the round of closures was complete. Only the youngest four of the fourteen production reactors remained in operation: P, K, and C at Savannah River, and N reactor at Hanford. The impact at Hanford was, of course, more profound: eight out of the nine reactors had closed there, whereas at Savannah River, two out of five had closed. Furthermore, as one of the MED-built communities, Richland, Washington, had no other raison d’être besides its nuclear work; with the closing of the reactors, Richland citizens easily visualized a return to 1940, when, they imagined, their community had been a dusty haunt of rabbits, tumbleweed, and an occasional buzzard. In reality, in 1940, developing orchards and vineyards had already begun to benefit from irrigation and cheap electric power before the MED and Du Pont arrived. But the town dwellers, dependent on government and contractor employment, feared that further closures would reduce Richland to a ghost town.

The drawn-out process of closing had reduced the number of layoffs at any one time. Yet the AEC’s oft-repeated announcements that the current reactors were an appropriate number, followed by repeated further shutdowns, soured relations between the AEC managers on the one hand and contractors, employees, local community leaders, and congressional representatives on the other. At no time in the process did the AEC explicitly state that the nation had more plutonium than required but only that remaining reactors could meet requirements. Under the culture and practice of secrecy, more detail on the nuclear stockpile was not considered public information. Rather than minimizing public and political impact, the 8-year round of closures had maximized it, with a new blow to the Hanford region economy almost every year, as shown in Table 6.

Production reactor shutdowns in the 1960s represented more than the AEC’s efforts to eliminate surplus, expensive, unneeded, and aging equipment. With the closures, the total thermal megawattage of production reactors declined, while the output of the electrical-generating commercial reactors steadily climbed.

The transition from reactors for weapons to reactors for peace at first was a matter of rhetoric and wishful thinking. However, one very tangible measure of the rate of implementation of that new emphasis in the 1960s
Table 6. Reactor closings during the plutonium glut period, 1964–1971

<table>
<thead>
<tr>
<th>Reactor</th>
<th>Year closed</th>
<th>Approximate years operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savannah R</td>
<td>1964</td>
<td>11</td>
</tr>
<tr>
<td>Hanford DR</td>
<td>1964</td>
<td>14</td>
</tr>
<tr>
<td>Hanford F</td>
<td>1965</td>
<td>20</td>
</tr>
<tr>
<td>Hanford H</td>
<td>1965</td>
<td>16</td>
</tr>
<tr>
<td>Hanford D</td>
<td>1967</td>
<td>22</td>
</tr>
<tr>
<td>Savannah L</td>
<td>1968</td>
<td>14(^a)</td>
</tr>
<tr>
<td>Hanford B</td>
<td>1968</td>
<td>22(^b)</td>
</tr>
<tr>
<td>Hanford C</td>
<td>1969</td>
<td>17</td>
</tr>
<tr>
<td>Hanford KW</td>
<td>1970</td>
<td>15</td>
</tr>
<tr>
<td>Hanford KE</td>
<td>1971</td>
<td>16</td>
</tr>
</tbody>
</table>

**Average approximate years of operation** 17

*Note: Totals are approximate in that reactor shutdowns for refueling and maintenance are not deducted; years have been rounded off to nearest full year.*

Reactors still in operation in 1972 were P, K, and C at Savannah River and N at Hanford.

\(^a\)L was later reopened between 1985 and 1988.

\(^b\)B was closed temporarily in 1946–47.

*Source: AEC annual reports; EGG Box 2, 5661.1.7.2 Background Briefing.*

was the strictly objective number representing the total thermal megawattage of production reactors in the United States compared to the total thermal megawattage of the new generation of power reactors. The shrinkage of the production reactor family and the growth of the electrical power reactor family show exactly the rate and timing of the actual supplanting of the weapons-related use of reactors by the peaceful use of reactors. Five large commercial power reactors came on line in 1970, while C and KW at Hanford closed in 1969–70, tipping the balance.\(^4\) In the United States by the end of 1970, the total power of reactors devoted to electrical generation exceeded that of the production reactors (Fig. 2). As a concrete measure of the peaceful atom compared to the weapons atom, megawattage told the story of the 1960s transition.

**Local Pressures at Hanford**

For the men and women employed at the production reactors, the end of an era was not seen in statistical terms nor in terms of a gradual changeover
from weaponry to peacetime hardware. Rather, it was a matter of income, employment and for those at Hanford, the very existence of a community. Closing the eight Hanford production reactors had the effect of moving the strictly technical issues of production reactors not only into the political realm of Congress and its committees but into the grassroots realm of community action and community politics. The AEC’s actions in spreading the shutdowns out over nearly a decade had the effect of slowly building a local pro-nuclear constituency that became organized and more vocal. Although in favor of nuclear research and development, that constituency, like Glenn Lee, remained suspicious of decisions reached by the AEC or its successors in Washington. The closures created groups that tried to bring a popular form of participatory governance to the formerly closed decision-making process of the AEC. The groups and alliances continued to attempt to shape reactor technical choices over the following decades. The origins of the
grassroots alliances lay in the AEC’s own policies. Paradoxically, the organizations could be simultaneously supportive of nuclear research and nuclear industry, and critical of or even hostile to the Atomic Energy Commission.

On 8 November 1962, the Atomic Energy Commission announced a policy of cooperation in industrial development efforts with the community of Richland at Hanford to ease the transition to peaceful uses of the site. Attempting to show sensitivity to local feelings, the AEC stated that “such cooperation will not be a substitute for community leadership and initiative, nor intrude in the management of local affairs by the elected representatives of the people.” In particular, the plan stressed the use of government-owned land for industrial use, the funneling of non-AEC government work to the area, planning for industrial development, and funding for educational and tourism activities.49

The AEC’s cooperation policy took the form of the so-called Slaton Report, which offered assistance to both Richland and Oak Ridge, two government-built communities facing transitions. In the report the AEC promised cooperation but urged local initiative.50 Based on this encouragement, in January 1963, a group of local businessmen in the Hanford area formed the Tri-City Nuclear Industrial Council. The tri-city area, with a combined population of about 55,000, included the nearby communities of Pasco and Kennewick, as well as the government-built community of Richland, which directly bordered the Hanford Reservation on the downriver, southern side. Richland had just been incorporated as a community in 1958.51

The local press became involved, working with local bankers and businessmen to try to stimulate interest among industrialists in leasing facilities at the Hanford site and making use of the local technically trained labor pool. The efforts, while smacking of local boosterism and often colored by a self-delusional mix of optimism and jawboning, did eventually result in additions to the mission at Hanford and the construction of both experimental and electrical generation reactors there.52

Newspaperman Glenn Lee became a prominent spokesman for the group. The activist editor of the Tri-City Herald addressed a group in Seattle in February 1964 to “give them the story behind the headlines.” Lee indicated that the planned closure of three reactors and plans for General Electric to pull out as chief operating contractor led many people to believe that Richland would be “boarded up” and turned into a “ghost town.” He bitterly claimed
The Hanford site.
that although the Hanford area benefited from the $2 billion invested there, the area had been “a slave and a captive of the plutonium production department” of the AEC. He decried the Commission’s “hammerlock on this plant, its secrets, its people.” Lee credited the local community with foreseeing the negative effects of dependency on the AEC and indicated that local support for the Washington Public Power Supply System (WPPSS) generating system at N reactor had stimulated that development. He saw N-reactor commercial power as the first nonfederal “proposition” behind “the plutonium curtain.” He continued to be critical of the Commission and its closed-door methods while remaining a nuclear enthusiast, a position not unlike that of many of his local newspaper readers.53

Working through the Tri-City Nuclear Industrial Council, Lee as secretary kept in touch with the JCAE, advocating a variety of specific projects for Hanford. In 1964 he pushed for a fast-fuel test reactor, for a fuel reprocessing center, and for unspecified work for NASA.54

Diversification Efforts
With promoters like Glenn Lee keeping the fate of Hanford in the public eye, the AEC worked to implement diversification to solve the area’s employment problems. As the term came to be employed at Hanford, “diversification” had two meanings. Both the employers and the products would be diversified. First, a number of separate contractors would replace General Electric, which phased out its participation at Hanford in the mid-1960s. Separate aspects of the Hanford operation were assigned to different contractors, with the main N reactor operation transferred first to Douglas United Nuclear and later to Westinghouse. Glenn Seaborg told Senator Pastore of the JCAE that multiple contractors were “in the best interests” of both GE and the government, would help in “stimulating commercial diversification,” and would “contribute to the future development of the communities in the Hanford area.”55

The rationale was that Richland would no longer be dependent on a single firm for employment. Furthermore, the various firms would attempt to attract private business of one kind or another to their separate functions, in physics, engineering, chemistry, and computer work. Both the AEC and Lee’s group visualized a pattern in which Richland would be converted from a GOCO company town to an industrial community with a diverse corporate base.

The Atomic Energy Commission intended this diversification of contrac-
tor organizations to lead to the second meaning of the term—diversification away from AEC contract work to a more varied range of products and clients for its industries. Early in the planning, the Tri-City Nuclear Industrial Council supported this second form of diversification by contacting NASA and the Department of Defense in hopes of lining up plant or laboratory development at Hanford. An AEC–General Electric study group chartered to look into alternate sources of employment tried to formulate a Hanford diversification program. The study group issued several reports. One studied fuel fabrication capabilities, a second evaluated Hanford as a site for experimental reactors, and a third report in the form of a brochure described Hanford’s capabilities. The reports combined technical information with evaluations of facility capabilities and personnel qualifications and could provide information for prospective industrial investors. The switch away from production reactors could represent a new era in nuclear matters, and Hanford technical experts made explicit the effort to adapt to the changed times. A fourth report, “The Potential for Diversification of the Hanford Area and the Tri-Cities,” issued in January 1964, concluded that the Hanford area was too dependent on AEC-funded plutonium production. The report suggested that at least 2,000 jobs would be lost over the period 1964–1968 with the reactor closings and that it was unlikely that government employment would replace the jobs. An “aggressive community effort” was required to make up the loss.  

This report also explored means of making use of one or more of the closed production reactors to produce either uranium-233 or polonium-210, or, after conversion, to generate power. Other suggestions included using one of the older reactors as a test reactor or as a training unit for reactor operators. The study group found all such proposals unworkable, for the simple reason that the closed reactors were of unique design. Their light-water cooling and graphite moderation were not suited to power production. For the same reason, they did not represent either a good basis for alternate isotope production or for training. Training on a once-through water-cooled graphite-moderated reactor had little bearing on the operational needs of the new pressurized water and boiling water reactors that were emerging as the standards for American commercial power production through the 1960s. Everything differed, from the basic physics through the safety systems and the instrumentation in the control room. However, since each of the closed reactors represented as many as 400 jobs, the study group strongly urged further consideration of alternate reactor mission possibilities.
The Commission worked to attract vigorous institutions to Hanford to engage in new projects. Battelle Memorial Institute agreed to operate the Hanford Laboratories, which employed 1,842 people, beginning in January 1965. Battelle announced its intention to invest $5 million to attempt to attract more private work to the laboratory. Commission chairman Glenn Seaborg publicized the successful wooing of Battelle at the 1964 Seattle World’s Fair when he spoke at the Hanford Exhibit. The AEC encouraged other initiatives by research and development groups, offering generous lease terms to land on the Hanford reservation, including 85 acres to the University of Washington and 1,000 acres to the state of Washington for nuclear industrial development. Another 400 acres were sold outright to the city of Richland.

In a glowing letter of praise, President Lyndon Johnson suggested that the diversification plans had his blessing. He wrote to Glenn Seaborg early in 1965, lauding the Commission for advanced planning done without much fanfare. He credited Seaborg with foresight: “The cutbacks in special nuclear materials production were planned sufficiently in advance so that the Commission, in cooperation with the local officials and business and labor people, could take appropriate actions, such as diversification programs, to minimize any significant economic impacts.” It was true that the AEC had planned in advance, but Johnson was a little premature in his praise, as the process was just beginning.

Some experts were less sanguine. The Advisory Committee for Reactor Safeguards, still representing a somewhat independent voice, met with the Production Division at the beginning of the diversification program and issued a four-point critique of the effort. At the heart of their concerns was the issue of how to fit obsolete equipment into the emerging safety requirements of the 1960s. The new efforts created a backlog of work for the ACRS that could endanger safety if it created pressures for premature approval of new devices or programs. The Savannah high flux reactor proposal, the curium-244 loading, and the U-233 programs all came at once.

The ACRS asked what safety standards should apply when production reactors were converted from making plutonium and tritium to production of alternate isotopes. Since plutonium and tritium were strategic materials for weapons, national security reasons might have justified a degree of risk in the design and operation of the reactors. However, production of peaceful-use isotopes like curium, which had no such defense-related justification, required a higher and more restrictive set of standards, such as those in the Code of Federal Regulations for private power and private isotope-production.
ing reactors. If a reactor were converted to peacetime use, it would have to meet peacetime standards, and the production reactors simply did not do so. The ACRS noted that the Atomic Energy Commission provided “no real answer” to this objection. In addition, the diversification at Hanford, which resulted in a variety of contractors, would lead to a dispersal of authority and, hence, a diminution of safety responsibility unless a coordinated safety plan was developed and implemented. The AEC promised such a plan.\textsuperscript{61}

Even if these new programs met safety concerns, the ACRS had further misgivings about diversification. The committee wondered if there was a viable market for the new isotopes, whose production had been used to justify the entire diversification process in the first place. The ACRS also thought that Hanford and Savannah River might compete for the limited number of viable alternative programs. This scramble for work, in the opinion of the ACRS, could have an “adverse effect on safety.”\textsuperscript{62}

One bright note for the Hanford communities through the period of closures was the operation of N reactor and its steam plant. Although a labor dispute closed the facility in September 1967 for several months, operation of the reactor in 1966 with its electrical generation system had proven quite successful. WPPSS, the consortium of public utility districts that operated the generating plant, announced that low construction costs and operating revenues allowed immediate retirement of about $25 million of the $122 million in bonds that had been raised to finance the project. Further, while the reactor-generating system operated through 1966, it produced 35\% of the nuclear-generated electric power on line in the whole nation at the time.\textsuperscript{63}

By the end of the production reactor closure period, Hanford’s vigorous diversification effort began to show signs of paying off. In 1970, the Richland City Council urged the creation of a nuclear industrial park on the Hanford site, at which a series of commercial reactors would be constructed.\textsuperscript{64} Although the federal reservation was never designated as such a Park, Hanford did become the site of several commercial and test reactors over the 1970s, which met some of the objectives of the local groups.

The Fast-Fuel Test Reactor (FFTR), which took nearly a decade to bring to fruition, was one such effort. The name was later changed to the Fast Flux Test Reactor and then to the Fast Flux Test Facility (FFTF). The FFTR under any of its names was a 400-MW sodium-cooled fast reactor that could run on and test either a plutonium oxide or uranium oxide fuel, or various mixes of the two, in stainless steel ceramic-metallic units called “cermets.” As the AEC contemplated a breeder reactor program that would use reactors to
produce, not weapons material, but reactor-grade plutonium fuels for further power generation, the test reactor would be a key research instrument, testing the fuels themselves in high-neutron-flux conditions. Later, with the termination of the breeder program under President Jimmy Carter, the mission of the reactor had to be altered to ensure its survival. The FFTR was completed in 1975 and went into operation as a research and testing facility for the AEC and its successor agencies.\textsuperscript{65}

Other long-range successful diversification efforts in the early 1970s included the construction of reactors for electrical generation. WPPSS built Washington Nuclear Power (WNP) number 2 at 1100 MW(e) and WNP-4 at 1220 MW(e). In addition, the consortium planned but only partially completed WNP-1, also at the 1220-MW(e) scale.\textsuperscript{66} A series of commercial light-water reactors, these large WNP reactors provided both employment for Richland residents and a partial raison d’être for Hanford, much as proposed by the Richland City Council in 1970.

**Monopoly and Overproduction**

The manner in which the Atomic Energy Commission dealt with the aging reactors and the plutonium oversupply of the 1960s led to several consequences that affected production reactor policymaking over the following decades. Despite the AEC’s efforts to soften the economic impact, closing the reactors in groups and seeking local industrial initiatives tended to foster a sometimes adversarial relationship between newly formed grassroots alliances and the headquarters management of the weapons complex. Groups at the two isolated sites regarded the question of reactor policy as intimately wrapped up in community survival and worker job security. The development of political advocates for the affected workers both in Congress and at the local level reflected the growing rejection of the closed-door style of decision-making that the Commission had inherited from the Manhattan Engineer District. In later decades, the agencies that took over the weapons complex from the AEC had to deal with the political groups and alliances stimulated by the AEC’s decision to close down 10 of the 14 production reactors.

Inside the AEC, the issues of oversupply and closure forced confrontation with the special nature of management of production reactors. Not only was production of plutonium and tritium controlled by the government as a monopoly, but consumption was all taken by the government, a single-consumer situation that economists call a “monopsony.” This unique ar-
rangement within the American economy simply did not fit with the rest of the political-economic structure. The problems of closure reflected the specific difficulties and dilemmas that came from that peculiar situation.

Once a surplus of plutonium was achieved, there was little choice but to take the reactors out of production. President Johnson, in announcing the closures, said that the production reactors could not be a “WPA nuclear project, just to provide employment when our needs have been met.” Yet the AEC and local politicians worked diligently to find ways to provide that employment; some of their efforts to maintain employment through new government projects did indeed smack of the New Deal rationale that Johnson formally eschewed.

The dilemma of production reactor availability became clearer by the mid-1960s. Plutonium’s half-life is 24,000 years, which meant that, for all practical purposes, once any plutonium was manufactured, it was forever available until fissioned. Shutting down the production capacity was difficult to do on a temporary basis. While some machines could be mothballed and possibly restarted, personnel had to be laid off, and the unique body of skills would erode or disperse. Yet alternative uses for the reactors, such as conversion to electrical power generation or isotope production, proved impractical and uneconomic. To keep the reactors producing plutonium in the face of decreased international tensions, surplus weapons material, and increased hazards was not an appropriate policy decision.

On the other hand, some production reactor capacity had to be maintained for the production of tritium. Although stockpiled amounts of both tritium and plutonium remained classified, it was clear that no matter how much tritium had been accumulated, its half-life of 12 years would reduce the stockpile by half in a little over 10 years if all production ceased. In an era in which the number of tritium-boosted weapons was scheduled to increase, a constant assured production of tritium was required. The reactors scheduled to be kept alive were all capable of tritium production.

In private-sector enterprises, such questions of risk of overexpansion and reaction to the vagaries of market demand were decided at the level of the enterprises. A business could take its losses, alter or shut down an operation, change its product, or possibly, if it could not adjust, go bankrupt as a consequence of a loss of market. In the private sector, the production companies took the risk.

But the production of plutonium and tritium in GOCO facilities represented an anomaly in the American industrial world: government-only mo-
nopoly production and government-only monopsony consumption. None of the operating contractors of Hanford or Savannah River risked major capital investments in the enterprises; the contracts provided for cost reimbursement. Demand was not driven by a free or even by a regulated economic market but by the single customer’s weapons policy. Policy decisions affecting demand put the government’s own capital investment and the jobs of the employees at risk.

Such problems were typical of a “command economy” like that developed by the United States in wartime but were not regarded as typical of the traditional American peacetime economy. It was precisely this aspect of the arrangement that Glenn Lee perceived as a bureaucratic “hammerlock” on the local community of Richland. His complaints sprang from the directly felt local consequences of a national transformation that was felt less painfully elsewhere. As a result of the Cold War and the imperatives of the nuclear standoff, this aspect of the American economy resembled the economy of the Soviet Union, in which decisions were made on a planned basis by a remote government, without reference to market forces, behind closed doors, for reasons that would not be made public. The dedication of a whole community to producing one or two products whose need was secretly set in Washington put the very life of that community at the mercy of the distant bureaucrats, and the sensation was culturally wrenching for Americans.68

In the United States, the federal government, after all, was somewhat responsive to political pressures. An AEC decision to lay off 4,000–6,000 workers in a specific locale had immediate political consequences. At Hanford, the response focused through the grassroots community leaders; in both Washington State and South Carolina, governors, state legislators, and members of Congress came to the aid of their distressed constituents. Because the AEC understood the political ramifications, it made the explicit and conscious, but closely held, decision to space out the closures over a period of years, and it made more public the energetic search for alternate projects and products in cooperation with local spokespeople.

But despite the concerns of workers, community leaders, politicians, and contractors, the basic technical problem was not susceptible to an easy political solution. The huge government-owned facilities were practical only for producing certain products; they were appropriate for the purposes for which they had been built, and it was difficult or impossible to convert them to other uses. When the need for one of the products declined, the govern-
ment faced what ultimately had to be construed as an “on or off” decision when it came to particular reactors. Delaying or stretching out the closings might ameliorate the impact, but ultimately such measures only stretched out the pain and gave the advocates of continued operation more time to organize, to protest, and to build relations with political allies. Placing one or more reactors in temporary shutdown or some form of standby status had only a rhetorical attraction. To keep the reactors truly available required programs of manning, maintenance, training, upgrade, and safety work almost as expensive as continued operation. On the other hand, a true shutdown meant that the capacity would vanish.

From the point of view of the workers and their advocates, alternate nuclear uses for the Hanford site seemed quite appropriate. If other types of nuclear facilities could be built on the site, if a number of corporations could enter the field and hire for a variety of jobs, the Tri-Cities could remain viable.

Eventually, it was inevitable that the United States had all the plutonium it would ever need; conversely, tritium’s short half-life meant that production reactor capacity had to be assured with at least one reactor. The remaining four reactors continued to age, inevitably approaching some future date at which their continued operation would no longer be safe. The attempts to come to grips with these production reactor issues in the open forum of national technopolitics in the late 1970s and the 1980s is the subject of the following chapter.