CHAPTER 6

NUCLEAR WEAPONS: A NEW REALITY

Two hours before dawn on a chilly March morning in 1953, *Newsweek* correspondent Leonard Slater huddled with nineteen other newsmen in a dirt trench on Yucca Flat within the Commission's Nevada Proving Grounds. Slater and the others had been selected to accompany an infantry unit into advance positions just 3,500 yards from a steel tower holding a test version of a full-scale atomic bomb. Like hundreds of observers before and after him, Slater endured hours of boredom as he awaited the detonation, but there was something special about this test: Slater and the troops were closer to ground zero than anyone had been since the Hiroshima and Nagasaki attacks.

Shivering more from the anticipation than from the cold, Slater heard the final countdown over the public address system, blinked in momentary shock as the nuclear fireball lit the trench brighter than the noonday sun, braced himself for the shock wave, and listened for what seemed like minutes for the dull roar generated by the detonation. Scrambling from the trench at the "all-clear" announcement, Slater and his companions watched in awe the purplish fireball swirling upward from the desert floor. Within minutes the familiar mushroom cloud, nearly five miles high, was forming where the shot tower had been.

At Alamogordo in 1945 the first atomic test had drawn from observers comparisons with scenes in the apocalypse. Little more than seven years later at Yucca Flat, Slater detected a tone of condescension among the troops. One officer thought the trip had not been worth the effort. Others compared the blast unfavorably with the flash and concussion produced by a standard artillery piece. In a matter of minutes soldiers with radiation monitoring equipment were calmly moving out in jeeps in the direction of ground zero.[1]

This striking change in reactions to the bomb was more than just a matter of time. Oppenheimer and his associates at Alamogordo had seen *Trinity* in terms of their own intimate experiences in building the bomb and their knowledge of its size and physical characteristics. It had been truly terrifying to witness what their groping with theory and experimental evidence had produced. For those who came to Yucca Flat, however, the bomb was not a finite experiment in physics. It had become in the popular mind a specter of enormous power, of superhuman dimensions, seemingly greater even than the ordinary forces of nature. For the troops the detonation of a very small atomic bomb, witnessed at a distance of about two miles, did not measure up to the image that popular literature had evoked in their minds. As with all physical phenomena, the meaning lay in the eyes of the beholder.

But the 1953 tests gave thousands of Americans an opportunity to witness the power of the atomic bomb directly, while millions of others around the world through the eyes of television, newsmen, and photographers could experience the bomb in terms they could understand. This time the bomb was not being tested solely on warships as at Bikini or on military equipment, but on such familiar objects as automobiles, white frame houses, fences, telephone poles, power lines, packaged foods, and aspirin. These artifacts from the everyday world provided a human scale against which both ordinary citizens and public officials could measure the significance of the bomb. Furthermore, the tests were being conducted in the continental United States, where their weekly progress would be reported in the press, on radio, and on television. The bomb would no longer be a vague, mysterious instrument of infinite disaster but rather a dangerous and immediate reality in American life.

UPSHOT-KNOTHOLE

The test series that began on March 17, 1953, was the product of more than a year of planning by the Commission, the Department of Defense, and the Federal Civil Defense Administration (FCDA). Even before the *Tumbler-Snapper* series was concluded in spring 1952, Los Alamos began to formulate requirements for another continental test series designated as Operation *Upshot*. Although no one knew exactly what experimental devices would be tested, the Los Alamos scientists were certain that the first detonation of the thermonuclear device and the huge fission weapon called *King* would raise many questions that could be answered only by further experiments. The Nevada Proving Grounds was too close to urban areas (sixty-five miles from Las Vegas) for testing multimegaton devices like *Mike* or even fission devices, like *King*, which exceeded 100 kilotons; but it was far more economical and convenient than Enewetak for tests of smaller yields, which would provide essential information for designing the components of both thermonuclear and fission weapons. Twenty shots in two previous Nevada tests in 1951 and 1952 had demonstrated the value of a continental test site.[2]

The other half of the test series was Operation *Knothole*, which would include a variety of experiments for both the Department of Defense and the Federal Civil Defense Administration to determine the implications of nuclear detonations for both people and equipment. The enormous expense and complexity of nuclear tests made it imperative to integrate the objectives of both *Upshot* and *Knothole.* There were special advantages of a dual test series in Nevada, given the space to deploy thousands of troops and military equipment and the relative ease to set up civil defense experiments. But a dual test series also had disadvantages, particularly for the Commission's weapon laboratories. The efficient conduct of *Knothole* required firm schedules set long in advance; but Operation *Upshot* was essentially a series of field experiments in a rapidly developing technology and, therefore, constantly subject to change. As early as the *Greenhouse* tests in 1951, the Los Alamos scientists had discovered the inhibiting effect of dual operations when they were unable to take advantage of continuing research because a design change to increase yield would have upset plans for both tests of military effects and biomedical experiments. Dissatisfied as the scientists were with the prospects of a dual test series, there was no way to avoid it.[3]

By early 1953 the test program was set (see the following list of Operation *Upshot-Knothole* test shots). Los Alamos would have five shots primarily related to diagnostic experiments, although all would involve civil defense or military effects or both. The new weapon laboratory at Livermore had scheduled two specialized experiments to check novel design principles for weapons; neither test was encumbered with military or civil defense projects. Finally, Los Alamos had scheduled three shots primarily related to effects. Five of the six diagnostic shots would be fired on three-hundred-foot towers for precision in data collections. The sixth diagnostic shot was planned to verify yield only and could be air-dropped to fire at a relatively high altitude in order to reduce the uptake of ground dust in the radioactive cloud. Two of the tests of military effects were also to be air-dropped to simulate combat conditions for the troops; the third military shot was an atomic artillery shell to be fired from a 280-millimeter cannon.[4]

Shot	*Date 1953*	*Type*	*Yield (Kilotons)*
1. Annie	March 17	Tower	16.0
2. Nancy	March 24	Tower	24.0
3. Ruth	March 31	Tower	0.2

Shot	Date 1953	Type	Yield (Kilotons)
4. Dixie	April 6	Airdrop	11.0
5. Ray	April 11	Tower	0.2
6. Badger	April 18	Tower	23.0
7. Simon	April 25	Tower	43.0
8. Encore	May 8	Airdrop	27.0
9. Harry	May 19	Tower	32.0
10. Grable	May 25	Gun	15.0
11. Climax	June 4	Airdrop	61.0

THE CIVILIAN DIMENSION

Along with the twenty newsmen and the troops in forward positions for the March 17 shot was Val Peterson, the newly appointed Federal Civil Defense Administrator. Peterson's presence was just one more way of demonstrating the importance of civil defense activities in the *Upshot-Knothole* tests. For more than a year the civil defense agency had been planning for this day. Originally hoping to have a shot of its own, the agency, like the Commission and the military services, had finally accepted the necessity for a combined operation.

The day before the first shot, Harold L. Goodwin, the director of FCDA's operations staff, briefed the press on the experiments set up on Yucca Flat. None had proved more fascinating during the press tour of the site than the two frame houses built 3,500 and 7,500 feet from ground zero. These two-story, center-hall dwellings with basements were typical of thousands of American homes. They were complete except for interior finish, plaster, and utilities. Government-surplus furniture, household items, and fully-dressed manikins were installed in the houses to measure damage. House No. 1, closest to ground zero, was expected to be completely destroyed by blast and had been equipped with reflective paint and venetian blinds to keep it from burning. The house at 7,500 feet would be damaged but probably not destroyed. Two types of blast shelters, located in the basements of the houses, were designed to protect occupants from the heavy debris load of the collapsing structure. Eight other shelters designed by FCDA for backyard use had been built nearby.

Also of great press interest were the fifty automobiles of various types, colors, and operating conditions placed at different distances and orientations from ground zero; some contained manikins. Goodwin told the reporters that these tests were especially important because they would indicate whether the family car would provide any effective protection against the radiation, heat, and blast of a nuclear bomb.[5]

The third major FCDA project was the testing of four types of calibrated instruments that would record the angle of incidence of thermal energy from the bomb and thus help to determine its exact air-zero position. Such information would be essential to civil defense officials in directing rescue teams and estimating damage and casualties. FCDA had also planned several classified projects for later shots in the series to test blast effects on standard wall panels and partitions, to determine the effects of radiation on lungs, and to measure the reliability of radiation survey instruments.

Important as the technical results of the civil defense experiments would be, they would have even greater value in giving the general public some impression of what an atomic attack could mean in everyday life. For this purpose the Commission and FCDA had jointly organized an elaborate public information plan for the March 17 test and several others later in

the series. More than 250 newsmen, 360 state governors and mayors, and scores of county and civil defense officials had been invited to visit the site before the *Annie* shot, observe the test, and if possible inspect the results. Reporters and photographers would have an excellent vantage point from a rise dubbed "News Nob" on the edge of Yucca Flat, and there was to be live radio and television coverage.

The shot on March 17 was successful in both its technical and informational aspects. The countdown went smoothly, and the yield was close to the planned fifteen kilotons. House No. 1 was destroyed by blast as planned, and the high-speed camera shots of its destruction provided a series of dramatic photographs that were widely published in newspapers and magazines. House No. 2 suffered some damage but remained intact as predicted. The battered manikins provided graphic evidence of the weapon's vicious power. The basements afforded good protection against radiation, and the simple basement shelters were effective against debris. The family automobile would be relatively safe outside a ten-block radius for a small weapon of this type, provided that some windows were left open to prevent the roof from caving in on the passengers. Most heavily damaged cars that did not burn and were not radioactive could be driven away soon after the shot.[6]

News coverage of the shot was excellent, as expected. Most daily newspapers and weekly news magazines covered the story with special reports and photographs. A television audience estimated at eight million viewers had a somewhat less than satisfactory impression of *Annie*, particularly in establishing some sense of scale, but reporter Chet Huntley's somber descriptions of the drama from the forward trenches were judged impressive. Most newspapers gave their readers adequate factual accounts of the test and pointed up the implications for civil defense. Some even reminded readers that the absence of total destruction resulted from the relatively small size of the device and the long distances from ground zero to the experiments and the observers.

Probably more significant than the first news stories were the follow-up articles by state and regional civil defense officials in their local newspapers. These articles were important in translating the effects of *Annie* into terms that had meaning in neighborhood surroundings and stressed the substantial value of even the simplest precautions in the event of a nuclear attack. These local appeals were supported naturally by Peterson's hard-hitting plea for national action on civil defense with Eisenhower's strong endorsement.[7] With careful planning Peterson and his associates had been able to capture the nation's attention with the March 17 event, and they were able to sustain much of this interest as the tests proceeded during spring 1953.

THE MILITARY SPHERE

Vital as the civil effects tests appeared to be for national security, the military implications for *Upshot* were even more critical. Largely hidden from public view was the vast complex of government organizations, military units, scientific laboratories, and private contractors that made the tests possible. Unlike the Pacific tests, directed by a joint military task force for the Commission, the continental tests at Nevada were entirely in the Commission's hands. The line of authority led through the headquarters division of military application, headed by Brigadier General Kenneth E. Fields, to Carroll L. Tyler, manager of the Commission's Santa Fe operations office, who served as test manager. Because all previous continental tests and all but two in *Upshot* depended on research at Los Alamos, officials of that laboratory under the direction of Alvin C. Graves were in charge of scientific aspects of the tests. Herbert F. York, a young physicist who would later be officially designated director of the new Livermore laboratory, worked with Graves in staging the two Livermore tests. Military operations were coordinated through the Albuquerque field command of the Armed Forces Special Weapons Project, established in the Pentagon soon after World War II to handle atomic energy matters for all three military services.[8]

Shots scheduled for *Upshot* and other series at the Nevada site in the 1950s typically involved various purposes, and as many as possible were incorporated in a single shot. Some shots included fundamental research in nuclear physics that would test the feasibility of new theoretical approaches to weapon design. Others provided technical data for full-scale production engineering of a new weapon. Often shots were planned to explore phenomena that could affect the efficiency and performance of weapons but that were not susceptible to theoretical analysis. Sometimes shots were designed to provide a basis for choice between two or more theoretical methods of weapon improvement or to gain time by eliminating the need for months of calculations and laboratory experiments. In the *Upshot* series several shots were designed to test components that would be used in new weapon designs. Only occasionally was it necessary to proof-test complete or stockpiled weapons, and such tests were combined whenever possible with studies of weapons effects, for both civilian and military purposes. In most instances the shots consisted of highly instrumented experimental devices rather than complete weapons.[9]

In terms of direct participation, the most important parts of *Upshot-Knothole* for the armed services were the weapon effects tests. Under the technical direction of the Armed Forces Special Weapons Project, these tests were designed to reveal tactical problems involved in the use of nuclear weapons, to determine the effects of radiation and blast on military equipment, and to give combat troops experience in maneuvers with nuclear weapons. Exercise *Desert Rock V* involved more than fifteen thousand ground troops of the Army, Navy, Marines, and Air Force. The placement of combat units in advanced positions, as was done for the *Annie* shot, continued during the series. In subsequent shots, officer volunteers occupied positions as close as two thousand yards from ground zero. Larger numbers of combat troops were stationed about twice that distance from the blast.

The military services also provided vital support functions for the tests as they had in all such exercises since the *Sandstone* tests in the Pacific in 1948. The Air Force furnished weather services, about twenty-five aircraft, and one thousand civilians and military personnel in direct support of the series. At least fifty combat and other operational aircraft were involved in dropping test devices, cloud sampling and testing, radiological terrain surveys, photography, training, and data collection.

HAZARDS OF CONTINENTAL TESTING

The Nevada Proving Ground did offer substantial advantages over Enewetak or Bikini for testing nuclear devices and defense against nuclear attack, but the rapidly expanding use of the continental test site also posed an ever increasing threat to the American public. The potential hazards in continental testing had been weighed against defense requirements before the Alamogordo test in 1945 and had been considered again by the Commission before the first Nevada tests were authorized in 1951.

In planning and executing the twenty continental tests before *Upshot-Knothole*, the Los Alamos scientists had acquired considerable skill and experience in predicting the potential hazards and minimizing them. That these capabilities had reached a level of some sophistication was clearly evident in the special fifty-page section on "Public Safety in Continental Weapons Testing," which the Commission published as part of its thirteenth semiannual report to the Congress in January 1953. To be sure, there was a certain amount of special pleading in the title of the report and its contents. The purpose of the report, after all, was to reassure the American people, not to present an even-handed analysis candidly describing the uncertainties involved. But in light of the extreme secrecy that still prevailed in Commission activities at that time, the report was surprisingly detailed and informative. It reviewed the reasons for establishing the Nevada Proving Grounds in the first place; it described in a straightforward manner the flash, airblast, and radiation effects of nuclear detonations; and it clearly acknowledged radiation as the most serious hazard. The report honestly discussed the origin and rationale for maximum permissible doses of radiation, both on the surface of the human body and internally, and the implications of fallout in terms of both somatic and genetic effects. The report concluded,

> There is negligible hazard to property from blast; that proper warnings and patrolling have prevented any injury to humans from heat, light, or blast; and that the highest levels of radioactivity released by fall-out of particles are well below the very conservative standards fixing the amounts of radiation that can be received externally or internally by the human body without harming the present or later generations.[10]

But the public report did not reveal the growing uneasiness within the test organization over the difficulty of holding radiation effects below the standards set forth in the report. About the time that the public report was released, Tyler convened a special committee at Los Alamos to appraise the operational future of the test site. The committee included not only Los Alamos scientists and military officers from Washington but also the Commission's directors of public information and biology and medicine. After concluding that the Nevada Proving Ground was "vital" to weapon development, the committee found that considerations of public safety were the major restriction on the type and size of devices tested at the site and that this restriction was related mostly to yield, placement of the device or mode of delivery, and resulting fallout near the site. There would have to be "a very strong, overriding reason" to justify a surface or subsurface shot exceeding one kiloton. A tower shot over thirty-five kilotons should be fired "only under very stable, predictable [weather] conditions." Airbursts should not exceed fifty kilotons until the laboratory could further assess the probability that a fuse failure might turn an aerial device into a surface shot. The committee admitted that luck as well as good planning had prevented fallout radiation from exceeding the established standards in past tests. To reduce this possibility in the future the committee recommended new firing sites, less frequent use of each site, aluminum towers, higher towers, and soil stabilization at the base of the towers.[11]

Because plans for *Upshot-Knothole* were virtually complete when the Tyler committee met, the report probably reflected an effort to evaluate the hazards posed by the series rather than an attempt to establish a ceiling for shots scheduled in the series. In any case, the report, an internal document, was not sent to the Commission in Washington until May 1953, when two-thirds of the series had been completed. Certainly Graves and the test group did not think it necessary to comply literally with the guidelines stated in the report. Of the seven tower shots scheduled for *Upshot-Knothole*, four were expected to reach or exceed the thirty-five kiloton ceiling recommended by the committee. Because all the shots were in several respects experimental, it was not possible to predict yield exactly, and the actual yields in some cases exceeded and in others fell short of the estimates.[12] The test group clearly expected substantial fallout beyond the test site, but drawing on experience in earlier series there was confidence that the monitoring teams could quickly detect fallout patterns after each shot in the *Upshot-Knothole* series. In theory, the plan was to warn people in communities to take shelter if significant fallout appeared to be heading in their direction; in fact, however, it was not always possible to contact isolated prospectors and ranchers.

Although offsite fallout was in some way related to yield, the relationship was not linear. It was possible to exceed the thirty-five kiloton limit without significant offsite fallout. The test group had greatly improved its ability to determine from weather data the probable direction and speed of the radioactive cloud and thus to select firing times that would result in a minimum of offsite fallout. Despite these precautions, however, some offsite fallout occurred from seven of the ten shots originally scheduled for the series.[13]

There was no easy way to determine the health hazard of this fallout, but with the intention of providing a conservative margin of safety the test group had established a maximum permissible weekly exposure of 0.3 roentgen (R), a physical unit of measure defined in terms of the ionizing effect of X-rays. This limit was derived from standards recommended by the National Committee on Radiation Protection and the International Commission on Radiological Protection in 1950 on the basis of data accumulated over several decades of industrial and clinical experience. The best authorities at that time believed that the human body was capable of repairing most if not all somatic damage produced by 0.3 roentgen over a one-week period. In fact, Commission scientists believed that a rapidly delivered dose of about 25 roentgens of whole-body radiation was required to produce permanent damage in humans. Because *Upshot-Knothole* was planned to occur over a period of three months, or thirteen weeks, the test group simply extrapolated the 0.3-roentgen figure to cover that period. Thus, the guideline for the series became 3.9 roentgens.[14]

Also to be considered was the genetic damage that might be caused by this amount of radiation. As the Commission's semiannual report informed the public in January 1953, scientists agreed that genetic mutations were directly proportional to dose, with no recovery or repair processes at work. Daily or weekly repetitions of such doses could produce a noticeable increase in the number of mutations among offspring. The determination of the effects of radiation on mutation rates was a difficult process that required experiments with large numbers of laboratory animals over many years. Preliminary data then available on mice suggested that exposing the germ cells to 80 roentgens would double the natural rate of human mutations. Obviously the less radiation received by the genes, the better.

The test group never considered the 3.9-roentgen figure as an outside limit that could be approached without concern. The large uncertainties about the effects of radiation required that exposures be held to the lowest possible levels. The first precaution was to fire the shot only under weather conditions that would preclude the radioactive cloud from moving rapidly from the test site and in a direction that would carry it over populated areas. Second, the test group routinely used an elaborate system of fixed air-sampling stations and mobile teams to monitor fallout in the area within 200 miles of the test site. Beyond that distance mobile units and 121 stations manned by the U.S. Weather Bureau collected air samples for analysis at the Commission's Health and Safety Laboratory in New York City.[15]

FALLOUT IN UPSHOT-KNOTHOLE

The test group's monitoring teams were able to determine fallout patterns very quickly after each shot. The radioactive cloud from the first shot, *Annie*, did move due east from the test site and dropped fallout on St. George, Utah, but the Commission reported that the maximum radiation level was no more than 0.026 roentgens per hour, far below the guidelines set for offsite exposures. *Nancy*, the second shot, was somewhat larger than *Annie* and apparently dumped substantial amounts of fallout in sparsely populated areas northeast of the test site. Because monitoring teams had been stationed only in communities and took only a limited number of readings along roads, it was impossible to know the precise radiation levels in the hinterland. In its public releases the Commission merely reported that there had been no fallout in populated areas, although it was admitted that the small number of residents at Lincoln Mine, Nevada, had been requested to remain indoors for two hours while radiation from fallout exceeded 0.5 roentgens per hour. The third through the sixth shots produced no radioactivity measurable in inhabited areas.[16]

More radiation exposures, however, did occur during the high-yield shots that concluded the series. A wind shift at the time *Simon* was detonated on April 25 carried the radioactive cloud over two highways in Nevada. When fallout reached 0.46 roentgens per hour, Graves ordered roadblocks set up, and about forty vehicles with interior readings of 0.007 roentgens per hour were washed at government expense.[17]

By far the most serious was the fallout from the *Harry* shot on May 19. Postponed three days because of unfavorable weather, *Harry* was fired under what seemed to be perfect conditions. But a wind shift and a slight increase in wind velocity spread fallout in a pattern about fifty miles square over populated areas east of the proving ground. For the second time in a month roadblocks were set up on major highways to monitor motor vehicles.

At 9:10 a.m., about four hours after the shot had been fired, readings as high as 0.32 roentgens per hour were being recorded at the roadblocks. At that time Edward S. Weiss, the Public Health Service officer stationed in St. George, called the sheriff's office and radio station to warn people in the area to take cover. Local schools kept children indoors during the morning recess, and the washing of contaminated cars in St. George was suspended. By 9:40 a.m. most of the population in St. George was under cover, and the community came to a standstill.

The all-clear came before noon when the first officials from the test site arrived to look over the situation. Because of the understandable tension among the residents, Weiss was ordered to remain in the area for several more days. During that period he considered collecting milk samples from local dairies to check for radioactivity, but because of the uneasiness in the community Weiss concluded that such a survey might create alarm. For that reason he limited his investigation to a few samples of milk purchased in local stores. From measurements at St. George the test group later estimated that the maximum amount of external exposure that could have been received at St. George was 6.0 roentgens and 5.0 roentgens at Cedar City. Scientists later estimated that children living near the test site received thyroid doses from iodine-131 ranging from inconsequential levels to those possibly causing some thyroid abnormalities.[18]

PUBLIC AND PRIVATE CONCERNS ABOUT FALLOUT

Although many people in these Utah communities were unnerved by the incident, they were reassured by statements from the test group that the radiation exposure had been below hazardous levels. Most people did not complain about having to remain indoors or waiting at roadblocks. There was neither public alarm nor open protest in the communities, but individuals did complain that fallout had caused physical injuries or disabilities. Only two very mild Congressional inquiries resulted from the *Simon* and *Harry* incidents, and both took the form of requesting reassurance rather than registering protest. In both instances, Commission officials and the test group were able quickly to convince the congressmen that adequate precautions had been taken to assure public safety. Very few newspapers outside the immediate area covered the incidents, and most of these stressed the Commission's reassurances. Incomparably more troublesome were the deluge of letters and flurry of newspaper and magazine articles speculating on whether the seemingly unusual number of severe tornadoes occurring across the nation that spring were caused by the Nevada tests. The Commission's public information staff was still answering tornado inquiries long after the fallout incidents had been forgotten.[19]

Public alarm had been avoided, but the Commissioners were privately concerned about the fallout from the larger shots in the series. On May 13, 1953, John C. Bugher, director of the Commission's division of biology and medicine, reported that the total potential integrated dose to inhabitants in thinly populated areas following the *Simon* shot had been as high as 10 roentgens. A new dimension to the fallout problem developed when a heavy rainout near Troy, New York, the following day delivered a potential integrated dose of 2 roentgens. The Commissioners expressed concern about the unexpected high yield of *Simon* (forty-three kilotons). Dean observed that there had been an understanding that high-yield shots would be fired outside the United States, but he admitted that the Commission had no firm criteria for deciding such issues.[20]

The Commissioners also received troubling reports that sheepmen who customarily wintered their herds north of the test site had encountered unusually heavy losses after trailing their sheep to an area west of Cedar City, Utah, for shearing during April. Losses ranged up to 30 percent for newborn lambs and 20 percent for ewes or mature sheep. Because the winter range had received substantial fallout from the *Nancy* shot on March 24, there was a possibility that radioactive fallout could have been a factor in the sheep deaths. Unfortunately most of the dead sheep had been disposed of before veterinarians and radiation specialists arrived on the scene, but many surviving sheep in the affected herds showed lesions on the face and back after shearing. State and local veterinarians were unable to diagnose the malady, and those from the Public Health Service and Los Alamos were not certain whether the lesions were caused by fallout. Arrangements were made to sacrifice some of the surviving sheep for detailed biological studies and further radiation experiments on sheep were started at the Commission's Los Alamos and Oak Ridge laboratories.[21]

The fallout question became more pertinent the following week when the Commission considered a proposal to add an eleventh shot to the series. Design work had just been completed at Los Alamos on some new principles that would be used in the *Castle* series in the Pacific early in 1954 to develop a deliverable thermonuclear weapon. Because Los Alamos had completed this work earlier than expected, it would be possible to test the new principle at *Upshot-Knothole* rather than in a special single-shot series in the Pacific in autumn 1953.

Testing the device in Nevada would have significant advantages over a Pacific test in terms of saving time and money, but the yield would be more than sixty kilotons, about 30 percent greater than *Simon*. When Dean expressed grave concern about local fallout or more distant rainout, Graves could give the Commission only partial assurances. First, *Simon* had made possible a more reliable estimate of yield. Second, the proposed test would be an airdrop rather than a tower shot, a factor that would greatly reduce fallout. Third, because it would be the last shot in the series, the test group could afford to wait for the best possible weather conditions.[22]

The Commission approved the eleventh shot on May 18, but the decision was clouded in uncertainty the following day when the first reports of fallout from *Harry* were received in Washington. Zuckert immediately requested a statement of the weather criteria that would be considered the minimum acceptable for the eleventh shot and raised the whole question of the test policy at the Nevada site. He considered the fallout from *Simon* and *Harry* as posing "a serious psychological problem" that would require the Commission to consider alternatives to continental testing. Zuckert also noted that the Commission's request to the President for authorization to use additional fissionable material for the eleventh shot had not alerted Eisenhower of the magnitude of the shot or the possible dangers involved. At Zuckert's suggestion, Dean discussed these considerations with Strauss at the White House. Strauss expressed greatest concern over the possibility that heavy fallout or rainout might jeopardize future testing in Nevada, primarily because he was impressed by the substantial advantages of conducting the test there. Strauss took the matter to Eisenhower, who with some misgivings approved the test.[23]

The eleventh shot, *Climax*, fortunately performed close to predictions. Although the yield was sixty-one kilotons, offsite fallout was far below that of *Simon* and *Harry*, and the test provided the information needed for the *Castle* series. These results, however, did not end the matter for Zuckert. The weather criteria that he had requested for *Climax* were vague at best and did not reach the Commission until the day after the shot. A week later Zuckert suggested the need for a full-scale review of "the highly interrelated public relations and safety problems that we have created" at the Nevada site. The committee appointed to study these problems should, in Zuckert's opinion, include experts in public information as well as in weapon and related technologies.[24]

THE QUESTION OF CONTINENTAL TESTING

To Zuckert and others the problems raised by the increasing size and number of Nevada tests were more a public relations concern than a safety problem. This was not to say that safety was considered unimportant—far from it. But safety could be managed by technology; public relations could not. Tyler, whom the Commission designated chairman of the study group, followed Zuckert's lead in giving public relations a prominent place in the investigation. He invited Morse Salisbury, the Commission's director of public information, to serve as a member of the committee, and Richard G. Elliott, the Commission's public information officer at Los Alamos, had a key role as secretary of the committee. Other members included Bradbury and Graves from Los Alamos, Bugher on radiation matters, and veteran specialists from other government agencies on weather and blast effects.

Without any written instructions from the Commission, Tyler assumed that his job was to produce a more detailed study than the one completed in January 1953 and that any conclusions should be supported by comprehensive reports or documentation. To get the committee started, Tyler proposed that it examine various questions under the general headings of the radiological problems of testing, both in the immediate test area and at greater distances: factors determining the amount of fallout; the blast and the shock problems; the need for the continental test site; public education; and the kind of conclusions the committee should expect to reach. Elliott saw the task as supplementing the earlier report with *Upshot-Knothole* experience, preparing a definitive study of the value of continental tests, and recommending guidelines for future continental testing, specifically in terms of public safety and education. Much groundwork was to be covered by eleven studies assigned to committee members and others for completion in August 1953.[25]

By late September, the Tyler committee had unanimously concluded that a continental test site was necessary and that the Nevada Proving Grounds was still the best site available. The committee was also confident that operational controls at the site could be strengthened "to provide continuing assurance of public safety" and believed that a better education and information program was necessary.

One issue to be resolved before Nevada testing could be resumed was whether the *Upshot-Knothole* series had caused the sheep kill. Commission personnel at the test site were fully aware that the future of continental testing might hang on the results of the investigations already started. The studies completed during autumn 1953 concluded that neither the level of external radiation, nor radiation burns on the sheep's skin, nor radiation of the sheep's thyroid from iodine-131 in the fallout could have caused the deaths. The supporting data presented by the Commission's laboratories were impressive and seemed conclusive. It seemed much more likely at the time that the excessive number of deaths resulted from the extremely dry weather that left the herds badly undernourished that spring. Although the results were favorable, Commission officials in the field threw the best possible light on the findings, not only to show the general public that the tests could be conducted safely but also to reassure the Commissioners, some of whom remained unconvinced.

When a group of sheep owners brought suit for damages against the government in 1955, the court found in favor of the government on the basis of the unanimous opinion of expert witnesses that there was no evidence that the fallout had caused the sheep deaths. Twenty-seven years later, however, in 1982 the same judge who had tried the original case vacated his decision on the strength of evidence that the Commission officials had perpetrated a fraud upon the court by suppressing the contrary opinions of some scientists.[26]

Although the point was not made explicitly, the committee's task had obviously changed from that originally conceived by Tyler. No longer was the committee expected simply to assess Nevada operations; the Commission now was demanding a solid justification for continental testing at the Nevada site. Personnel at the test site had been cut back to a skeleton force, and the Commission had refused to authorize any further construction until the Tyler committee had completed its report. To make certain that the committee's findings were fully documented, Tyler requested committee members and others to prepare additional reports and expand those already written. When completed in February 1954, the report consisted of a 62-page document backed up by twenty-five studies totaling more than 220 pages.[27]

Although the Tyler committee reaffirmed its September recommendation that tests be continued at the Nevada site, the report did propose certain restrictions on test operations. First, the committee set forth guidelines for justifying the need for shots, controlling or reducing fallout from potentially hazardous shots, prohibiting marginal shots under questionable weather conditions, and imposing yield limitations on surface, tower, and airborne shots. Second, the committee proposed a "planning maximum" of ten to fifteen shots in one year at the Nevada site. Third, the committee advocated lowering the standard for offsite exposure from 3.9 roentgens over thirteen weeks to the same amount integrated over an entire year.

The Commissioners were inclined to accept all the recommendations of the Tyler committee, but all except Murray wanted the views of the Commission's principal advisory committees before taking final action. Murray could see no reason to delay preparations for the next series at Nevada. Consideration by the advisory committees centered on the planning maximum. The advisory committee on biology and medicine favored a maximum of ten shots per year with no more than three high-yield tower shots. The general advisory committee, on the other hand, could find no sound reason for limiting the number of shots. A better approach, the committee thought, was to exercise the greatest precautions possible to protect test personnel and the public but to let operational needs determine the number of shots. Finally, on June 30, 1954, more than a year after Zuckert first raised the issue and on the last day of his term, the Commission approved the continuation of Nevada tests, subject to the restrictions proposed by the Tyler committee but without limiting the number of tests in any one year.[28] On this basis Tyler would make plans for the next continental test series in 1955.

RAW MATERIALS

Upshot-Knothole had helped to make nuclear weapons something of a reality for many Americans, particularly those living in the vicinity of the Nevada Proving Grounds, although the tests revealed almost nothing about the vast network of production and manufacturing plants that had been created to produce nuclear weapons. The far-flung complex of mines, ore-processing mills, feed material plants, gaseous-diffusion plants, production reactors, chemical separation plants, metal fabrication plants, and weapon component and assembly plants was still largely concealed behind the security barriers established by the Atomic Energy Act. Only cleared observers, and then only those with a real "need to know," were privy to concise information about the production chain.

Some of the most tightly held data related to the procurement of uranium ore. Production rates were top secret until mid-1953 and were available only to a few persons beside the Commissioners because the amount of uranium ore processed could be related in a rough way to the production of fissionable materials. Ore data were also considered especially sensitive in the early years because most uranium used in the American project came from overseas sources under secret agreements. Of the 3,700 tons of uranium concentrates (U_3O_8) that the Commission received in 1953, only about one-quarter (1,100 tons) came from mines in the United States; the rest was produced in the Belgian Congo (1,600 tons), South Africa (500 tons), Canada (400 tons), and Portugal (100 tons). Another reason for secrecy was that successful accomplishment of the expansion program was heavily dependent upon the availability of sufficient ore to feed the production plants then under construction. The plants then in operation or under construction would require 9,150 tons of uranium concentrates per year when in full operation. Thus, 1953 receipts were less than one-half the ultimately required amount, and that goal was not expected to be attained before 1957, more than a year after all the plants were to be completed.[29]

These facts justified the high priority the Commission put on ore procurement, but they did not tell the whole story. Prospects for new sources of ore were developing so rapidly that it was difficult to keep up with them. As for foreign sources, the leveling off of production from the Shinkolobwe mine in the Belgian Congo would be more than offset by projections of rapidly increasing deliveries later in the decade from the Union of South Africa and Canada. South African concentrate production could reasonably be expected to rise to five or six thousand tons per year by 1960 as leading plants were constructed to process uranium in residues from gold-mining operations in the Transvaal and the Orange Free State. Increased Canadian production was expected to come from new ore discoveries in northwestern Saskatchewan and northwestern Ontario.[30]

By far the most dramatic increase in concentrate production came from domestic sources in the western United States. In 1948 just over 100 tons of concentrates were delivered from domestic sources, principally from the Salt Wash member of the Morrison geologic formation in southwestern Colorado and southeastern Utah. By 1953 progressive exploration and Commission production incentives had extended the ore-producing area on the Colorado plateau to three times its original size and had led to the discovery of significant deposits in other types of geologic formations in New Mexico, South Dakota, and Wyoming. So rapidly had ore prospects improved in the western states that Jesse C. Johnson, the Commission's director of raw materials, was able to abandon earlier plans to extract very low-grade ore from Tennessee shales and Florida phosphates. Although hundreds of millions of tons of ore were potentially available from these sources, the concentrates would cost $40 to $50 per pound, compared to an average cost of $12 per pound for plateau ores.[31]

Uranium mining on the plateau, in fact, was taking on boom proportions, which the newspapers found reminiscent of gold-rush days. As often happened in the mining industry, intense exploration resulted in discoveries of large deposits of relatively high-grade ore where only scattered, small deposits had been found before. The 1953 boom added the names of Charles A. Steen and Vernon J. Pick to the list of rags-to-riches legends in American mining history.[32]

With ore receipts approaching one-half million tons per year in 1953, Johnson's highest priority was to see that mills were built on the plateau fast enough to process the ore into concentrates. All the mills on the plateau in early 1953, except the Commission mill at Monticello, Utah, were privately owned. The largest private mills, all in Colorado, were two operated by the U.S. Vanadium Company at Rifle and Uravan, two operated by the Vanadium Corporation of America at Naturita and Durango, and one at Grand Junction, operated by the Climax Uranium Company; Vitro Chemical Company also had a plant at Salt Lake City, Utah. These mills barely met 1953 requirements. Despite efforts to build new mills, specifically near the New Mexico discoveries, the Commission's ore stockpile grew to 775,000 tons by the spring of 1954, when ore was being delivered at a rate of 900,000 tons per year at an average grade of 0.3 percent U_3O_8. Ore deliveries, if not mill capacity, continued to outstrip requirements.[33]

The domestic procurement experience seemed to substantiate the position Commissioner Murray had consistently taken—namely, that in searching for supposedly ever scarcer minerals, strong incentives for private industry often produced generous supplies. In July 1952 Murray had urged the Commission to establish a procurement goal of 12,500 tons of concentrate per year, about 25 percent more than the 9,150 tons needed for all plants to be built under the expansion program. The Commission adopted the higher goal within a price ceiling of twenty-five dollars per pound. As the Colorado uranium boom developed in 1953 along with prospects for much larger deliveries from South Africa and Canada, the Commission had no difficulty in raising the goal to 15,000 tons in April 1954. Five months later, the Commission could adopt a firm target of 17,500 tons per year with a permissive target of 20,000 at a maximum price of fifteen dollars per pound. Continuing improvement in the raw material outlook was reflected in further increases in the procurement goal to about 25,000 tons in July 1955 and to 27,000 tons in February 1956. Although projections for both civilian and military uses were still uncertain, there was growing confidence within the Commission that ore procurement would not inhibit future development.[34]

PRODUCTION PLANTS

The increasing amounts of uranium concentrates being delivered in the mid-1950s provided feed for the growing network of facilities that produced plutonium, uranium-235, and other materials for nuclear weapons. During most of this period the concentrates delivered from domestic and foreign sources were reduced to uranium metal at the Mallinckrodt Chemical Works in St. Louis, Missouri, or at the Feed Materials Production Center, a new facility the Commission had constructed at Fernald, Ohio, near Cincinnati. Slugs of metallic uranium were shipped to Hanford, where they were welded into aluminum cans and inserted in the six plutonium-producing reactors in operation in early 1953. The much larger stocks of "virgin" uranium to be produced in the feed plants in subsequent years would serve as fuel for the new "Jumbo" reactors (KE and KW) at Hanford and for the five huge heavy-water reactors at Savannah River.[35]

Under the expansion program the increase in uranium-235 production was to be even larger than that of plutonium. Some measure of magnitude of the expansion could be gained from the gigantic effort to construct new gaseous-diffusion plants for producing uranium-235. The original U-shaped building at Oak Ridge had been one of the largest industrial plants ever constructed in the United States. In 1953 the original facility was dwarfed by the construction of three much more efficient plants at Oak Ridge (K-29, K-31, and K-33). As the year began, the foundations for K-33 were completed. Roughly comparable in physical size to the Oak Ridge complex would be the gaseous-diffusion plants at Paducah, Kentucky, and Portsmouth, Ohio. Started early in 1951, the first unit (C-31) of the Paducah plant was in operation late in 1952, and the three other units were in various stages of construction. Site studies had just started for the three big units at Portsmouth.

Because of the severe shortage of feed materials, very little of the uranium hexafluoride to be processed in these plants would come from virgin uranium. Instead the Commission was forced to rely on the enormous quantities of slightly depleted uranium that would come from the Hanford and Savannah River reactors. Until recently all the uranium removed from the Hanford reactors since 1945 had been stored in a chemical soup with a variety of fission products in huge underground tanks at Hanford. After years of plodding development by several laboratories, the Commission had placed in operation the Redox plant, which recovered uranium as well as plutonium from the irradiated fuel slugs at Hanford. Although Redox was theoretically capable of extracting uranium from material in the underground tanks, a solvent-extraction process using tributyl phosphate (TBP) as the solvent showed greater promise for this process. After a long series of construction delays, the TBP plant was just coming into operation early in 1953, and Redox was just approaching capacity operation.

The rapidly improving prospects for developing a thermonuclear weapon during the early 1950s stimulated interest in producing the materials that would probably be used in such a weapon, especially the heavy isotopes of hydrogen: deuterium and tritium. The Commission already had an impressive production capacity for deuterium in the heavy-water plants at Dana, Indiana, and Savannah River, South Carolina, which had been built to supply moderator for the production reactors at Savannah River. Tritium, a radioactive isotope with a relatively short half-life, did not ordinarily exist in nature and had to be produced by irradiating the light element, lithium, in a production reactor. Although both the Hanford and Savannah River reactors would be capable of producing tritium, their use for this purpose would reduce their capacity for plutonium production. Unless additional reactors were built, the Commission would have to balance its needs for plutonium and tritium.

There was another approach to the thermonuclear weapon that could conceivably reduce the demand on reactor capacity for tritium production. This was the idea, first discussed at the Princeton conference in 1951, of placing lithium in the weapon itself and using fission neutrons to produce tritium in place. For this purpose, however, it appeared necessary to use the lighter isotope of lithium, which made up only 7 percent of the element in nature. In 1949 there had been some interest in separating the lithium isotopes, not for lithium-6 but for lithium-7, which had some attractive properties for use as a reactor coolant and moderator. Preliminary research on methods of separating the lithium isotopes was thus available at Oak Ridge in 1951, when the Los Alamos laboratory first requested a small amount of highly enriched lithium-6 for thermonuclear research. This material was produced with the old electromagnetic equipment built at Oak Ridge during World War II. The gross inefficiency and high cost of this operation, however, prompted the development of a better method, for which an electric exchange process was selected. Elex, as it was called, consisted of large shallow trays in which mechanical agitators mixed an amalgam of lithium and mercury with an aqueous solution of lithium hydroxide. After counterflow through a series of stages, the lithium-6 tended to concentrate in the amalgam while the lithium-7 could be extracted by electrolysis from the hydroxide solution. Chemical reaction between lithium and water was prevented by placing anodes in the hydroxide solution and using the amalgam as a cathode.[36]

Although Oak Ridge had nothing more than laboratory data on the Elex process, the urgent need for lithium-6 for the thermonuclear program led the Commission in August 1951 to approve construction of a small plant to be in production by autumn 1952. Within a matter of weeks, however, this plan was overtaken by Los Alamos research, which suggested the possibility of a dry thermonuclear fuel using lithium deuteride. Late in September 1951 Oak Ridge had a new requirement: produce lithium deuteride by September 1953 in an Elex plant with twice the capacity of the original plant. Top priorities and special effort brought the first half of the plant into operation on August 14, 1953, and the second half came into operation a month later.[37]

DRIVE FOR THE HYDROGEN BOMB

The steadily increasing tempo of the Commission's production and construction activities reflected in large part the evergrowing sense of urgency to achieve an operational hydrogen bomb. A formal military requirement laid down by the Joint Chiefs of Staff in June 1952 called upon the Commission to produce a thermonuclear weapon in the megaton range that would be compatible with delivery systems to be available in 1954.[38] There were two ways of approaching that goal. One was to develop a very large fission weapon using substantial amounts of thermonuclear fuel. Before the

Mike shot in November 1952, this "semi-thermonuclear" weapon seemed the shortest and surest route to the formal requirement, but it offered no other advantages. Besides being a very large and heavy weapon, it did not seem to point to promising avenues of future development. The second approach was the "true" thermonuclear weapon. Because it depended on a radical new design using the Teller-Ulam principle, it involved more risk than the "semi," but it opened a wide range of possibilities for thermonuclear designs, including weapons much smaller than the "semi" on the one hand or very much larger in yield on the other. Either approach seemed amenable to wet or dry thermonuclear fuels.[39]

Important as *Mike* was in verifying the Teller-Ulam principle, it was not the key to reaching the military requirement. *Mike* and other experiments conducted during the *Upshot* series merely increased the probability that the "true" weapon would work. The actual testing of models that could be turned into weapons would come in Operation *Castle*, originally scheduled for autumn 1953. To meet the military requirement on time, it seemed that *Castle* could be no later than that. The schedule would also have made it possible to use elements of Major General Percy W. Clarkson's Joint Task Force 132, which had conducted the *Ivy* series in 1952, to provide the logistics and support operations for *Castle*.

PLANNING FOR CASTLE

The stunning success of the *Mike* shot resulted almost immediately in postponing *Castle* until early 1954. The postponement opened the opportunity to conduct in the *Upshot* series further experiments that would contribute directly to *Castle*. The delay also assured the availability of more lithium-6 for *Castle* devices and moved the tests to the late winter and spring, when favorable weather conditions were more likely in the central Pacific. There was one disadvantage: the military services would have to disband some support units at Enewetak and then assemble new teams for *Castle*.[40]

Long before *Mike* and the change of schedule, however, plans had been laid for a major revision of testing procedures in the Pacific. *Mike* would merely confirm what Alvin C. Graves, the scientific test director, and others at Los Alamos had already concluded: namely, thermonuclear shots in the megaton range were too powerful to be conducted at Enewetak without threatening the extensive facilities that had been constructed there for earlier tests. *Mike* had destroyed an entire island in the Enewetak atoll and had damaged facilities on other islands. With the much larger tests contemplated for *Castle*, even the permanent facilities at the southern rim of the atoll would be threatened by thermonuclear tests on the northern islands. After considering several alternatives, Graves recommended that most shots in the *Castle* series, specifically the large thermonuclear tests, be conducted at Bikini, some 180 miles east of Enewetak. Bikini, the site of Operation *Crossroads* in 1946, was still uninhabited, but it offered no facilities that would be useful in 1954. Graves's plan was to keep the main operational base for *Castle* at Enewetak, where the low-yield tests would be conducted. For the large tests at Bikini it was necessary to construct only a tent camp for construction and test personnel, a power plant, and a runway for small cargo planes. The two atolls would be linked by aircraft, ships, and radio and telephone communications.[41] In a sense one could say that nuclear weapon technology had now reached such colossal dimensions that a test site more than 180 miles wide was required.

The unprecedented radioactive fallout during the *Upshot-Knothole* series, the public anxiety about the possible effects of testing on weather, and the Eisenhower Administration's interest in budget stringency all combined to prod the Commission to reduce the number of tests scheduled for *Castle*. From the other direction, the Commission heard persuasive arguments from the weapon laboratories for at least six shots. Graves told the Commissioners on July 23, 1953, that there were compelling reasons for all six tests. The first three were high-yield shots necessary to assure an emergency capability with thermonuclear weapons; they would lead to weapons that could be carried in a B-36 bomber. The fourth, also high-yield but somewhat smaller in size and weight than the others, was intended for use in the new B-47 bomber. As a Los Alamos leader, Graves could vouch for the value of the first four high-yield shots, just as Herbert F. York and others at Livermore could speak for the need for the two low-yield tests, which it was hoped would open the way to thermonuclear weapons much smaller in size and yield than *Mike*.[42]

There were the usual discussions of the relative merits of the proposed shots with some agonizing over how many should be devoted to assuring an emergency capability and how many to developing new and more promising designs. Beyond these concerns was always the dilemma of substituting for the recommended shots one or more highly experimental tests with new designs that might easily fail but that might also provide a giant step forward in weapon technology should they prove successful. Strauss asked Graves how long the Commission could postpone the decision without jeopardizing the February 15 start of the *Castle* series; Graves suggested the middle of September.

By that time the Soviet Union had detonated *Joe 4*, an event that raised the level of anxiety and urgency within the Commission and the laboratories. When Kenneth E. Fields, the director of military application, presented the revised shot schedule on September 22, 1953, he noted the need for one substitution and a delay in starting the series until March 1, mostly because of a lag in construction at Bikini but also in order to ease the strain on logistics. Again the Commissioners struggled with the need to assure emergency capability with pedestrian but reliable designs as opposed to testing more risky but also more promising concepts.

NEW PRODUCTION REQUIREMENTS

A new issue appearing in September 1953 was the critical need for lithium deuteride and tritium. To the extent that any device designed to provide emergency capability relied on large amounts of these materials, the less probable it was that the laboratories would meet the required stockpile dates. And beyond that point, there was still no positive assurance that a dry weapon would work. If the first test in the series, which was to be a weapon using lithium deuteride, should fail, the test schedule would have to be revised, and the possibility would increase that Los Alamos would have to fall back for emergency capability on such unpromising systems as the weapon version of *Mike* with its great bulk and cumbersome cryogenic gear.[43]

Although the Commissioners were determined to give the highest priority to the emergency capability, they were also prepared to take a large risk that dry weapons would be successful, an assumption that dictated a much larger potential requirement for lithium deuteride than the recently completed plants at Oak Ridge would produce. On September 30 to meet this prospective demand the Commission authorized construction at Oak Ridge of a second plant, larger than the first, using a somewhat different process called Colex, which utilized countercurrent exchange in columns. As officials in the Bureau of the Budget found, to their consternation, the Commission had approved the new plant simply on the anticipation of need and with no firm requirement from the Department of Defense. Instead of following usual budget channels, Strauss obtained the required apportionment of funds directly from Budget Director Dodge while Defense proceeded to draft the requirement.[44]

Formal statement of the higher requirement came from the Joint Chiefs of Staff on December 15, 1953. The Joint Chiefs expressed the opinion that *Joe 4* threatened the "substantial lead in destructive capability" that the United States enjoyed over the Soviet Union. Because production of thermonuclear weapons was "the cheapest method to obtain high-yield weapons and more destructive capability," the Soviet Union could be expected to pursue this course. Unless the United States substantially accelerated its schedule for producing thermonuclear weapons, the Soviet Union would obtain nuclear superiority by 1958.

In this dangerous situation, the Joint Chiefs saw only two solutions: first, to build new production facilities at great expense; or, second, to shift production in order to increase the size of the thermonuclear stockpile more rapidly. The latter course seemed the better, although it would mean some reduction in requirements for fission weapons in the megaton range. Following this course the Joint Chiefs proposed new requirements for the composition of the stockpile that would allocate available production capacity mostly to high-yield thermonuclear weapons and low-yield fission weapons for tactical support, air defense, and demolition.[45]

Even before the Joint Chiefs sent the formal notification, the Commission's operating contractors were considering how best to meet the new requirements. It seemed likely that the military requirements could be met over the long range, but there were questions about the near term. With the existing reactors at Hanford and the new units just coming into operation at Savannah River it would be difficult to produce the large amounts of tritium needed for weapons in the proposed stockpile, but there were reasons to be hopeful. First, new methods of loading the reactors would substantially increase production of either tritium or plutonium, and, second, the *Castle* tests might significantly reduce the amount of tritium required for each thermonuclear weapon.[46]

If tritium requirements could be reduced, the Commission would have more capacity at Hanford and Savannah River for producing plutonium, which would also be in short supply. Plutonium was needed for not only low-yield fission weapons but also the fission component that would initiate thermonuclear reactions in the hydrogen bomb. The Commission's production staff undertook detailed studies to determine the optimum allocation of reactor capacity at both sites to tritium and plutonium formation.

Other nuclear materials needed to meet the new requirements from the Joint Chiefs would also be in short supply, but there were ways in which the Commission could close most gaps. The outlook for deuterium production was relatively good because the existing plants at Dana and Savannah River could produce all the heavy water required; but it would be necessary to enlarge the electrolytic plant at Savannah River and build a new one at Oak Ridge to extract deuterium from heavy water. Part of the near-term deficiency in uranium-235 production could be overcome by accelerating completion of the new gaseous-diffusion plants at Oak Ridge and Paducah. Beyond that, until the Portsmouth plant could be built, more production of uranium-235 could be accomplished only by either feeding more uranium to the Oak Ridge and Paducah plants or increasing the amount of electric power used to drive the compressors. In either case, the decision would rest ultimately upon how much the Commission was willing to pay for additional production. As for lithium-6, the expansion of the Oak Ridge facility authorized only a few weeks earlier would meet the Joint Chiefs' requirements if the amount of feed for one new Colex plant was increased.[47]

THE QUESTION OF RESPONSIBILITY

It did seem possible to meet most Joint Chiefs' requirements, and there was no sentiment within the Commission on December 23, 1953, to delay the immediate actions that General Manager Nichols proposed on an emergency basis. The letter from the Joint Chiefs, however, did raise some old concerns about the nature and implications of military requirements, which the Commissioners had discussed many times over the preceding seven years.[48] Although Strauss favored quick action, he wanted to confirm his impression that the stockpile recommended by the Joint Chiefs was based on specific targeting plans, not just their estimates of the Commission's ability to produce.

Zuckert, who remained unconvinced on this point, spoke at some length about the enormous destructive capability of the proposed stockpile, which he estimated would be equivalent to several billion tons of TNT by 1957. He posed the frightening possibility that by then the United States might have the capacity to destroy the entire arable portion of the Soviet Union. Zuckert did not think the Commission should question military requirements on military grounds, but he believed that the Commissioners had individual responsibilities as civilian officials to make sure that the President understood the implications of a decision that clearly transcended military matters. The decision, in Zuckert's opinion, involved a determination by the highest civilian authority that the proposed size and composition of the stockpile were consistent with national objectives as well as military needs.

Although Strauss did not really question the validity of the requirements, he acknowledged the obligation to discuss the issue with the President. In addition to the points Zuckert had raised, Strauss shared Smyth's concern about the potential hazards from radioactive fallout if military plans for using thermonuclear weapons were ever carried out. Early in February 1954 the Commissioners reviewed the entire proposal in detail and discussed its implications. As a result, the question was presented to Eisenhower in a joint letter from Strauss and Secretary of Defense Wilson, and the President signed a formal directive approving the decision on February 6, more than two months after Nichols had alerted the staff to prepare for the new requirements.[49]

BUILD-UP FOR CASTLE

Although the Commissioners did not begin to concentrate their attention on *Castle* until late 1953, preparations for the tests had started more than a year earlier. On October 2, 1952, within weeks after the Commission had approved the Bikini site, the first contingent of thirty-nine employees of

Holmes & Narver, Inc., the Commission's construction contractor at the Pacific Proving Grounds, landed on Bikini to begin site preparations. By the time the *Ivy* series began a month later, about two hundred people were working on the few essential facilities needed to accommodate air and sea transportation from Enewetak.[50]

As soon as the essential activities of Operation *Ivy* were completed early in 1953, General Clarkson established Joint Task Force 7, which included many components of the *Ivy* group, and began to build the complex of administrative arrangements that would enable the three military services to support the scientists in the *Castle* series. The first task was to reach agreement on the general conception of the operation. All high-yield tests would be conducted at Bikini, but the main base of operations would continue to be Enewetak. Activities at Bikini were to be limited to the minimum necessary to instrument and fire the devices. In fact, the devices themselves, with one exception, would not be assembled at Bikini but rather in the Enewetak Atoll. Placed on barges, the test devices would be towed to firing positions at Bikini.[51]

The plan reflected in many ways the incredible magnitude of the effects expected from large thermonuclear weapons. So enormous were the projected yields that it hardly seemed feasible to maintain habitable facilities at Bikini, even when the shots were fired on the opposite side of the atoll. In addition, experience with the *Mike* shot at Ivy made clear that the relatively small amount of land above sea level at Bikini would soon be destroyed if all future tests were to be land-based.

But the operation of the proving ground, which stretched over more than two hundred miles of open ocean, posed logistical and administrative problems for Clarkson and the Joint Task Force. Transportation requirements alone challenged the capabilities of the peacetime military services in moving thousands of personnel and tons of equipment between the atolls and between the islands composing each atoll. Communication needs were equally demanding, not only in terms of installing telephone, cable, and radio facilities but also in managing the networks. At Enewetak Island, which served as the base of operations, and Parry Island, where most test devices were assembled, the task force had to arrange for construction of machine shops, laboratories, warehouses, repair facilities, barracks, offices, and port facilities.

As in the *Ivy* series, Clarkson organized the Joint Task Force by task groups. The scientific task group (7.1) under William E. Ogle, a Los Alamos scientist, was responsible for all aspects of assembling, positioning, and firing the devices. The group also installed all related test instrumentation and managed the radiological safety program. Each military service operated as a task group. The Army group (7.2) was responsible for ground security and all base facilities at Enewetak. The Navy task group (7.3) provided security for the thousands of square miles of ocean within the danger area, operated the interatoll ship transport system, provided shipboard technical facilities, and moved the firing targets to Bikini. The Air Force task force (7.4) supplied aircraft for cloud sampling and tracking, technical photography, and weapon effects on aircraft. A major Air Force assignment was operating a network of weather stations on islands in the central Pacific that reported, along with Air Force weather reconnaissance planes, to Weather Control at Enewetak. The Air Force task group also operated the interatoll air transport system and provided search and rescue operations. A fifth task group, not included in the *Ivy* operation, was staffed by Commission personnel from the Santa Fe operations office to supervise construction operations by Holmes & Narver.[52]

The unprecedented yields projected for some *Castle* shots were something the military task group could understand. Very early the Air Force task group concluded that the aircraft used in *Ivy* for sampling airborne debris from the detonations lacked the speed, range, and altitude capabilities needed to track and sample the downwind movement of particles from the *Castle* tests. Acquiring suitable aircraft and developing effective procedures for cloud sampling thus became matters of special concern. Both the Air Force and the Navy recognized the growing importance of accurate weather forecasting as the yield of the shots increased. Wind patterns, not only on the surface but at all altitudes up to 100,000 feet, could conceivably carry clouds of radioactive particles over inhabited islands as far away as Enewetak or other islands in the Marshalls, where rainfall might cause substantial fallout. Despite extensive experience gained by the military weather services in earlier Pacific tests, the relative lack of good data, compared with those available for continental land masses, posed a special challenge for the weatherman.[53]

Likewise the military task groups had no trouble appreciating the security implications of an operation as big and dispersed as *Castle*. Lacking the authority to censor mail or other private communications, the Joint Task Force recognized that it would be almost impossible to prevent some information about the tests from seeping to the outside world, despite extensive measures for indoctrinating personnel on the importance of security. The enormous magnitudes of the projected yields in themselves threatened security. The flash and sonic shock wave might be observable fifty or more miles away, and, depending on weather conditions, some fallout might occur at even greater distances. Samples of fallout material picked up by Soviet spy ships could reveal important information about the nature of the test. Thus, it was deemed essential to conceal any information about the precise time or location planned for any test. It was also vital to establish an exclusion or "danger" area large enough to preclude obvious intelligence gathering by the Soviet Union or other nations.[54]

The military task groups, however, were less impressed with operational considerations posed by the less familiar characteristics of nuclear tests, specifically the dangers of radiation. Radioactive fallout was considered a potential but unlikely hazard beyond the immediate vicinity of Bikini. This attitude resulted from the *Ivy* experience, where extraordinary precautions were taken at considerable expense and to little purpose when virtually no local fallout occurred from the *Mike* shot. Graves and Commission officials had some difficulty convincing the military to make comparable plans for aerial surveys and emergency evacuation plans for *Castle.*[55]

The absence of any pressing concern about fallout was clearly reflected in the definition of the "danger" zone established for *Castle.* Obviously the *Ivy* exclusion area had to be enlarged eastward to include Bikini, but the question was how much further east. Extending east and south of Bikini were two long chains of atolls that composed the Marshall Islands. With unfavorable precipitation and wind patterns, significant fallout on some of these islands was theoretically possible. For that reason, the scientific task group intended to exercise every reasonable precaution within the limits of weather forecasting to see that radioactive debris from *Castle* shots would move in a northeasterly direction, away from Enewetak and the Marshalls. Recognizing the margins for error, the scientists insisted that the military services establish a capability for emergency evacuation of Enewetak and of the Marshall atolls immediately east of Bikini. The nearest of these atolls were Rongelap and Ailinginae, which lay scarcely more than fifty miles east-northeast of Bikini. If the exclusion area had been established with the fallout hazard as the primary concern, these atolls might well have been included within its boundaries. But in fact the eastern border of the exclusion zone was established, on the recommendation of the Department of the Interior, precisely to exclude the two atolls on the grounds that inclusion would require evacuation of the inhabitants for the duration of *Castle.* Thus, the eastern boundary at 166° 16′ east longitude was fixed primarily for security reasons, and to that extent it was misleading to refer to the zone as a "danger area."[56]

By early 1954 more than ten thousand military and scientific personnel were pushing to meet the March 1 deadline for the first shot in the *Castle* series. Much activity related to the twenty experimental programs to be carried out with the detonations. Although many of these were directly related to weapon diagnostics, six experimental programs were sponsored by the Department of Defense and concerned weapon effects.[57] Actual assembly of the first device could not be completed until February 17, after the USS *Curtiss* arrived at Enewetak under destroyer escort with the nuclear components.[58]

The three military task groups conducted operational rehearsals during February, concluding with a general task force rehearsal on the morning of February 23. All task groups participated as fully as possible to test security and emergency evacuation procedures, the cloud sampling system, and communications. The scientific task group tested the readiness of in-

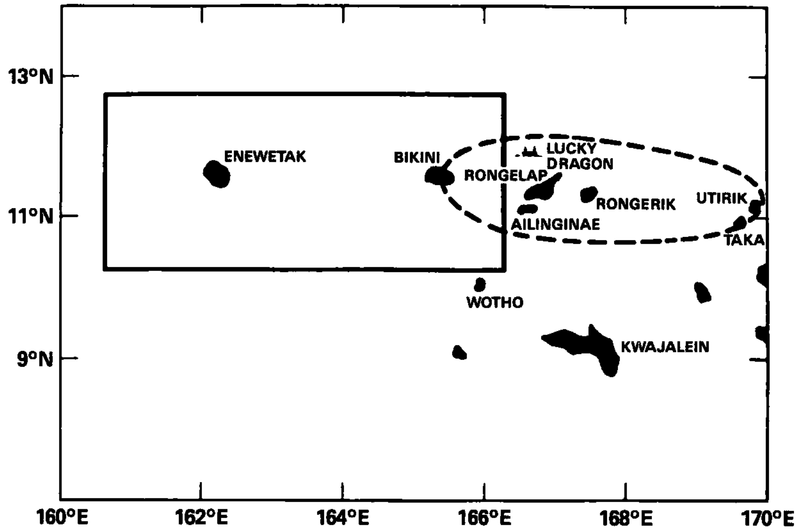

Figure 1. The exclusion area established for the March 1, 1954, *Castle Bravo* shot did not contain the Marshall atolls east of Bikini. The dotted lines indicate the path of the fallout cloud. Also shown is the position of the Japanese fishing vessel, the *Lucky Dragon*, at the time of the detonation.

strumentation and firing circuits as far as possible. Ogle encountered several technical problems that would have aborted an actual detonation on that day. During the last two days in February, small craft began evacuating the last 1,400 workmen and technicians from the island camps at Bikini to ships in the lagoon, which then moved southeast about thirty miles from ground zero. All usable equipment had been moved south to Eninman and Enyu Islands so that it would be the maximum distance (about twenty miles) from the point of detonation. Only the firing party remained ashore, in a specially constructed bunker on Enyu.[59]

BRAVO

On February 22, 1954, the scientific task group under Ogle's direction completed the installation of the *Bravo* test device. Because it was to be the first shot in the series, the device had not been placed on a barge but in a small structure on a reef off Namu Island at the northwestern perimeter of the atoll. As the first test of a dry thermonuclear system, *Bravo* had special significance. Its performance would affect the subsequent agenda for *Castle* and could conceivably change the course of future development of thermonuclear weapons.

Once the final equipment checks were completed, the long countdown began to H-hour, at 6:54 a.m., local time, on March 1. The actual firing time now depended mostly upon weather conditions, which in the central Pacific could change significantly from hour to hour. Clarkson, Graves, Ogle, and several other task group commanders attended weather briefings at midnight and at 4:00 a.m. March 1. There was little concern about precipitation because the forecasts called for a relatively light cloud cover and only widely scattered showers. The group gave more attention to the ever changing complex of wind patterns at various altitudes. That morning surface and low-altitude winds were from the northeast while those above 20,000 feet tended to be from the west, an almost typical pattern. The variability and hence the cause for uncertainty lay in the wind pattern from 7,000 to 11,000 feet. At these altitudes the winds were light, but they had a decidedly northerly component. The more northerly the wind vectors, the more likelihood there was that the radioactive cloud would pass over the inhabited islands east of Bikini in the northern part of the Marshalls. At the moment the weather picture seemed favorable if not ideal. In fact weather conditions had been near perfect on February 27 and had deteriorated only slightly since then. To postpone the shot might well have pushed the beginning of the *Castle* series into a decidedly unfavorable period with the possibility of a long and expensive delay. At the end of the four o'clock briefing, Clarkson and his advisers decided to fire *Bravo* on schedule.[60]

From the moment of firing *Bravo* gave every sign of being a spectacular success. Even the crudest, most preliminary measurements indicated a yield far greater than the six megatons estimated as the most likely figure. Other and more ominous indications of large yield were the surprisingly high levels of radiation recorded. Aircraft approaching Eninman Island a few minutes after the detonation recorded radiation levels that would preclude immediate reopening of the airstrip. A few minutes later the firing party in the control bunker on Enyu Island reported rapidly rising radiation readings even after the doors of the bunker had been closed. Before eight o'clock the Navy ships, which carried the shore personnel from Bikini and served as floating laboratories and offices in the lagoon, began reporting dangerously high radiation levels. The ships, already thirty miles south of Bikini, were ordered to head south at best speed to a fifty-mile range, to activate washdown systems and to use maximum damage control measures. Radiation readings on the decks were as high as 5 roentgens per hour with maximum readings of 25 roentgens in deck drains. Personnel were forced to stay below decks in the stifling heat for more than four hours, until fallout declined to safe levels.

The ships were then ordered to return within ten miles of Bikini, but they could not enter the lagoon because of high levels of radioactivity. The firing party had been evacuated by helicopter from Enyu, and radiation levels on Eninman were too high to permit either landing on the island or operating the airstrip. Extensive physical damage to the equipment stored on Eninman and to other facilities on the island showed the enormous destructive power of *Bravo*. Examination of test data gave a yield of fifteen megatons, almost three times the most probable figure. Much more troublesome were the unexpectedly high radiation levels, which gave the Joint Task Force no choice but to double maximum permissible exposures of 3.9 roentgens for critical personnel such as helicopter pilots, flight deck personnel, and boatpool operators. Unable to enter the lagoon, the principal vessels of the Navy task group returned to Enewetak and prepared to resume operations at Bikini from a shipboard base of operations. Severe overcrowding of personnel on the ships, plus the unavailability of shore facilities, would hamper subsequent operations, but the earlier decision to use barge shots with instrumentation on buoys now seemed fortuitous.[61]

As radiation levels began to fall in the Bikini area late on March 1, reports of rapidly increasing readings trickled in from the atolls immediately to the east. These reports supported data collected by the Air Force cloud tracking teams that winds aloft were carrying the main body of *Bravo* debris in a direction just slightly north of east. As radiation levels climbed on March 2, the Air Force sent amphibious aircraft to Rongerik, 133 nautical miles from ground zero, to evacuate 28 military personnel who manned the weather station and other scientific equipment for the Joint Task Force. Later the same day the Navy task group dispatched destroyers from Bikini to rescue native populations on other atolls. Early the next morning a beaching party went ashore at Rongelap, only about one hundred nautical miles southeast of ground zero. Within hours the islanders had gathered their personal belongings for what they believed would be a temporary stay at Kwajalein and boarded the USS *Philip*, where radioactive fallout was removed by washing. Later in the day another 18 islanders were picked up at nearby Ailinginae Atoll before the ship proceeded overnight to Kwajalein. The second destroyer reached Utirik on March 4, and despite the heavy surf the Navy transferred 154 islanders by life raft and small boat to the USS *Renshaw*.[62]

At Kwajalein military physicians examined the islanders and treated them for radiation exposure. When the people from Utirik showed no signs of radiation injury, they were transported to another island in the Marshalls, where they stayed until they returned to their home island in June. The people from Rongelap and Ailinginae were less fortunate. Because they had been much closer to Bikini than had those from Utirik, they had received much more fallout. Average readings at Rongelap were 0.375 roentgens per hour, and some soil samples were as high as 2.2 roentgens. Taking into account the length of time the islanders remained on Rongelap after the fallout occurred, radiation safety personnel computed that the islanders received a whole-body gamma dose of 175 rad on Rongelap, 69 rad on Ailinginae, and 14 rad on Utirik. As could be expected from such exposures, the Rongelap islanders developed low blood counts and suffered some temporary loss of hair, skin lesions, and hemorrhages under the skin. In terms of blood count, the islanders suffered about the same degree of damage as did Japanese who were about 1.5 miles from ground zero at Hiroshima and Nagasaki. Equally distressing to the Rongelapese was that they were effectively exiled from their island home. Despite assurances of early repatriation, presumably by May 1955, the Rongelapese were not permitted to return to their home island until June 1957.[63]

THE LUCKY DRAGON

The final and in many ways the most telling radiation incident from *Bravo* was not discovered until March 14, when a Japanese fishing vessel, the *Fukuryu Maru* (*Lucky Dragon*) *No. 5* arrived in Japan with all twenty-three members of the crew suffering from radiation exposure. The ship's log and interviews with the crew indicated that the vessel had been about eighty-two nautical miles from Bikini at the time of the *Bravo* shot, or just beyond the eastern boundary of the exclusion area. The crew had seen the flash and heard the detonation. Although the fishermen suspected that the blast was a nuclear weapon test, they did not know that tests were scheduled at that time or that there was any danger from fallout. In fact, only after skin irritation, nausea, and loss of hair developed on the return voyage to Japan did some of the crew begin to guess that the white powdery substance that had fallen from the clouds like snow was radioactive. Fearing that they might be detained by the Americans or even that their ship might be sunk if their presence near Bikini were detected, the crew members decided to give no hint of what had happened until they returned home. By the time the ship reached its home port of Yaizu, the effects of radiation had become so prominent and irritating that several members of the crew reported to the local hospital. The two who appeared most seriously injured were taken to the Tokyo University Hospital, and within a few days all the rest were in the hospital in Yaizu.[64]

The Commission in Washington first learned of the *Lucky Dragon* tragedy on March 15 from commercial news reports. Without waiting to consult Strauss, who had already left for the Pacific to witness the second shot in the *Castle* series, the other three Commissioners asked Nichols to provide immediate technical assistance to the American ambassador in Tokyo and to the Japanese scientists and physicians treating the fishermen. John J. Morton, director of the Atomic Bomb Casualty Commission in Hiroshima, arrived in Tokyo on March 18 by military plane with a team of doctors and hematologists who had extensive experience in observing radiation effects in Hiroshima and Nagasaki survivors. Radiation physicists provided by the U.S. Air Force joined the team in Tokyo. The team examined the two crewmen in the university hospital and compiled full clinical reports. The following week the team went to Yaizu, where they were permitted to board the *Lucky Dragon*, take some samples of fallout, examine some of the fish caught during the voyage, and use Geiger counters to measure radiation on the twenty-one crewmen in Yaizu.[65]

By this time the incident had received sensational treatment in the Japanese press. *Yomiuri Shimbun*, one of the largest Tokyo dailies, carried a series of frightening stories about "ashes of death." Another large Tokyo paper, *Shukan Asahi*, reported that the Japanese people were "terror-stricken by the outrageous power of atomic weapons which they [had] witnessed for the third time." *Asahi* editors speculated on the nature of the weapon tested and raised the possibility that the Americans had detonated a cobalt bomb, intentionally designed to spread poisonous radiation. Much to the discomfort of Strauss, Murray, and other security-minded Commission officials, *Shukan Asahi* also raised the possibility that a bomb using lithium had been tested.[66]

Although the Americans seemed sincerely to regret the incident and offered the Japanese full cooperation and assistance in treating the injured fishermen, the Commission was deeply concerned about what the remaining traces of radioactive ash on the ship might reveal about the design of *Bravo*. The Americans were especially sensitive about any evidence that might suggest the success of a dry thermonuclear weapon. For this reason the Americans refused to provide any information about weapon design or fallout content. The Japanese were especially offended by this refusal because they believed that the fishermen had been subjected to a new type of radiation and that it would be impossible to treat their injuries adequately without this information. The Japanese scientists and physicians simply could not accept the assurances of American experts that this information was unnecessary.

In this atmosphere of suspicion, the initial Japanese willingness to cooperate with the Americans quickly evaporated. When Merril Eisenbud, director of the Commission's health and safety laboratory in New York, arrived in Tokyo on March 21, he was greeted courteously but was not permitted to examine any of the fishermen. Only after much persuasion that urine tests were essential in determining the amount of ingested radiation received was he able to obtain samples from some patients. As the Japanese position stiffened, the Americans became more frustrated. They were convinced that the fishermen were not receiving the best possible treatment largely because, in Eisenbud's opinion, the Japanese did not wish to appear dependent on American help. The Americans were also disappointed that they were not permitted to make full biomedical studies of a group of people who had lived for two weeks in a high radiation environment. The Japanese, for their part, did not wish once again to be "guinea pigs" for American experiments.[67]

As the incident became a major issue in Japanese politics and continued to dominate the newspapers, the Japanese people reacted with an intense emotionalism. It was as if all the pent-up fears and anxieties engendered by Hiroshima and Nagasaki had suddenly burst into the open. For the third time in a decade Japanese civilians had been inflicted with the disfiguring and insidious injuries caused by nuclear weapons. The involvement of a fishing vessel was especially disturbing because it suggested that radioactive fallout from weapon tests might poison a major source of food for the Japanese people.

Both the State Department and John M. Allison, the American ambassador in Tokyo, at once sensed the full potential of the incident for damaging international relations. Allison had some success in conveying a sense of deep personal concern and in reassuring the Japanese government. He may also have been instrumental in keeping public criticism focused almost entirely on nuclear weapons while surprisingly little hostility was expressed against the United States. Within the Commission, however, there was much less evidence of compassion for the fishermen and more concern about the security and scientific implications. Eisenhower refused to say anything about the *Bravo* shot at his press conference on March 17, but he promised to answer questions the following week.[68]

From Enewetak Strauss sent Hagerty a report on *Bravo*. The tests, Strauss reported, were routine, but the results to date had been of great value and significance. The reports of radiation injuries to the Marshall Islanders were exaggerated, Strauss maintained, and claims about the fishermen were unverified. After describing how the danger area was established and patrolled, Strauss concluded: "The tests are continuing as planned." On March 24 the President relayed to the press only Strauss's statements about the exaggerated reports and deferred further comment until Strauss returned.[69]

After witnessing the second *Castle* shot, Strauss released a statement on March 31 summarizing unclassified portions of his report to the President. Going back to the first Soviet atomic explosion in 1949, Strauss justified the tests as part of the nuclear arms race and then set about to correct "exaggerated and mistaken characterizations" of the tests by the press. Although the statement did serve that purpose, it was cast in cold, almost imperious language that tended to belittle the implications of fallout on the Marshall Islanders or the Japanese fishermen. One clearcut misstatement in Strauss's report was that the *Lucky Dragon* "must have been well within the danger area." All available evidence was and is to the contrary. That Strauss chose to reject evidence of the ship's true position probably reflects his conviction, conveyed privately to Hagerty, that the *Lucky Dragon* was probably a "Red spy ship." Similar suspicions expressed earlier in Japan by Congressman Cole had outraged the Japanese.[70]

COMPLETION OF CASTLE

For Clarkson and the Joint Task Force at Bikini the international implications of *Bravo* were more than overshadowed by the immediate logistical problems involved in completing the *Castle* series. The widespread devastation wrought by *Bravo* and the heavy fallout at Bikini required extensive changes in operational plans. *Bravo* had left Bikini all but uninhabitable so that logistical support and technical operations for the most part had to be based on Enewetak or on Navy ships assigned to Joint Task Force 7.3. The need to abandon even the limited base facilities at Bikini imposed a substantial transportation burden on shot preparations. Much equipment stored on Eninman Island before the *Bravo* shot now had to be loaded on ships and transported to Enewetak.

The disastrous fallout following *Bravo* required the imposition of much more stringent weather criteria for later shots in the series with attendant costly delays. *Romeo*, the second shot, was scheduled after *Bravo* for March 13 but could not be fired until March 27 because of unfavorable weather. Other shots in the series were also delayed as the frequency of favorable weather conditions declined during the spring. The exclusion area was greatly extended by adding a new sector centered on a point midway between Bikini and Enewetak and sweeping a huge semicircular area 450 miles in radius from west through north to the east. Both the new weather criteria and the expanded danger area recognized the unparalleled magnitude of both blast and fallout produced by thermonuclear weapons. The Nevada Proving Grounds, comprising about 500 square miles of desert, was a sizeable portion of the state, but it was miniscule compared to the exclusion area of 15,000 square miles at Enewetak for Operation *Ivy*. Then for *Bravo* the Commission had expanded the exclusion area to include Bikini and its size reached more than 67,000 square miles, or roughly the size of New England. After the *Bravo* fallout, the area was expanded to about 570,000 square miles, or twice the area of Texas. Thus, the testing of a single large thermonuclear weapon was beginning to require the exclusion of people from a significant portion of the earth's surface.

The most profound changes in *Castle* operations after *Bravo* resulted from the extraordinary nature of the technical information revealed by the tests. In addition to demonstrating the feasibility of a dry thermonuclear weapon, *Bravo* opened the way to other design improvements, of which the surprisingly high yield was only one indication. Following *Bravo* the sequence of shots was changed for a second time; some planned shots were canceled, and others were changed or added. Although such schedule changes in the middle of a series always introduced the possibility that some shots would not be used to the best advantages, the Los Alamos and Livermore scientists accepted the risk in order to capitalize on new opportunities for design improvement. As it turned out, four shots followed *Bravo* and *Romeo*: *Koon* on April 7, *Union* on April 26, *Yankee* on May 5, and *Nectar* on May 14.[71]

THE NEW REALITY

Long before *Nectar* was fired, both the laboratories and the Commission realized that *Castle* had surpassed the most sanguine expectations for the series. In autumn 1953 the Joint Chiefs of Staff and the Commission had faced a given possibility of multiple failure. There had been no assurance that any shots would be successful; even if some devices were successful, they might not provide an emergency capability in megaton weapons that seemed essential to national security in meeting the Soviet challenge. And even if by chance one device offered that slim margin of emergency capability, there seemed even less chance that the Commission's production plants could turn out the special nuclear materials needed to meet stockpile requirements. For Strauss, Murray, Teller, and some Los Alamos scientists, the deadly race with the Soviet Union was very much in doubt. Possession of the hydrogen bomb alone could dangerously alter the balance in the Cold War.

But *Castle* changed all that. Even after *Bravo*, and certainly after *Romeo*, the future looked entirely different. It seemed that the American scientists had suddenly found the key to new realms of nuclear weapons. With a few notable exceptions, every new design principle incorporated in the *Castle* series seemed to work, often beyond the hopes of the most optimistic designers. By the time *Castle* was over, the United States had a choice of weapons for emergency capability. The feasibility of the dry thermonuclear weapon had been demonstrated so decisively that the Commission with confidence could cancel its contracts for cryogenics research for the wet device.

Equally important, the decision for dry weapons would immediately relieve the heavy pressure on the Commission's production complex. The plan to use a substantial portion of the neutrons in the Savannah River reactors for producing tritium could now be abandoned and that much more of the capacity devoted to plutonium formation. *Castle* also opened new possibilities for the more efficient use of all special nuclear materials, including lithium-6. Thus, even a heavy dependence on dry thermonuclear designs did not severely tax the capacity of the Alloy Development Plant, which was already producing beyond its design specifications at Oak Ridge.[72]

The design concepts demonstrated in *Castle* opened the way not only to multimegaton weapons of vast destructive capability but also to a whole "family" of thermonuclear weapons in a spectrum of yields, ranging from small tactical weapons to those matching the yields of much heavier and larger fission weapons already in the stockpile. In fact, *Castle* had rendered some stockpile weapons obsolete and seemed to be overtaking the utility of others. In explaining the significance of *Castle* to the general advisory committee on July 14, 1954, Bradbury went far beyond a description of specific design improvements. *Castle*, he said, had made possible a new philosophy for building the stockpile. Rather than try to achieve a balanced distribution of yields, Bradbury wanted both to concentrate on types in which large numbers of weapons would be needed and to develop the best possible weapons with optimum characteristics. This change alone would effectively enlarge the stockpile of ready weapons.

Isidor I. Rabi, the distinguished physicist who had replaced Oppenheimer as chairman of the committee, saw in Bradbury's remarks "a complete revolution" in nuclear weapons. Two years in the future, Rabi said, the stockpile would have little resemblance to what it had been two years earlier in 1952 before the *Mike* shot. These sweeping changes in weapon technology, Rabi suggested, reflected a growing maturity that would require a more sophisticated use of systems engineering. In this respect, the Sandia laboratories operated by Western Electric at Albuquerque could make an important contribution. The entire committee agreed that the performance of the Los Alamos scientists at *Castle* had been outstanding. Committee members sensed an increasing feeling of strength and experience that had been missing at Los Alamos a few years earlier.[73]

As for Livermore, the committee saw in the new laboratory an exciting potential for the future, despite the fact that the Livermore shots planned for *Castle* had proved no more successful than those at *Upshot-Knothole*. Both Rabi and John von Neumann, the metamathematician, agreed that the Livermore scientists had done a remarkable job of diagnosing data from *Castle* experiments. Herbert F. York and the young colleagues he had helped recruit for the new laboratory were talented and energetic. They were purposely concentrating on the more difficult, high-risk designs that they hoped would quickly establish the laboratory's reputation as second to none, including Los Alamos. While York and his associates reveled in the freedom and informality they enjoyed under Ernest Lawrence's protection, the more experienced and conservative members of the general advisory committee were concerned about the lack of organization at Livermore. Although York was scientific director, the laboratory still had no formal head. Teller still wielded an enormous and stimulating intellectual influence in the laboratory, but he could not give it the kind of stable management the committee thought it needed. York might be able to provide that stability, but he was young and relatively inexperienced. The committee hoped that the leadership question could be settled soon so that Livermore could reach its full potential.[74]

As results of the *Castle* series came in, the sense of accomplishment shared by the weapon laboratories and the Joint Task Force was certainly

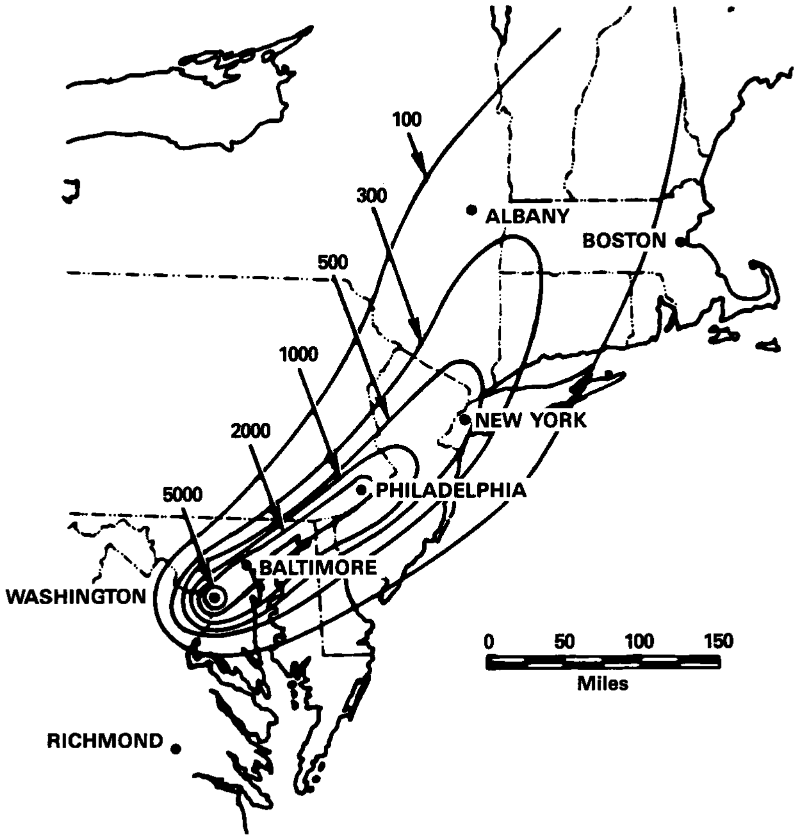

Figure 2. Fallout pattern from March 1, 1954. *Castle Bravo* detonation superimposed on the eastern United States.

justified. The weapon devices themselves were evidence of exceptional scientific ingenuity and imagination. The successful conduct of the tests, despite the unexpected difficulties created by *Bravo*, were a tribute to all three military services under Clarkson's command. But *Castle*, like *Upshot-Knothole*, did taint the sweet taste of success with a sickening reality: mankind had succeeded in producing a weapon that could destroy large areas and threaten life over thousands of square miles.

In fact, the hydrogen bomb was so enormous in its destructive power that it defied human description. The general public caught some sense of this dimension at the conclusion of the President's press conference on March 31, 1954, when in response to a question, Strauss said that the bomb could be made big enough "to take out any city," even New York. The remark made headlines in the nation's newspapers. More precise descriptions of the bomb's destructive power were not possible in unclassified statements. Much more frightening was General Fields's statement on the fallout effects of *Bravo* at a Commission meeting on May 24. If *Bravo* had been detonated at Washington, D.C., instead of Bikini, Fields illustrated with a diagram, the lifetime dose in the Washington-Baltimore area would have been 5,000 roentgens; in Philadelphia, more than 1,000 roentgens; in New York City more than 500, or enough to result in death for half the population if fully exposed to all the radiation delivered. Fallout in the 100-roentgen area, which might have been roughly comparable to the *Lucky Dragon* exposures, stretched northward in a wide band through New England toward the Canadian border. This diagram was classified secret and received very little distribution beyond the Commissioners.[75]

Although not privy to this information, knowledgeable scientists did not fail to grasp the significance of *Castle*. Eugene Rabinowitch, editor of the *Bulletin of the Atomic Scientists*, saw an ominous warning in the *Castle* results, especially when they were placed alongside John Foster Dulles's enunciation of "massive retaliation" as a principle of American foreign policy only a few months earlier. Rabinowitch expressed his alarm

> that statesmen (and ordinary citizens) discuss (and some of them advocate) "massive retaliation" as an answer to local aggression, at the very moment when the Bikini test should have taught them that "atomic retaliation" has become something no sane person should even consider as a rational answer to *any* political or military situation (short of direct Soviet aggression against the United States or Western Europe—if then).[76]

For four years the hydrogen bomb had been the preoccupation of hundreds of American scientists and engineers. In spring 1954 success had come in almost too heady a form. And just behind it were the frightening problems—some that threatened human existence itself—created by that success. The Atomic Energy Commission, the United States, and the world truly faced a new reality in the technology of war.

CHAPTER 7

NUCLEAR POWER FOR THE MARKETPLACE

In his testimony before the Joint Committee on July 31, 1953, Lewis Strauss was careful to avoid committing himself on any sticky issue arising from the development of civilian nuclear power and industry's potential role in it. In fact, Strauss told the committee, in the few weeks since he had become chairman, he had been able to do little more to prepare himself than to read portions of the transcript of the hearings that had begun on June 24 with Gordon Dean's farewell statement. The transcript presented new facts that, Strauss said, would cause him to approach the question of nuclear power with an open mind in the months ahead.[1]

Surely an open mind would be an asset in trying to cope with the tangle of policy issues produced by the sudden burst of interest in nuclear power. If nuclear energy were no longer to be an isolated, esoteric technology but a commodity in the American marketplace, significant adjustments had to be made in the nation's organic law and economic policies. But even in the more limited sphere of developing and introducing the new technology itself, Strauss and the Commission faced an impressive array of imponderables.

Many of these questions were related to the process of technological innovation: How does one best go about introducing a new technology into society? A familiar problem for large manufacturers, the management of technological innovation was hardly a common function for federal officials, except in the area of regulation. The application of radio broadcasting as a new technology in the United States, for example, did not depend upon promotional efforts by the federal government, although it did require federal regulation. The introduction of commercial air travel did require federal subsidies in several forms, but the technology itself was already in private hands. In the case of nuclear power, however, the entire technology was confined within the government in 1953. Thus, the Atomic Energy Commission faced an almost unprecedented situation in bringing nuclear reactor technology into the marketplace.

The Commission had already identified the principal vehicles of innovation. These included, first, the dissemination of technical information itself, a process severely restricted by classification rules and security procedures until the new Atomic Energy Act became law in 1954. Second, the Commission had an obvious responsibility to build experimental power reactors and to perform basic research on potential reactor materials and nuclear processes in the national laboratories. Third, it was conceivable that the Commission might build a full-scale nuclear power reactor that would provide private industry with realistic data on operational performance and costs. Fourth, the Commission might offer to assist private in-

dustry in designing, developing, and constructing full-scale power reactors. Lastly, the Commission could provide incentives for completely independent projects by private industry to construct and operate nuclear power plants. Most of these incentives were made available in the Atomic Energy Act of 1954.

DISSEMINATING TECHNICAL INFORMATION

Ever since 1947 the Commission had been trying to establish effective channels for communicating technical data to private industry within the restrictions of the 1946 act. Some of the earliest efforts, which involved clearing a few corporate executives for access to classified data, were too small to be effective; but by 1950 some useful data were reaching industry through the Oak Ridge School for Reactor Technology and the distribution of classified technical reports. Later that same year, Charles A. Thomas had requested that industrial study teams, composed of engineers from equipment manufacturers and electric utilities, be given access to the Commission's reactor development files so that the companies could judge for themselves the feasibility of building nuclear power plants.[2] By spring 1953, three such studies had been completed, a fourth had been approved, and even more industrial groups had asked the Commission for similar arrangements.[3]

With good reason the Commissioners were reluctant to accept additional study agreements. Thomas and others had used them to promote the construction of dual-purpose reactors, which could lead to undesirable subsidies to industry by exposing the government to virtually open-ended commitments to purchase the plutonium produced in such reactors at the very time that the Commission's plutonium production capacity was beginning to catch up with military requirements. As Lawrence R. Hafstad, the director of reactor development, wrote the commissioners in September 1953, "the blunt fact seems to be that we are now too late for the 'dual purpose' approach . . . and too early for the 'power only' approach." In Hafstad's opinion, reactor technology simply was not yet well enough developed to justify large investments of private money. There was a limit to what industry could learn from paper studies, and more studies were unlikely to produce new information.[4] Not until the new act was passed in 1954 would it be possible to open new channels of technical information for industry.

SEARCH FOR A PROGRAM

In opposing the encouragement of industrial study groups, Hafstad recognized that the Commission would have to respond in some other way to the growing public demand for rapid development of civilian nuclear power. A veteran administrator of government research and development projects, Hafstad had directed the Johns Hopkins Applied Physics Laboratory, which had produced the proximity fuse and other military technology during World War II. After the war he had served with Vannevar Bush as executive secretary of the research and development board in the Department of Defense before becoming director of the Commission's reactor development division early in 1949. Hafstad's ability and reputation as a physicist had enabled him to hold his own with the prestigious and influential members of the general advisory committee while his down-to-earth, practical approach as an engineer had assured him good relationships with the Commissioners and the staff.[5]

Since 1950 Hafstad had been steering a middle course between those who advocated a government-dominated reactor program, concentrating on military projects, and those who urged an accelerated civilian power program, relying heavily on private industry for reactor development. Hafstad had been caught in the cross-fire between these opposing views before, but never had his position been more uncomfortable than it was during the summer of 1953. While executives from large corporations spoke confidently of private industry's ability to take over development of civilian nuclear power at the public hearings before the Joint Committee in June and July, members of the committee openly questioned industry's willingness to invest substantially without some clear indication that nuclear power was economically feasible. Democratic members of the Joint Committee, led by Congressmen Chet Holifield and Melvin Price, pressed the Commission impatiently for a vigorous development effort that would lead to operating a full-scale nuclear power plant within a few years. At the end of the hearings Chairman Cole, in an essentially bipartisan action, requested the Commission formulate "a three to five year program consisting of specific research and development projects—perhaps including construction items."[6]

REACTORS FOR THE MILITARY

Hafstad faced several difficulties in attempting to respond to the committee's request. The Commission's reactor development program was already heavily committed to military propulsion reactors for the Navy and Air Force. The military projects not only preempted a substantial portion of available funds as well as scarce resources in the national laboratories but also tended to preoccupy the reactor development staff, to the detriment of the civilian power program. Members of Hafstad's staff were sometimes intimidated by the uphill fight against the established military projects. So strong was the military emphasis, in fact, that the Commission commonly referred to the remainder of its reactor development projects as the "civilian power program."

The strong military orientation of the reactor program was largely the result of Captain Hyman G. Rickover's extraordinary impact as chief of the naval reactors branch. Since 1948, when Rickover had succeeded in establishing himself as both a Commission official and head of the Navy's nuclear propulsion program, he had carried within the Commission's headquarters as much weight as some division directors and certainly more than any other branch chief. Totally committed to the task of bringing nuclear propulsion to the fleet, Rickover worked relentlessly to assemble within his personal control all the elements of an effective development program. By skillfully capitalizing on his dual function for the Commission and the Navy, Rickover had won for himself an unusual degree of independence from both organizations before Hafstad became director of the division. Although Rickover was careful always to comply with the formal procedures of the bureaucratic system, he took full advantage of the inattention, indifference, or mistakes of other officials to build between the Commission and the Navy an independent and (except for funding) self-sufficient development enterprise.[7]

An important step in this struggle for autonomy was Rickover's success in acquiring Commission laboratories whose entire mission was tied to his program. In 1949 and 1950 he had had no choice but to use Argonne National Laboratory to generate the scientific and technical data needed to fix the basic design of the first submarine reactor, but by 1953 he had transferred almost all work to the Bettis Laboratory, which the Commission established near Pittsburgh exclusively for the navy project. In 1950 Rickover had helped the reactor development staff to terminate an unpromising project that General Electric had been pursuing to develop a power-breeder reactor and had used this opportunity to bring the company into the navy program as a second major development contractor. With General Electric and its staff of experienced engineers and managers came the Knolls Atomic Power Laboratory, which the company had established with Commission funds as a center for developing nuclear power reactors. Although the company fought to retain at least a portion of Knolls for this purpose, Rickover eventually succeeded in excluding all activities not related to his project.[8]

Although Westinghouse and General Electric performed their work under Commission contracts, all technical supervision and much contract administration came from Rickover's office in Washington. Rickover's staff even followed the work of Westinghouse and General Electric subcontractors and took a direct interest in negotiating and administering procurement contracts for critical materials. On major policy or budget issues, Rickover had the initiative; Hafstad and the Commissioners usually endorsed his recommendations. Even on routine administrative actions, the Commission staff learned to give Rickover's requests special attention.

Administrative control was not an end in itself for Rickover; it assured him an effective voice in technical matters. In the early years Rickover had devoted an enormous amount of his time and effort to building a staff that was fully competent in nuclear science and technology. He insisted that members of his staff be prepared to review every technical decision by Westinghouse, General Electric, or any other contractor and report back with comments or criticisms for further study. Rickover focused unrelentingly on the technical unknowns or obstacles that stood in the way of successful development, and this focus took precedence over organizational relationships or the status of individuals. Rickover did not relieve contractors of their responsibilities for producing according to their contracts, but he never hesitated to intervene at any point to make sure that wrong decisions and mistakes were not threatening scheduled programs. Rickover and his staff were as unyielding and unforgiving as was the technology they were attempting to master.[9]

This highly aggressive and uncompromising style of management did not win Rickover many friends among the reactor development staff, laboratory directors, field managers, naval officers, or company officials; but his extraordinary performance against the most challenging schedules made him a force that could not be denied. Rickover himself had played a part in establishing a Navy commitment to have a nuclear submarine ready for sea by January 1, 1955. This goal required him to accomplish in five years with a completely new technology a task that often had taken as many as fifteen years in the Navy. By eliminating small reactor experiments and mock-ups, Rickover had dared to strike out simultaneously to build land-based prototypes of two types of propulsion systems: the Mark I version of the submarine thermal reactor, which Westinghouse developed at Bettis, and the Mark A version of the submarine intermediate reactor, which General Electric developed at Knolls. Because Mark I and Mark A had the same configurations and power capabilities of the proposed shipboard plants, their successful operation would provide some assurance that the shipboard units would work. Fighting against time, Rickover and his staff had the Mark I prototype operating at the Commission's Idaho test site in March 1953. Several months of testing revealed no major flaws, and on June 25 Mark I began a full-power test that Rickover continued until the plant had generated enough power to carry a submarine across the Atlantic. This magnificent achievement, perhaps more than any other single event, convinced government officials and members of the Joint Committee that nuclear power was a reality. Now it seemed possible that with some luck and hard work, Rickover might actually have the Mark II plant operating in the submarine *Nautilus* by late 1954. At the same time, General Electric was making good progress on the Mark A prototype at West Milton, New York, and Bettis had already started engineering studies for the submarine advanced reactor, which would include many improvements over the *Nautilus* plant.[10]

Although the Navy project caused Hafstad some headaches, it was by no means so troubling as the joint effort with the Air Force to develop nuclear propulsion systems for military aircraft. Since 1946 some Air Force officers had dreamed of using nuclear power to provide essentially unlimited range for a bomber carrying nuclear weapons. During the overly exuberant early days at Oak Ridge, aircraft companies under Air Force contracts were eager to design airframes and jet engines for such a plane even before any concept of the nuclear power plant had been developed. Designing a reactor with sufficient power and reliability and at the same time light enough and with sufficient shielding against radiation proved no easy task. By 1953 the Commission was spending more than $17 million per year on two types of propulsion systems: one by General Electric, in which air from the turbines would be heated directly in the reactor core, and a second at Oak Ridge National Laboratory, which would use as a heat source a reactor fueled with a liquid mixture of fused salts containing uranium. Liquid sodium would carry heat from the reactor to a heat exchanger. The Truman budget for fiscal year 1954 proposed a substantial increase that would have brought total expenditures by the Commission and the Air Force close to $54 million per year. The Eisenhower Administration, in its quest for budget reductions, had cut the project back to $15.3 million in Commission funds and $9.4 million from the Air Force, figures not much below actual costs in the previous year. The cuts moved the several projects back from pilot plants and prototypes to fundamental experiments.

The continuing lack of coherence in the aircraft program proved that there was nothing magical about the organization of the Navy project. In a deliberate effort to copy the Rickover pattern, the Air Force and the Commission had set up a joint project with an Air Force officer, Brigadier General Donald J. Keirn, to serve in a dual capacity much as Rickover did. By summer of 1953, however, it was evident that Keirn, despite his considerable abilities and experience, had probably taken the reins too late to bring order out of chaos. Lacking both a clear focus and a promising technical base, the aircraft program was doomed to continuing frustration.[11]

REACTOR EXPERIMENTS

In responding to the Joint Committee's request for a short-term commitment on civilian power reactors, Hafstad had to consider the reactor experiments that the Commission was already planning or building. The problem was that, although some of these projects had been started years earlier, none could possibly lead to an economic power reactor in three to five years, no matter how much the Joint Committee insisted on quick results. In fact, as Hafstad pointed out to the Commissioners in September 1953, five years was too short a period for effective planning, much less constructing reactors.[12] The reactor experiments that the Commission had first authorized in 1948 were only the beginning of a long-term development process. In one sense, these experiments represented a judicious and commendably conservative approach to nuclear power. By building a series of small, relatively inexpensive reactor experiments, each using a theoretically promising approach to the design of a power reactor, the Commission hoped that it could evaluate the relative advantages of several designs before heavily committing to constructing full-scale reactors. Approaching innovation on a broad front in the early stages of development was precisely the strategy that Vannevar Bush and James B. Conant had advocated with stunning success in producing fissionable material for the first atomic weapon.

Despite the compelling inner logic of the broad front approach, it had substantial disadvantages for the Commission in summer 1953. Most obviously, none of these experiments could conceivably produce significant amounts of power. With luck, one of them might justify starting work on an actual power reactor in five or ten years. Coupled with the broad front, the experimental approach suggested to the uninitiated timidity and indecisiveness within the Commission. Second, the Commission's approach reinforced certain Joint Committee and public misconceptions about the nature of technological development. For example, some thought that a small reactor experiment would tell the engineers most of what they needed to know to build a power reactor; however, although the experiment often produced valuable clues, it almost never revealed a clear pathway to success. The popular assumption, frequently expressed in Joint Committee hearings, was that the progression from reactor experiment, to pilot plant, and then to full-scale power reactor was not only direct but automatic. As many reactor engineers had already learned, even the successful operation of a reactor experiment did not necessarily warrant further development.

These misconceptions originated in another popularly accepted assumption: the familiar pathways of development in chemical engineering provided an adequate model for reactor technology. In the past, engineers had enjoyed notable success in translating the results of an experiment in a chemistry laboratory into an efficient industrial process. In reactor technology, however, the phenomena involved were just as complicated, and the number of nontechnical variables was much larger. As in chemical engineering, scientific data were essential to developing reactor technology, but they were far from sufficient. Still in its early stages, reactor technology

also required a large measure of creative and imaginative engineering to make the transition from experimental reactor to proven reactor.

Most Commission experience since 1947 testified to these limitations of the reactor experiment. The most publicized effort of this type by 1953 was the experimental breeder reactor, which Walter H. Zinn and his Argonne team had built at the Commission's Idaho test site. The experiment, in generating token amounts of electric power in late 1951, had first suggested to the American public that nuclear power was imminent. The experiment also demonstrated that breeding was at least theoretically possible. But the reactor, despite its success as an experiment, did not open the way to a practical power source. The facility verified scientific principles; it did not address the host of extraordinarily difficult engineering problems involved in extracting useful energy from a power source of very high density with a liquid-metal coolant. In 1952, following the successful operation of the experiment, the Commission had approved simultaneous studies of an intermediate-scale breeder by Argonne and a full-scale breeder by the California Research and Development Company. The Commission, however, was unable to convince the Bureau of the Budget that this next step was likely to lead to concrete results, and the plan was dropped.[13]

The efforts of Alvin Weinberg and his staff at Oak Ridge to develop a homogeneous reactor had experienced a similar fate. Oak Ridge had built a homogeneous experiment, which in 1953 had generated a few watts of electric power and had demonstrated the principle of operation. The distinctive advantage of such a reactor was that it avoided the expensive process of fabricating fuel elements, moderator, control rods, and other high-precision core components by placing a fluid mixture of fissionable material, moderator, and coolant in a tank of proper configuration to produce a critical mass. Energy could be extracted simply by pumping the fluid through external heat exchangers, and, theoretically at least, the reactor could be refueled by continuously reprocessing the fluid without shutting down the system. Thus, the system held out the possibility of very low costs and high efficiency in heat transfer. In the eyes of many nuclear scientists and engineers these advantages made the homogeneous reactor potentially the most promising of all types under study, but once again the experiment did not reveal how the tricky problems of handling a highly radioactive and corrosive fluid were to be resolved. Weinberg's next step was not to be a power reactor but merely another experiment of slightly larger size with design improvements that might make continuous operation possible.[14]

Of all the promising reactor types, the Commission's laboratories had the most experience with water reactors, in which either ordinary water or heavy water served as both moderator and coolant. Argonne had taken the lead in developing heavy-water reactors, not for power generation, but for plutonium production at Savannah River. The high cost of heavy water and the availability of enriched uranium from the gaseous-diffusion plants, however, did not make this type attractive for power generation. Of much greater interest was the light-water reactor, which Weinberg and others had suggested at Oak Ridge during World War II. The materials testing reactor, developed cooperatively by Oak Ridge and Argonne, used the light-water system, and Rickover had adopted light water for the Mark I prototype (and, of course, for the Mark II as well).[15]

In all these light-water applications, the moderator-coolant was kept under pressure to prevent boiling, and special care was taken to design reactors so that no local boiling would occur. There was some concern among engineers that boiling within the reactor might either cause voids, "hot spots," that would affect reactivity or lead to oscillations that could produce destructive power surges. In his quest for a reliable propulsion system, Rickover had selected the pressurized water system for the aircraft carrier reactor as well as for Mark I, Mark II, and the submarine advanced reactor. The decision by the Eisenhower Administration to convert the carrier reactor into a civilian system meant that the Commission's first full-scale power plant would use pressurized water.[16]

Logic suggested, however, that a boiling-water reactor would have a higher thermal efficiency than a pressurized system. For that reason it was only a matter of time before someone investigated this possibility. Early in 1950 Samuel Untermyer at Argonne suggested that steam formation in the core of a light-water reactor during a power excursion might actually shut down the reactor. If this were true, it might be possible to build a power reactor actually using boiling as a control mechanism. A series of experiments at Argonne with electrically heated fuel elements immersed in water gave promising results on heat transfer and steam formation. To provide data on the effect of steam voids on instability Untermyer proposed construction of a reactor experiment at the Idaho test site. Joseph R. Dietrich and others at Argonne designed the boiling reactor experiment, called Borax-I, that operated successfully at just about the time the Joint Committee issued its request for a reactor plan in summer 1953. Borax-I showed not only that a boiling reactor had a high degree of inherent safety in its ability to shut itself down, but also that it could operate stably.[17] When the Commission came to formulating the five-year reactor program, the boiling water reactor would certainly be an option to consider.

THE ROLE OF INDUSTRY

The centerpiece of the Commission's five-year program as it developed in autumn of 1953 was to be the pressurized-water reactor, which Murray and Dean had managed to salvage from the demise of the carrier propulsion project. With Eisenhower's approval and the National Security Council's acquiescence, the Commission had decided in June that the quickest way to build a full-scale nuclear power plant would be to give Rickover the tasks of stripping the naval features from the carrier propulsion project, which Westinghouse had already started at Bettis, and developing the basic design for power purposes.

The decision, however, was inherently too controversial to be made so easily. When Strauss succeeded Dean as chairman just two weeks later, the issue was ripe for reopening, especially since the Commission had not yet announced the decision. The first move for reconsideration came from the reactor development staff itself at a Commission meeting on July 9, 1953. Hafstad's assistants made a plea for a reactor that would be large enough to have a chance of being economical. Rickover countered that argument by insisting that the power rating was limited by the size of the pressure vessel, which approached the limits of power plant technology at that time. He could not, however, respond so easily to the implications of a letter that arrived from the Joint Committee by special messenger during the course of the meeting. In the letter Cole notified the Commission that his appeal to the House Appropriations Committee for construction funds for the pressurized-water reactor had been approved. Thus, in Cole's words, the project had been "*initiated* by the Congress," and for that reason the Joint Committee had "a more than usual interest" in it. Cole also expressed concern about the "heavy emphasis" on naval aspects. The implications were clear: the Joint Committee intended to see that the Commission built a full-scale power reactor and that Rickover did not dominate it for his own purposes.[18]

Rickover interpreted the letter as a challenge to his own role in the project, but he told Murray on July 13 that he was more concerned about rumors of industry opposition. Murray confirmed this report in a call to Willis Gale, chairman of the Commonwealth Edison Company of Chicago. Murray held firm on the Commission's decision to build the reactor under Rickover's direction, but he did invite Commonwealth Edison and other utilities to join the project. Gale made it clear that he was not interested in sending a few engineers to work under Rickover, but he was enthusiastic about Murray's earlier suggestion that several other electric utilities join Commonwealth Edison in building a nuclear power plant. At the moment, however, Gale and his associates seemed much more interested in a heavy-water reactor than in the Commission's proposal.[19]

Murray still believed that no one company could afford to build a nuclear power plant without some hope that it would be economically competitive, but he had to admit that Gale was assembling an impressive group of companies. The Nuclear Power Group, as it came to be called, included some of the largest electric utility companies in the nation: the American Gas and Electric Service Corporation of New York City, the Pacific Gas and Electric Company of San Francisco, and the Union Electric Company of St. Louis. Also part of the group was the Bechtel Corporation of San Francisco, one of the nation's largest construction firms for conventional power plants.

Although Murray was willing to entertain serious proposals from such groups, he was not ready to permit vague expressions of interest to undermine the Commission's decision to build a pressurized-water reactor under Rickover's control. To ratify that decision, Murray urged Strauss to issue a press release, preferably one from the White House. After Moscow radio on August 19 revealed the detonation of *Joe 4*, Murray urged the Commission not to lose the enormous propaganda advantage of responding to the Soviet saber rattling with a declaration of the United States' intention to develop nuclear power for peaceful purposes. Strauss, however, continued to procrastinate, perhaps as a caution against Murray's exuberance, perhaps to get a better feel for the Commission's policy stance during his first weeks as chairman. Strauss himself told Murray that he was simply trying to make sure that the plant was built at minimum cost.[20]

While Murray continued to press the Commission to announce its decision on the pressurized-water reactor, he also pursued discussions with the Nuclear Power Group in hopes that it would join the project. Murray could do this with the Commission's blessing following approval of a study agreement with the group on August 20. Further discussions with Philip Sporn of American Gas and Electric encouraged Murray to believe that the Nuclear Power Group might agree to build and operate the reactor at a site near Portsmouth, Ohio, where the facility might provide some of the enormous quantities of electric power needed to operate the new gaseous-diffusion plant. He predicted that, once the Commission announced its decision to build the plant, the Nuclear Power Group would offer to meet one-third of the costs for the steam system and turbogenerator, which might total $10 million.[21]

NUCLEAR POWER AND NATIONAL SECURITY

By mid-October rumors of the Commission's decision were beginning to leak to the press, and Strauss could no longer put off Murray's insistence upon an announcement. In a dramatic speech before an electric utility convention in Chicago on October 22, 1953, Murray announced that the Commission would build a full-scale power reactor capable of producing at least 60,000 kilowatts of electricity. The drama of the speech, however, came, not from this statement of fact, but rather from Murray's effort to put the decision in context. He took the occasion to reiterate every argument he had used over the previous six months when internally discussing nuclear power policy and the role of industry. Attaining economical nuclear power, in Murray's opinion, was just as vital to national security as the United States' preeminence in nuclear weapons. Friendly nations were counting on the United States not only to protect them from Soviet aggression but also to supply them with nuclear power technology. In fact, Murray pointed out, some of these nations (he did not name Belgium and South Africa) provided the United States with uranium ores essential for building the nuclear arsenal. "Unless we embark on an all-out attack on our nuclear power program immediately, we may be deprived of foreign uranium ores." Thus "the atomic arms race and the nuclear industrial power race [were] strangely related."[22]

Having evoked this starkly pragmatic argument, Murray explained the background for the Commission's decision going back to the nuclear power statement in spring 1953. Murray assured his audience that as a business man in private life, no one was more anxious than he to end "nationalization" of atomic energy. But he was convinced, along with most of the Commission, that the federal government had to build the first full-scale plant; only then would the skills and competitive motivations of private industry be effective. Thus, the Commissioners' decision to build the pressurized-water reactor was only an interim measure, merely a first step toward establishing the new industry. In the meantime, the pressurized-water reactor would be America's answer to the recent Soviet thermonuclear test. "For years," Murray concluded, "the splitting atom, packaged in weapons has been our main shield against the Barbarians—now, in addition, it is to become a God-given instrument to do the constructive work of mankind." *U.S. News and World Report* summarized the message for the busy reader:

> Atomic power for industry is on the way. An international race for supremacy has started. Britain, with one atomic-power project, is in the race. Russia probably is starting. Now the U.S. is jumping in. Plan is for a full-scale atom-power plant at a big atomic-materials center. If it works, as expected, U.S. will keep its atomic lead.

Time called the announcement "a new phase" of the atomic age, and the *New York Times Magazine* forecasted the age of atomic power.[23]

THE FIVE-YEAR PROGRAM

By the time Murray delivered his Chicago speech, the Commissioners were already well on their way to formulating the five-year development program that the Joint Committee had requested. At the policy conference at White Sulphur Springs in September 1953, Hafstad had presented the full scope of the issues that the Commission faced in developing nuclear power for the marketplace. Hafstad's alternatives ranged all the way from a plan for developing nuclear power by private industry, using as much as $200 million in federal funds over the five-year period, to a government-controlled program centered in the Commission's national laboratories.[24]

As Murray's speech revealed, Commission thinking was much closer to the second extreme than to the first. Three projects in the five-year program represented continuing efforts by the Commission's national laboratories and were completely under government control: the fast-breeder and boiling-water experiments at Argonne and the homogeneous reactor experiment at Oak Ridge. One concept, the sodium-graphite reactor, would be pursued by North American Aviation, Incorporated, as the only example of a private development effort financed by the Commission. The fifth project, the pressurized-water reactor, was government-sponsored and directed, with the degree of participation by private industry to be determined by the response to the Commission's invitation of December 7, 1953, for proposals to invest in the project.[25]

The classified report of more than 130 pages, which the Commission delivered to the Joint Committee in February 1954, outlined in detail the rationale for selecting the design concepts to be developed. The report included reasonably candid evaluations of the status of each concept. The pressurized-water reactor seemed most likely to be successful in the short term, by the end of 1957, but it offered a poor long-term prospect of producing economic nuclear power. Argonne's next step beyond the Borax tests would be an experimental boiling-water reactor to be built at the Illinois laboratory. Because the concept was new, the boiling-water reactor would not be ready for large-scale testing for at least five years, but it showed more promise of achieving competitive power than the pressurized-water reactor. The first step toward the sodium-graphite reactor was to be the sodium reactor experiment, which North American would build at the company's site in Santa Susana, California. Because, like the pressurized-water reactor, the sodium reactor experiment could take advantage of relatively well-developed technology, the experiment was likely to prove successful in the short term but did not hold great promise for generating economic nuclear power. As for the fast breeder, Argonne had scaled down its plan for developing medium- and full-size plants simultaneously and had decided to build a second experimental breeder reactor at the Idaho testing station, where the first breeder was still operating. Oak Ridge intended to take a similarly modest step toward a homogeneous reactor by building a second experiment at the Tennessee laboratory. Both the homogeneous and fast-breeder projects were unlikely to result in significant breakthroughs in the short term, but there was widespread agreement that these types were the most promising approaches to the commercial power plants of the future. The Commission expected to spend $8.5 million per year on research and development, while the five experimental plants would cost $200 million.[26]

SHIPPINGPORT

A careful review of the proposed five-year program on February 5, 1954, led the Joint Committee to the conclusion that the plan was sound and deserved support. The only reservation concerned the wisdom of building the pressurized-water reactor as a full-scale plant when it had no chance of generating economic power. Holifield wanted to make certain that, if the project were terminated, Hafstad would not be tempted to substitute one of the more promising reactors. Hafstad assured him that other types, such as the homogeneous or boiling-water reactors, although more promising in the long run, were not ready for full-scale construction at that time. Holifield found more reassurance in the fact that Rickover had now scaled down the estimated cost of the pressurized-water reactor to $52 million, but he was still concerned that some scientists who opposed the Commission's decision to build the reactor might later accuse the Joint Committee of wasting the money on what the members knew was going to be an uneconomic reactor. With Hafstad's assurance that the project was sound, Holifield and the committee were willing to proceed, but they wanted to review the situation again after the responses to the Commission's invitation for proposals from industry had been evaluated.[27]

Even before the February 15 deadline, the Commission had eliminated the Nuclear Power Group, which in November had submitted an offer to provide trained personnel, build the conventional electrical generating portions of the plant, and operate the plant. The estimated financial contribution by the group, however, was so small that the Commission had no choice but to reject it. With that rejection, the last hope for construction of the nation's first commercial nuclear power plant by private industry disappeared.[28]

Of the nine offers received by the February deadline, the one from the Duquesne Light Company of Pittsburgh was clearly superior. The company offered to build a new plant on a site it owned in Shippingport, Pennsylvania, on the Ohio River twenty-five miles northwest of Pittsburgh. At no cost to the government, Duquesne offered to provide the site, build the turbogenerator plant, and operate and maintain the entire facility. The company also agreed to assume $5 million of the cost of developing and building the reactor, which Westinghouse would design and the Commission would own. For the steam delivered by the reactor the company was willing to pay the equivalent of eight mills per kilowatt-hour, a comparatively high price. Hafstad's staff estimated that over the course of the five-year contract Duquesne's contribution would be more than $30 million, compared to $24 million for the next most attractive proposal. Also, under the Duquesne offer the Commission could cancel the contract at any time without incurring termination charges.[29]

As General Manager Nichols told the Joint Committee on March 12, 1954, the Duquesne proposal was almost too good to believe. He was convinced that the company had extended itself to make an attractive offer simply because Duquesne wanted to get in on the ground floor in nuclear power. Patiently Nichols reviewed every project in the five-year plan and assured the committee that only the pressurized-water reactor was ready for full-scale construction. The decision to build the plant, however, did not mean that the other projects would be neglected. The decision, Nichols said, might actually spur the other projects to new efforts, and he did not rule out the possibility that in another year another approach might be ready for full-scale construction.

In the course of the discussion Representative Carl Hinshaw, the only engineer on the Joint Committee, raised a new and intriguing question: Had the Commission considered the international implications of the five-year program? As Murray had suggested in his Chicago speech, the Commission was developing power reactors not just for domestic use but also for friendly nations abroad. Had the Commission thought about what type of reactor would be best suited for export? Smyth replied that the Commission had discussed the subject without coming to any conclusion, but he did make some personal observations after determining that it was permissible to speak on classified matters. The facts were that the United States could offer to export either heavy-water or light-water reactors under the Atoms-for-Peace program. Heavy-water reactors might be more attractive to European nations because they could probably obtain supplies of heavy water and natural uranium without depending on the United States. If, however, the United States selected light-water reactors for export, the Commission would have to supply the slightly enriched uranium fuel because no European countries were likely to make the heavy financial commitment necessary to build an enrichment plant. One advantage, then, of using light-water reactors for export, Smyth noted, was that the United States could control both the supply of uranium fuel elements and also reprocessing of spent fuel. This leverage could be important in assuring reliable safeguards against the diversion of fissionable material.[30]

NUCLEAR POWER AND ATOMS FOR PEACE

While the Joint Committee continued to press the Commission on developing commercial power reactors, the Eisenhower Administration was exerting similar demands from the sanctuary of the National Security Council. In the summer of 1954 the council's planning board, on which Roy Snapp represented the Commission, began to formulate the specific measures for following through on the President's Atoms-for-Peace proposal. Efforts to create the International Atomic Energy Agency and to organize an international conference on the peaceful uses of atomic energy were high on the list. But the planning board expected nuclear power to offer a practical goal for international cooperation.

Snapp and his colleagues recognized that economic nuclear power was still at least a decade away and that most countries had neither the trained personnel nor the resources to support its development. It did seem feasible, however, that the United States could provide small experimental or training reactors with limited amounts of slightly enriched uranium as fuel. By suggesting that experience with research reactors was an essential step in achieving technical capability for building power reactors, the United States could gain time for resolving the difficult policy questions involved in selling power reactors abroad.[31]

As Strauss pointed out to the National Security Council on August 12, 1954, the United States could not avoid the issue for very long. Countries with critical shortages of power, like Sweden and Japan, might want to move quickly toward nuclear energy. How would the United States decide which countries would receive the limited assistance that the United States would be able to provide? And how could the United States prevent the diversion of fissionable material produced in power reactors to nonpeaceful purposes?[32]

To answer these and other questions the planning board appointed a subcommittee under Snapp's direction to draft a policy statement. Drawing heavily upon the Commission's staff for ideas and opinions, Snapp completed his paper before the end of 1954. Cautionary in tone, the statement first contained the warning voiced by Commissioner Murray and members of the staff that the operation of research reactors was not an essential step in the development of power reactors as the planning board's August draft had implied. Although a research reactor in a foreign country might help to train scientists and engineers in nuclear technology, the research reactor itself would not reveal much about the design of a power reactor. Second, Snapp and the Commission took a dim view of building a full-scale power reactor, like the Shippingport plant, in a foreign country; such a plant would be neither economical nor reliable for continuous and fault-free operation. In fact, the project might do the cause of nuclear power more harm than good.[33]

Throughout fall 1954 and into winter 1955, however, the Commission had to contend with the persistent hope expressed by State Department officials and other members of the planning board that nuclear power might be the key to a successful Atoms-for-Peace program. No sooner did the Commission deflate one idea than the planning board came up with another. By the time Snapp's policy paper reached the National Security Council itself, it advocated, not the construction of a Shippingport reactor abroad, but a cooperative effort by scientists and engineers from friendly nations to construct an experimental power reactor in the United States.[34]

Strauss rose in the National Security Council on February 10, 1955, to oppose this idea. Such a project would result in hopeless confusion, a "tower of Babel"; but even worse, it would give foreign scientists access to the most advanced United States designs for power reactors. This argument appealed to Secretary of Defense Wilson, who hoped that such advantages would be reserved for American industry. On the other side were Secretary of State Dulles and United Nations Ambassador Henry Cabot Lodge, who, although not questioning the Commission's technical appraisal of the idea, expressed concern that the Administration still had not come up with one solid project that would clearly support the President's commitment to nuclear power in his United Nations speech. Strauss argued that the training and assistance programs already launched would do much more for Atoms for Peace than would the experimental reactor. Eisenhower agreed that the reactor idea was just a "gimmick." No decision would be made until Strauss had completed a comprehensive report on the status of nuclear power.[35]

NEW HORIZONS

International implications were not the Commission's only concern in reactor development policy in 1954. Equally pressing were the requirements of the new Atomic Energy Act, which became law in August. Nichols had already asked the staff to begin thinking about the administrative structure and regulations required to transform the government's near-monopoly of nuclear energy into a new commercial industry. Before the end of the summer, Nichols established several task forces within the staff to begin drafting the series of required regulations and procedures.[36] The task forces included one or more experienced attorneys from the general counsel's office and appropriate specialists from the program or staff divisions. To supervise and coordinate the work of the task forces, Nichols selected Harold L. Price, a crusty, conservative lawyer who had been a mainstay of the legal staff since Manhattan Project days at Oak Ridge. Thoroughly professional to the point of being impersonal, Price was not the sort who would have been picked to be general counsel, but he was a conscientious and reliable practitioner of the legal art.[37] He had drafted much of the atomic energy legislation enacted since 1947, including crucial sections of the 1954 act.

Price could be relied upon to do the job right without yielding to pressures for expediency even if they came from the Commissioners, industry, or members of Congress.

The Commission had no intention, however, of waiting for Price to construct the new regulatory framework before encouraging direct private participation in nuclear power development. Strauss in particular was driven by the National Security Council directive, which placed a high priority on nuclear power to be developed with private rather than government funds. Although Strauss accepted the necessity of the five-year program and the Shippingport reactor to get commercialization started, the Commission had been criticized for recommending government control in these two instances. Beyond that, both Strauss and his fellow Commissioners were sensitive to the repeated claims by industry executives, particularly in the Nuclear Power Group, that private companies were ready to make the substantial financial commitments necessary to build a full-scale nuclear plant. The Commissioners were ready to call what they considered industry's bluff by soliciting proposals for joint or full participation.[38]

During autumn 1954, Nichols worked with Price, Hafstad, and Don S. Burrows, the Commission's controller, in designing an acceptable form of solicitation. Because Nichols and his associates entertained almost no hope that industry would undertake to build full-scale plants without some government support, Burrows had to make some provisions for funding in the 1956 budget, which was then in the final stages of preparation. Informal discussions at the Bureau of the Budget had encountered considerable skepticism about the Commission's request for $50 million in operating funds and $25 million for construction to stimulate industrial participation. Bureau officials wondered whether this kind of stimulation was warranted so soon after passage of the 1954 act, especially when Nichols admitted that there was no urgent domestic need for nuclear power. The motivation, Nichols said, was the Atoms-for-Peace program and the international race with the Soviet Union and the United Kingdom for world leadership in the new technology.[39]

To support the budget request, Nichols sent the Commissioners a brief staff paper on December 13, 1954. He suggested a power demonstration reactor program, under which private companies would be invited to design, build, and operate their own nuclear power plants with only limited assistance and funding from the Commission. The Commission would waive all fuel-use charges for seven years, although industry would be required to pay for fissionable material actually consumed in the reactors. The companies could perform some work in Commission laboratories and would enter into contracts that would provide fixed amounts of funding for development, fabrication, and experimental plant operation. All proposals were to be submitted by April 1, 1955, and would be evaluated in terms of their probable contribution to achieving economically competitive power, the cost to the Commission of fuels and materials, the risk assumed by industry, and the competence and responsibility of the proposer.[40]

Most discussion at the Commission meeting on December 21, 1954, centered on the April 1 deadline. Two Commissioners thought the short deadline would eliminate companies that were not already involved as contractors or members of industrial study groups. Nichols admitted this danger, but he thought it essential to have some replies in hand when he defended the $75-million budget request before Congressional committees in spring 1955. Informal discussions with industry leaders led Nichols to believe that there would be at least three proposals, an estimate on which he had based the $75-million request. He assured the Commissioners that they could issue a second invitation in autumn 1955 if all of the funds were not committed in response to the first.[41]

In retrospect it is difficult to understand how a paper with such far-reaching consequences could win Commission approval so easily. The power demonstration reactor program was, after all, the most decisive step the Commission had yet taken toward creating a nuclear industry. The plan was intended to draw private enterprise into the complex and usually controversial relationships that were part of the process of federal licensing and regulation. The five-year program had focused entirely on technological development; it did not involve private enterprise. Shippingport was really a government project with only a limited role for private industry. With power demonstration reactors the Commission would finally begin to cross the dividing line between government monopoly and private enterprise.

Yet the Commission approved Nichols's idea without considering its economic or political implications. Perhaps the quick decision was a tribute to Nichols's firm management of the staff, but more likely it resulted from the general manager's cool and competent presentation. Nichols reduced the decision to the practical perspective of the engineer-administrator. The plan seemed a sensible first step toward a distant goal, a step that the Bureau of the Budget and the Congress could understand and appreciate. It was not cast as a major policy decision. Certainly there was good common sense in Nichols's tactics, but there were dangers in this casual, almost tentative approach. It opened the possibility that the Commission would have to resolve in public many specific issues it had not settled in the comfortable confines of the conference room on Constitution Avenue.

NEW FACES ON THE JOINT COMMITTEE

Strauss had every reason to anticipate controversy when he next met with the Joint Committee. Democratic victories in the 1954 fall elections deprived the Republicans of Congressional control after two short years. Within the Joint Committee the shift in power was reflected in both leadership and membership. Following the pattern established in 1953, the committee chairmanship now reverted from the House to the Senate, where the ranking Democrat was Clinton P. Anderson of New Mexico. A member of the Joint Committee since 1951, the former Secretary of Agriculture under Truman had become a prominent critic of the Eisenhower Administration for its efforts to enlarge private industry's role in nuclear power development at the expense of government projects. Although Anderson's initial impression of Strauss was favorable, that opinion had begun to deteriorate following the Democrats' failure to kill the Dixon-Yates proposal in summer 1953, and Murray's ever more pointed attacks on Strauss hastened the process. The Republican stalwarts on the Senate side were still to be reckoned with: Hickenlooper, Eugene D. Millikan of Colorado, Knowland, and Bricker. They were matched by Democrats John O. Pastore of Rhode Island, Albert Gore of Tennessee, and Henry M. Jackson of Washington, who was returning to the committee after previous service as a congressman. On the House side the leaders were the same—Holifield and Price for the Democrats and Cole and Hinshaw for the Republicans—but the 1954 elections gave the Democrats a dominant position.

The aggressive and experienced leadership already demonstrated by the Democratic members of the committee foreshadowed a sharp challenge to the Eisenhower Administration and its nuclear policies. Soon after the new Democratic Congress convened in January 1955, Senator Anderson set out to reverse the action of the lame-duck Republican majority, which in November 1954 had waived the thirty-day waiting period for Joint Committee consideration of all electric utility contracts so that the Dixon-Yates agreement could be signed before the Democrats took over. On January 28, 1955, the Joint Committee formally revoked the Republican resolution and recommended cancellation of the Dixon-Yates contract.[42]

THE PUBLIC FORUM

The opportunity for direct confrontation between the Commission and the committee first appeared in the hearings that Anderson called for January 31, 1955, pursuant to Section 202 of the new act. In authorizing the committee to conduct hearings on "the development, use, and control of atomic energy" during the first sixty days of each session of Congress, Section 202 gave the committee license to probe ultimately into every aspect of the Commission's activities. That privilege, plus the mandate to pass on all authorizations for construction appropriations under Section 261, gave the Joint Committee two powerful tools with which it would influence national policy on nuclear power over the next decade.[43]

Anderson began the Joint Committee hearings on January 31 on a cordial note by extending Strauss best wishes on his birthday, and Strauss replied by discussing the power demonstration reactor program and its relationship to the five-year program, as the committee had requested. But later that afternoon Murray moved the hearing into a political context by charging that the Commission had been so preoccupied with the Dixon-Yates contract in recent months that important business had been neglected. Strauss refuted the charge the next day as "unfortunate and inaccurate," and both men proceeded to poll the staff on the actual amount of time spent on the Dixon-Yates matter since the contract had been approved in November. When Murray claimed a week later that the figure was more than two thousand hours, Strauss tried to put the facts into perspective by having a courier wheel into the hearing room a pile of boxes containing all the staff papers considered by the Commission since Dixon-Yates was first introduced a year earlier. As a contrast he showed the committee a small folder containing all the papers coming to the Commissioners on Dixon-Yates. This unseemly display, which caused Anderson to lose his patience, was but further evidence of the petty bickering and accusations of dishonesty that undermined relations between the two Commissioners. Under the circumstances, Anderson was not inclined to accept the charges of either antagonist, but the dispute did not enhance his confidence in Strauss. Trivial to the point of annoyance, the squabble did breed distrust and suspicion between the Commission and the Joint Committee.[44]

Despite the disruptive effects of the Dixon-Yates issue, Anderson and the committee were able to pursue a thoughtful and penetrating discussion of the power demonstration reactor program. Nichols provided a well-rounded justification for the Commission's invitation as a first effort to determine the amount of government assistance that industry might require before entering the nuclear power field. The Commission was convinced, Nichols said, that industry was not yet prepared to build nuclear power plants without financial help from the government, but at the same time the Commission was determined to hold government assistance to a minimum.

If the Commission's predictions were wrong and industry was willing to proceed alone, the Commission certainly would not stand in the way.

Very close questioning of industry witnesses during the hearing supported the Commission's rationale. Walker L. Cisler, spokesman for a group of midwestern electric utilities planning to submit a proposal under the new program, admitted that government assistance of this kind was needed to demonstrate the feasibility of nuclear power in full-scale facilities. But Cisler still maintained that industry was fully prepared after successful demonstration to take the next step on its own; he claimed that a large-scale government development program was unnecessary.[45]

Although the Commission's program, as Nichols argued, did attempt to respond to the realities of the situation, it had the disadvantage of most compromises: it was subject to attack from two directions. Holifield saw the program as an admission that the confident statements by private industry about the promising commercial prospects for nuclear power were merely window-dressing. Cole, however, saw the Commission's program as a subtle effort to use government contracts rather than licenses under the new act to develop nuclear power. Specifically, Cole questioned whether the Commission could provide assistance and funds for research on power demonstration reactors without violating the "no-subsidy" provision that the act applied to licensees. Nichols assured Cole that the Commission would be careful to see that no Commission money went into bricks and mortar for power demonstration plants and that funds for research would be limited to a predetermined amount.[46] Thus, the 202 hearings reinforced the Commission's determination to hold government assistance to a minimum.

Whether this kind of limitation was consistent with the aim of accelerating nuclear power development was another question. In fact, the general tenor of the hearings was that rapid development should take precedence over other considerations. Jerry Voorhis, executive director of the Cooperative League, once again criticized the 1954 act for encouraging monopoly in the electric power industry, but he too put nuclear power first. "In part the resolution of the present crisis in the world," Voorhis declared, "depends on the relative success of the free world, as contrasted with the totalitarian world, in building a quality of life that is good for all its people and I believe atomic energy can play a major role in this great enterprise." When Senator Pastore asked whether the United States was doing all it could to develop nuclear power, Cisler reminded him that the nation already had 40 percent of the world's electrical generating capacity, which was sufficient at the moment. But Pastore was unconvinced: "Are we not trying to win the hearts and minds of people in other parts of the world? . . . That is the great inspiration that was given to the world in the speech made by the President. Are we winning that race?"[47]

At least, the Joint Committee was prepared to await the results of the Commission's invitation. If attractive offers were received on April 1 and industry demonstrated a willingness to build reactors, perhaps no further government encouragement beyond the power demonstration program would be required. In the meantime, however, the Joint Committee was closely watching the Commission's activities, especially the five-year program for building reactor experiments. In early March 1955 the committee, anticipating inspection trips to the laboratories, asked the Commission for a progress report on the five reactor experiments. A few weeks later, just before the deadline for the power demonstration proposals, the committee announced the appointment of a special panel to study the impact of the peaceful uses of atomic energy. Such a panel would surely probe the Commission's nuclear power efforts, and the appointment of Robert M. McKinney, editor of the *Santa Fe New Mexican* and friend of Senator Anderson's, suggested the likelihood of political motivations in the study.[48] Clearly the public debate on nuclear power policy was just beginning.

POWER DEMONSTRATIONS: DEFINING INDUSTRY'S ROLE

In spring 1955 the Commission pinned most of its hopes on the power demonstration reactors. After worrying for weeks that the response to the January invitation would be unimpressive, the Commission was mildly pleased to receive four proposals by the April 1 deadline. The Nuclear Power Group, which had bid unsuccessfully on the Shippingport project, offered to build a 180,000-kilowatt boiling-water reactor, to be completed near Chicago by 1960. A group of nine electric utilities headed by the Detroit Edison Company proposed to build a 100,000-kilowatt fast breeder, to be completed by 1958 in the Detroit area. The Yankee Atomic Electric Company of Boston, a consortium of thirteen utilities in New England, opted for a 100,000-kilowatt pressurized-water reactor, to be completed in western Massachusetts by late 1957. Finally, the Consumers Public Power District of Columbus, Nebraska, proposed a 75,000-kilowatt sodium-graphite reactor, to be completed in 1959. All four projects represented an extension into the demonstration phase of four of the five reactor types that the Commission was developing under the five-year program, and Strauss confidently expected in a few weeks a fifth offer, which never came, for a homogeneous reactor. In the weeks before the April 1 deadline, company officials were frequently in contact with Strauss, other Commissioners, Nichols, and the staff. The utility groups probably knew enough about each other's interests to match the Commission's program almost project for project.[49]

The almost casual way in which the Commission had approved the demonstration program in December 1954 and the very general selection criteria set forth in the invitation did not provide much guidance for evaluating the proposals. By the time the selection board and the director of reactor development reported back to the Commissioners in late June, Nichols had left the agency; he was replaced by Brigadier General Kenneth E. Fields, the director of the division of military application, who had retired from the Army to accept the general manager's position.[50] An experienced engineer with an outstanding military record, Fields had held several assignments in the atomic energy program since Manhattan Project days. Although he was as familiar as most Commission staff with the agency's activities, he could not have been privy to all the rationale and motives that underlay Nichols's advocacy of the power demonstration program.

Almost at once the Commissioners got bogged down in the details of the proposals, despite the fact that the selection board recommended accepting all four. A problem remained: no response strictly adhered to the kinds of assistance that the Commission offered to provide in the invitation. The Consumers and Yankee plans went so far beyond the rather narrow limits set forth in the invitation that they took on the nature of government projects in which industry would participate, rather than being industry efforts using limited government support.[51]

Even the limits on support had proved too liberal in light of questions raised by Congressman Cole during the Section 202 hearings in February. Cole challenged the Commission's authority to provide funds ostensibly for research and development if in fact such funds were to be used to offset construction and operating costs. This foray into the legislative history of the Atomic Energy Act was inconclusive, but it did make the Commissioners more sensitive to the fine points of administration than they had been in December. In some respects the Commission in July was making the kinds of policy decisions that should have been reached during the previous December, and some applicants under the demonstration program complained privately that the Commission was making up the rules after the contest had begun.[52]

The extended discussions within the Commission during July and August 1955 revealed the kinds of dilemmas that any federal agency found in moving a new technology from government control into the marketplace. Even as late as summer 1955 the Commission still had no real confidence that private industry was prepared to make sound decisions about the direction of nuclear power technology. Thus, evaluating the power demonstration proposals became not just a matter of matching them with the criteria in the invitation but also of appraising the technical merits of the reactor systems presented. Commissioner Libby struggled for weeks to find some way to bend the criteria to permit the selection of the Consumers offer, which he considered the most attractive technically but the least responsive to the invitation's terms. In the opposite direction, the Commission was not enthusiastic about the Yankee proposal, even if it could be brought into line with the terms of the invitation, because it seemed to offer nothing new beyond the Shippingport plant; hence, it was scarcely worth the expenditure of funds for research and development. Therefore, the Commission's dilemma was twofold: trying to maintain technical balance in the program while attempting to move the technology into the economy, where presumably economic as well as technical factors would influence the course of development.[53]

The Commission also faced what could be called the Shippingport dilemma. To the extent that the Commission agreed to furnish forms of assistance going beyond the terms of the invitation, the closer the power demonstration projects would come to being government enterprises of the Shippingport type. In fact, Congressman Cole's position suggested that once government support passed a certain point, at least the nuclear portion of the plants would have to be government property; this would defeat the very purposes of the power demonstration reactor program by eliminating the possibility of private ownership and control. Thus, the smaller the percentage of government support, the farther away from the Shippingport model the new projects would be. The trouble with pursuing this goal was that, as the projects became more independent of government support, the Commission would lose its hold on technical information developed in the course of design, construction, and operation of the demonstration plants. The prospect of losing access to the technical data produced in the projects worried the Commissioners. It seemed that while the technology was still in transition from government monopoly to marketplace conditions, some sort of middle course between government projects like Shippingport and the private construction of licensed facilities was in order.

Beyond these considerations the Commission was motivated by the simple desire to see the demonstration program, once launched, become a success. In the simplistic terms that often prevailed on Capitol Hill, success would be determined by the number of power reactors actually resulting from the invitation. The Commission also feared that it would discourage industry proposals in the future if it rejected any of the first four. Yet the staff kept reminding the Commissioners that two constraints made it virtually impossible to accept the Consumers and Yankee proposals: the limitation on funding authority stressed by Congressman Cole and the potential danger of the Shippingport dilemma.[54]

These reservations were responsible for both delaying announcement of a Commission decision until August and phrasing it as a compromise that revealed the Commission's two minds on the subject. The Commission found the proposals by the Nuclear Power Group and the Detroit Edison consortium acceptable for negotiation. The Yankee and Consumers offers as submitted were not acceptable, but the Commission authorized the staff to continue discussions that might result in revised submissions. The product of four months of deliberation would hardly impress either the Administration or the Congress as a bold and aggressive response to insistent demands for nuclear power.[55]

Since the beginning of the Eisenhower Administration the Commission had responded positively in its own way to the public demand for nuclear power. At the end of 1952 the new technology was still a military secret and a government monopoly. Even before the 1954 act became law, the Commission had taken steps to give private industry access to the technical data needed to evaluate the prospects for a nuclear power industry. In one short year since the passage of the new law, the Commission had launched an ambitious plan for private development and construction of nuclear power plants.

In terms of its technical dimensions, the power demonstration reactor program was a bold, and perhaps even an unwarranted, effort to make nuclear power common in the marketplace. Privately the Commissioners still questioned whether the technology would support the grandiose public vision of the nuclear age, and they hoped that the resources and ingenuity of private industry could find a shortcut to economical nuclear power. In summer 1955, however, the technology needed to achieve that goal did not exist. Nuclear power was not yet ready for the marketplace.

CHAPTER 8

ATOMS FOR PEACE: BUILDING AMERICAN POLICY

The scene was one Lewis Strauss would never forget. The President, his eyes glistening with emotion, sat almost meekly in his high-backed chair on the rostrum as delegates to the United Nations General Assembly filled the hall with applause. Throughout Eisenhower's twenty-minute statement the 3,500 delegates had listened in silence as the President pledged that the United States would devote "its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life." Now that he had concluded, even the Soviet delegation joined the acclamation.[1] December 8, 1953, would be a memorable day in the history of the United Nations, but would it be more than a brief flash of idealism in a world drifting toward nuclear war?

WORLDWIDE REACTIONS

The President's speech, broadcast worldwide by the Voice of America, received enthusiastic response from every continent. With the exception of communist governments and press, most officials and newspapers hailed Eisenhower's proposals as constructive, courageous, and a possible step toward improved East-West relationships. There was general agreement that Eisenhower had delivered one of the most significant speeches of the postwar era, a statement in the "grand design" tradition of the Marshall Plan. But there was also widespread recognition that Eisenhower's vision would become reality only if there were good faith on all sides, a requirement that some pessimists did not expect from the communists. Initial reactions from *Pravda* and other communist newspapers were almost predictable. Suspicious and hostile, communist editors charged that Eisenhower described the threat of atomic warfare without offering any suggestions for banning atomic weapons. The Soviet foreign ministry promised only to give the proposal "serious attention." For the moment the world pushed aside concerns about Korea, Trieste, and Berlin as millions reflected on the meaning of the President's words.[2]

The domestic response to Eisenhower's speech was highly favorable, although not unboundedly so. On Capitol Hill, reporters found a marked difference between public statements and private comments, but no one doubted the sincerity of Congressman Cole when he pledged support for the President's proposals "with all my heart" to secure Congressional approval of the plan. Senators from McCarthy of Wisconsin and Hickenlooper of Iowa to Mike Mansfield of Montana described the speech as "a good suggestion," "great," and "daring." Democrats and Republicans alike saw the speech as a master stroke of propaganda, but they divided on the feasibility of establishing an international atomic energy agency. Carl Durham of North Carolina raised the specter of another foreign "giveaway" program. Freed from attribution, some Congressional leaders doubted that the "nationalist bloc" would vote to share the United States' atomic energy technology with an international body. Still other senators complained that Eisenhower should have consulted them before launching such a fundamental departure in foreign policy.[3]

Like the miffed senators, no Commissioner except Strauss had known of the President's intention until the day of the speech. After accidentally finding a reference to the speech in newspaper reports from the Bermuda conference, Murray had obtained a preliminary draft from the State Department. Murray was furious over yet another example of Strauss's failure to keep the Commission informed of White House policy discussions about atomic energy matters. He was even more appalled that Strauss would confide in Lord Cherwell while keeping his fellow Commissioners in the dark. Murray was so angry that he even advocated cabling Strauss to request clearance of the President's speech. The Commissioners did not take this step, for obvious reasons, but Eisenhower's speech suggested, just as his unilateral action in the Oppenheimer case had, that they were outside the Administration's inner circle on atomic energy affairs. After these two experiences both Zuckert and Smyth gave serious thought to leaving the Commission. Murray, whose term still had more than three years to run, girded himself for a relentless and often bitter struggle with Strauss and the Administration.[4]

Although Strauss, as he did in the Dixon-Yates case, was careful to conceal any personal reservations about the Atoms-for-Peace proposal out of loyalty to the President, there was some scanty evidence that his enthusiasm was limited. In October, Strauss had worried about the risks to international security in collecting nuclear fuel in a United Nations pool. After the speech Strauss seemed to fear that the President's remarks might create false expectations over the prospects for nuclear disarmament and perhaps some lowering of America's defenses. Strauss thought the President should express his gratitude if the Russians unexpectedly accepted the President's proposals, but even then Eisenhower should warn the American people that

> it would be most unfortunate . . . if, despite the hope which a war-sick world will reasonably draw from this gleam of light, we of the United States assume that the present danger is diminished or that our military posture should meanwhile be affected to the slightest degree.[5]

Strauss said he did not oppose the President's proposal; he merely wished to warn that Atoms for Peace would not soon take precedence over Atoms for War.

A NEW ROAD TO DISARMAMENT

The White House press conference was jammed with reporters on December 16, 1953. Even experienced hands on the White House press corps sensed unusual excitement because the President, reflecting his continued commitment to *Candor*, authorized for the first time direct quotation of all his remarks. Still tanned from the Bermuda sun and exhilarated from his United Nations triumph, Eisenhower met the press with full confidence and relaxed humor. He was not reticent in claiming the Atoms-for-Peace idea as his own. Granting that many people had contributed to the formulation of the final proposal, Eisenhower remarked that he had "originated the idea of a joint contribution to a central bank in an effort to get all people started on thinking in different terms about this whole business of atomic energy." Previous ideas, he explained, called for international inspection, which provided the Russians an automatic reason for rejecting them. The President hoped that his Atoms-for-Peace plan would sweep all previous proposals from the negotiating tables and thus "open up many lines of study."[6]

The President was undoubtedly referring to the years of frustration that the United States had endured in its quest for international control of atomic energy, ever since Bernard M. Baruch made his dramatic proposal in a similar appearance before the General Assembly in June 1946. By the end of that year, American hopes for effective action in the United Nations Atomic Energy Commission were all but dead; in 1947 discussions tapered off and finally stopped.[7] International control remained a dead issue in the United States until October 1950, when President Truman, in an address to the General Assembly, proposed a new disarmament commission to consider both conventional and nuclear weapons. The National Security Council directive (NSC 112 of July 6, 1951) gave evidence of the frustrations and disappointments encountered in five years of discussions with the Soviet Union. By the time the General Assembly finally established the new disarmament commission in January 1952, there was little reason for optimism.[8]

The United States delegation, lead by Benjamin V. Cohen, wanted to focus on the problems of disclosure and verification in 1952. The Americans probed the Soviet Union's willingness to accept effective inspection, presuming that any verification plan agreeable to the Soviets would also be acceptable to the United States; furthermore, a Russian rejection would have an obvious propaganda advantage for the United States. For its part, the Soviet Union continued to advance proposals already rejected: a one-third reduction of armed forces by the Big Five—the Soviet Union, the United States, the United Kingdom, France, and China; a prohibition of atomic weapons through a mere declaration that these weapons would be outlawed (the ban binding only after effective controls were established); and the disclosure of official data on armed forces and armament.[9]

To break the disarmament stalemate Secretary of State Acheson had appointed a panel of consultants, chaired by Oppenheimer, to take a fresh look at the full range of disarmament questions and their implications. The panel's report in January 1953, with its stress on *Candor*, had sparked Eisenhower's interest in developing an entirely new approach to the nuclear threat in international affairs. Other members of the National Security Council, notably Secretaries Wilson and Humphrey, were slow to follow the President's lead. But after the Russians fired *Joe 4* in August there was no doubt that the Soviet Union had gained the propaganda edge over the United States, which had a shopworn, dead-end disarmament policy.[10]

Formulating a new policy for the Administration was a complex operation that had to proceed simultaneously at both the presidential and the agency levels. While Eisenhower, Dulles, Jackson, and Strauss made their tortuous way through Operation *Candor* to the United Nations address, Walter Bedell Smith, the Acting Secretary of State, coordinated the extensive staff work necessary in developing the details of the new policy. It was logical for Smith to call upon the Commission to evaluate the technical factors on which the new policy would rest, and it was just as reasonable for Commissioner Smyth to head the technical committee.[11] Smyth had performed similar functions as far back as 1949, when the Truman Administration formulated its policy on thermonuclear weapons.

Smyth's committee found that the situation had changed radically since the days of severe uranium shortages that characterized the 1940s. Without hurting weapon production in the United States, sufficient uranium could now be supplied to satisfy the world's need for research and nuclear power, even if all the existing mines and production plants were shut down for ten or twenty years. On the debit side, with so much uranium available, there was no longer any way of assuring that all fissionable material had been declared, short of a system of continuous and unimpeded inspection in all countries.[12]

Although Smyth's (and the Commission's) role in the policy process may have seemed clear and logical to the State Department and the National Security Council, Strauss's special relationship to the President and the council did arouse distrust in his fellow Commissioners. Murray became so upset that he attempted to interject the Commission into the decision process in October 1953, by proposing that the United States release information about the location of its uranium mines and production plants and even admit United Nations observers to the *Castle* test series in the spring of 1954 as a way of embarrassing the Soviet Union.

By October 15 tensions within the Commission had risen so high that in Strauss's absence his colleagues had adopted a formal resolution stating that the agency "as a Commission" had a responsibility to participate in formulating United States policy in international control. Growing more impatient and frustrated, Smyth decided to drop all work on the technical committee because Strauss and Dulles were making the policy decisions. Only a personal appeal from Strauss on October 18 convinced Smyth to continue as head of the technical committee, although he was still seriously considering resigning from the Commission. Smyth might not have been so discouraged had he known that Strauss had actually forwarded his recommendations to the President through C. D. Jackson, but Strauss's sense of loyalty to Eisenhower would not permit him to reveal even this confidence.[13]

INTERPRETING THE EISENHOWER PROPOSAL

Once the President decided, in October 1953, to address the United Nations, Eisenhower's conception of the Atoms-for-Peace plan became an important factor in any consideration of American disarmament policy. The United Nations speech was the product of the President and a few close advisers; it did not reflect the concerns and interests of the professional bureaucracy in Washington or of allied governments abroad. Enunciated by the President almost as a personal hope, the speech could not set forth specific proposals. American officials and foreign governments were all uncertain about the precise intentions of the President's noble sentiments. The glowing generalities were subject to many interpretations, and these in turn would ultimately determine the proposal's fate.

Among the first to face the problem of interpretation were the British, who had an opportunity to review the draft at the Bermuda conference just before Eisenhower went to New York. Churchill's first goal at Bermuda was to try to reestablish the full measure of cooperation on nuclear weapon development that the two nations had created in the early years of World War II. As diplomatically as possible, Eisenhower explained the inhibitions imposed by the 1946 Atomic Energy Act and pledged to do what he could to secure a number of amendments at the next session of Congress; however, Churchill was impatient with such vague reassurances. If the United States wanted the United Kingdom to be a full military partner, the British would need information on the weight, dimensions, and ballistics of American weapons adapted for the design of British planes. Cherwell assured the Americans that the British did not intend to develop a hydrogen bomb, but until the United Kingdom could build its own stockpile of atomic weapons, the Royal Air Force would have to rely upon the United States for atomic bombs.[14]

Eisenhower, perhaps embarrassed that he could not reply to Churchill's requests directly, launched a disquisition on atomic weaponry, which continued the following evening at dinner. To the discomfiture of his British hosts, Eisenhower concluded that "the atomic bomb has to be treated just as another weapon in the arsenal." Should hostilities resume in Korea, for example, there was a distinct possibility that the United States would use nuclear weapons against communist air bases, supplies, and troop concentrations. Churchill protested that such an action might touch off World War III and the consequent bombing of London with "the destruction of all we hold dear, ourselves, our families and our treasures." In a state approaching desperation, Churchill could not immediately comment on the draft of the Atoms-for-Peace speech. Eventually he suggested two changes to tone down overly belligerent passages. Cherwell accepted the idea of an atomic bank but predicted that the Russians would obstruct negotiations of any proposal.[15]

After Stalin's death in March 1953 and the end of the Korean War in July, Americans held a faint hope for some change in the Soviet Union's foreign policy toward the United States. Although Malenkov, speaking before the Supreme Soviet in August, did not stint on any usual criticism aimed at the United States, Ambassador Charles E. Bohlen had noted a greater frankness and realism than ever before in Russian discussions of internal affairs. C. D. Jackson, for one, was determined to remain as optimistic as possible "that the Soviet leaders will recognize the President's proposal as a serious and feasible first step toward atomic peace." Even the initial Russian reaction, Jackson added, need not be regarded as the Soviet government's considered decision.[16]

Jackson's caution was well advised. On December 21, 1953, Soviet Foreign Minister Vyacheslav M. Molotov informed Dulles that the Soviet government was prepared to discuss Eisenhower's plan, assuming that the United States would also agree to entertain Soviet proposals for the total ban of nuclear weapons. Although the Soviet note did not contain an unqualified endorsement of Eisenhower's speech and reiterated some old disarmament slogans, Jean Allary of the *Agence France Presse* observed that if the Soviets' demand for a nuclear ban was not a preliminary condition but a goal to be worked for, then agreement was possible. Other foreign observers noted that the lack of vituperation in the Russian reply gave hope that the Soviet Union really desired to negotiate.[17]

Within the American government interpretations of the President's intentions also differed, much to Jackson's annoyance. The State Department virtually accepted the Soviet construction that would have initiated negotiations on "atomic disarmament" without reference to general disarmament, including conventional weapons. The Department of Defense, on the other hand, argued that the State Department's position was not only counter to long standing United States policy, as confirmed by the National Security Council, but would also be tantamount to defense suicide. Atomic disarmament alone would reduce the United States to a position inferior to the Russians in conventional weapons. The dispute reflected both the hope of some State Department officials who argued that Eisenhower had successfully broken the disarmament stalemate and the fear of those in the Defense Department who worried that Atoms for Peace might be used to clip the wings of the Strategic Air Command.[18] Strauss pointed out that the purpose behind the atomic bank proposal had been to ease international tensions by reducing existing nuclear stockpiles. Nevertheless, if the Russians rejected the idea, the United States would still have won a substantial psychological victory. The President wanted to sidestep the disarmament issue, not confront it, Strauss argued.[19]

Ultimately, only Eisenhower himself could settle the fundamental questions concerning his intentions. Meeting with Dulles, Strauss, Jackson, and Deputy Secretary of Defense Roger Kyes, on January 16, 1954, the President stated his central point as simply and forcefully as possible: the distinction between total and atomic disarmament was largely academic because neither could be accomplished without the most rigid and comprehensive system of inspection. Surprisingly, Eisenhower did not oppose outlawing the atomic bomb without an agreement on conventional weapons and armies. The bomb, he ruefully observed, had really frightened America because it was the first weapon that could cripple American industry, the winning factor in all major conflicts since the Civil War. If atomic and hydrogen weapons were outlawed, the Russians would be left with a vastly superior conventional force, but American industrial capacity could readily cope with any military assault on the North American continent. No disarmament agreement with the Russians, however, could be effective in the current international climate, the President staunchly argued, without foolproof inspection safeguards.[20]

Dulles agreed, but he reminded Eisenhower that the Russians would press for nuclear disarmament no matter what the United States did. Consequently, with the President's concurrence, Dulles recommended two courses of action. First, the United States would "listen" to any proposal the Soviet Union cared to submit on control or abolition of nuclear weapons, but Dulles would not be drawn into negotiations on this subject. Second, the United States would press forward on discussions of peaceful uses entirely separate from any negotiations on weapons. To implement the latter, a joint working group from the Commission, State, and Defense had been appointed to develop issues that would serve as the basis for discussions and to explore whether the discussions should proceed privately with individual governments or be pursued through an international organization such as the United Nations.[21]

As part of the Administration's effort, Strauss asked Smyth and his committee to draft a charter for the international organization suggested in Eisenhower's speech. Smyth, still smarting from the sting of the "Bermuda crisis" while becoming increasingly worried by the Oppenheimer affair, reluctantly agreed to accept the assignment with the proviso that the Commission support his understanding of the President's speech. Because there were many interpretations of Atoms for Peace, Smyth asked the Commission to sponsor the most radical possibility—namely, that Eisenhower intended to look beyond peaceful uses to envision the eventual reduction of atomic stockpiles in the United States and the Soviet Union. After extensive discussion Smyth received his endorsement.[22]

Once disentangled from disarmament questions, Atoms for Peace faced three other policy questions, none of them insurmountable from the American perspective. The first concerned the amount of fissionable material each country would be expected to contribute to an international agency. Initially, Strauss had feared theft of the material unless it were stored in a highly dilute solution at a remote location. In fact, the question was whether the United States could induce the Russians to contribute anything at all to the bank. Smyth, who also served as chairman of the joint working group, asserted that the United States contribution should be large enough to launch the program but not so great as to make it impossible for the Soviets to participate, assuming they responded in good faith. It would be best, Smyth thought, to begin with small contributions of normal and partially enriched uranium, which could be gradually increased over time to the point where contributions actually began to reduce weapon stockpiles. Although all contributions ought to be made on a one-to-one ratio by the United States and Russia, the initial United States contribution might acceptably be two or three times that of the Soviet Union.[23]

There was also the question of how much information the Commission would provide the international agency. Everyone agreed that declassified information could be made available as a matter of routine; the agency would thus act as an international library and clearinghouse for nuclear information. It was also foreseen that as soon as the international agency moved into nuclear power, almost all reactor technology would have to be declassified. The most sensitive information would involve advanced military propulsion reactors, such as those designed for submarines, ships, and airplanes. But even in this area, Robert LeBaron from the Defense Department observed that the technology could be declassified once the military no longer needed to keep it secret.[24]

Finally, the working group debated whether it would be permissible for members of the international agency to exchange fissionable material or information outside the organization's jurisdiction. The question was of special interest to the United States, which had the option of negotiating directly with friendly nations. The working group saw that Congress would never allow the United States to work exclusively through a United Nations agency. On the other hand, the members believed that certain countries, such as India, might prefer to obtain reactors through a neutral agency rather than directly from either the United States or the Soviet Union. Consequently, the group decided that the agency should not have a monopoly on international negotiations but that bilateral arrangements between countries would also be acceptable. Thus, the agency would be a clearinghouse, for both nuclear materials and technical information, without authority to plan, finance, or conduct projects of its own. Membership in the agency would be open to all nations, regardless of their United Nations affiliation, and even nonmember nations that accepted its conditions would be eligible for its services.[25]

Thus did the joint working group set forth the outlines of a charter for the international agency. Now it was the State Department's responsibility to open the way for international discussions.

APPROACHING THE RUSSIANS

On board the *Santa Isabel* cruising in the Caribbean, David Lilienthal also reflected on the Atoms-for-Peace idea. Initially, the former chairman of the Commission had been enthusiastic about Eisenhower's speech and had urged the United States to proceed immediately with the proposal without waiting for Soviet participation. Before leaving New York, however, Lilienthal had been told by a confidant, who had declined to lead the American team negotiating with the Russians, that "there was no substance in the proposal itself." Lilienthal concluded that the President's performance had been nothing but a propaganda ploy, a shocking deception, not only for the Russians but for the American people as well.[26]

Perhaps Lilienthal's judgment would not have been so harsh had he known of the Administration's determination to push ahead with Atoms for Peace, with or without cooperation from the Soviet Union. But neither the State Department nor anyone else was certain of how to proceed. Dulles favored private negotiations through normal diplomatic channels apart from the United Nations disarmament commission. In fact, he thought there was considerable logic to limiting initial discussions to the three countries that actually had nuclear weapons—the United States, the United Kingdom, and the Soviet Union. Although there was no way to avoid talking about disarmament in bilateral discussions with the Russians, Dulles thought it futile to work through a United Nations committee that could neither limit its membership nor keep its discussions pertinent.[27]

Strauss and Secretary of Defense Wilson agreed that bilateral negotiations with the Russians, and possibly with the British, would be best. Eisenhower's correspondence with Churchill, Strauss's conversations with Cherwell, and Dulles's meetings with Sir Roger Makins, the British ambassador, had already advanced British participation to the point where it would be impractical to exclude them.[28] There was even the risk, Dulles observed, that Churchill might undertake negotiations on his own initiative if left out of the discussion. Actually the Americans had few objections to including the British; however, the possibility of French involvement did concern them.

The American architects of the international agency who met on January 6, 1954, were unanimous that the French should be excluded as long as possible, largely for reasons of security. Dulles was not overly worried about alienating the French or driving them toward the Soviet Union. He underscored his preference by noting that Churchill had a similar attitude toward the French and would also resist including them in atomic discussions. Assistant Secretary Livingston T. Merchant pointed out that it would be difficult to exclude the French, particularly if the Canadians and Belgians were eventually brought into the discussions. Strauss seemed to concur with Merchant, for, although he hated to think of French participation, he remarked that most likely the Belgians, and therefore the French, would have to be included within a year. Since Bermuda, he reported, the Belgians' noses had been "out of joint," and with the uranium ore purchase agreements about to expire it might even be prudent to consider Brussels as the headquarters for the proposed international agency. For the present, the group decided to exclude the French from American planning for the international agency.[29]

The following day Dulles fully explained the American strategy to Ambassador Makins and stressed that the United States intended to conduct preliminary talks with the Soviet Union to determine when, where, and with whom the Russians wanted to meet. Dulles promised to keep Makins fully informed of developments; but alluding to the sensitive problem of excluding the French, he asked the British not to participate formally in the discussions until after the four-power conference scheduled for Berlin late in January. Makins assured Dulles that the British, aware of the French problem, had no intention of inserting themselves into the preliminary talks with the Russians. Indeed, British Foreign Minister Anthony

Eden was anxious that atomic discussions not get mixed up with the Berlin conference itself. Makins warned, however, that once the negotiations became multilateral, it would be difficult to proceed without Canada and the Union of South Africa, let alone France and Belgium.[30]

With assurance of British support, Dulles on January 11, 1954, presented Soviet Ambassador Georgi N. Zaroubin the United States' suggestion for private discussions of atomic energy, including the proposed international agency. In addition to urging early bilateral discussions of Eisenhower's plan, the United States expressed its willingness to consider any proposal that the Soviet Union wished to make concerning nuclear weapons, with the proviso that the first efforts would necessarily be modest in order to build "trust and confidence." The following week the Soviet Union accepted the proposal for confidential exchanges with the understanding that, at an appropriate stage, the negotiations would include Communist China. Until such time, the Soviet Union conditioned its acceptance of the American overture by insisting on the principle of rotation, under which one meeting would be devoted to the international agency and the next to the Soviet proposal for a ban on nuclear weapons.[31]

The Berlin conference in January and February 1954 had been convened by the Big Four to discuss Korea, Indochina, Germany, Austria, and other outstanding problems; but it also provided Dulles and Molotov an opportunity for further atomic energy discussions. Meeting after the plenary session on January 30, Dulles informed Molotov that the United States was preparing a memorandum that would set forth the United States' proposals for establishing an international atomic energy agency. Although the United States had consulted with certain allies, Dulles said he did not want to include other countries at this stage. Molotov was prepared to receive the American memorandum and offered a draft Soviet declaration also designed to counter the nuclear threat. Predictably the Russians pursued disarmament by advocating that the Big Five, including Communist China, join in an unconditional renunciation of using nuclear weapons. Molotov assumed that the five countries would also participate in subsequent atomic energy negotiations. Dulles could offer no comment, but he did not object to informing Eden and French Foreign Minister Georges Bidault of the Soviet document, provided American-Soviet talks remained private. Prudently, Dulles had already briefed Bidault on American intentions and had received his polite acquiescence in the American proposal.[32]

THE ATOMS-FOR-PEACE PROPOSAL

While Dulles conducted his leisurely discussions with the Russians, Smyth's committee continued drafting an outline of the proposal. On at least one occasion prior to the Berlin conference Strauss had briefed the

Commissioners on the exchanges between Dulles and the Russians; but, as Smyth had noted, the Commission had never been assigned an official role in preparing or approving the draft. Consequently, except for those informal discussions, the Commission had no official voice in completing the memorandum sent to the State Department on February 12, 1954.[33]

Smyth's outline, more a checklist than a plan, highlighted the atomic bank by defining broad functions for the international agency: receiving, storing, and allocating nuclear materials and fostering technical information services. The agency's administrative machinery, its financing, and its relationship to the United Nations were left purposely vague to avoid prematurely rigid assumptions about its functions. As promised, the United States submitted the outline to the British, Canadians, and French for comment and to the Belgians, South Africans, and Australians for information.[34]

The reactions from the British and Canadian governments were generally favorable, while the French offered no substantive comments. The United States' atomic partners had so little part in the plan that it was easy to accommodate their suggestions by changing only a few sentences. When the British wondered whether the proposed agency had been tied too closely to the United Nations, the Americans changed the provision requiring the agency to report to the Security Council, where its work would be subject to veto. The Canadians, however, openly expressed resentment at not having been consulted more extensively. Sensitive to the Canadians' objections, R. Gordon Arneson, in charge of the atomic energy section of the State Department, expressed the United States' hope for consultation among the three governments as the negotiations proceeded.[35]

Although not overly optimistic about the possibilities of success with the Russians, American Kremlinologists had been searching for evidence of a softening in Soviet foreign policy. C. D. Jackson noted that the Russians had sent their first team to Berlin—Molotov, Gromyko, Malik, and Zaroubin. But apart from unusual personal friendliness, especially from Molotov, Jackson found no visible evidence of a new direction in Soviet foreign policy. More astutely, Jacob D. Beam of the policy planning staff and later ambassador to the Soviet Union observed that the Kremlin had engaged in an "Operation *Candor*" of its own since Eisenhower's United Nations speech. Malenkov's electrifying address of March 14, 1954, let the facts about the Soviet nuclear arsenal and its destructive power speak for themselves without resort to threat or bombast. Beam identified a subtle, but important, shift in Soviet rhetoric on international atomic problems made necessary by the latest developments in that field. Before the Russians had built their own nuclear weapons, they stood for abolition of all nuclear armaments. As they approached technical parity, the Russians stressed prohibition on use, not abolition, showing they had no more intention than the United States of totally scrapping such weapons. And for the first time the Kremlin admitted Russia's vulnerability in a nuclear war.[36]

The United States presented its plan for the international agency to Soviet Ambassador Zaroubin on March 19, 1954, but one month later in Geneva the Russians smashed any hope for an immediate acceptance. In his note to Dulles, Molotov virtually ignored the American outline. Purposely assuming that Eisenhower's atomic bank plan was primarily a disarmament scheme, the Soviets criticized the very point that Smyth had used to promote the idea—that the small amounts of nuclear materials allocated to the international agency would not in any significant way diminish the stock available for nuclear weapons. Instead, the American plan only created the illusion of a "peaceful atom" because growing electrical generation using nuclear reactors would actually increase the amount of nuclear material available for weapons.[37]

From a propaganda point of view, the Russian note was severe and perhaps damaging. In substance, the Russians charged that Eisenhower had spoken grandiosely before the United Nations, that he had frightened the world with the prospect of a nuclear holocaust while promising new solutions to the Cold War. Sadly, the Soviets implied, the vaunted new approach turned out to be a piddling American proposal for an insignificant international pool, which, if anything, would only accelerate the arms race. Furthermore, the Russians charged, the Americans privately evaded the problem of the "inadmissibility" of atomic weapons and thus failed to meet the President's own purpose—eliminating the threat of atomic war. The Kremlin ardently professed its support for the "peaceful atom," but the Russians claimed that the American proposals were so one-sided that they could only be considered as a supplement to a more fundamental agreement. In other words, Molotov would not negotiate the charter for the international agency until the United States had signed a disarmament agreement.[38]

Unfortunately, according to one State Department analyst, there seemed to be some basis for the Russian claim that the modest proposal submitted by the United States hardly met the expectations aroused by the President's eloquent speech. While striving to preserve the secrecy of the talks, the United States could offer only one response: it was necessary to take small steps showing good faith so that greater accomplishments could follow. Accordingly, on May 1 at Geneva, Dulles conferred informally with Molotov on the proposal. He stressed that the agency would not be able to solve the disarmament problems worrying the Russians. Dulles bluntly told Molotov that a greater degree of confidence had to exist between the countries before significant progress would be made on disarmament. In a curious reversal of roles, Dulles argued that the President's speech contained only a modest proposal for improving East-West relations. Molotov, on the other hand, insisted that the United States plan was not so innocuous as the Americans assumed because power reactors could also produce materials that might be used to fabricate atomic bombs. The deficiency in the American plan, Molotov asserted, was neither political nor ideological but scientific—a fact Dulles could confirm by consulting directly with American scientists.

Nonplussed by Molotov's technical argument and clearly disadvantaged when discussing scientific matters, Dulles weakly promised to look into the matter fully, although he was skeptical about his ability to understand Molotov's point. Ultimately, the State Department answered Molotov by vaguely asserting that methods could be devised to prevent the diversion of nuclear materials from power reactors. Dulles did not assume that the Russians had rejected the international pool, but he informed Molotov that, unless the United States received a positive answer, the United States would consult other interested nations. To take it or leave it was the Soviet dilemma, and throughout the summer of 1954 no one in the Western world was certain of the Soviet Union's final decision.[39]

A MORATORIUM ON TESTING

Concurrent with planning the international agency in winter and spring 1954, the Eisenhower Administration, at the prompting of Commissioner Murray, briefly explored the possibilities of adopting a moratorium on nuclear testing. Murray accepted Jacob Beam's view that the Russians had shifted from advocating abolition of nuclear weapons to proposing prohibition of their use. He believed that the Soviet Union had created the opportunity for another initiative by the United States, one that would further Eisenhower's atomic energy aims. Murray considered the atomic arms race unique because large-scale testing, which was necessary for weapon development but which could not be kept secret, only intensified world tensions and stimulated successive rounds in the race. Yet this very combination of circumstances offered the possibility of stopping the headlong rush toward world disaster. A moratorium on large-scale testing, in Murray's opinion, would not only sharply curtail weapon development to the point where it might even be halted, but it would also remove the need for inspections or interference with national sovereignty. Because the United States was well ahead of the Russians in thermonuclear technology, a moratorium on testing would not upset American superiority in nuclear weapons. If the Soviet Union rejected the idea, however, Murray thought the President would win another stunning propaganda victory.[40]

It was ironic that the suggestion to link a test moratorium with the Atoms-for-Peace program should come from within the Commission on the eve of the *Castle* test series in February 1954. Furthermore, despite

Strauss's encouragement, it was almost certain that Murray's proposal would have received little attention from the Administration had not Prime Minister Jawaharlal Nehru of India, supported privately by the British, also advocated a moratorium on testing hydrogen weapons. Nehru's pleas, made in April after the *Castle-Bravo* shot, indicated that the full impact of Eisenhower's warning about the consequences of thermonuclear warfare could only be understood in the shadow of the awesome Bikini explosion.[41]

Eisenhower had alluded to the destructive power of thermonuclear weapons in his United Nations speech; but his references to tons of TNT and "explosives equivalents," while frightening, did not convey the picture of a world in ruins. Two months later in Chicago, Congressman Cole completed the sketch that the President had outlined before the General Assembly. After *Bravo* every metaphor was obsolete. Cole had mentioned nothing about *Bravo* in his talk, but even the details of the comparatively primitive *Mike* shot of November 1952 had been sufficient to panic Winston Churchill, who apparently had little comprehension of the power of thermonuclear weapons before he went to Bermuda. Perhaps for the first time Churchill was aware that England was defenseless against a nuclear attack. Not only was he concerned that a single bomb could destroy London, but he also realized that a hydrogen bomb dropped in the sea to the windward side of Great Britain could poison the entire country with radioactive fallout. The *Bravo* shot brought Churchill under intense pressure from the Labour opposition for details of the test and launched a protest against further experimentation. Distraught at being personally attacked for Britain's lack of information concerning American policy, Churchill informed Eisenhower that he intended to publish the text of the 1943 Quebec Agreement in order to demonstrate that the leaders of the Labour government after the war, not the Conservatives, had failed to keep abreast of United States developments.[42]

In response to the mounting anxiety over American tests, from both inside and outside the government, Dulles obtained Eisenhower's approval in April 1954 to explore the possibility of ceasing all thermonuclear testing. The President appointed Dulles, Strauss, and Admiral Arthur W. Radford, chairman of the Joint Chiefs of Staff, to study the matter. Thereafter, in London, Dulles was able to reassure Eden that the United States was sensitive to world opinion about the Bikini tests and that the President had requested technical advice on the subject.

Once again the Commission was left officially in the dark about Strauss's special assignment from the President. On May 7, 1954, after the National Security Council had received a report from the Joint Chiefs of Staff opposing any agreement on a test moratorium, Strauss informed his fellow Commissioners that the President had reconstituted the special committee on atomic energy for the purpose of considering the possible suspension of thermonuclear weapon testing. Again Strauss's colleagues protested. Murray especially complained that Strauss had authorized an official agency position on Nehru's proposal without consulting the Commissioners.[43]

For Strauss, harried now by the Oppenheimer case and Dixon-Yates, the dispute with Murray was minor but irritating. As before, Strauss moved somewhat reluctantly under the President's direct orders, while attempting to keep the Commission informed without compromising the confidence of either the President or the National Security Council. Strauss informed his colleagues on May 21 that the special committee was meeting, but he did not relate the substance of the discussions during which he and Robert B. Anderson, the Acting Secretary of Defense, had strongly opposed the moratorium to the dismay of Robert R. Bowie of the State Department's policy planning staff.[44]

The struggle for a test moratorium, however, was all shadowboxing in early summer 1954. The moratorium stood no chance at all as long as the United States dominated the thermonuclear club. Initially Dulles had favored the idea as a means of improving United States relations with the British, a position that became unnecessary when Churchill personally informed Eisenhower of Britain's decision to proceed with thermonuclear development, contrary to what Cherwell had told the Americans at Bermuda. With the British vying for the thermonuclear weapon along with the Russians, the Americans were not about to sacrifice any real or imagined advantage. More sensitive to scientific questions after his embarrassment by Molotov in Geneva, Dulles asked for a thorough technical evaluation of the moratorium idea in comparison with its political and propaganda advantages. On the technical level, it was necessary to solicit the views of the Commission directly.[45]

To answer Dulles's questions, the Commission invited representatives of its two weapon laboratories, Edward Teller and Norris E. Bradbury, to comment on the feasibility of suspending United States tests. In the main, the scientists' technical advice was negative and with Oppenheimer's fate hanging in the balance, they refrained from offering political observations. If there were a total ban on tests, they noted, it would still be possible for the Russians to conceal low-yield tests. Furthermore, even if the moratorium were adequately policed, any ban that extended beyond 1957 would seriously impair weapon development in the United States.[46]

Not wishing to appear totally negative, Strauss had the concurrence of all the Commissioners, except Murray, in stating that a moratorium on large-weapon testing would be to America's advantage, an important step toward general disarmament if arranged by a dependable agreement; but such an agreement with the Russians was in Strauss's opinion "illusory." Furthermore, should the Administration decide that an unenforceable agreement with the Russians was desirable for propaganda purposes, Strauss warned that it might not be possible to resume testing thereafter.

The United States could then lose more international goodwill than could be gained by sponsoring the moratorium in the first place. Without exploring the matter further, the National Security Council accepted Dulles's and Strauss's recommendations and shelved the moratorium idea on June 24, 1954.[47]

ATOMS FOR PEACE: WITH OR WITHOUT THE RUSSIANS

For the moment the path toward Atoms for Peace was obscured. With the moratorium and disarmament blocked, the international agency still unchartered, the Russians uncooperative, the British near panic, Oppenheimer cashiered, Dixon-Yates festering, and the atomic energy bill stuck fast in the Senate, the Administration was understandably uncertain about its next step. An obvious alternative was to plunge ahead with a modified international agency, with or without Russian partnership. The advantages of this course of action were clear enough. It would dramatize America's intention to promote internationally the constructive uses of atomic energy, even though Cold War tensions might not be lessened. To some extent, the step would counteract the adverse publicity following the *Lucky Dragon* fallout incident and counterbalance the communists' pleas for outlawing the use of nuclear weapons. Most important, the move would put the Russians in a bad light and tend to counteract centrifugal forces in the Western alliance. It would also be politically popular in the United States.

On the negative side officials worried about the consequences of Russian absence from an international agency. A Soviet boycott would frustrate Eisenhower's two main aims in proposing an atomic pool: to lessen Cold War tensions and to siphon off weapon-grade material from existing nuclear stockpiles. In addition to the possibility that the Cold War might even be intensified, there was fear that Soviet espionage would be aided to the extent that the United States provided classified or formerly classified information to the international agency. By proceeding without the Russians, the United States would lose the propaganda advantage of being able to state that Soviet rejections of the plan had scuttled Eisenhower's dream. At the same time, the Russians would be left with the option of joining the agency whenever it suited their interests. Finally, absent Russian participation, the State Department thought it advisable for the United States to negotiate nuclear power agreements directly with various countries, especially with those rich in uranium and thorium deposits, in return for their allegiance and material support.[48]

Characteristically, Eisenhower fretted over the indecision of his advisers. When Strauss appeared before the Joint Committee to testify on the atomic energy bill, the President directed Strauss to make it "abundantly clear" that the United States had no intention of giving up its Atoms-for-

Peace plan just because the Soviet Union had rejected it. By June 4, 1954, Eisenhower had decided to proceed without the Russians, if necessary. He ordered Dulles, Strauss, and Wilson to explore means of sharing atomic energy information through the North Atlantic Treaty Organization (NATO) and other channels in addition to intensifying United States planning efforts on the international bank. At his news conference on July 7, the President unambiguously served notice that he was "not going to let it die, if I can possibly help it." Later, when the Senate filibuster against the atomic energy bill also seemed to threaten Atoms for Peace, Eisenhower even considered introducing a special bill that would at least save the international plan. Although that was ultimately unnecessary, the President reiterated his determination to press forward with or without the Russians when he signed the Atomic Energy Act into law on August 30.[49]

Dulles had quickly endorsed the President's decision to proceed, although he knew this move would trouble the British, who were not enthusiastic about an atomic pool without Soviet contributions. Apparently the British feared getting caught shorthanded in an international agency that would dilute American interest in bilateral agreements and weaken Commonwealth obligations between the United Kingdom and uranium-rich South Africa and Australia. Eden expressed these concerns during his June meetings with Eisenhower in Washington, only to receive an eloquent presidential soliloquy on the virtues of the peaceful atom coupled with Eisenhower's vague assurances of American cooperation "within the limits of the law."[50]

Although Strauss also supported the presidential directive, he was not anxious to push plans for the international agency while the fight over the atomic energy bill continued in Congress. On July 12, Strauss, fearing the United States had been losing ground to Soviet delaying tactics, congratulated Eisenhower for his decision to move ahead with the Atoms-for-Peace plan; yet, on the same day, the chairman ordered Snapp to hold up everything on the international agency until after the atomic energy bill had passed. Strauss's motives were unclear, and his refusal to act apparently took the State Department by surprise. Perhaps Strauss wanted to mark time while waiting for passage of the act, with its restrictive international sections that forbade United States participation in a multilateral atomic pool. Certainly he was nervous about the membership in such an organization. He favored limiting membership in the international agency to countries recognized by the United States, a restriction that excluded Communist China. Nevertheless, Strauss continued to promote Eisenhower's program by including glowing references to it in his address before the Veterans of Foreign Wars on August 5.[51]

Most questions concerning the direction of the Atoms-for-Peace plan and the future of the nuclear material pool were resolved by the National Security Council on August 13, 1954. Assuming that the Russians would not participate in the international agency and that the atomic energy bill would become law, the council adopted a policy consistent with the proposed law. Dulles hoped to keep the relationship between the international agency and the United Nations as tenuous as possible in order to avoid criticism of the United Nations in Congress; he estimated that it would take at least two years to negotiate a multilateral agreement that would receive Senate ratification. In the interim, the United States was to maintain its leadership in the peaceful uses of atomic energy by sponsoring international scientific conferences, offering assistance in construction of small-scale research reactors, and providing training programs and technical information.[52]

Even more progress could be made through bilateral negotiations, which would salvage something of the spirit of the President's plan for an international atomic energy bank. In keeping with the agreements for cooperation, Section (123) of the 1954 act, the National Security Council stipulated in NSC 5431/1 that all bilateral agreements for sharing nuclear material would have to meet three requirements. First, no agreement could be inimical to the United States' security, and, where possible, any agreement should promote the United States' own atomic energy interests. In this respect, as Strauss had been recommending since December, the first bilateral agreement might be made with Belgium, which still controlled the uranium-rich Belgian Congo. Second, no agreement could be negotiated that either required weapon-grade materials or significantly diverted fissionable materials or trained personnel from nuclear weapon development in the United States. In every case where the United States provided nuclear materials for research or power reactors, whether by gift, lease, or sale, the Atomic Energy Commission would require the return of all spent fuel and nuclear by-products for reprocessing in the United States. Finally, the council wanted to insure that the United States gained the "maximum psychological and educational advantage" from its endeavors in this field. Dulles was particularly bothered about this point because he thought the directive of the National Security Council fell short of the President's United Nations proposal. Strauss and Robert Cutler allayed Dulles's concerns, however, by arguing that the proposed program would be well received, especially if it were announced by the President in conjunction with ground-breaking ceremonies for the nation's first commercial power reactor at Shippingport, Pennsylvania.[53]

Speaking from Denver via radio and television on Labor Day 1954, Eisenhower ended the Administration's long silence about its Atoms-for-Peace plan. Ignoring the Russians except to note that American initiatives had been "cynically blocked in the councils of the world," the President briefly outlined the United States' determination to work for an international agency while negotiating bilateral agreements. This time, however, no one was caught unprepared by the President's speech, which was made all the more dramatic when he used an "atomic wand" in Denver to set a bulldozer in motion at the Shippingport site. Not only was the Commission consulted closely about the contents of the speech, but Strauss had explained the matter carefully to Cole for the information of the Joint Committee. The State Department, in turn, briefed Canada, the United Kingdom, South Africa, France, Portugal, Belgium, and Australia. Subsequently, Eisenhower ordered Dulles and Strauss to implement NSC 5431/1, with the Atomic Energy Commission assigned leadership in formulating a definitive program of action while the State Department continued its diplomatic exploration.[54]

THE RUSSIAN BOMBSHELL

Dulles was looking forward to the ninth session of the United Nations General Assembly in September 1954 as an occasion for announcing the steps the United States intended to take in giving life to the President's proposals. Dulles wished to address the General Assembly early in the session when he planned to propose establishing the international agency and calling an international scientific conference on the peaceful uses of atomic energy. In an effort to draw attention to the speech, Dulles planned to conclude with a dramatic and unexpected announcement that the United States would also extend invitations "to a substantial number of medical and surgical experts from abroad" to work in American cancer hospitals using atomic energy techniques. Leaving to Ambassador Henry Cabot Lodge the task of explaining why the United States had dropped the nuclear material pool from its proposal, Dulles would conclude with the pious assurance that the United States intended to exclude "no nation from participation in this great venture," including the Russians.[55]

On September 22, the day before Dulles was to deliver his address, the Soviet government ended five months of silence on Atoms for Peace by declaring its willingness to continue discussions with the United States. Although the Russians reiterated their desire to obtain an international ban on the use of nuclear weapons, they agreed to examine American ideas for safeguards against the diversion of nuclear materials from research and power reactors to military uses. Then, for the first time, the Russians outlined three "important principles" to be followed in creating the international agency. First, no state or group of states should be permitted to enforce its will on other states. Second, an international atomic energy agency should not jeopardize the security of any of its members. And third, the Russians explicitly agreed with the United States that the agency should report its activities to the Security Council and the General Assembly on the grounds that all matters affecting the security of member states were to be referred to the Security Council as provided in the United Nations' charter.[56]

The Soviet proposal to continue negotiations was a bombshell for Dulles and the Administration; they had assumed that the Russians would not be a party to such an international agreement. Already in its discussions with the British and Canadians the United States had virtually abandoned the March 19 outline in favor of an international agency without an atomic bank and only nominally associated with the United Nations. Passage of the Atomic Energy Act of 1954, as well as British and Canadian nervousness about losing their special nuclear relationship with the United States, had caused the Administration to reevaluate its original approach in favor of an agency planned and initiated by the United States, the United Kingdom, and Canada. France, South Africa, Australia, Portugal, and Belgium would be invited to review the plans and, if in agreement, join the organization as charter members. This approach, however, had its drawbacks. Although the eight member-nations of the "working group" could all be justified by their status as producers or consumers of raw materials, they also constituted the principal colonial powers, including Portugal, not a member of the United Nations, and South Africa, one of the most unpopular countries in Africa and Asia. Nevertheless, in order to satisfy its allies and the law and with a vague hope of ratifying an international agreement by mid-January 1955, the Administration decided to proceed without devising a formula to add acceptable and cooperative nations to the working group.[57] Thus, the Russians' unexpected agreement to continue discussions abruptly ended the Americans' brief consideration of founding a private nuclear club.

Not surprisingly, some State Department officials thought the Russian communiqué was only a troublesome propaganda ploy that did not represent serious intentions. For example, Gerard C. Smith, recruited from the Atomic Energy Commission in 1954 as Dulles's atomic energy adviser, put the matter succinctly: "Do we want the Russians in the Agency? and if so, do we want them in the Agency planning now?" Although only forty-one, Smith had an impressive background and wide experience. A graduate of the Yale Law School, he had served in the Navy during World War II and had practiced law in several prominent New York firms before coming to Washington in 1950 as special assistant to Commissioner Murray. Smith's four years in Murray's office exposed him to the intricacies of atomic energy policy at the highest levels. As a Republican, he was acceptable to the Administration. Mature and knowledgeable, Smith was a natural choice as the State Department's expert in atomic energy, which was still in 1954 an esoteric and intimidating subject within the department.

Smith realized that it would not be possible first to establish the agency on American terms and then accept Soviet membership at a later date. Nevertheless, it was also obvious that continuation of discussions with the Soviet Union might paralyze American negotiations with other countries or destroy the United States' momentum toward creating a functioning agency. Smith reflected somewhat bitterly that Americans should welcome Soviet obstruction if the United States ultimately decided it did not really want an international agency. In this fashion, Americans would gain all the good will necessary through bilateral arrangements and still control the situation while appearing to want multilateral international cooperation. The outcome would be the same as the fruitless disarmament negotiations, with all sides agreeing in principle that the goal was desirable but disagreeing on the means to achieve it.[58]

Despite the unresolved problem of responding to the Soviets, the United States presented the second "Preliminary Outline" of an international agency for review and comment by the French, South Africans, Belgians, Portuguese, and Australians. Predictably this outline, which became known as the October 6 plan, did not provide for pooling of nuclear materials as proposed in March. As critics of the pooling idea had stated, without Russian participation it was pointless for the United States and the United Kingdom alone to release weapon materials to an international agency when other purposes would be achieved without actual physical transfer of fissionable material. Even with the Russians in the picture again, the British and Canadians, who had never really liked the pooling concept, were opposed to returning to the original March 19 atom bank idea. More important, the National Security Council in NSC 5431/1 had determined that in keeping with the Atomic Energy Act the United States would "earmark" reasonable quantities of fissionable materials for use in approved projects without actually physically placing the material in an agency bank. Although no one was certain whether the Russians would be interested in the revised proposal, no serious thought was given to returning to the original plan.[59]

Consequently, the Administration was forced to explore a confusing contingency plan in the event the Soviets entered seriously into the eight-power discussions. There was no doubt in the Americans' minds that an international agency with the Russians would be far different from one without them. Strauss, for one, thought it naive to expect that the Soviet Union would honor any commitment merely to earmark material for an agency; he would not be satisfied unless the Russians actually "ponied up" the material to be held physically by the agency. The trouble with his demand, as Strauss knew full well, was that under the Atomic Energy Act it was impossible for the United States to do the same thing. In the face of the State Department's exasperation, Strauss shrugged off the dilemma by stating that he took a "pragmatic view" of the situation, assuming that in the agency the United States would cooperate with friendly nations first. To the State Department's suggestion that the United States might donate a research reactor to the agency, Strauss replied that he had already been thinking about placing just such a reactor in Puerto Rico. The only question that Strauss seemed prepared to discuss with the Russians was how to prevent the diversion of nuclear materials from power reactors to weapons. On this score, he was even willing for Commission representatives to meet with Russian experts in Moscow, although Strauss thought the solution was simple enough: merely require all fuel elements from power reactors to be reprocessed under United Nations' auspices.[60]

When the State Department lamented the trend toward more shadow and less substance in the United States' plans for the international agency, Strauss replied that placing even a small amount of fissionable material at the disposal of the agency, rather than at the complete discretion of the United States, would be severely criticized by the Joint Committee as a serious security breach. Strauss, in turn, complained that there were too many "cooks" in the nuclear kitchen. He expressed concern over the divided responsibility among himself, Lodge at the United Nations, and Morehead Patterson, the New York industrialist appointed to negotiate the international agreement. Strauss's pique may have been prompted by Lodge's "freewheeling" on the peaceful uses issues at the General Assembly.

Lodge, who had been joined in New York by C. D. Jackson for the Atoms-for-Peace item, worried both the Commission and the State Department with his penchant for departing from the prepared script. In an effort to check Lodge's independence, the State Department had promised the British and the Canadians, as well as the Commission, that they would have prior review of Lodge's remarks. Dulles, however, who was equally worried about keeping "a rein on the combination of Lodge and C. D. Jackson," showed little inclination to suppress the publicity that the two men were generating at the United Nations. With the collapse of the atomic pool, Lodge and Jackson believed it was necessary for the United States to puff its international efforts with movies and atomic energy kits in order to offset Russian propaganda claims that the United States had abandoned its Atoms-for-Peace campaign. Subsequently when Andrei Y. Vyshinsky of the Soviet delegation charged that the President's great proposal of December 1953 had been reduced to isotopes and fertilizer, Lodge and Jackson clamored for approval to make a spectacular announcement that the Atomic Energy Commission had decided to allocate to the international agency 100 kilograms of nuclear materials for peaceful projects.[61]

The idea of announcing the allocation had been discussed before the opening of the General Assembly session, but neither the President nor the Joint Committee had authorized the announcement. Thus, when the initial draft became "lost" at the Commission, no action could be taken. Frantically, C. D. Jackson worked on the telephones from New York while Smith lobbied from within the government to get Strauss to act. In the meantime, Lodge wrote directly to Eisenhower. He observed that the only way to bring the President's program back to life would be to issue a statement that the United States had set aside a specified quantity of fissionable material earmarked solely for the project.[62]

Whatever the reasons for his reluctance, Strauss could hold out no longer; in a last-minute call to Jackson in New York, Strauss informed him that the State Department had cleared the announcement with White House approval. At that, Jackson drafted a paragraph that he rushed to Lodge, who was just about to begin his remarks. Inserting the paper at the very end of the speech, Lodge dramatically concluded his outline of American proposals by stating, "I have just been authorized by the President of the United States to state to you that the Atomic Energy Commission has allocated 100 kilograms of fissionable material to serve as fuel in the experimental atomic reactors to which the Secretary of State and I have previously referred." Vyshinsky had been furiously scribbling notes as Lodge talked. Jackson later recalled, "When he heard the 100 kilograms statement, [he] shrugged his shoulders, gathered up his papers, and put them in his briefcase—and that was that."[63]

PLANNING FOR GENEVA

Dulles's United Nations speech focused attention on the proposal for the international agency and the American offer to allocate fissionable material for peaceful purposes, but the text of the speech gave almost as much weight to calling an international scientific conference on the peaceful uses of atomic energy. Like the international agency, the conference had its origins in the events leading up to Eisenhower's United Nations address almost ten months earlier. Strauss had mentioned the idea to Cherwell at Bermuda; and when international discussion of Atoms for Peace reached a stalemate during spring 1954, Strauss had recalled his earlier suggestion as a way of giving substance to the President's proposal. Strauss discussed his idea with Isidor I. Rabi, the Nobel physicist who had replaced Oppenheimer as chairman of the Commission's general advisory committee. Although Rabi had been one of Oppenheimer's staunchest defenders during the security investigation, Strauss greatly respected Rabi as a scientist and sought his views. Rabi accepted Strauss's argument that an international conference might have propaganda value in winning worldwide support among scientists for the President's plan.[64]

Initially Strauss and Rabi were thinking in terms of a small, strictly scientific conference, to be held in the United States and sponsored by the National Academy of Sciences or the National Science Foundation. To keep things simple, Strauss and Rabi envisaged that the delegates would attend as scientists and not as official representatives of their nations. Strauss quickly obtained assurances that the National Science Foundation would consider sponsoring the conference. After checking with the White House, Strauss announced in a speech before the Los Angeles Foreign Affairs Council on April 19, 1954, that the President intended "to convene an international conference of scientists at a later date this year . . . [to explore] the benign and peaceful uses of atomic energy."[65]

Gerard Smith offered the State Department's full cooperation in arranging the conference; but a host of uncertainties, many of them the same as those delaying the whole Atoms-for-Peace plan, made it impossible to come to any final decisions during spring 1954. Would the Soviet Union and other communist countries attend the conference, and could it be held without Russian participation? Would the United States be pressured by other nations to release scientific information that was still classified under the terms of the 1946 act, and was there any possibility of a successful conference without the release of really substantive technical information on nuclear power reactors? Could such an international conference be held in the United States without imposing embarrassing restrictions on communist delegates and other scientists who held views unpopular with Americans? Should the conference be tied to the President's atom bank proposal, or should it deal with a broader range of scientific and technical questions?

Rabi discussed these and other considerations with the general advisory committee at its May meeting. Although the conference might well win worldwide support among scientists for the President's proposal, the committee members were even more enthusiastic about the opportunity for "a real forum for the exchange of information in biology, medicine, basic science, and engineering." There was general agreement that political issues should be excluded. Walter G. Whitman, a chemical engineer from the Massachusetts Institute of Technology and a veteran adviser to the Commission, was captivated by the bold approach the President had taken; he urged that the conference be organized around a series of sessions at which delegates would present technical papers on peaceful applications of atomic energy. The conference agenda, the committee agreed, should be drafted by an international working group.[66]

Through Smith at the State Department Strauss arranged for Rabi's appointment as head of the preliminary planning group and obtained permission for Rabi to discuss these suggestions with his counterparts in the United Kingdom and Canada. Even before going abroad, Rabi learned from embassy officials in Washington that both nations had reservations about the political nature of the conference, the wisdom of holding it in the United States, and the feasibility of convening it in 1954. When Rabi, however, took account of these criticisms in drafting a "prospectus" for the conference in July 1954, Smith and his associates at the State Department objected to holding the conference outside the United States. They questioned whether the conference could really avoid political issues; if it did not entertain political issues, the conference would lose its official status and would raise the sticky question of whether delegates from Communist China and East Germany could attend. One obvious solution would be to hold the conference under United Nations auspices, and the State Department was leaning in that direction.[67]

In August 1954 Rabi visited England and France, where his discussions with leading scientists greatly expanded his conception of the conference. In both formal and private meetings Sir John Cockcroft, head of the British nuclear research establishment, proposed a wide range of subjects for the conference agenda, including the social and economic aspects of nuclear energy, basic nuclear science, nuclear technology, research reactors, nuclear power, medical and biological applications, industrial uses of radioactive isotopes, health and safety, education and training, and an exhibition of nuclear information and equipment. Rabi and Cockcroft agreed that the conference would be valuable if the United States, Britain, and Canada all presented papers of real substance on the technical aspects of building nuclear power reactors. Rabi suggested that the conference probably could not be held before spring 1955 in order to give British and American officials time to declassify information that could now be released under the terms of the new Atomic Energy Act. It was also apparent that if their broad agenda was adopted, the conference would have to be sponsored by the United Nations. The French were not happy with United Nations sponsorship but agreed to follow the American lead.[68]

In his United Nations speech on September 23, 1954, Dulles committed the United States to a conference to be sponsored by the international organization. In working with the British and Canadians on the details of the agenda, Smith was joined by John A. Hall, director of the Commission's office of international affairs. A Harvard Ph.D. in government, Hall had joined the State Department after World War II as an adviser to the United States delegation to the United Nations, before going to the Commission in 1948 as its resident expert on liaison with the State Department. Urbane and debonair, Hall looked every inch the professional diplomat. The same age as Smith and with a comparable professional background, Hall had come to know and respect his State Department counterpart during Smith's four years at the Commission.

In planning for the conference on the international organization, Smith and Hall could draw on Cockcroft's memorandum, suggestions from a number of French scientists and representatives of the European scientific community, and strong staff support from the Commission. Robert A. Charpie, a physicist with Union Carbide at Oak Ridge, compiled drafts of the agenda with help from Hafstad, Kenneth Davis, and others. In planning the technical content of the agenda, the group was concerned that many proposed topics could not be discussed in American, British, or Canadian papers because important technical data on power reactor technology were still listed as confidential in the new tripartite classification guide drafted in England early in October; some data, relating to the costs of producing fissionable material and heavy water, were still classified secret or top secret.

After extensive discussion the Commission decided early in January 1955 that the conference papers would be permitted to go beyond the classification guide in only a few specific instances. American delegates could be permitted to discuss the economics of producing uranium concentrates for reactor feed but not actual costs of material from individual sources; the sales price but not the production cost of heavy water; the cost of uranium-235 but only up to a 20-percent enrichment; the general features only of one obsolescent type of reactor fuel element; and details of the aqueous fuel for a homogenous reactor unlikely to be of practical value. None of this information would reveal anything about the leading edge of power reactor technology in the United States. Still, the agenda was far broader than Rabi's original conception of it, and it seemed likely that many delegates, especially from smaller nations with no atomic energy program, would find much of substance in the papers to be presented by scientists from the western nations.[69]

By this time the United Nations General Assembly had approved the American proposal for the international conference, and Secretary-General Dag Hammarskjold had taken steps to create the official conference organization. In addition to the agenda, Rabi and Hall were also prepared to suggest appointments of conference officials and rules of procedure. Rabi would serve as the United States member of the United Nations advisory committee that would make formal arrangements for the conference. Rabi was also successful in obtaining the appointment of Walter Whitman of the general advisory committee as secretary-general of the conference. United States officials, especially Strauss, were relieved to have an American in this strategic position. The Americans were willing to concede appointing a scientist from a neutral nation as president of the conference. Over Strauss's strong opposition, the State Department accepted Britain's nomination of Homi J. Bhabha of India as president; but the department insisted that the conference be held in Geneva, Switzerland, largely because it would be more economical to use existing United Nations buildings there rather than build new facilities elsewhere.[70]

BILATERAL AGREEMENTS

While the United Nations organized the international scientific conference to be held at Geneva, the United States pressed ahead with its own program for the international development of atomic energy. On November 4, 1954, Eisenhower had appointed Morehead Patterson to be the principal United States Atoms-for-Peace negotiator. Patterson, who had directed development of equipment for classified projects at Savannah River and Hanford while he was president of American Machine and Foundry, had just completed his first major diplomatic assignment as United States representative at the 1954 disarmament talks conducted in London during May and June. He accepted the President's challenge to produce "deeds, not words" by directing a vigorous program of bilateral discussions while at the same time advancing negotiations to establish the International Atomic Energy Agency.[71]

The first agreements for cooperation concluded in 1955 modestly provided for American assistance in establishing research reactors abroad. The research bilaterals, as they were called, provided for the exchange of unclassified information on the design, construction, and experimental operation of research reactors. In addition, the Commission agreed to lease to each participating nation not more than six kilograms (at any one time) of uranium enriched to 20-percent uranium-235. The agreements also required cooperating countries to maintain adequate safeguards and accounting procedures as well as to permit American inspection of research reactors in which leased fuel was used. Finally, the research bilaterals mandated the reprocessing of all spent fuel elements by the United States. From the Commission's perspective, the military potential of such transactions was minor.[72]

By the time the Geneva conference was convened in August 1955, the Commission had negotiated two dozen research bilaterals. The first of these agreements was concluded with the government of Turkey on June 10, 1955, after the Joint Committee was assured that the Turkish bilateral was not "open ended" in its provisions for the lease of special nuclear materials. Typical of the agreements signed at this time, at the request of the Turkish government, American firms would be allowed to sell research reactors to Turkey and to provide other assistance including information related to health and safety problems, the use of reactors in medical therapy, and the use of radioactive isotopes in biological, agricultural, and industrial research. By 1961 the United States had negotiated thirty-eight research bilaterals with thirty-seven participating countries.[73]

The Commission also offered technical assistance to foreign countries developing research reactor plans, including advice in selecting an appropriate reactor and guidance in contacting United States industrial firms to obtain detailed assistance in solving design problems. Once a design was adopted, Commission staff experts assisted in preparing a hazard evaluation report. Although the United States did not assure operational safety of the foreign research reactor or assume liability for accidents, the Commission's technical committee reviewed the hazard report along with the research plans before offering financial assistance or allocating fuel.[74]

Of greater concern to the Administration and the Commission were the power bilateral agreements, negotiated at the same time, and often in conjunction with the research bilaterals. In January 1955 the Commission perceived a close relationship between United States foreign policies on nuclear power and nuclear weapons. To maintain American nuclear strength, the Commission advised the National Security Council that the United States had to obtain uranium abroad, establish overseas bases, and convince its allies that nuclear weapons could be legitimately used against communist aggression. Although the Atoms-for-Peace program could not reduce foreign anxiety concerning nuclear war, the Commission believed that atomic power contributing to the "peaceful well-being of the world" would greatly assist in attaining these objectives while at the same time refuting Soviet propaganda that the United States was concerned solely with the military atom.[75]

Thus, from the Commission's perspective, priority was given to aggressive implementation of the foreign power reactor program. Only secondarily did the Commission support multilateral projects such as the International Atomic Energy Agency. In fact, because power bilaterals offered political and economic advantages, as well as maximum supervision of foreign activities, Commissioner Murray hoped the United States would continue negotiating bilateral agreements even after the international agency was established. On the other hand, Murray, who had long advocated a more vigorous American program, did not object to framing bilateral agreements in such a way that they would be compatible with the international agency or any other multilateral group of nations that the United States approved.[76]

A year had now passed since the President had made his momentous speech at the United Nations. During those twelve months not only the American government but also its allies and the Soviet Union had attempted to respond, each in its own way, to the proposal that had captured world attention. With the failure to make any headway on either disarmament or a moratorium on thermonuclear tests, the urgency for some agreement on an international agency became more apparent. In the face of Soviet objections, Eisenhower had determined to press ahead without the Russians, even if that meant limiting international cooperation to a series of bilateral arrangements. The unexpected announcement of Soviet support in September, however, had revived the Administration's hopes for the international agency. The primary outlook for the new organizations and for the peaceful uses conference suggested that Atoms for Peace might be successfully launched on the diplomatic front in 1955. Still to be determined was the best course the Administration might take in pursuit of the peaceful atom at home and abroad.

CHAPTER 9

PURSUIT OF THE PEACEFUL ATOM

The efforts of John Foster Dulles in the State Department and Henry Cabot Lodge and C. D. Jackson in the United Nations in the closing weeks of 1954 at last had given the Eisenhower Administration some evidence of positive achievement in establishing the framework for international control of atomic energy. Unless the Russians balked again, the charter for the new international agency might be completed for ratification by the time the nations of the world convened in Geneva, Switzerland, in September 1955 for the opening of an international conference on the peaceful uses of atomic energy. Erecting the international framework, however, constituted only a small part of the President's proposal. It was equally important to the Administration that the United States produce something more tangible than draft charters, diplomatic notes, and grandiose plans for international meetings. Eisenhower sensed that his dreams for the peaceful atom would attain reality only when informed citizens in America and throughout the world had practical evidence of the peaceful uses of atomic energy. As 1954 produced more talk than solid results, the President became more impatient. He seemed determined in the new year that the nation should produce something, if only a symbol, that demonstrated the beneficial application of nuclear technology.

The President's determination sent ripples of influence through the National Security Council to several departments and agencies, but none was more directly affected than the Atomic Energy Commission. As the nation's manager and promoter of nuclear technology, the Commission was the one agency that could produce the hardware or other visible accomplishments that the President was seeking. In one respect, Eisenhower's personal interest offered the Commission an exceptional opportunity: It assured the agency a sympathetic ear, if not uncritical endorsement of its programs and budgets. In other respects, however, meeting the President's expectations posed a dilemma for Strauss and his associates.

On the one hand, no group could have been more eager to fulfill the President's hopes by demonstrating the practical benefits of the atom. All the Commissioners personally believed in the promise of atomic energy and were as anxious as the President to see that promise realized. They were not immune to the sense of moral compulsion that drove the President to seek some redeeming value in a new technology that threatened the future of civilization. They responded to the challenge posed by the British and the Russians in the international race for nuclear power. They shared the view that nuclear technology could be used as a benign force, demonstrating the superiority of the democratic system and a capitalistic economy, as well as a horrifying threat in the Cold War.

On the other hand, Strauss and his colleagues were also aware of their responsibility as managers and guardians of a new technology to see that it was developed wisely, safely, and economically. During the Eisenhower Administration, nuclear technology had caught the imaginations of both influential business leaders and many ordinary citizens at home and abroad. The almost unbridled enthusiasm over the potential uses of atomic energy raised the danger of heavy political and financial commitments to questionable projects. Precipitous decisions could result in embarrassing the Administration, imposing severe financial losses on American business, endangering the public safety, fostering monopolistic control of the new technology, undermining private ownership of electric utilities, damaging national prestige, and losing the Cold War. In short, the dilemma was how to promote and support the Administration's pursuit of the peaceful atom while at the same time exercising responsible control over its development.

NUCLEAR POWER AND FOREIGN POLICY

No one was more sensitive to the relationships between nuclear power and foreign policy at the beginning of 1955 than was Lewis Strauss. For six months Strauss and Roy Snapp, his representative on the National Security Council's planning board, had been struggling to steer the council's foreign policy pronouncements in a direction that made sense in terms of nuclear technology. Fully convinced that the United States could employ the promise of nuclear power as a major instrument in foreign policy, the planning board had become impatient with the technical reservations and objections that Snapp relayed from the Commission. After listening to Snapp's arguments, the planning board had given up the idea that research reactors could be a credible expression of the Atoms-for-Peace program, but the board refused to abandon small reactors as the quickest way to demonstrate nuclear power abroad. This time the board recommended small power reactors producing up to 20,000 kilowatts, on the theory that reactors of that size might be economical in certain remote, high-cost power areas in foreign countries. The Commission considered the proposal risky because there was no solid evidence that a foreign market for small power reactors existed.[1]

The planning board's final version, sent to the National Security Council early in March 1955, represented the first formal restatement of the Administration's policy on the international atom since April 1953. The early development of nuclear power was still the key to maintaining the

United States' lead in nuclear technology. The nation's nuclear facilities and technology were "a great asset in the effort to promote a peaceful world compatible with a free and dynamic American society." Promoting the peaceful uses of nuclear energy could "generate free world respect and support for the constructive purposes of U.S. foreign policy, . . . strengthen American world leadership and disprove the Communists' propaganda charges that the U.S. is concerned solely with the destructive uses of the atom." Both the Soviet Union and the United Kingdom, according to the policy statement, were challenging America's superiority for promoting nuclear power. More veiled in this version than in earlier drafts was the military justification for Atoms for Peace, but the Administration understood that assistance to other nations, particularly Belgium and South Africa, in developing nuclear technology could be vital in assuring continued American access to foreign sources of uranium ore.[2]

Early in the National Security Council meeting on March 10, 1955, Strauss questioned a statement in the policy paper that "private rather than government financing should be used to the maximum extent possible, without jeopardizing the early development of nuclear power." Strauss complained that the statement implied that private financing would delay development, but Eisenhower, probably to Strauss's consternation, took just the opposite view. The President thought that atomic power should be developed without too much concern about the role of private industry, although he said he firmly believed in private enterprise. He thought the council's first concern should be the national interest, not the demands of private industry. The council quickly agreed that peaceful uses would be developed "as rapidly as the interests of the United States dictate, seeking private financing wherever possible."[3] The new policy certainly would not help Strauss in promoting private development of nuclear power in the face of Joint Committee demands for a government program.

STRAUSS BUILDS HIS TEAM

Despite his aggressive leadership as chairman during 1954, Strauss was not in the best position for the impending public debate as 1955 began. Three Commissioners—Zuckert, Smyth, and Campbell—had left office during the last six months of the year. To replace Zuckert and Smyth, the President had accepted Strauss's recommendations, nominating two distinguished scientists, both of whom had served on the Commission's general advisory committee. Willard F. Libby, a talented chemist, had been associated with the atomic energy project since the 1940s, first with gaseous-diffusion research during World War II and then as a scientist working under Commission research contracts at the University of Chicago. As a member of the general advisory committee since 1950, Libby had staunchly supported the Commission's activities in basic research and weapon development.[4]

Although Libby was later to win the Nobel prize in chemistry for his radiocarbon dating techniques, John von Neumann was even more renowned than Libby at the time of his nomination to the Commission. One of the nation's most respected physicists, a world authority in mathematics, and a pioneer in the theory of games, von Neumann had built at Princeton one of the first large electronic computers, which had helped to resolve some complex design problems associated with thermonuclear weapons.[5] Strauss had known von Neumann personally for many years and admired his friend for his intellectual brilliance and his unstinting devotion of his talents to national defense in the Cold War. Strauss could hardly have done better in choosing men with a broad understanding of nuclear science and technology, but both were relatively inexperienced in the rough and tumble of political life in Washington. Presumably they would confine themselves to technical matters and leave the initiative on policy to Strauss, as neither Zuckert nor Smyth had been willing to do.

As trusted members of the inner establishment, neither nominee seemed vulnerable to challenge by the Joint Committee. Libby, in fact, was confirmed speedily without a formal hearing, but Congress adjourned late in 1954 without acting on the von Neumann nomination. Strauss learned privately that there was some uneasiness in the Joint Committee about von Neumann's security record. There was some concern that von Neumann was a close friend of Oppenheimer's and that he held an appointment at the Institute for Advanced Study, where Oppenheimer was director. For years both men had kept their highly classified atomic energy files in a common vault at the institute, and there were rumors that Oppenheimer's secretary, who had maintained his classified files, would now work for von Neumann. Buried in von Neumann's security file was a notation that he had written a letter on behalf of one defendant in the Canadian atomic spy trials in 1946.

Strauss responded by noting that the accused person had been acquitted. No information in the file was new; nor had it prevented the government from using von Neumann on highly classified projects for almost a decade. The security problem at the institute had been resolved after removing all of Oppenheimer's classified files from the facility; and, Strauss assured the council, Oppenheimer's secretary would not be working for von Neumann. No one inside the establishment seemed concerned about von Neumann's personal integrity, much less his loyalty, but the potential for a second Oppenheimer case was frightening. Eisenhower agreed with Strauss that the Administration should stand firm on the nomination, and members of the Joint Committee cooperated by keeping the matter quiet and arranging to meet with von Neumann individually and privately to avoid giving hints to the press. So touchy was the whole affair, however, that von Neumann's confirmation was delayed until mid-March 1955.[6]

Strauss also had to accommodate the departure of several key members of the staff. Nichols privately told the chairman in September that he would be leaving in spring 1955 to set himself up as an engineering consultant.[7] Some members of the staff believed that having purged the staff of some of the "liberal," antimilitary holdovers from the Lilienthal period, Nichols considered his job essentially complete; the headquarters staff seemed fully in the control of former Army engineers from the Manhattan Project. Others guessed that Nichols was leaving because, with Strauss as chairman, he saw no possibility of exercising the kind of operational control over the agency that General Groves had enjoyed in the Manhattan Project.

Strauss was perhaps most reluctant to see Hafstad resign as director of reactor development. After five years on the job Hafstad was ready to move into a more lucrative position in business, which opened up at the Chase National Bank in New York with Strauss's recommendation. Over the years Strauss and Hafstad had become personal friends, and Strauss had come to rely heavily on Hafstad's judgment in technical matters.[8]

Replacing Hafstad was to be something of an ordeal for Strauss because the issue led to another round in his endless feud with Murray. In this case Murray was absolutely unyielding in his determination to see Rickover as Hafstad's successor. Strauss could hardly deny Rickover's technical qualifications on the basis of his record in developing naval propulsion reactors. The undeniable, if somewhat embarrassing, fact was that Rickover was the only Commission official who could lay claim to success in building power reactors. But Rickover's highly individualistic style, his close ties to the Joint Committee, and his hard-nosed approach to relations with private industry gave Strauss reason to seek other candidates. Strauss's friends in private industry and leading scientists in the national laboratories warned the chairman that Rickover's appointment would lead to mass defections from the Commission's reactor development program. Without committing himself too firmly, Strauss supported Richard L. Doan, a physicist who directed the nuclear activities of the Phillips Petroleum Company, which operated the Commission's national reactor testing station in Idaho. With Strauss and Murray at a stand-off, Libby refused to take sides, and Strauss was deprived of von Neumann's support pending his Congressional confirmation.[9]

Finally, late in February 1955, a compromise candidate emerged in W. Kenneth Davis, who had been serving as acting director of the reactor development division since Hafstad's departure.[10] Davis was a chemical engineer who had joined Hafstad's staff in April 1954. Just thirty-six years old, Davis had four years of experience in nuclear technology with the California Research and Development Company, a subsidiary of Standard Oil of California, where he had worked on the Commission's Livermore project to develop a large accelerator for producing plutonium and tritium. Like Hafstad, Davis was not a specialist in reactor technology, but he had demonstrated good judgment and administrative ability in his presentations to the Commissioners. He had quickly grasped the issues involved in bringing industry into nuclear power development, and he was a principal architect of the power demonstration reactor program. For technical support and a working knowledge of the division's activities, Davis recruited as his deputy Louis H. Roddis, Jr., a former naval engineering officer who had been a member of Rickover's senior staff since 1946.[11]

Strauss also lost the services of two other men who had been at the center of the Commission's activities since the 1940s. Roy Snapp had organized the secretariat and then had served as the Commission's representative on the planning board of the National Security Council. Edward R. Trapnell, after working in public information matters and special projects like the New York briefing of President-elect Eisenhower, had become director of Congressional relations. Both men found the agency under Strauss increasingly uncongenial and decided to leave government for the business world.[12]

Snapp was replaced as secretary of the Commission by Woodford B. McCool, whom Snapp had recruited in 1953. McCool, however, would never become one of Strauss's protégés. Intensely loyal to the Commission, always tough and hard driving, McCool would occasionally clear the Commission meeting room of all staff members so that Strauss and Murray could vent their anger and frustration in private. Nonetheless, McCool principally devoted himself to institutionalizing a professional secretariat that insured the accurate recording of the Commission's decision-making process. In time, it became well known throughout the Commission that one would "get it straight" from McCool, who could be distant and rigid but who above all protected the integrity of the decision process.

THE NUCLEAR MERCHANT SHIP

During a long session of the National Security Council on March 10, 1955, the discussion drifted to the possibility of installing a nuclear propulsion plant in a merchant ship. Eisenhower was fascinated with this idea, which had come from Admiral Arthur W. Radford, chairman of the Joint Chiefs of Staff. The United States had been the first nation in the world to use nuclear power to propel warships, as the spectacular performance of the *Nautilus*, the world's first nuclear submarine, had just demonstrated. What could better promote Atoms for Peace than to use the same or a similar propulsion system in a commercial vessel?

Strauss assured the President that the Commission already had a contractor investigating the idea, but he was more than a little troubled by Eisenhower's half-serious suggestion that the Commission try to get a nuclear-powered commercial ship in operation within three months. When Strauss reported two weeks later that the ship would cost $12 million and take two years to build, he suggested that by that time the Atoms-for-Peace program would be so far along that the ship would have no great impact on world opinion. The ship could be completed sooner, Strauss admitted, with a high priority, but such a move would inevitably interfere with developing nuclear ships for the Navy. Even on a less pressing schedule, Strauss said, Rickover had reservations about the idea. Rickover doubted that a well-qualified crew could be trained in two years, and he thought it risky to rely on a power plant as new as that in the *Nautilus* to maintain scheduled sailing dates during a well-publicized world tour.[13]

Ignoring these warnings, the National Security Council reaffirmed its directive to the Commission to "make an urgent study, including estimates of cost and time of completion, of installing at the earliest possible date a nuclear reactor propulsion unit in a U.S. merchant ship, which ship might travel throughout the free world to dramatize" the Atoms-for-Peace program. Working almost around the clock with headquarters and field personnel, Davis completed the report on April 5. The next day, with no time to clear the draft with his fellow Commissioners, Strauss presented the report to the National Security Council. Although the time estimated to complete the project had now risen to thirty months and the cost to $31 million, both Eisenhower and Vice-President Nixon were enthusiastic. Strauss again warned that the project might delay Rickover's work on nuclear submarines, but the council approved high-priority construction of a ship using a standard dry-cargo hull and a reactor similar to that in the *Nautilus*. When Strauss conveyed this decision to the Commissioners a week later, they were faced with another fait accompli in formulating nuclear policy.[14]

Despite the President's endorsement in a New York speech in April 1955, the ship project foundered in Congress. Strauss and the Commissioners set aside their private misgivings and loyally supported the project before the Subcommittee on Authorizing Legislation of the Joint Committee, but Holifield and the subcommittee skillfully used Rickover to slow it down. The spectacular success of the *Nautilus* had vindicated the Joint Committee's tenacious support of Rickover in his efforts in summer 1953 to obtain promotion to rear admiral and thereby remain head of the naval propulsion project. Carefully avoiding any comment on the wisdom of the President's decision to build the ship, Rickover testified in May 1955 that the project would inevitably interfere with his own efforts to build a nuclear navy. Rickover's reservations were enough to derail the project, at least temporarily, as Holifield's subcommittee deleted it from the authorization bill.[15]

THE SMALL POWER REACTOR

Strauss and the Commission had just as much trouble curbing the Administration's enthusiasm for the small power reactor. In January 1955 Nelson A. Rockefeller, who had succeeded C. D. Jackson as the President's special assistant, became infatuated with the idea that power reactors might serve as the basis for an "Atomic Marshall Plan" for the world. Rockefeller was anxious to implement the council's directive as boldly as possible by offering research reactors to friendly countries and rapidly declassifying power reactor information while providing assurances on the availability of enriched uranium. Rockefeller envisioned the United States paying about $15 million for at least forty research reactors, as well as aiding India, Japan, Brazil (where there were important impending elections), and Italy with immediate power reactor programs. Neither the Commission nor the Department of State, however, was enthusiastic about Rockefeller's expansive plans. From the State Department came complaints that no one—including foreign service officers, Commission staff, or prospective foreign recipients—knew enough about technology to implement Rockefeller's suggestion. Furthermore, with Strauss's concurrence, Gerard Smith objected to the temptation to push atomic energy beyond its technical possibilities in order to gain short-term psychological advantages.[16]

Rockefeller, nevertheless, prevailed upon the President to announce during his commencement address at Pennsylvania State University on June 11, 1955, that the United States had made important progress in negotiating agreements with ten foreign countries. Furthermore, Eisenhower said the United States would "contribute half the cost" of building research reactors abroad. In addition to announcing publicly the essence of the National Security Council's decision to promote American-built nuclear reactors abroad, the President promised sufficient technological and material assistance to support foreign development. Yet, for all of his optimism, Eisenhower confessed to the graduates that the social and political problems accompanying nuclear power development could "be foreseen but dimly." The solutions, he suggested, might require the lifetime work of some of those present that day at University Park.[17]

In the face of the Administration's enthusiasm over small power reactors, Strauss had to resort to delaying tactics rather than overt opposition. Despite occasional prodding from Murray, Strauss avoided the subject for months. In July 1955 he told the National Security Council that the Commission was already involved in several projects to develop small reactors and that he did not think that the council should dictate the specific size or design. The precise size of the reactor was a technical matter that he thought the Commission should decide. When the President seemed to accept his argument, Strauss assumed that the council agreed, and he later confirmed with the council's staff his conclusion that the meeting had reduced the directive to a mere recommendation.[18]

A SECOND INVITATION TO INDUSTRY

Strauss had broad support within the Commission and the staff for his opinion that a precise requirement for a power reactor did not make much sense. The most economically promising reactors appeared to be those several times larger in capacity than the 10,000 kilowatts now prescribed by the National Security Council, and as yet no one reactor type was clearly superior to any other for this application. A better approach seemed one the Commission was already considering: to ask industry to submit proposals for developing and building reactors smaller than those resulting from the first round of the power demonstration reactor program.[19]

Other considerations also recommended a second round. First, it would allay criticism that the terms of the first round limited participation only to teams of very large equipment manufacturers and utilities. Second, small electric cooperatives were effectively excluded by the Commission's refusal to contribute to plant costs under the first round. Third, some way was needed to accept the proposal from the Consumers Public Power District, which Libby considered technically superior to the others. And fourth, although it was never discussed explicitly in formal Commission meetings, Strauss was determined to keep the government out of commercial reactor development after Shippingport was built. So fixed was he on this point that he risked challenging Eisenhower's direct orders at the March 10 meeting of the National Security Council to give more weight to speedy development of nuclear power than to private participation by industry.

Strauss hoped that Commission approval of the second round would dissipate the criticisms from all sides. In addition to the kinds of assistance offered in the first round, the second invitation, announced on September 21, 1955, requested proposals in three specific output ranges, all less than 40,000 kilowatts, and offered broader assistance in providing that the Commission would take title to any portions of the plant constructed with government funds. In this sense, the second round represented a return to the type of joint government-industry project adopted for Shippingport. By establishing the deadline for proposals as February 1, 1956, the Commission also acknowledged the charge that the response time allowed for the first round had been too short to permit many companies to participate.[20]

Although announcement of the second round was received favorably in most quarters, it actually exacerbated relations with the National Security Council. Members of the planning board, led by Robert R. Bowie and other State Department representatives, insisted that the small-reactor requirement had not been rescinded. They were incensed that Strauss had chosen to ignore the President's order and cavalierly to assume that the Commission's judgment in this matter should prevail. Navy Commander Charles E. Nelson, who had replaced Snapp as the Commission's representative on the planning board, was frustrated by what he considered Bowie's sincere but wrong-headed notion that the small reactor could bring immediate success for the Atoms-for-Peace program and that there were unique aspects of small-reactor technology that the Commission was ignoring in the demonstration programs. So vigorous was the planning board's reaction that Strauss had to withdraw his original report on the small reactor, which had attempted to finesse the presidential requirement. Strauss tried to make light of the matter on February 9, 1956, when he told the Security Council that he was facing a "soft impeachment" on grounds of incompetence and insubordination. First, Strauss questioned whether the planning board was really qualified to select the type and size of reactor most appropriate for use abroad; second, Strauss contended that the Commission, through the demonstration program, had done far more to develop reactor technology than the single small-reactor project could hope to accomplish. The President agreed, and the requirement in the March 14, 1955, directive was revised to read that the United States "as rapidly as possible" would develop "power reactors of an appropriate size and design for use abroad." The implication was clear that the Commission, not the National Security Council, would determine what was appropriate.[21]

DIXON-YATES AGAIN

During winter 1955 Strauss also faced renewed political conflict over the Dixon-Yates proposal. An early action of the new Democratic majority on the Joint Committee had called upon the Commission to cancel the contract, but that request in itself indicated that the Democrats still did not have enough votes to kill Dixon-Yates in a direct assault. Instead, they resorted to delaying tactics, attempted unsuccessfully to call hearings on the contract, and tried to put pressure on insurance companies to withdraw financial support from the project. Under the circumstances, Strauss took a hard line against the almost daily attacks on Dixon-Yates. He consistently turned aside Murray's attempts to get a formal Commission vote on canceling the contract and elected to consider Eisenhower's strong public statements of support as binding on the Commission.[22]

Failing to shake Strauss or the President, the Democrats quietly began probing every detail of the contract negotiations during the previous summer for any evidence of irregularity. Early in February a promising clue turned up in some sleuthing by Joseph Volpe, Jr., who had been retained by a group of intervenors opposing the waiver of certain debt-financing requirements by the Securities and Exchange Commission. Volpe, former general counsel at the Atomic Energy Commission and one of Oppenheimer's attorneys during the security hearings, knew how to use the Washington bureaucracy to gain information, and he had no compunctions about embarrassing Strauss. Following rumors that some "mystery man" had been involved in the contract negotiations between the Dixon-Yates group and the government, Volpe discovered that Adolphe H. Wenzell, a vice-president and director of the First Boston Corporation, had served as a consultant to the Bureau of the Budget on the Dixon-Yates project during the first four months of 1954, at the same time that he was advising the Dixon-Yates group on financing construction of the power plant. Volpe alerted Senators Clinton Anderson and Lister Hill, who asked the bureau for information about Wenzell's employment. When it developed that records of Wenzell's participation had not been included in supposedly complete chronologies prepared by the Atomic Energy Commission and the bureau on the Dixon-Yates negotiations, Hill in a Senate speech on February 18, 1955, charged the Administration with concealing important facts about Dixon-Yates. In the scramble to check their records, bureau and Commission officials found additional instances of Wenzell's participation, revelations that inevitably led to more charges of a cover-up.[23]

Both Eisenhower and Strauss, however, stood firm in the face of political sniping. Unless positive evidence of improper or illegal activities by Wenzell turned up, they thought Dixon-Yates would probably weather the storm. More serious at the moment were reports from Memphis that the city would not accept power from the Dixon-Yates plant even if it were built. During the early phases of contract negotiations in summer 1954, Memphis city officials had expressed no enthusiasm for the Dixon-Yates solution, mainly because the plant would be located across the Mississippi River from Memphis, in Arkansas; the city would have to rely upon another state for rate and service regulations. There was also some sympathy in Memphis for the Tennessee Valley Authority, which had been providing power to the city for more than a decade. Two alternatives to Dixon-Yates were apparent: the city could join pro-TVA forces, overwhelming in Tennessee, to obtain construction of a TVA power plant on the eastern side of the river, or the city could build its own power plant. Walter Von Treschkow, a veteran promoter of electric utility financing, was urging the latter course on city leaders as a practical solution and on the Republican party as a way of halting TVA growth while avoiding the inevitable political damage to the party from a direct assault on TVA.[24]

As new charges in the Wenzell affair continued to fuel the Dixon-Yates controversy in Washington during spring 1955, Memphis leaders became more explicit in rejecting Dixon-Yates power, if only in private communications to the Commission and the Bureau of the Budget. General Manager Nichols took these seriously enough in March to start some contingency planning for terminating the contract. In June the issue came to a head when the Securities and Exchange Commission began hearings on debt-financing of the Dixon-Yates project. When Volpe announced plans to call Wenzell to testify, Sherman Adams of the White House asked the Securities and Exchange Commission to postpone the hearings for several days. They were not renewed until the House had voted on the TVA appropriations bill, which included funds both to build a transmission line from the Dixon-Yates plant across the river to TVA territory and to construct a TVA steam plant at Fulton, Tennessee, on the east bank of the river. When the House voted down the Fulton plant, the Memphis officials publicly declared their intention to build a municipal power plant.[25]

This decision, plus the Democrats' determination to call hearings before the Senate Judiciary Subcommittee on Antitrust and Monopoly, spelled the doom of Dixon-Yates. In response to a barrage of questions at a press conference on July 6, Eisenhower expressed his delight that Memphis was taking responsibility for its power needs at the local level. As Senator Estes Kefauver continued to make headlines and political capital out of Wenzell's testimony at the hearings, Strauss began to back away from Dixon-Yates. On July 16, Eisenhower accepted the recommendation from the Atomic Energy Commission and the Bureau of the Budget that the contract be terminated.[26]

Even then the political repercussions of Dixon-Yates did not end. A legal opinion from the Atomic Energy Commission and a ruling from the Comptroller General cast doubt on the validity of the Dixon-Yates contract on the grounds that Wenzell's activity had constituted a conflict of interest. The Commission's effort to negotiate a cancellation settlement with the Dixon-Yates group was thus aborted, and the company went to court in an effort to recoup up to $3.5 million already spent in the project.[27]

REACTORS AT GENEVA

While Strauss and the Administration fought to save the Dixon-Yates plan in early summer 1955, the Commission was at the same time preparing for an unprecedented presentation of American accomplishments in nuclear technology. The United States had already taken the initiative in organizing the international conference on the peaceful uses of atomic energy that the United Nations was sponsoring in Geneva in August. In planning the conference the Commission had decided in the United States' presentation to highlight American achievements in developing commercial nuclear power. Mirroring the five-year reactor program, the American papers and exhibits presented at Geneva were impressive in the breadth and sophistication of the technology produced under the Commission's auspices. While some nations in Western Europe could cite experiments in reactor physics or vague plans for designing experimental reactors, the United States presented an astounding panoply of richly detailed information, not only in reactor technology but also in other areas of the nuclear sciences. American delegates described in full engineering detail reactors actually operating or under construction in the United States, including the full-scale Shippingport plant.[28]

The only nations potentially capable of challenging the United States in developing power reactors were the Soviet Union and the United Kingdom. Although the Russians described a small power reactor already in operation, questions by American delegates at the Geneva conference revealed that the plant was neither very sophisticated in design nor efficient in operation—smaller and much less efficient than the Shippingport plant, which would be far from economically competitive with conventional power plants. Surprising about the Soviet presentation in Geneva was the highly technical competence of Russian scientists and engineers generally and the large numbers of students in training in universities and technical schools.

The British reactor effort was miniscule by comparison with the five-year reactor and power demonstration programs, but it was sharply focused on commercial power. The British put their best efforts, not in the scientific and technical exhibit at the United Nations site, but rather in the commercial exhibit in downtown Geneva. Equally impressive were the British descriptions of the new Calder Hall reactors, then under construction. These dual-purpose reactors would produce both plutonium for weapons and power for civilian use; the plutonium subsidy and the relatively high cost of power in Britain were enough to make the Calder Hall plants look economically attractive as power producers. Thus, the British effort, although modest by comparison, commanded a sense of reality and directed purpose that the American program lacked. As one news magazine put it, the United States was ahead in the race for nuclear power "but not as far ahead as you might think." One American scientist was reported as saying: "If the United States vanished off the face of the earth tomorrow, the rest of the world could easily overtake our atomic science within three years."[29]

Overseas competition was developing, but Strauss continued to remind the Congress and the public that American achievements had been substantial. By late 1955 all four projects in the first round of the power demonstration reactor program were moving forward. The Detroit Edison consortium had formed the Power Reactor Development Company, which was planning to build a breeder reactor named for Enrico Fermi near Monroe, Michigan. Both the Consumers and Yankee proposals had been revised to conform with the terms of the first-round invitation, and the offer by the Nuclear Power Group had been replaced by a decision by Commonwealth Edison of Chicago to build a boiling-water reactor at Dresden, Illinois, independent of government support. Two other utilities in the East had already announced plans to build full-scale nuclear plants as independent ventures.[30]

Equally encouraging was the response to the second round. Six of the seven proposals received on February 1, 1956, were from small municipal power systems or cooperatives. There was at least one proposal for each range of capacities set forth in the invitation, and virtually every type of reactor under consideration by the Commission was represented. The response also nicely complemented the first round in terms of geographic distribution.[31] The Commission probably could not have done better if it had orchestrated the response itself. Indeed, it would have been remarkable if Strauss, Davis, and others did not steer some proposals into appropriate categories.

In the Commission's laboratories the five-year program was still the focus of attention as the five original experiments were supplemented by one new project at Oak Ridge and two at Los Alamos. Descriptions of the five-year program suggested that the Commission was exploring a remarkable variety of approaches, each intended to determine the engineering feasibility of a different design. Each was pictured as drawing on existing scientific and technical data and in turn contributing new information for the next generation of experiments or demonstration plants. The five-year program appeared rational and comprehensive, but it lacked focus; it offered no simple, direct, and predictable route to nuclear power.

BUILDING THE REGULATORY STRUCTURE

Strauss could take some satisfaction in the staff's achievements in developing the administrative and regulatory structure necessary to support and control the new nuclear industry. The task had been far more difficult and time-consuming than most people had expected, but Harold Price had refused to be hurried as he erected the new structure. In the last six months of 1954, after the act had been passed, the task groups under Price's direction had drafted most new regulations required to govern private ownership of reactors and other facilities using fissionable material. Once the Commissioners had reviewed the drafts, Price arranged to confer with utility executives, scientists, engineers, and state officials to explain the drafts and gather comments. By summer 1955, Price's staff had been organized as a new Commission division of civilian application, which prepared new drafts of the regulations. By the end of the year, the Commission had approved most regulations in final form, and they were published for public comment before becoming effective in spring 1956. Even after this long process, Price had to admit to the Commissioners that the new regulations were little more than a beginning. Most of them had to anticipate the workings of a commercial technology that did not yet exist. The work required a delicate balance between protecting the public with effective regulations and giving private industry as much freedom from regulation as possible. Whether a proper balance had been struck could be determined only after industry had had an opportunity to test the new rules.[32]

Creating a new industry also required the wide dissemination of nuclear technology. Under new security regulations the Commission gave engineers from industry clearances to special categories of reactor data after only limited investigation. By late 1955 more than six hundred access permits had been granted to various companies, and more than three thousand security clearances had been processed in the last half of that year. Before the holders of these new limited or "L" clearances could use them, however, the Commission staff had to review thousands of technical documents and laboratory reports to determine which could be placed in the new classified category, which still contained secret restricted data, and which were unclassified. Of the twenty-five thousand reports reviewed by February 1956, more than one-third had been declassified entirely and about one-fourth had been downgraded to the "L" category.[33]

THE RESEARCH BASE

In pursuit of the peaceful atom, Administration leaders and congressmen tended to measure success in terms of visible products of technology. Fully aware of this fact, Strauss and his colleagues justified the Commission's nonmilitary activities with statistics demonstrating technological achievements. But the Commissioners also believed that technical advances usually had their origins in basic knowledge amassed by scientists and research engineers. In his 1945 report, *Science, the Endless Frontier*, Vannevar Bush had presented the common wisdom growing out of the wartime experience: basic research was like money in a savings account; engineers could draw only so much from that investment for practical applications before it was necessary to replenish the account with more basic research. Bush's argument had been part of the rationale for the Commission's ambitious research program, which in the 1950s still overshadowed all other federally sponsored research except that in the Department of Defense.[34]

Sponsoring research, however, was more than an onerous task of keeping the accounts of knowledge and application in balance. The opportunity to foster activities that contributed positively to knowledge, that might even enrich the lives of people everywhere, was to the Commissioners and the staff a welcome relief from the harsh and unrelenting burden of producing more materials and nuclear weapons for the ultimate purpose of destruction. The millions of dollars the Commission lavished on research activities helped to salve the consciences of many who could not forget the potential for human disaster that lurked in the nation's growing stockpiles of nuclear weapons. Within the atomic energy establishment, the hope was probably all but universal that somehow the benefits of nuclear technology would eventually dispel the dark cloud of horror and destruction cast by the bomb. To bring that hope to reality was a strong and uplifting motivation.

Beyond these questions of conscience, there was the sheer delight in discovery, the excitement of exploring new realms of nature revealed by the powerful research tools of nuclear technology. The stunning successes within a single decade in applying scientific data and then adding once more to the store of basic knowledge raised the possibility that the world was on the brink of a new renaissance. For a man like Lewis Strauss, who stood in awe of scientists and their achievements, the chance to participate in and even to contribute to this extraordinary enterprise offered the ultimate in self-fulfillment.[35]

The Commission's research base rested on the national laboratories, university-based projects, special development laboratories, and a vast network of research activities performed by hundreds of colleges, universities, private research institutions, and other government agencies. By the time Strauss became chairman in 1953, the research base was firmly established. The three large multidisciplinary national laboratories—Brookhaven, Oak Ridge, and Argonne—all had roots in the Manhattan Project. All three were intended to be regional centers where resident scientists and others from nearby universities could work together on nuclear research requiring human resources and equipment beyond the capabilities of a single private institution.

Of the three, Brookhaven came closest to realizing the original model of a regional, cooperative research center. Managed by an association sponsored by nine universities in the Northeast, Brookhaven reflected, more than did Oak Ridge or Argonne, the interests of academic scientists in basic research. The only national laboratory with a large research reactor and a proton synchrotron in the billion-electron-volt range in 1953, Brookhaven could offer scientists a bountiful supply of subnuclear particles, fission products, and radioisotopes for a wide variety of nuclear research activities in both the physical and the biological sciences. The research reactor completed at Brookhaven in 1950 made the laboratory a natural center for a Commission-wide project to compile a complete set of data on the nuclear characteristics of the many materials used in atomic research and development. The cosmotron, capable of accelerating protons to more than three billion electron volts (GeV), was already producing in 1953 a variety of heavy mesons that gave Brookhaven at least a temporary lead in research in high-energy physics, a field that was capturing the attention of physicists throughout the world.[36]

Compared with Brookhaven, Oak Ridge National Laboratory had more of an industrial than an academic flavor. Originally built as a pilot plant for plutonium production during World War II, the laboratory had long been managed by an industrial contractor, more recently by the Union Carbide and Carbon Corporation. The Commission's contract with Union Carbide did not provide for the Brookhaven type of cooperative arrangement with university scientists in the region. Instead, the Commission supported the Oak Ridge Institute of Nuclear Studies, a consortium of twenty-four southern universities, which used laboratory facilities at Oak Ridge for research, training, and education.[37]

Well staffed by reactor physicists at the end of the war, the Oak Ridge laboratory had suffered a setback in 1947 when the Commission decided to make Argonne its center for reactor development; but under Alvin M. Weinberg's skillful leadership, Oak Ridge won from the Commission a series of assignments to study some of the more exotic reactor concepts. The laboratory was also the home of the aircraft nuclear propulsion project, supported by the Commission and the Air Force. The laboratory's principal research tools in the 1950s were the research reactor built during the war and an eighty-six-inch cyclotron. The reactor was the only one of its kind in the United States until the Brookhaven facility was completed. In addition to providing irradiation space and radioactive products for physical and biological experiments, the Oak Ridge reactor produced more than a dozen radioisotopes for distribution to industrial and research users. The reactor, the cyclotron, and other facilities at Oak Ridge made the laboratory a world center for the production and distribution of stable and radioactive isotopes. During the lean years in the 1950s when the Commission had little to boast about in advancing the peaceful uses of atomic energy, descriptions of the isotope distribution program filled Commission reports and press releases.[38]

Although the Commission in 1947 intended Argonne to be a regional research center accessible to universities in the area, the laboratory never achieved the degree of academic participation enjoyed by scientists at Brookhaven. Walter H. Zinn, the laboratory director, had himself been an academic physicist and appreciated the need for strong programs in basic research at Argonne. In fact, the laboratory under his direction pursued important areas of applied research in metallurgy, radiation chemistry, nuclear physics, and the biological effects of radiation. Zinn, however, felt even more keenly pressures from the Commission to develop nuclear power and meet defense requirements. Thus, Argonne had initiated some research on naval propulsion reactors for Rickover, had built the first breeder reactor, had completed design studies for the plutonium production reactors at Savannah River, and had developed the boiling-water reactor, which was fast becoming a credible approach to nuclear power. The facilities required for all these projects, and especially the experimental reactors built by the laboratory at Argonne and the Idaho test station, prompted the Commission by 1956 to pour more capital investment into Argonne than into the other two multipurpose laboratories.[39]

Important as these achievements were, they came at the cost of strong dissatisfaction among scientists in the thirty-two universities and research institutions in the Midwest that, on paper at least, were to have a voice in setting research priorities at Argonne. Zinn gave little more than lip-service to the board of governors, who represented the participating institutions, and proceeded as if all program decisions were to be made by the University of Chicago as the Commission's operating contractor at Argonne. By early 1948 the board of governors had abandoned all pretense of exercising any real influence over the laboratory's research program, and the Commission's revision of the laboratory's charter in June 1950 replaced the board with a powerless advisory body. The new charter suggested that the Brookhaven model of a cooperative regional laboratory was not to be duplicated at Argonne.[40]

While Zinn struggled for independence at Argonne, Ernest O. Lawrence already enjoyed a free rein at the University of California Radiation Laboratory in Berkeley. Lawrence had founded the laboratory before World War II with private and state funds and had made it a world center for research in high-energy physics before the Manhattan Project was created. Without hesitation Lawrence had thrown all his influence and all the laboratory resources into the war effort. He was thus in a strong position after the war to assure Berkeley its full share of federal funding for research without accepting either the designation of a "national laboratory" or a formal commitment to provide a research center for other universities on the West Coast.

Although the Radiation Laboratory conducted nuclear research in many areas of the physical and biological sciences, it primarily focused on high-energy physics centered on the bevatron and other accelerators, transuranium chemistry and the creation of transplutonium elements under Glenn T. Seaborg, and weapon research at Livermore. By 1956, the combined work force of more than four thousand people at Berkeley and Livermore made the Radiation Laboratory the largest of all the Commission's research facilities.[41]

Among the Commission's single-purpose research installations, the largest by far in 1956 was the Los Alamos Scientific Laboratory, also operated by the University of California. Virtually all the research and development at Los Alamos before 1956 was related to nuclear weapons, but the laboratory did perform basic research, for example on the physical, chemical, and metallurgical properties of materials used in weapons. Much basic research at Los Alamos was similar to that funded at other Commission laboratories, except that the work at Los Alamos was usually weapon-related and hence classified. Deeply concerned in 1954 that younger scientists would ultimately see little future in a laboratory devoted entirely to weapon research, Norris E. Bradbury, the director, urged Strauss to broaden the laboratory's charter. As a result, Los Alamos began investigating a very advanced concept for a power reactor in 1956 and, like Livermore and Oak Ridge, entered the new field of research on controlled thermonuclear reactions. At that time Los Alamos had the largest operating budget (more than $47 million) of any Commission laboratory and employed 3,300 persons. Comparable in size to Los Alamos were the two naval reactor laboratories: the Bettis Plant operated by Westinghouse near Pittsburgh and the Knolls Atomic Power Laboratory operated by General Electric near Schenectady.[42]

Other single-purpose laboratories were smaller than those already mentioned, but they still performed vital research functions for the Commission. The Sandia Laboratory in Albuquerque and the Mound Laboratory in Miamisburg, Ohio, had essential roles in weapon development and production. The Raw Materials Development Laboratory at Winchester, Massachusetts, and the Ames Laboratory at Iowa State College helped to improve processes for refining uranium ore and reducing it to metal. The Commission also supported medical and biological research using nuclear materials and equipment at the Universities of Chicago and Rochester and the University of California at Los Angeles and San Francisco. In all its laboratories in 1956 the Commission spent more than $51 million for research in chemistry, metallurgy, and physics and more than $30 million for research on cancer, medicine, and biology. During that same year, the Commission committed almost $19 million for more than eight hundred off-site research contracts, which included nearly every major research organization, college, and university in the country.[43]

HIGH-ENERGY PHYSICS

This unprecedented commitment to scientific research was expected to contribute in hundreds of untold ways to the increase in human knowledge and the beneficial application of nuclear technology. By its very nature, however, research produced small increments of data, most of which could not be appreciated by the news media or the general public. To justify the value of research for the Administration's Atoms-for-Peace program, the Commission had to rely on a few projects that seemed to push the frontiers of science into exotic realms that somehow captured the imagination of nonscientists. Ernest Lawrence had learned in the 1930s that probes into the submicroscopic world of the atomic nucleus with the cyclotron elicited that kind of response. The discovery of the synchrotron principle during World War II had sparked new enthusiasm for high-energy physics after the war, and it became the research area in basic physics most generously supported by the federal government. Two products of that enthusiasm were the Brookhaven cosmotron and the Berkeley bevatron, which was expected to achieve proton energies above 6 GeV when the accelerator came into operation in 1954.[44]

Even before the bevatron was completed, physicists were looking for ways to reach even higher energies, which seemed necessary for fully exploiting the research possibilities already revealed by the cosmotron. Both the cosmotron and the bevatron, however, were approaching the maximum practical size of a synchrotron. Higher energies appeared to require that particles be accelerated over much greater distances than ever before. That meant that the vacuum-tight annular or "racetrack," through which the particles would move, would have to be considerably larger than those used at Brookhaven and Berkeley. As the radius of the racetrack was increased much beyond thirty feet, the cost of the steel and control equipment required for the magnets that focused the proton beam on its circular course became almost prohibitively large. Also, as the diameter of the racetrack increased, the volume of the doughnut-shaped race course to be evacuated with vacuum pumps became enormous.

In searching for a new approach to synchrotron design that would overcome these limitations, physicists at Brookhaven in summer 1952 investigated a design principle suggested by scientists at the European Center for Nuclear Research (CERN). The new idea was called alternating gradient, or strong focusing. Instead of flat, parallel pole faces on the focusing magnets, the European scientists proposed a curved surface. It had long been known that nonparallel or curved pole faces would cause variations in the magnetic field at different points in the cross section of the beam, but only relatively small variations or "shims" had been used. The scientists found that by introducing a relatively large variation or gradient and then alternating the orientation of successive magnets around the racetrack, a focusing and defocusing effect was produced that sharply compressed the beam's cross section. A sharper beam meant that the aperture of a synchrotron could be reduced from a width of about 30 inches in the cosmotron to about 1.5 inches in a machine using strong focusing. The implications of strong focusing for accelerator design were dramatic. The smaller aperture made possible much smaller magnets and volumes; hence the diameter of the racetrack could be increased, and much higher energies, perhaps as high as 100 GeV, now seemed possible. Strong focusing could also be used in Van de Graafs and linear accelerators, which served as particle generators and injectors for the large machines.[45]

The advantages of strong focusing, apparent to physicists, were likely to mean little to most government officials. It so happened, however, that the first studies of strong focusing in summer 1952 were an international venture involving both European and American physicists. Fully appreciating the advantages of strong focusing, the European group made plans to use it in a cooperative effort to build a 30-GeV proton synchroton in Switzerland. Although scientists at Brookhaven saw strong focusing primarily as an opportunity for new research in high-energy physics, the Europeans' plans raised for Commission officials the specter of lost American preeminence in a preeminent field of science. The Commission proposal to build an alternating-gradient synchrotron at Brookhaven with a power of 25 to 35 GeV noted that "American scientists have held the lead in nuclear science since the invention of the cyclotron and they do not now wish to fall behind." Thus, the pace of American development in high-energy physics had become a measure of success in the Atoms-for-Peace program.[46]

The Commission's prompt decision to fund the Brookhaven accelerator, however, did not meet the expectations of many American physicists, particularly in the Midwest. With the cosmotron and bevatron in operation by 1954 and the first of a new generation of accelerators already approved for Brookhaven, scientists in the Midwest still had no prospects for an accelerator in the GeV range. Argonne was the logical location for such a machine. In January 1954, within weeks after Commission approval of the Brookhaven project, Zinn proposed to meet the growing demand for a large Midwest accelerator by building it at Argonne in cooperation with university physicists in the region. Reluctant at first to risk dilution of Argonne's work on reactors or to request additional funds from the tight-fisted Bureau of the Budget, the Commission in June 1954 approved a design study at Argonne, mainly to forestall attempts by the Midwest Universities Research Association to obtain federal funds for an accelerator project independent of Argonne. The core of the new association consisted of physicists who had been frustrated for years in trying to extract from Zinn and the Commission some role in establishing research priorities at Argonne. The depth of the scientists' disaffection with Zinn's high-handed methods became apparent in October 1954, when the association summarily rejected Zinn's offer to set up a separate accelerator division at Argonne and to give the Midwest group a voice in selecting the division director, who would have complete technical but not administrative control of the accelerator project. Drawing from experience, members of the association did not trust Zinn, and he looked upon the rejection of his proposal as another example of their unreasonable expectations.[47]

The uncompromising stance taken by both sides in autumn 1954 stalled for almost a year all attempts at settling the dispute. In the meantime scientists were publishing exciting results of experiments conducted with the cosmotron and bevatron. Most significant had been the discovery of the antiproton, which had been produced with high-energy protons in the bevatron and identified by Owen Chamberlin, Emilio Segre, and others at Berkeley with the recently developed liquid-hydrogen bubble chamber. With frustration and impatience growing on both sides in the Midwest, Lawrence A. Kimpton, chancellor of the University of Chicago, offered a compromise proposal, in which the university as the Argonne contractor offered significant concessions: namely, something similar to the Oak Ridge Institute of Nuclear Studies be established to design and build an accelerator at Argonne as an independent Commission contractor. The Midwest scientists welcomed the idea, but Kimpton had mistakenly assumed that he could convince Zinn to accept the compromise. Zinn instantly rejected it and submitted his resignation, to be effective within three weeks; only with difficulty did Strauss persuade Zinn to delay. The Commission now faced a quandary. On the one hand, the Commissioners did not want to lose Zinn or threaten the future of Argonne; they did not want to abandon the idea that Argonne was to become a regional multipurpose laboratory; and they also knew that it would be hard to obtain funds for two laboratories. On the other hand, the Commission knew that if Zinn stayed, the Midwest group would never agree to work within Argonne. Pressure from the Commission would free the group to seek an independent laboratory at another site. If the Commission refused to cooperate, the Midwest group might well seek funding from the Department of Defense and thus threaten the Commission's hegemony over basic research in the Midwest.[48]

A compromise solution emerged early in November 1955 with help from the general advisory committee: the Commission proposed to fund two accelerator projects but only one laboratory. Argonne was to be asked to build a 12-GeV scale-up of the bevatron, a machine that presumably would involve more engineering than high-powered physics and could be completed before the Soviet Union could operate a machine somewhat larger than the bevatron. Thus, Argonne could maintain the United States' lead in high-energy physics until the new Brookhaven accelerator took the lead in the world contest. The Midwest group would be offered funds to design a truly advanced accelerator, to be built a year later at an unspecified site. Privately the Commission hoped that, by the time site selection became an issue, new faces might be on the scene and the Midwest accelerator might be built at Argonne.[49]

The Commission's compromise was acceptable to the Midwest group but not to Zinn, who insisted that Argonne was not staffed to build the 12-GeV machine and that in any case it could not be completed before the Brookhaven alternating-gradient accelerator. Instead, Zinn held out for an accelerator that would advance the state of the art. When the Commission formally assigned the 12-GeV project to Argonne, Zinn resigned.[50]

The turmoil that the Commission and Zinn experienced during his last two years at Argonne revealed the complex pattern of decision making in federal support of scientific research. It was by no means unusual that the quality of proposals and the ability of the scientists involved were not the only factors in determining which projects were accepted and which rejected. Regional interests, politics, budget limitations, bureaucratic competition, existing policy, and personality conflicts all played a part. In this kind of debate, it seemed inevitable that the appeal to national interest and even to national security should be involved. It was no accident that the solution to the Commission's dilemma should rest in part upon the argument that high-energy physics offered a significant battlefield in the Cold War.

ENERGY FROM THE STARS

Secretly the Commission was supporting research that would challenge the United States' competitors in another race for nuclear power—harnessing the power of the hydrogen bomb for peaceful purposes. Since 1951, even before a workable thermonuclear weapon had been designed, the Commission had been supporting secret research on controlled thermonuclear reactions. In March of that year Lyman Spitzer, Jr., an astrophysicist at Princeton University, had begun to consider how he might design a reactor that would contain an ionized gas or "plasma" of hydrogen isotopes, which might be fused to release the enormous energy associated with the thermonuclear reactions that powered the sun and the stars. In order to fuse the hydrogen nuclei, the temperature of the plasma would have to be raised to one hundred million degrees, hotter than the interior of the sun and many times any temperature ever achieved in the laboratory. Because no material vessel could contain such a plasma, other methods of confining the gas would be required. Experiments with ionized gases in previous decades suggested that confinement might be accomplished with strong magnetic fields, and within a few weeks Spitzer conceived of a simple confinement system that would use an external magnetic field to confine the plasma within a vacuum chamber shaped like a doughnut twisted into a figure-eight. In summer 1951 the Commission funded Spitzer with $50,000 for a paper study of his idea.[51]

Spitzer's interest in fusion energy stemmed from the theoretical work that he was undertaking with John A. Wheeler on the design of a hydrogen bomb. Likewise, scientists at Los Alamos and Livermore saw fusion energy development as an offshoot of the thermonuclear research that they were already pursuing, and both laboratories staked out claims for other theoretically obvious but completely untested systems for magnetic confinement in 1952. Spitzer called his device the "stellarator," an optimistic reference to the stars as fusion energy systems. The Los Alamos approach was called the "pinch" and the Livermore concept the "magnetic mirror." By summer 1953, when Strauss became chairman, the Commission had spent about one million dollars on fusion energy research: 50 percent of it at Princeton, 30 percent at Berkeley and Livermore, and 20 percent at Los Alamos. Thirty scientists in the four laboratories were devoting part of their time to these projects, and the pace was unhurried and relaxed.[52]

When Strauss became chairman, he moved at once to enlarge and accelerate fusion research. Both Teller and Lawrence, whose opinions Strauss considered virtually unchallengeable, believed that the work deserved high priority. Strauss saw it as a priceless opportunity for the Atoms-for-Peace program and a telling refutation of the claims of fainted-hearted scientists like Oppenheimer, who, Strauss contended, had seen no redeeming or beneficial value in thermonuclear research back in 1949. What greater success could the Administration contemplate than to present the world with a new, clean, and limitless source of power while other nations were still striving to perfect the fission reactor? Fusion offered a "quantum jump" over fission reactors similar to that which the hydrogen bomb held over atomic weapons of the Hiroshima type.[53]

Under Strauss's leadership the Commission launched Project *Sherwood* and directed the staff to seek proposals from the laboratories for actual experimental devices, not mere paper studies, that would serve either as testing equipment or as prototypes for fusion reactors. Under pressure from Washington, Spitzer by June 1954 produced a plan for a full-scale operating stellarator even before bench-top experiments or a small-scale prototype could be completed. By summer 1955 the number of scientists engaged in fusion research had risen to one hundred full-time workers. Operating costs had reached almost $5 million annually. There was no shortage of enthusiasm for Project *Sherwood* in the chairman's office and no lack of funds in the laboratories. In fact, as one scientist remarked, "one gets the feeling in visiting the various sites that the number of dollars available per good idea is rather uncomfortably large."[54]

With his almost naive faith in the power of science, Strauss seemed to believe that with sufficient money and effort almost any technical goal, including controlled fusion, could be attained. But the fact was that in autumn 1955 scientists had not yet begun to understand the complex phenomena that would influence the behavior of plasma in a fusion reactor. By giving Project *Sherwood* a high priority, Strauss did raise morale among the scientists and put more of them to work, but the generous flow of funds from the Commission also had unfavorable effects. More money meant more reliance on cut-and-try methods of engineering design at the expense of systematic theoretical studies that were already in short supply. Big budgets also encouraged scientists to explore every idea that might conceivably work as long as money was available. And as the fusion projects in each laboratory grew in size and numbers of scientists, overhead increased and institutional requirements gained more importance.

Strauss had also handicapped the scientists by tightening the security restrictions on their work. In 1951 and 1952, when the first studies

seemed closely related to weapon research, even the existence of the projects was classified secret; but many data on basic physics had been assigned to the confidential category, which permitted all scientists within the project to share the results of the several laboratories. Under Strauss the secret classification was imposed on all data and information compartmentalized in each laboratory despite appeals for declassification from both the scientists and the Commission staff. Not until the British and others described some of their work on controlled fusion research at the Geneva conference did Strauss agree to reveal the existence of Project *Sherwood.* Strauss had put more fuel in the research furnace, but he had closed the damper at the same time.[55]

RADIATION AND LIFE

No Commission activity held greater promise for the peaceful uses of nuclear energy than did research in biology and medicine. Long before the discovery of nuclear fission, scientists had foreseen the possibility of using radiation in the treatment of disease, particularly cancer. Strauss himself had first acquired an interest in the nuclear sciences in the 1930s when he learned that the cyclotron, which Lawrence was developing at Berkeley, might be used in treating cancer, which had killed both of Strauss's parents. In the years after World War II, scientists and physicians in the national laboratories, universities, and other private research institutions clamored for various radiation sources to be used in biomedical experiments. Not only high-energy particles from accelerators were available but also a cornucopia of fission products and radioisotopes providing a wide variety of radiation characteristics. The Commission became the generous provider of these materials.[56]

From the outset the Commission allocated a significant portion of its funds for biology and medicine to cancer research. By 1955 the Commission was spending more than $2 million a year on cancer research and the distribution of radioisotopes for cancer therapy. The national laboratories took the lead in developing teletherapy units and radiation sources and finding new applications for radioisotopes. The Argonne Cancer Research Hospital, operated for the Commission by the University of Chicago, used both radioisotopes and high-energy radiation in investigating therapeutic applications and developing clinical techniques. Both national laboratories and university contractors used isotopes in a wide range of studies of biological systems, from studying antibody synthesis in blood proteins to measuring the effectiveness of drugs.[57]

One of the most exciting areas of biomedical research opened by the plentiful supply of radioisotopes was their use in tracer studies. Scientists found that they could introduce radioisotopes into biological systems without disrupting existing life processes and then use the radioactivity emitted to trace specific chemical compounds through the system. In physiology, tracers were used to study the rate of distribution of common elements in the body; in cytology, to study the turnover of biochemical compounds in living cells; in metabolic studies, to measure protein synthesis with carbon-14-labeled amino acids. Tracers were also used in various studies to measure the uptake and distribution of nutrients and other chemicals.

In devising new uses for radiation sources, scientists also had to give greater attention to radiation effects. For along with the therapeutic and diagnostic powers of radiation came many unknown effects on biological systems. From the earliest days of the Manhattan Project, the study of radiation effects was closely tied to industrial safety in nuclear technology. After World War II, studies were broadened beyond specific problems to include basic research on the biological effects of all kinds of high-energy radiation and scores of radioisotopes. In the early 1950s many animal studies were concerned with the gross effects of whole-body irradiation; in plant research scientists at Brookhaven and elsewhere measured the effects of exposing commercial plants to gamma radiation during the growing cycle.

After the *Upshot-Knothole* and *Castle* weapon test series in 1953 and 1954, research on radiation effects began to focus on phenomena directly related to the biological effects of radioactive fallout. In addition to research on whole-body effects of external radiation, scientists began giving greater attention to the metabolism and toxicity of radioisotopes entering the body, particularly the most health-threatening products of weapon testing: strontium-90, cesium-137, and iodine-131. Animal experiments were conducted to measure the effects of radiation on blood platelets, blood clotting, and embryos as well as the effects on life expectancy and productivity. In plant studies biologists followed radionuclides from fallout through dispersion in the soil to uptake by plants and then to ingestion by animals and humans. In addition to these studies of somatic effects, the Commission also funded genetic studies in an attempt to relate radiation exposure to mutations in germ cells. The Commission continued to support, through the Atomic Bomb Casualty Commission, studies of the only large human population exposed to heavy amounts of radiation—the survivors and offspring of Hiroshima and Nagasaki. The long generation span in humans, plus inevitable complexities in keeping track of large groups of individuals, made the studies in Japan difficult at best. To avoid some of these problems, the Commission funded genetic studies with mice, principally at the Oak Ridge National Laboratory, and with fruitflies at several universities.[58]

During the mid-1950s the Commission's budget for biomedical research hovered around $25 million per year. About 37 percent of this amount went to studies of radiation effects; 34 percent to investigating beneficial effects of radiation; 21 percent to research related to industrial health and safety; and 8 percent to experiments on combatting the detrimental effects of radiation.[59] Most of this research was fundamental enough to attract the interest of scientists in research institutions, many completely outside the context of nuclear technology. Basic knowledge generated under research contracts could then be used by scientists in the Commission's laboratories in studies directly related to Commission programs. Before 1955 many of these studies concerning the radiation effects of nuclear weapons were classified. Thus, as public concern over fallout hazards increased after 1954, it became difficult to evaluate the adequacy of the Commission's response. Critics could point to only nominal growth in the Commission's biomedical budget during the mid-1950s and to the fact that almost no funds were specifically earmarked for studies of the radiation effects of fallout. The Commission, however, could with some justification claim that the tens of millions of dollars dedicated to basic research represented an effective and significant response to the fallout problem. It was also true after 1954 that much fallout research related to testing was charged to the budgets for weapons.[60]

GABRIEL *AND* SUNSHINE

Even more difficult for the public to appraise were the Commission's efforts to understand the larger implication of nuclear weapon testing and nuclear warfare. Obviously, estimates of the biological effects of fallout on large human populations were more likely to arouse fear and controversy than were small-scale experiments on laboratory animals. Thus, it was not surprising that initial studies of large-scale effects were highly classified and unknown to the public. The Commission's division of biology and medicine first sponsored a macrostudy in 1949, when one physicist at Oak Ridge undertook a theoretical calculation of the number of nuclear weapon explosions that would produce a significant radiological hazard. Revising his initial estimates in 1951 after the *Ranger* and *Greenhouse* test series, the scientist concluded that it would require the detonation of one hundred thousand weapons of the Nagasaki type to reach the "doomsday" level.[61] The likelihood of such an occurrence seemed so remote at the time that the Commission's biology and medicine staff could lightly give the study the code name Project *Gabriel.*

The 1951 weapon tests and quick estimates by the headquarters staff, however, indicated that the short-term, close-in effects of a nuclear detonation could have serious consequences for a densely populated area. At the request of the general advisory committee, the Commission supplemented occasional staff work and laboratory studies on Project *Gabriel* with a Rand Corporation contract in 1952 to make a systematic analysis of the "intensive, short-time hazard to residents of areas relatively close to points under attack with near-surface bursts or air-bursts in rainy weather." At that time the division of biology and medicine could find no contractor capable of undertaking a study of the long-term, widespread hazard.[62]

Within weeks after the conclusion of the *Upshot-Knothole* tests, which dumped significant amounts of fallout in localities beyond the Nevada test site, Willard F. Libby, then professor at the University of Chicago and a member of the general advisory committee, called a classified conference of Rand personnel, scientists from the Commission's laboratories, and military representatives in Santa Monica, California. Libby noted that Rand had divided Project *Gabriel* into two distinct studies: the first directed at short-term, close-in consequences; and the second at long-term, distant implications. The first study, Libby admitted, had to remain secret because the revelation of data gathered within the first few days of a weapon test would reveal classified information about weapon design. The study of long-term effects, however, could be unclassified, and Libby argued that gathering fallout data on a national and perhaps a worldwide scale could best be done in the open. Long-term studies were essential, Libby believed, because growth of the stockpile and recent Nevada tests made clear as never before that strontium-90 could pose a serious radiological hazard for the public.

In the original *Gabriel* studies the principal concern had been the potential toxicity of plutonium disbursed as particles in the radioactive cloud. But since 1950 scientists had become more concerned about the possible effects of strontium-90, which behaved much like calcium in plant and animal chemistry; hence it tended to concentrate in the bone, where, with its twenty-eight year half-life, it could cause bone cancer. Later *Gabriel* studies had used strontium-90 as the critical factor in determining the number of weapon detonations that constituted a radiological hazard. Not until the *Upshot-Knothole* tests in 1953, however, was it evident that strontium could be widely distributed over the northern hemisphere, not only by nuclear war but also by fallout from testing. Knowing that all previous work on *Gabriel* had been secret or top secret, Libby faced a skeptical audience in arguing for an unclassified survey.

Commission officials attending the conference found Libby's ideas "stimulating" but not very practical. To single out strontium for special attention in an unclassified study might easily arouse undue public alarm, while the cost and complexity of a worldwide sampling project seemed too ambitious to undertake without further study. Libby was encouraged to begin limited sampling and analytical work in his Chicago laboratory, but no extensive project could be authorized until more data had been gathered. In the meantime Project *Gabriel* remained classified.[63]

Although the Commission did not move as far or as fast as Libby recommended, a substantial effort had been organized by autumn 1953.

In addition to Rand's theoretical studies, scientists from the University of California at Los Angeles were continuing to study soils, plants, and small animals collected within a few hundred miles of the test site. Data were available from the fallout monitoring network of more than one hundred stations established for *Upshot-Knothole*. Libby and other scientists were already analyzing the strontium content of materials collected from widely scattered locations. Possibly to suggest that strontium-90 could be as widely distributed over the earth's surface as solar energy, Libby and his colleagues began referring to their work as Project *Sunshine*, a name that unfortunately implied in later years an attempt to put a "sunny" connotation on a somber and frightening subject. By the end of 1953 the Commission was supporting Project *Sunshine* at a level of fifteen man-years and $140,000 per year. The division of biology and medicine estimated that it was also funding basic research related to Project *Gabriel* in about seventy projects costing $3.3 million per year. Although most basic research was unclassified, *Sunshine* and *Gabriel* were still considered secret.[64]

THE MULLER FIASCO

The Geneva Conference in summer 1955 offered a potential opportunity for openly discussing the radiation effects of fallout. The purpose of the conference, after all, was to afford scientists from many nations an occasion to exchange information and ideas on the peaceful uses of atomic energy. A preliminary agenda drafted in November 1954 included eleven papers on "medical and biological applications": six on the use of tracers, one on radiation use in medicine, two on its use in plant physiology and morphology, and one on its genetic effects.[65]

It was all but inevitable that any session on the genetic effects of radiation would include a paper by Hermann J. Muller, who had won the Nobel Prize in 1946 for his work on this subject. First developing an interest in genetics as an undergraduate at Columbia University in 1909, Muller had embarked on a productive career as a teacher and researcher at universities and research institutes in Texas, the Soviet Union, and Scotland before going to Indiana University in 1945. Muller had startled the scientific world in 1927 with a paper describing experiments that proved it was possible to use radiation to induce mutations in genes. Always sensitive to the social and practical implications of his research, Muller never ceased before World War II to warn physicians of the genetic hazards of X-rays, although he believed that their therapeutic and diagnostic value was worth the risk if proper precautions were taken in using them.[66]

After the war Muller noted in several articles the potential genetic hazards posed by the atomic age, but his views did not attract widespread attention until April 1955, when he delivered a lecture at the National Academy of Sciences in Washington on "The Genetic Damage Produced by Radiation." The lecture caused alarm in government circles because it explicitly related genetic damage to nuclear testing and nuclear warfare and because Muller had already given a copy to the *Bulletin of the Atomic Scientists* for publication.[67]

Despite its bald title, Muller's paper must have seemed surprisingly moderate and judicious, especially to those who did not know his earlier publications. Muller challenged both those who discounted any genetic damage among the descendent populations of Hiroshima and Nagasaki and those who called, as he put it, "loudly, and in some cases in a suspiciously vitriolic tone, for an end to all nuclear test explosions, on the ground that even the tests are already seriously undermining the genetic basis of all mankind." Radiation, Muller admitted, did cause genetic damage, but he demonstrated that the potential effects of nuclear testing were exceedingly small and probably could never be traced to individuals. Much as he had done in warning physicians about X-rays, he urged great care to minimize radiation exposure from nuclear testing, but he took an unequivocal position that the national security requirements for nuclear weapons far outweighed the potential genetic damage of testing. Nuclear war would be a disaster, both genetically and otherwise, but nuclear testing seemed to Muller the best way to avoid it.

If Muller's lecture on the genetic effects of radiation upset some government officials, it did not seem to bother American scientists, both inside and outside the Commission, who were planning the Geneva conference. The Commission staff sent an abstract of Muller's paper to the United Nations early in May 1955, and the paper was promptly accepted for presentation at the conference. On June 6 the Commission's staff recommended that Muller be invited to the conference as a technical adviser to the American delegation. On that same day, however, perhaps as a result of the staff's action, steps were taken within the Commission to remove Muller from the invitation list. Circumstantial evidence suggests that Strauss made this decision on security grounds after talking with Bryan LaPlante and Charles Bates, the FBI liaison officer.

The problem was that Muller's FBI file bulged with derogatory data. He had been an active socialist during his youth in New York City. During the Depression of the 1930s he had openly espoused communism as the hope of the future. He probably had not ever been a member of the American Communist party, but he had been active in organizations sympathetic to the communist cause. He had spent almost four years at the Institute of Genetics in Moscow, had many Soviet friends, and had come home from Europe, according to FBI reports, with bundles of communist propaganda. The facts that Muller after World War II had bitterly attacked communism and the genetic theories of Lysenko and that he advocated continued nuclear testing as a necessary defense against Soviet aggression were perhaps discounted simply as a cover for his communist sympathies. As a result, the Commission asked the United Nations not to accept Muller's paper for oral presentation, although it was to be printed in the conference proceedings.[68]

Muller, who was already in Europe on vacation with his family and counting on the invitation to pay for his own travel expenses, could hardly have welcomed the rejection, but he did not openly object. He did, however, attend the conference at his own expense and sat silently as he received a standing ovation from the scientists attending the session at which he was to have presented his paper. The incident did not have reverberations beyond scientific circles until a month later, when a *Washington Post* reporter called the Commission staff about the incident. A Commission press statement released the next day explained that Muller's invitation had been rejected because the full text of his paper "was belatedly found to contain material referring to the nonpeaceful uses of atomic energy, namely, the bombing of the Japanese city of Hiroshima."[69]

This transparent explanation at once raised an outcry of protest among American scientists, some of whom demanded an investigation by the National Academy of Sciences. Strauss attempted to defuse the protest by claiming personal responsibility for rejecting the paper when he did not read it carefully under the press of business. The public impression, however, was that the Commission was attempting to suppress any discussion of the potential genetic effects of testing, no matter how balanced such an account might be.[70] The truth was that a reappearance of the Oppenheimer security syndrome supplied the compelling reason for rejecting Muller's presentation. The fact, however, that Strauss apparently acted within days after Muller's academy lecture appeared in the *Bulletin of the Atomic Scientists* suggested that the popular conception was in part correct. The net result, as in previous instances, was further to destroy the Commission's credibility on matters relating to the radiation effects of fallout.

THE BALANCE SHEET

In the year following the adoption of the Atomic Energy Act of 1954 Strauss and other Administration leaders enjoyed some success in promoting the peaceful uses of atomic energy. Most prominent on the Commission's list of achievements was the impressive array of activities to develop nuclear power for commercial purposes. The five-year reactor program in the Commission laboratories, augmented by the first two invitations to industry in the demonstration program, at least gave the appearance of a concerted effort to develop a new energy source. Even more remote, but perhaps of even greater ultimate promise than power from fission reactors, were the Commission's programs to harness fusion energy and to probe the mysteries of the atomic nucleus with high-energy accelerators. Of more immediate and direct benefit to society were the results of Commission-sponsored research in biology and medicine; the growing use of radioisotopes in both clinical therapy and diagnosis was already producing dramatic results in treating cancer and other diseases. The Commission effectively presented all these benefits and achievements of nuclear technology, both in technical papers and exhibits, at the peaceful uses conference in Geneva in 1955; and the Commission hoped that they would be reflected in the report of the McKinney panel in early 1956.

Along with the benefits and accomplishments, however, came unexpected difficulties, disappointments, and public skepticism. For all Strauss's claims for the demonstration program, a practical nuclear power plant still seemed a long way in the future, and the American effort seemed to be lagging behind the British and the Russian. Strauss had yet to defuse growing Congressional demands for a massive government program, and the bitter, seemingly endless controversy over Dixon-Yates threatened permanently to politicize the nuclear power program. For the moment the United States appeared to have the lead in the international race for fusion energy and in high-energy physics, but research in neither area as yet seemed to have any important applications in nuclear technology.

In the biomedical sciences, where the results of Commission sponsorship had been most impressive, impending consequences were also the most sobering. The very technologies that brought enormous benefits to human welfare also revealed previously unknown and unpredicted hazards. Commission-sponsored studies following the *Upshot-Knothole* weapon tests in 1953 showed conclusively that the radiation hazards from fallout could be continental or worldwide. Research was revealing new and potentially serious hazards from internal emitters like strontium-90 and iodine-131 entering the human body through the food chain. Ironically, the ability to detect and measure such hazards came from research that had strikingly advanced knowledge of biochemistry in plants and animals. And just below the surface of public consciousness was the question of genetic effects, a subject politically so sensitive that even a world-renowned scientist could not approach it with impunity. Atomic energy did have peaceful applications; the question now was whether the accompanying disadvantages made it worth the effort.

CHAPTER 10

THE SEEDS OF ANXIETY

From Bikini the remnants of the gigantic cloud generated by the *Bravo* shot spread eastward, first over Rongelap, then on to Utirik and beyond, where white ashes fell like snow on the deck of the *Lucky Dragon*. A few hours earlier the same "snowfall" had silently descended on the unsuspecting islanders. Many of them suffered the skin lesions and discoloration and loss of hair that scientists had come to identify with radiation exposure at Hiroshima and Nagasaki. For the crew of the *Lucky Dragon*, the name of their vessel belied its fate. The fishermen already bore evidence of substantial radiation exposure when their ship reached port. As time passed, the superficial scars of radiation damage disappeared, and most of the crew could return home. But not radioman Aikichu Kuboyama, who languished without appetite or spirit week after week. By the time Kuboyama died in late September, the Japanese had their own name for fallout. They called it *shi no hai*—"ashes of death."[1]

The introduction to the nuclear age experienced by the Marshallese and the Japanese fishermen represented an extreme but highly localized example of the anxieties many people around the world would feel during the 1950s as they groped their way toward understanding nuclear weapons and their implications. For many Americans the stunning success of the atomic bomb in bringing a quick and merciful end to World War II engulfed concerns about the human toll in death and affliction. But the seeds of anxiety took root at *Upshot-Knothole* and began to flourish after *Bravo*. Scientists began to reexamine their earlier assumptions about the nature and significance of fallout and began gathering new data. Public officials, from Commission employees at the Nevada Test Site to the President in the White House, struggled to interpret the bloodless facts streaming in from the laboratories in technical reports and briefings. Politicians looked for ways to capitalize on the issues raised by fallout and testing while the public struggled to relate the controversy and growing anxiety to everyday life.

EVALUATING BRAVO

Following a visit to the South Pacific test site and a briefing on the *Bravo* shot, Congressman Chet Holifield felt compelled to convey his deep concern to the President. "I believe it is imperative," he wrote Eisenhower in March 1954, "that the people know the effect of these weapons in order that they may be able to more realistically evaluate the gravity of international tensions and the necessity of making the financial sacrifices necessary to protect our free way of life." Holifield's call for "plain words" rather than generalities or confusing scientific explanations arose from his assumption that the American people were "mature enough to accept an authoritative statement of the facts without panic or hysteria." He believed that the facts about the hydrogen bomb would lead to a "surging and irresistible demand for peace."[2]

The facts about the hydrogen bomb, however, were not that easy to relate. Security considerations aside, it was not just a problem of collecting and analyzing fallout data. The *Castle* test series had upset fundamental assumptions about strategy and civil defense, a basic fact that took some time to sink in. Just a few months before, in January, John Foster Dulles had given his "massive retaliation" speech to the Council on Foreign Relations. Revised and qualified in the spring issue of *Foreign Affairs*, Dulles had outlined the basic defense policy expressed in NSC 162/2, which had formulated the "new look." Although not involved in developing the "new look," Dulles summarized the Administration's policy of relying upon rapid and overwhelming nuclear retaliation to deter or counter Soviet aggression against either the United States or its allies. Emphasizing collective security, the "new look," with its reliance on strategic thermonuclear weapons, was intended to meet the Soviet threat without seriously burdening the American economy. Yet the ink was scarcely dry on Dulles's *Foreign Affairs* article when the Administration faced nuclear tragedy in the Pacific without knowing exactly the consequences of the *Castle-Bravo* data.[3]

At his White House news conference on March 31, 1954, Strauss acknowledged the radiation injuries suffered by servicemen, the Marshallese, and the *Lucky Dragon* crew, but under questioning from reporters he also stated that the H-bomb could "take out a city" the size of New York. The fact that a nuclear bomb could wipe out a city, of course, was not new. Nevertheless, the *New York Times* understandably featured Strauss's devastating remarks and virtually ignored the fallout question. The fact that a thermonuclear bomb dropped on Washington might ravage the entire northeastern seaboard with radiation was still secret information.[4]

Meanwhile, on March 27, Eisenhower had set in motion the establishment of a special Technological Capabilities Panel to study the dangers of surprise attack. Although the study was not directly related to the fallout problem, *Castle-Bravo* no doubt reminded Eisenhower that the United States was vulnerable to sneak attack from a hostile but closed nation, such as the Soviet Union. Thus, concurrently with the Commission's fallout studies, the President asked James R. Killian, Jr., president of Massachusetts Institute of Technology, to evaluate through a comprehensive review of weapons and intelligence technology ways of avoiding surprise attack. The Killian Report to the National Security Council in February 1955 would conclude that both sides would be vulnerable to a surprise attack by thermonuclear weapons, although the panel expected the United States to maintain the upper hand until 1960. Thereafter, attack by either side with thermonuclear weapons would undoubtedly destroy more than cities or devastate regions; it would result in mutual destruction of the combatants.[5]

Even while tests continued at the Pacific Proving Grounds in 1954 there were hurried efforts to evaluate fallout data from *Bravo*. This task fell to both Commission staff and scientists working with the Armed Forces Special Weapons Project, the Department of Defense organization primarily responsible for managing the military aspects of nuclear weapon technology. Established in 1947, the special weapons project had succeeded the Manhattan District in overseeing weapon development and production for the Defense Department. Before the end of May the special weapons project sent the Department of Defense and the Commission an analysis of "Radioactive Fallout Hazards from Surface Bursts of Very-High-Yield Nuclear Weapons." Faced with an unprecedented and alarming situation, the Commission, the Federal Civil Defense Administration, the Department of Defense, and the Office of Defense Mobilization formed a special interagency task force to revise minimum standards for dispersal of new industrial facilities from the ground zero of potential targets. Prior to *Bravo* the standard had been ten miles. Had it not been for fallout, the federal government would have found it comparatively easy, albeit sobering, to recommend new industrial guidelines based on information derived from the Bikini tests. But tripling the radius to thirty miles would not compensate for a fallout cloud forty miles wide and two hundred miles long.[6] After reviewing the dispersion standards on March 26, 1954, the President's Science Advisory Committee expressed its satisfaction with existing standards but stressed that there could be no fixed standards for absolute safety. On May 26, however, when the *Bravo* implications were somewhat clearer, Arthur S. Flemming, director of the Office of Defense Mobilization, requested Strauss's advice on establishing new criteria.[7]

For almost four months Strauss did not respond directly to Flemming's request for help. Instead, during the intervening summer of 1954, the Commission studied the fallout problem, evaluating data that it shared with its own scientists and other agencies. Meeting in late May, the general advisory committee not only endorsed continued fallout studies but also recommended that, when the fallout phenomenon was better understood, the public should also be informed of the facts. As General Advisory Committee Chairman Isidor Rabi's report to Strauss noted, it was hardly necessary to point out both the importance of and the ignorance about fallout from low-level thermonuclear bursts.[8]

During the months immediately following the *Castle* test series, the Commission was swamped with pressing problems of fallout evaluation, "clean up," and public relations. Through the torrid summer there was little time for calm reflection or plans for public education. There was no precedent, not even at Hiroshima or Nagasaki, for widespread contamination of human populations and habitats such as occurred after the *Bravo* shot. Data on acute or long-term radiation effects, both external and internal, on humans, pigs, chickens, dogs, coconut palms, papaya, tuna, and other flora and fauna were scarce or nonexistent. Immediate relocation and care for the sick Marshallese and negotiations with the Japanese government over compensation for the *Lucky Dragon* crew and its owners were the major post-test concerns.[9]

A TEST MORATORIUM CONSIDERED

Bravo had also raised international issues. At the United Nations, the Soviet Union and India were pushing for a resolution to condemn the United States for testing in its Pacific trust territories. More astonishing, Commissioner Murray at home suggested the possibility of a comprehensive test moratorium. On February 2, 1954, just a month prior to the *Bravo* shot, Murray explained to Strauss and the President that he had raised the issue "for discussion and exploration only" in response to Eisenhower's Atoms-for-Peace initiative. Following Prime Minister Nehru's public call for a test moratorium on April 2, Murray's tentative proposal could no longer be brushed aside. Subsequently, Albert Schweitzer and Pope Pius XII in his Easter message joined the prominent persons who expressed moral concern over continued testing.[10]

At the April 6, 1954, meeting of the National Security Council, Secretary of State Dulles slipped the President a handwritten note. "I think we should consider whether we could advantageously agree to Nehru's proposal of no further experimental explosions." The Secretary of State offered the President assurances that "this could be policed—or checked—." Eisenhower thought for a moment, and then launched his Administration's first exploration of the test ban idea by jotting in reply: "Ask Strauss to study."[11]

Six days later, in response to the worldwide expression of fear, but especially to Nehru's proposal, United States Ambassador to the United Nations Henry Cabot Lodge asked Dulles whether the United States might agree to a partial moratorium on tests above one megaton.[12] Although there never was a serious possibility that the United States would suspend the *Castle* test series, the Murray-Nehru-Lodge proposals ultimately forced the President and the National Security Council to grapple formally with the issue.

On May 6, Dulles reported to the National Security Council that he had discussed the possibilities of a nuclear test moratorium with British Foreign Secretary Anthony Eden during the April talks in London. Dulles reflected that the United States ought to favor a moratorium on the grounds that the *Castle* series had placed the Americans well ahead of the Russians. Strauss agreed that the *Castle* tests were of utmost importance, but he expressed skepticism, which Secretary of Defense Charles E. Wilson shared, that the United States could satisfactorily police a test moratorium. Eisenhower countered that enforcement of the test ban was not a major issue; if the Russians violated a test ban, the United States could simply resume its own testing. More important, the President believed United States sponsorship of a moratorium would put the Soviet Union on the spot. Vice-President Nixon concurred by noting that the Russians had a greater need to test nuclear weapons than did the United States. Consequently, the President directed Foster Dulles, Strauss, Allen Dulles, and Acting Secretary of Defense Robert Anderson to report to the National Security Council on the possibilities for stopping or limiting atmospheric tests.[13]

Eisenhower's interest in a nuclear test moratorium, however, was not motivated simply by a desire to gain a propaganda advantage over the Russians. The President also fervently believed that it was wrong for the United States to view "this terrible problem" negatively. Noting that the world faced a bleak future overshadowed by the hydrogen bomb, Eisenhower could not envision a long-term solution to the danger of nuclear warfare without first establishing a test ban.[14]

Unfortunately Eisenhower's pursuit of a nuclear test ban was short-lived in spring 1954. After a month of study, Dulles informed the National Security Council that his committee was virtually unanimous in opposing a nuclear test moratorium. The recommendation reflected the power of logic over the power of will, Secretary Dulles wryly observed, because all members of the committee had professed their desire to end testing. Strauss, for one, had advised Dulles that a moratorium on testing large weapons would be advantageous to the United States, provided a dependable agreement could be worked out with the Soviet Union. The trouble, of course, was that Strauss believed that a reliable agreement with the Soviets was illusory.

Following advice the Commission had solicited from Edward Teller and Norris Bradbury, Strauss warned that it was feasible to conceal a low-yield test. Also worrisome to the Commission would be the deleterious effect on the weapon laboratories of a long-term moratorium. Dulles observed that the United States would enjoy an advantage over the Russians only in the short run, but that after January 1956 American weapon development would have to be significantly curtailed.[15]

Eisenhower was genuinely disappointed that a nuclear test ban appeared unenforceable at the time. On May 25, the United States had introduced into the United Nations Disarmament Subcommittee a proposal to establish enforcement committees to oversee any disarmament programs. Subsequently, the United States also supported an Anglo-French proposal of June 11, 1954, which called for a phased approach to disarmament through successive stages and for nuclear disarmament phased with reduced conventional armaments and forces. Although the President accepted the assumption that a test ban could not be effectively policed, he nevertheless categorically refused to link testing to an agreement on general disarmament. Putting the National Security Council on notice, Eisenhower informed his advisers on June 23 that if there were any way to negotiate an effective nuclear test ban or moratorium, he would do it.[16]

The gathering in the Red Room of the White House the following afternoon was unusually somber. Off by themselves, Strauss and Lord Cherwell were talking quietly. Surrounding the President and Prime Minister Churchill were Anthony Eden, Dulles, and a few other guests who had attended the Sunday luncheon in honor of the British delegation. Churchill spoke at length and with great feeling about his fears for the future of the British Isles. He had been told that two or three hydrogen bombs could wipe out all the inhabitants of England, Scotland, Wales, and Ireland. After viewing the movies of the *Ivy-Mike* shot Churchill had ordered all work on air-raid shelters abandoned, given that shelters would prove useless in a thermonuclear attack. Then reversing a position he had taken in Bermuda the year before, Churchill informed Eisenhower that the British would proceed to develop a hydrogen bomb.[17]

TOWARD AN UNDERSTANDING OF FALLOUT

The Oppenheimer case and the debate over the Atomic Energy Act left the Commissioners little time to reflect upon the larger implications of fallout during June and July 1954, but there was growing concern elsewhere in the government, particularly in the Federal Civil Defense Administration. Late in June Robert L. Corsbie, chief of the Commission's civil defense liaison branch, briefed civil defense officials on classified aspects of the fallout data collected at *Bravo*. For a second opinion the civil defense group turned to the Armed Forces Special Weapons Project. The staff of the special weapons group included a number of prominent scientists, among them Herbert Scoville, Jr., a physical chemist who had worked at Los Alamos for two years after World War II before going to the Pentagon. From the group's report it was clear that *Bravo* had brought the world into a new era of nuclear weapons. *Bravo* represented as revolutionary an advance in explosive power over World War II atomic weapons as the Hiroshima weapon had over conventional bombs dropped in Europe during the war.

The enormous fallout pattern from *Bravo*, however, indicated that thermonuclear weapons were far more deadly as a radiation device than any explosive. Using fallout patterns from *Bravo*, the group estimated that detonating a fifteen-megaton weapon would deposit radioactive material in sufficient densities over a 5,000-square mile area to be "hazardous to human life. Indeed, if no passive defense measures at all are taken, this figure probably represents the minimum area within which nearly one hundred percent fatalities may be expected."[18]

The implications of *Bravo* reports were serious enough to warrant briefings of the National Security Council and the Joint Committee. Strauss took responsibility for the security council while Scoville briefed the Wedemeyer panel, which Congressman Cole had appointed to study the impact of nuclear technology on continental defense. The distinguished membership of the panel, which included Army General Albert C. Wedemeyer, Gordon Dean, and Charles A. Lindbergh, indicated the importance the Joint Committee attached to the study.[19] The panel was greatly disturbed by Scoville's report on fallout effects and asked to what extent the American public and the world at large had been informed of the new data available since Operation *Castle*. Paul F. Foster, a retired Navy admiral and former business executive who had recently joined the Commission staff to assist the general manager on international matters, saw at once that the panel's concern would soon spread to the Joint Committee itself. Foster warned Nichols that, despite injunctions of secrecy, there would be leaks to the press from someone taking it upon himself "to alert the public to the gravity of this, as yet unknown, danger."[20]

No doubt anticipating problems from the report of the Wedemeyer panel, the Commissioners met twice in September with the Joint Committee to report specifically what fallout information had already been provided to the Federal Civil Defense Administration. During these same weeks Strauss and Nichols, now convinced that a public statement was necessary, discussed how best to bring the matter before the National Security Council and the Operations Coordinating Board for a decision on issuing a full statement. Concurrently, the special interagency task force on dispersion standards, on which Foster represented the Commission, had been asked to develop a new policy on dispersion for recommendation to the cabinet. The task force completed its preliminary study in October.[21]

Speaking before an industrial health conference in Houston on September 23, 1954, John C. Bugher, head of the Commission's division of biology and medicine, presented the first public analysis of the medical consequences of thermonuclear warfare. Although Bugher minimized the effects of continued testing by estimating that fallout "would have to be increased by the order of one million times before an increased frequency of bone sarcoma from this cause could be recognized" in the United States, he candidly reviewed the awesome characteristics of the *Bravo* shot. After describing the elongated cigar-shaped fallout cloud that contaminated approximately 7,000 square miles in the Pacific, Bugher concluded that thermonuclear warfare would create unprecedented medical and social problems. Not only would the nation have to cope with blast and thermal casualties on a scale never before conceived of in warfare, but also, he warned, the radiological damage could create havoc far beyond the immediate attack zone. Although Bugher's speech received wide press coverage and was distributed throughout the United States by the Commission and the civil defense agency, its technical nature and guarded tone did not satisfy the increasing demands for public candor.[22]

On the day following Bugher's speech, Strauss finally answered Flemming's request for dispersion standards. Because it was impossible to predict what sort of weapon a potential enemy might develop within the next twenty years, for planning purposes the Commission estimated the effects of a sixty-megaton weapon as suggested by the Defense Department. Strauss stated that a distance of twenty-nine miles from the perimeter of the target area should provide reasonable protection from blast and thermal effects. Twenty-nine miles, of course, would not offer refuge from lethal fallout of even a fifteen-megaton weapon. Unless fallout patterns could be immediately and accurately forecast and citizens warned, mass evacuation after a nuclear attack could easily catch refugees in the open where they could be least protected from exposure to radiation. The most effective measure, Strauss suggested, would be to take shelter in basements or underground structures for a few hours or days until radiation levels decayed sufficiently to allow safe evacuation under escort. Thus, no matter what the dispersion radius, sheltering rather than evacuation would be required to protect the population against residual radiation if critical industries were to continue functioning after a nuclear attack.[23] Obviously, public education on the effects of fallout would be required to win public support for a large-scale civil defense effort to build shelters.

On October 1, Willard F. Libby replaced Smyth as the principal scientist on the Commission. Soon he would become the Commission's chief spokesman on fallout. Twelve days after Libby's appointment, the Commission briefed key State Department personnel, including Gerard Smith, on fallout from the *Bravo* shot. Several of Smith's advisers were worried about the expected adverse impact that publication of fallout information would have on American foreign policy, and they recommended against immediate release of a public statement. Several others opposed any publication at all. Thereafter, on October 21, Smith notified Foster at the Commission that the State Department had reached an "informal consensus" that publication would be deferred for some months.[24]

It was already too late, however, to stop public discussions. Like the radioactive cloud that had swept over the Pacific, the fallout debate could not be contained: it spread beyond government circles. Perhaps taking advantage of Bugher's Texas speech or press coverage given to it, Joseph and Stewart Alsop were among the first journalists to recognize that the hydrogen bomb was a radiological weapon and not simply a gigantic version of the atomic bomb. Atomic bombs inflicted radiation casualties, the Alsops observed, but these hardly mattered since blast and heat damaged a larger area than that affected by radiation. The radiation effects from the thermonuclear bomb, on the other hand, far transcended the destruction caused by blast and fire. The Alsops clearly understood the strategic implications of this fact. They estimated that one hundred such super bombs could not only destroy most of America's major cities but could also temporarily paralyze much of the industrial eastern seaboard.[25]

Thereafter, in the October issue of the *Bulletin of the Atomic Scientists*, Harold A. Knapp, Jr., a Navy Department analyst and the civil defense director for South Woodley, Virginia, estimated the potential threat of thermonuclear war to his small suburban community. Located seven miles from the Pentagon and ten miles from the White House, South Woodley was easily within the range of a hydrogen bomb aimed at Washington, D.C. Although Knapp focused almost exclusively on blast and thermal effects, he stressed the need for more technical information, especially concerning fallout, so that effective civil defense plans could be formulated.[26]

FALLOUT: WHAT THE PUBLIC SHOULD KNOW

From within the Commission and the interagency task force, Foster continued to push for full public disclosure. Foster identified the issue as one of the gravest problems facing the Administration—so important that no one less than the President could deal with it adequately. Foster conceded that disclosure by the government of the full dangers created by fallout was certain to create anxiety throughout the nation and abroad. Nevertheless, Foster believed it essential for Americans to confront "the stark facts of life" so that the public would support effective civil defense and dispersal of key industries. Acknowledging that recent press statements had hinted at the truth, Foster believed the public was prone to dismiss such reports as "journalistic exaggerations." Only with official sanction from the President would Americans be convinced that the thermonuclear age required a radical change in the physical structure of densely populated metropolitan areas.[27]

Foster anticipated several problems in releasing an official public statement of the effects of fallout. In Europe, he predicted, neutralist sentiment would almost certainly be strengthened, but at home the public might clamor for increased expenditures on continental defense at the expense of other military programs. Foster was also worried about the economic impact that such a statement might have on large cities where business interests could claim that property values were needlessly impaired by hysteria generated by disclosure. The political consequences were even more uncertain, and Foster speculated that an announcement could augment the ranks of either those who sought a retreat from containment or those who advocated preventive war on the theory that the United States might better survive an immediate conflict. Most seriously, he argued that without public disclosure the civil defense officials, ignorant of the potential dangers, could not organize effective programs. To minimize hysteria while properly emphasizing the dangers, Foster recommended that Eisenhower inform the American public in a fireside talk broadcast over television.[28]

Val Peterson, federal civil defense coordinator, did not wait to find out what the President's Cabinet planned to do. Three weeks after Bugher's Texas speech, Peterson startled state civil defense directors at a closed meeting in Chicago by warning that "many millions of lives" might be lost to fallout unless proper civil defense precautions were adopted. But the civil defense directors were not the only startled officials. With the assistance of several dramatic charts, Peterson had so graphically described fallout patterns that Commissioner Libby worried whether the civil defense administrator had compromised classified information. Reminding the Commission that fallout comes from fission not fusion, Libby observed that the government could not admit that several hundred square miles were contaminated without disclosing the fact that the thermonuclear bomb contained a fission component of real magnitude. Nichols quickly pointed out that both the *Lucky Dragon* incident and the injury to the Marshallese had already compromised this information to a considerable degree. Japanese analysis of the fallout debris collected from the *Lucky Dragon* would ultimately render Libby's objection moot. Nevertheless, the Commission decided to censor carefully a ten-minute film the Federal Civil Defense Administration was producing to describe the dangers of fallout.[29]

During November 1954 the Administration lost its chance to provide candid fallout information to the American public. Nichols told the general advisory committee that the British had already constructed an accurate map of a hypothetical fallout ellipse by scaling up known test data. Libby also noted that Knapp's article on South Woodley had underestimated fallout by factors of five to ten. Since 1953, Bugher reported, Project *Gabriel-Sunshine* had sharpened the Commission's understanding of fallout. After one big shot, for example, iodine-131 could be picked up anywhere in the world. Bugher estimated that every American received a dose to the thyroid equivalent to about 0.5 percent of that received by the Rongelap islanders. Without specifying localities, Bugher cautioned against the use of milk from heavily contaminated areas. Surveys also showed a consistent pattern of increasing levels of strontium-90 detectable in the New York milk supply. All this information on fallout, however, was still highly classified. In order to facilitate civil defense planning, Libby obtained a consensus from the committee that the Commission should increase the flow of information to the public despite the fact that fallout studies were still incomplete.[30]

Unfortunately Strauss was distracted by the Dixon-Yates hearings on Capitol Hill and was unable to attend a crucial luncheon conference at the Pentagon on November 8, 1954. Secretary of Defense Wilson, the highest ranking official present, strenuously objected to any recommendations involving presidential announcement of fallout hazards. Throughout the conference Wilson stressed the importance of allaying public anxiety about the prospects of thermonuclear warfare, particularly with reference to fallout. Too much had already been said publicly about fallout in his opinion; before the government outlined the danger's full extent, he believed that it should make civil defense plans to cope with an "atomic blitz." That was just the point, Peterson argued; he could not develop an effective civil defense program without popular support based on public understanding.[31]

Because he was the only cabinet-level officer present, Wilson dominated the meeting. Thus, instead of forwarding a recommendation to the President, as favored by Foster, the conference decided to establish a new working group organized by the Office of Defense Mobilization to study thoroughly the problems associated with "victorious survival in the event of atomic-nuclear warfare." Working in cooperation with the Commission, the Department of Defense, and the Federal Civil Defense Administration, the new working group was to confine itself to nonmilitary matters and report directly to Flemming, rather than to the public.[32]

Ironically, British Prime Minister Winston Churchill, not Eisenhower, first expressed public concern over fallout. Speaking to the House of Commons on November 30, 1954, Churchill expressed his worry that cumulative radioactivity released from nuclear explosions would have serious effects on the earth's atmosphere for five thousand years. As noted in the *New York Times*, Churchill's statement was technically and militarily "confused and confusing," yet it also addressed publicly one of the great mysteries and possibly one of the worst dangers of the nuclear age.[33]

As if to underscore Churchill's concern, Ralph E. Lapp published the first of his articles on fallout in the November issue of the *Bulletin of the Atomic Scientists*. What chance the Commission had enjoyed to lead public discussion on fallout was now gone. As a nuclear physicist who had worked at Los Alamos during World War II and later with the research and development board of the Defense Department, Lapp could write with some authority on nuclear weapons and their effects. Although Lapp referred to fallout as a "secondary hazard," he accurately observed that the fallout ellipses from *Bravo* had stunned civil defense planners and caused a major shift in policy. Lapp also demanded that the Federal Civil Defense Administration be given access to classified data on fallout so that the agency could accurately translate them into a realistic hazard assessment for the American public. Hanson Baldwin of the *New York Times* endorsed Lapp's plea. And in that same November issue the editors of the *Bulletin* reprinted Albert Schweitzer's appeal to scientists to speak out for a suspension of weapon testing. Thereafter, Eugene Rabinowitch, the *Bulletin*'s editor, in commenting on both Knapp's and Lapp's articles as well as Bugher's speech, stated that the American nation as a matter of right should be given "all the information needed to prepare intelligently for the defense of its cities, not only against blast and fire of an atomic war, but also against its radioactivity."[34] Clearly, public assessments and speculations were becoming more accurate and more insistent.

In its own way, the Commission continued to encourage studies of the effects of ionizing radiation. At a national conference on genetics sponsored by the division of biology and medicine at the Argonne National Laboratory in November 1954, more than fifteen leading scientists were invited to present research on the effects of radiation on genes, chromosomes, cells, tissues, organisms, and populations. Although the papers were mostly technical reports of experiments with mice, fruit flies, plants, or other organisms, Bugher reminded the conference of the geneticists' larger responsibility, as a consequence "of man's modification of his environment," to assist in replacing opinions with conclusions in the formulation of national policy.[35]

More directly related to the *Bravo* fallout, at the invitation of the science council of Japan, the Commission sent a delegation of six scientists headed by Paul B. Pearson, chief of the biology branch of the division of biology and medicine, to a United States–Japanese conference on radiology. The conference, a success far beyond the Commission's most sanguine hopes, met in Tokyo from November 15 to 19. It was apparent from the outset that the Japanese considered the conference of major international importance. Consequently, the Americans, including Morse Salisbury, the Commission's chief public relations officer, prepared carefully for the meetings. Despite considerable apprehension among the scientists arriving in Tokyo less than two months after Kuboyama's death in September 1954, a friendly atmosphere quickly developed between the delegates of both countries. At the end, the Americans were satisfied that they had provided the Japanese with a considerable body of useful information. In turn, the United States delegation was gratified to receive impressively extensive data concerning fallout from both American and Russian tests.[36]

In addition to these scientific conferences, with renewed support from the general advisory committee, Libby offered the Washington conference of mayors on December 2 the government's most definitive statement to that date on radiation hazards from fallout. Although Libby's speech was by no means alarmist, he took pains to emphasize the qualitative and unexpected differences between fallout and traditional hazards from blast and heat. Libby stressed that an unprotected populace would suffer seriously, but he was relatively optimistic that a sheltered citizenry, if beyond the immediate zone of detonation, could survive a thermonuclear attack. Skirting direct reference to testing, Libby did imply that the weapon tests had not added appreciably to worldwide natural background radiation.[37]

Considering the fact that neither the Cabinet nor the President had as yet approved a public statement on fallout, Libby's speech had been remarkably candid. Nevertheless, Strauss knew that the Commission could no longer delay issuing an official statement his colleagues had already approved. Citing the death of Kuboyama, Churchill's parliamentary speech, and recent articles by Baldwin, the Alsops, and Drew Pearson, Strauss also expressed his concern about the numerous alarming statements that had already been made by responsible American and foreign military authorities and scientists. Among the most serious, in Strauss's opinion, had been the widely quoted statements by Alfred H. Sturtevant, a professor of genetics at the California Institute of Technology, and by Louis de Broglie, the French physicist and Nobel laureate. They predicted that the H-bomb tests would inevitably increase future birth defects. De Broglie had warned that nuclear experiments had created a danger to the world's plant and animal life. Within security limits, Strauss insisted, the Commission simply had to be responsive to requests from the press for authoritative information on fallout hazards. Otherwise, the Commission would be accused of concealing vital information from the American public while at the same time it was attempting to counter fears that public health and safety were endangered by continued weapon tests in Nevada and the Pacific.[38] From Strauss's perspective, a policy of candor would provide the most certain protection for nuclear testing.

INTERNATIONAL IMPLICATIONS

At the State Department Dulles and Herbert Hoover, Jr., were the major opponents of releasing the Commission's statement on fallout. Fearing severe damage to American foreign policy, Hoover cautioned the Operations Coordinating Board that even a discussion with the Cabinet might result in a disastrous leak. The French parliament, which had recently rejected the European Defense Community, was then considering ratification of the London Agreement rearming West Germany. Hoover thought French communists would use this fact to distort the fallout data in a propaganda campaign against the United States. In addition, it seemed likely that the information would stimulate pacifism, especially in Germany, and create additional strains between the United States and the new government in Japan. At Hoover's suggestion, the Operations Coordinating Board recommended that the Commission's statement not be circulated even within the American government until after Strauss, Dulles, and the President determined how best to present the issue to the Cabinet.[39]

Hoover had not categorically opposed release of the Commission statement, only its timing, although, as Foster put it, "the State Department never will think the time is propitious." Strauss and Nichols observed that the Commission's authoritative statement could not cause any more damage than had uninformed but sensational speculations in the press. When Dulles personally requested Strauss to defer publication until the North Atlantic Treaty Organization negotiations had been completed, the chairman acceded but not without carrying the matter directly to the President. At a Cabinet meeting on December 10, 1954, Eisenhower also noted, as Strauss put it, "the virtue of laying all the facts on the line before there is an inquisition." Encouraged, Strauss reiterated that the best way to combat sensationalism and alarm was "to put the full facts forward with frankness."[40] Another month was lost, however, waiting for Dulles to return from Europe.

In the meantime, the Commission searched for a way out of its dilemma. At his news conference on December 17, Strauss reported that the Commission staff was studying the fallout problem and expressed his hope that a public statement could be made at a later date. In support of the chairman, the general advisory committee at its mid-December meeting continued to favor the release of a concise statement. Thus, with the State Department, the Federal Civil Defense Administration, and the Operations Coordinating Board kibitzing in the background, the Commission in January 1955 struggled through at least five different drafts of its statement on "The Effects of High Yield Nuclear Detonations."[41]

During these deliberations Libby insisted that a fallout map be included in the press release. Gordon L. Dunning, health physicist with the division of biology and medicine, did not regard the map as either necessary or advisable but rather contended that an official fallout map would raise more questions than it answered. Because a fallout map would have to be constructed using data gathered from only a few points, Dunning believed that any such illustration could be easily misinterpreted. Consequently, the idea of providing an official fallout map was ultimately abandoned, leaving journalists and others to devise maps of their own.[42]

Ironically, foreign, not domestic, developments precipitated publication of the Commission's fallout statement. In London, Harold Macmillan, Minister of Defense, informed Deputy Secretary of State Dillon

Anderson that the Admiralty was obligated by law to report to Parliament on February 15 on the state of the United Kingdom's defenses. Churchill had directed that the report include a statement on the effects of thermonuclear weapons. Having learned that the Commission was considering the release of a fallout statement, Macmillan requested an advance copy to assure that British and American fallout data were compatible. Gerard Smith, in his critique of the Commission's statement, was especially concerned that the timing of the release be coordinated with the British and the Canadians so that even minor discrepancies could be reconciled rather than feed further speculations.[43] Foster seized this opportunity to emphasize how embarrassing it would be to the Administration if the American people received their first detailed official information on fallout from the British government.

From another perspective Foster also saw the necessity of a prompt release. With the five-power discussions on limitations of armaments scheduled to begin in London in late February 1955, Foster was anxious for the United States to take the initiative by firmly establishing the American position. Communist propaganda, he observed, had already branded the United States as the originator and principal proponent of atomic warfare. Nehru, Mendes-France, and perhaps even Churchill might support Russian demands for halting thermonuclear testing. In agreement with Strauss, Foster believed that testing could best be defended by outlining the United States' position before the communists organized another worldwide campaign against testing on the basis of distorted use of fallout information.[44]

THE FALLOUT STATEMENT

Now that Whitehall had effectively made the decision for them, Eisenhower and the National Security Council finally saw the need to release the Commission statement. On February 2, 1955, the President personally reviewed and annotated the draft, principally by underlining key phrases in the report. The following day at a meeting of the National Security Council Eisenhower expressed his determination not to be scooped by the British. Strauss assured the President that the Commission's statement had been carefully worked out with the Operations Coordinating Board. The Federal Civil Defense Administration, he reminded the President, had been after such a statement for months. Despite continued fears expressed by Wilson and others, Eisenhower observed that his Administration had probably underplayed civil defense during a time when an informed citizenry was important.[45]

Eisenhower formally approved release of the Commission's statement on "The Effects of High-Yield Nuclear Detonations" on February 3;

whereupon the Commission immediately began preparations to publish its report. Before any action could be taken, however, Dulles returned from vacation. He complained that the Commission statement would stimulate neutralism and damage United States interests in West Germany and the Far East as well as feed the Russian propaganda mill, which had been churning out demands for outlawing nuclear weapons. After Eisenhower asked that the best public relations man be consulted on the advisability of releasing the statement, Strauss dutifully reported that William E. Robinson, president of the Coca Cola Company, recommended against issuing any statement at all, on the grounds that it might stimulate neutralism overseas. Undaunted, Strauss once again insisted to Eisenhower that, irrespective of international complications, the American people should be told the facts so that civil defense planning could proceed. In a personal appeal to Strauss, Val Peterson concurred that without the Commission statement,

state and local civil defense officials lacked any planning base for protective measures.[46] At this late date Dulles could not block publication, but at his behest the Commission dropped the dramatic fallout map that Libby had thought important.

Finally, on February 15, 1955, the Commission issued its report accompanied by a statement from Strauss. After reviewing the effects of the *Bravo* shot, Strauss offered assurances that continental testing at the Nevada Test Site created no off-site safety or health hazards. Concerned that the statement might jeopardize United States testing, Strauss stated without qualification that the hazard had been confined to the controlled area of the test site. The highest actual dose of radiation at an off-site community, he observed, was estimated to be less than one-third that allowed yearly for atomic energy workers under the Commission's "conservative safety standards."[47]

To the satisfaction of the State Department, foreign reaction to the Commission's statement was surprisingly mild. Among the North Atlantic Treaty Organization countries the announcement was accepted soberly and without much comment, according to reports to the National Security Council. Other international news tended to obscure the immediacy of the Commission's story. In Switzerland, anticommunists seized the Rumanian legation. In London the United Kingdom announced plans to build the H-bomb and to construct twelve nuclear power reactors. The French were bedeviled by their continuing political crisis, while in Japan a fire in Yokohama and Soviet-Japanese talks preempted most headlines. The only communist nation even to mention the report was East Germany. The Soviet Union and the People's Republic of China pointedly refrained from noting the statement, emphasizing instead the communists' commitment to peaceful uses of atomic energy as well as to banning nuclear weapons. There were scattered sharp reactions in India, Japan, and France, while in London the *Daily Worker* played up the terror of fallout to support its continued

"Ban the Bomb" campaign. But aside from predictable criticism from the left, the National Security Council could discern no stimulus toward neutralism among America's allies.[48]

At home the Commission did not fare nearly so well. Before the Commission could release its statement to the public, Ralph Lapp on February 11 published his second and most alarming article on "Radioactive Fall-out" in the *Bulletin of the Atomic Scientists*. Lapp based much of his information on Libby's December 2, 1954, speech and on the Japanese reports about the radiological analysis of "Bikini ashes." At a time when most people had scarcely begun to comprehend the meaning of Hiroshima, Lapp conceded that it was still too early to appreciate the implications of the *Bravo* test. Nevertheless, he asserted that the new super bomb could be considered a radiological weapon that could "contaminate a state the size of Maryland with lethal radioactivity."[49] Lapp agreed with Libby that sheltering would provide substantial protection from radioactive fallout, especially if the government constructed an extensive system of fallout shelters on the periphery of the major cities. But he also criticized the government for maintaining tight secrecy on this vital issue. Prophetically, Lapp defined radioactivity as something mystical, understood by less than 0.1 percent of the American people; for their part, few scientists understood the terror that the "invisible killer" held for the nonscientist. Candor and education were the only antidote to this modern terror.[50]

Lapp's article in the *Bulletin* and another in the *New Republic* on February 14 placed the Commission in the worst possible light. Not only did the Commission fail to receive credit for its candor, but its own statement, long in preparation, subsequently appeared a reluctant response to Lapp's crusade. All along Strauss had feared just such an eventuality. Back in November he had predicted that the Commission might be left "holding the bag" just as in the Dixon-Yates controversy "where we wished to make all the information public long before."[51] Now for the second time within six months the Commission had to accept the responsibility and criticism for an Administration decision over which it had no control.

THE KEFAUVER HEARINGS

Following a flurry of excitement in the press, the Senate Subcommittee on Civil Defense of the Armed Services Committee on February 22, 1955, quizzed Libby and Bugher on the Commission's weapon effects statement. Senator Estes Kefauver, chairman of the subcommittee, wanted to know why the Commission had not published official information about fallout until after the public was alarmed by Lapp's sensational disclosures. Neglecting to point out that most of the magazine articles were based on information taken from his own December 2 speech, Libby simply explained that the Commission wanted to get the facts straight. Although Kefauver and Stuart Symington, who had joined the hearing, pressed for a more detailed explanation, Libby was not free to tell them the real reason for delay—that State and Defense had blocked publication for several months. Consequently, as Symington pointed out, public confidence in the government's assurances was shaken when Lapp's article was published before Strauss's official announcement. Lapp himself, first as a witness before Kefauver's subcommittee and subsequently in a follow-up article in the *Bulletin of the Atomic Scientists*, also accused the Commission of being dilatory and dissembling in informing the American people of fallout hazards. The year of secrecy maintained by the Commission resulted in a year of paralysis on civil defense preparedness, Lapp charged.[52]

Even as Kefauver's committee conducted its hearings, the Commission continued continental testing in Nevada with Operation *Teapot*. Libby assured the senators that the Nevada tests were being conducted "in accordance with health and safety criteria designed to insure that there will be no harmful effects on the public." Indeed, Libby continued, the Commission had detected no fallout hazardous to humans, animals, or agriculture beyond the immediate vicinity of the test site. Libby did not actually state that there were no risks in continental testing, but he certainly implied that the risks were minimal. In a speech delivered to University of Chicago alumni on June 3, 1955, and later submitted as an exhibit for the published civil defense hearings, Libby stated that the genetic damage caused by fallout from the *Teapot* tests would be so slight that no measurable increase in defective individuals would be observable.[53]

FALLOUT MONITORING AT TEAPOT

Libby had every reason to speak with confidence about the effectiveness of fallout precautions taken at *Teapot*. In the two years since the *Upshot-Knothole* series the weapon laboratories at Los Alamos and Livermore had again accumulated a large backlog of tests that were urgently needed to develop various new weapons, especially small weapons, both fission and thermonuclear. Looking toward reducing the large amounts of fallout associated with tests in 1953 and 1954, the laboratories were also beginning to explore new designs that would reduce the ratio of fissionable to thermonuclear fuel in weapons so as to lessen fallout. The Commission had approved an ambitious program for fourteen shots at *Teapot*, but nine of these were less than ten kilotons, and all the high-yield shots were fired on towers 400 or 500 feet high. As a further precaution against heavy fallout, the new guidelines for continental test operations developed after *Upshot-Knothole* were now in effect. Among these was the decision to reduce the maximum permissible exposure for off-site personnel to three roentgens for an entire year.[54]

The most significant change in test procedures at *Teapot* was the increased attention given to off-site monitoring and the formal, largely independent role assigned to the U.S. Public Health Service. The service had first begun to respond to the health hazards of radiation in 1948; by 1950 it had organized a series of courses in radiation health training for its own officers and for other federal, state, and local agencies. About a dozen officers from the Public Health Service had assisted, at the Commission's request, in collecting fallout data at fixed stations in small communities just outside the test area during the *Upshot-Knothole* series. For the first time, complete fallout records were made for an entire test series in these communities. The Public Health Service officers, however, were under the complete control of the Commission and the test organization, and all the records they collected had to be turned over to the test group as classified information.

By the time of the *Teapot* tests, the Commission had signed an agreement with the Public Health Service to participate in radiation monitoring in a more formal way. Sixty-six officers from the service participated in *Teapot* and assisted in collecting information that was later published on each of the fourteen shots. During the series the officers were permitted to discuss their readings with residents and to provide them with information about the tests. These procedures not only produced more complete data than had been collected at earlier tests, but they also helped to assure nearby residents that potential fallout hazards were not being concealed by classifying the data.[55]

THE NEVADA TEST SITE

Despite official assurances, concerns about the continued use of the Nevada Test Site increased after release of Libby's fallout statement. On the day after his testimony before Kefauver's subcommittee, Libby was shocked to learn that Senator Anderson had written Strauss to request another reassessment of using the Nevada site for testing any but the very smallest devices. Anderson's about-face coincided with second thoughts Strauss also harbored. The chairman now confessed to Murray and Libby that, if the decision were his, the two largest shots in the *Teapot* series would be fired in the Pacific. He had always been frightened, Strauss noted somberly, that something would happen to damage the Commission's public image.[56]

When Strauss observed, however, that both Las Vegas newspapers favored continued use of the Nevada site on the grounds that the tests promoted both national defense and local prosperity, Libby interjected that this was a most sensible point of view. "People have got to learn to live with the facts of life," Libby declared, "and part of the facts of life are fallout." Such a philosophy was all right, Strauss countered, "if you don't live next door to it," "or live under it," as Nichols ruefully noted. Nevertheless, Murray insisted, the Commission could not let anything interfere with the *Teapot* test series, "nothing." Bugher assured the Commission that residents of the area, and especially those living in St. George, Utah, were hypersensitive to low-level radiation from fallout. "It is not a question of health or safety with St. George," Bugher reported, "but a question of public relations."[57]

New developments continued to make the Commission look bad on the fallout issue. In March, radioactive fallout from the *Teapot* tests was reported in widely scattered locations in Colorado, Nebraska, Chicago, New York City, New Jersey, and South Carolina. Yet in his testimony before Kefauver's committee on March 4, Val Peterson complained that security considerations had hampered the Federal Civil Defense Administration in making available to state and local civil defense planners pertinent information on weapon effects and fallout. Even within the Federal Civil Defense Administration, Peterson could not discuss fallout data with officials cleared for access to top secret information because they did not also have a clearance for Restricted Data. Unintentionally, Peterson left the impression that the Commission had hindered the civil defense effort by being overly strict, inflexible, or both. In fact, the Federal Civil Defense Administration had difficulty analyzing classified fallout data provided by the Commission because Peterson had consciously kept the number of cleared persons as small as possible. This restriction proved shortsighted after several cleared staff members resigned rather than move to the agency's new headquarters in Battle Creek, Michigan. Although Peterson duly explained the problem to the Joint Committee, the press in the meantime had castigated the Commission for being uncooperative and secretive.

The Joint Committee's hearings on civil defense planning on March 24, 1955, enabled Strauss to explain for the first time why the Commission had delayed in releasing the fallout effects statement. By then, however, the Joint Committee was rather disinterested in the Commission's old dilemma, and Strauss's explanation for the delay was greeted with little comment or publicity.[58]

Of far greater interest to the Joint Committee were the possible effects of nuclear tests on both weather and human health. On April 2, ranchers around Sheridan, Wyoming, were mildly annoyed when a spring snow began to dust the semiarid range. Before it was over, the storm buried northern Wyoming under almost forty inches of snow, killing livestock and paralyzing the region. Severe weather also complicated Senator Anderson's life: returning home for Easter recess by air, Anderson could not land at

Albuquerque; later, continuing storms prevented him from catching his return flight to Washington. It was the first time in thirty years that the senator had experienced such weather in New Mexico. Moreover, the Rio Grande was dry in April, an unprecedented situation according to the records of the U.S. Weather Bureau. Harry Wexler of the U.S. Weather Bureau observed that it was almost impossible "to prove that something isn't so." From Wexler's point of view, weather conditions were essentially normal, but he admitted that there was always a slight possibility that the tests had affected the weather. Because of this possibility, he concluded, no matter how much evidence the weather bureau marshalled to the contrary, a segment of the public would always be convinced that testing had altered the weather.[59]

FALLOUT: AN INTERNATIONAL ISSUE

While the public remained primarily concerned about the weather, which apparently still remained impervious to human will, scientists worried more and more about the health effects of fallout. On March 3, as a direct reaction to the Commission's February 15 statement, M. Stanley Livingston, a prominent nuclear physicist and chairman of the Federation of American Scientists, proposed establishing a United Nations commission to assess the radiation dangers from nuclear tests. Citing the injuries to the *Lucky Dragon* fishermen, the contamination of Pacific tuna, and the call of India's Prime Minister Nehru for an H-bomb test ban, Livingston observed that the implications of thermonuclear testing could not be limited to national considerations. On the heels of the federation's proposal, the Indian government sent a formal note to the United Nations Secretary General reiterating its intention to press for a moratorium on nuclear testing at the next meeting of the United Nations Disarmament Commission.[60]

That international fallout studies might be linked to demands for a cessation of nuclear testing was precisely what the Commission and the Defense Department had feared. Herbert B. Loper, Assistant Secretary of Defense (atomic energy), warned that a United Nations study "would place the United States in a position of recognizing and admitting that its weapons tests are endangering the lives and health of the peoples of other countries."[61] Although Loper did not think the tests had been inimical to public health, he did believe an international debate on fallout would damage United States national interests.

Similarly concerned, the British Embassy on March 18 advised the State Department that a United Nations scientific study of fallout would merely provide the Russians with a propaganda opportunity. As if to confirm the political sensitivity of the issue, four days later the Conservatives in the House of Commons beat back by forty votes a Labour motion for ceasing nuclear tests until an international conference of scientists had studied radiation effects.[62]

The Commission's initial strategy was to oppose the United Nations project while promoting an independent study by the National Academy of Sciences, funded by the Rockefeller Foundation. At the request of the Commission even before Loper expressed his opposition to a United Nations study, the National Academy of Sciences announced on April 8 its willingness to prepare a report with Rockefeller money and Commission cooperation. The Commission's division of biology and medicine had concluded that the National Academy of Sciences was not only a more appropriate group than the United Nations for this task but also that the American scientists could be given access to certain highly classified data that would lend greater public credibility to an academy report.[63]

The Commission's alternative was compromised, however, when United Nations Ambassador Lodge, as a countermove in the face of growing international concern, urged the State Department to submit a resolution to the General Assembly calling for the United Nations to collect and disseminate national radiation health studies. Under Lodge's plan, the National Academy of Sciences study would become the United States' major contribution to the international data collection. Lodge obviously wanted the United States to seize the initiative so that the Americans could gain some control over what appeared to be an inevitable United Nations responsibility. That same day, April 13, Senator Frederick G. Payne of Maine, supported by twenty-one other senators, introduced a resolution supporting a United Nations study of the radiation effects from nuclear explosions.[64]

Again Strauss found himself at odds with the State Department. In his April 15 testimony to the Joint Committee he had planned to state flatly his opposition to any international study on the "radiation problem." On the preceding day, however, at the urging of Under Secretary of State Hoover, Strauss agreed to withhold his opposition and merely to note that the possibility of an international study at some future date was not ruled out. Nevertheless, in executive session before the Joint Committee Strauss clearly indicated his sentiments by reporting that the Commission had taken a position not favoring the federation's proposal. Repeating British opposition to the idea, Strauss frankly indicated his concern that a United Nations panel might become "a packed jury of scientists," many of them from Iron Curtain countries more interested in propaganda than fact.[65]

Despite Strauss's and the Commission's continued objections, Lodge adroitly secured the Administration's support for the United Nations radiation study. On April 20, 1955, Senator Payne, now with the support of twenty-five sponsors, formally introduced a joint resolution calling for the United Nations study. Shortly thereafter, on May 4, Swedish Foreign Minister Bo Osten Unden announced that Sweden might also propose a United

Nations study. Lodge was now convinced that some delegation—either Sweden, India, or Pakistan—would raise the issue. He was determined to gain control of the situation in order to protect United States security interests, as well as to reap public credit. By advocating international coordination of national studies, Lodge hoped to divert attention from American tests to those of the United Kingdom and the Soviet Union and at the same time reduce building pressures for a moratorium on testing. Indeed, unless the United States acted positively, Lodge feared, the Geneva peaceful uses conference might degenerate into an international debate on the effects of nuclear testing.[66]

Although even Gerard Smith remained skeptical of Lodge's position, Loper conceded in May that from a propaganda point of view the Lodge approach had considerable merit. Because the United Nations would serve only as a clearinghouse for collecting and distributing studies that might be produced anyway, the Department of Defense had no continuing objection.[67] With Loper's acquiescence, Lodge could now tackle the Commission head-on.

On May 20, 1955, Dulles, Strauss, and Lodge, with Smith and Hoover, met to resolve the impasse. Although preliminary meetings among Lodge, Libby, Foster, and Smith had laid the foundations for an agreement, Strauss at first seemed as adamant as usual. After Dulles reiterated Lodge's arguments, giving special emphasis to the assumption that the Swedes or Indians would act if the United States did not, Strauss confessed that he was willing to accept the onus of opposing anything proposed by these governments. Strauss observed that it might take two hundred years to document the effects of radiation on human genetics. In the meantime, the use of antibiotics in modern medicine might produce even more serious mutations than radiation. But Strauss did not oppose the international study simply because he believed it would produce inconclusive results. Fundamentally, Strauss and the Commission feared that an international investigation of radiation effects would lead into "dangerous paths where demands for cessation of nuclear tests and the disclosure of information concerning [United States] weapons would possibly result."[68]

Lodge reassured Strauss that, if adopted, the United States proposal would not call for any "judgment" on the part of the United Nations. In fact, Lodge suggested using the Disarmament Commission, on which the Soviet Union served as a minority of one, as a clearinghouse to receive national reports. Strauss understood all this, but he was skeptical that the United States could control either debates or amendments once the matter had been brought before the United Nations. When Gerard Smith next predicted that the Defense Department would object to linking radiation studies with disarmament, Dulles replied that the alternative, an ad hoc body, inevitably would raise the question of Indian membership. The consensus was that the Disarmament Commission, on which India was not represented, was the most readily controllable body available. With that understanding, Dulles asked Lodge to prepare a revised draft resolution.[69]

Somewhat belatedly, General Loper, now with second thoughts, expressed the Defense Department's objections to any language in the draft resolution that suggested guilt or implied any official uncertainty on the part of the United States. Loper wrote to Smith,

> While we recognize that many of our scientists, particularly those not directly connected with the radiation evaluation program, are critical, skeptical and uncertain, the official position of the United States Government, as expressed by the Atomic Energy Commission, is that there is no basis for concern.

Accordingly, Loper insisted that the resolution make clear that the United Nations' only mission would be "to weigh the evidence and make known the facts."[70]

Throughout spring and summer 1955, the Commission contended that fallout from weapon tests had created a public relations issue, not a health and safety problem. Furthermore, along with the Department of Defense, the Commission believed that national security might be endangered if public concern over fallout led to political pressure to suspend nuclear testing. Consequently, the Commission intensified its public relations offensive by encouraging Dunning to prepare a scholarly article on "The Effects of Nuclear Weapons Testing." Dunning's highly technical paper, however, not published until December 1955, did little to relieve public anxiety.[71] In a more popular vein, Commissioner Libby addressed the alumni at the University of Chicago on "Radioactive Fallout."

Although Libby's speech was also highly technical, it was straightforward about the dangers of radioactivity while offering the public some assurances. If all the dosages from all atomic tests since 1945 were added together, Libby calculated, the total dosage for the American people would average considerably less than one-tenth roentgen or less than 0.02 percent of what was believed to be a lethal dose (400 roentgens). In actual fact, Libby estimated that as of January 1, 1955, the total dosage over the United States from tests was about 0.001 roentgen per year. The tests, he concluded, "therefore, do not constitute any real hazard to the *immediate* health." On long-range somatic hazards, Libby flatly stated that "natural radioactivities of the body, the effects of the cosmic radiation and the natural radiation of the radioactivities of the earth's surface constitute hazards which are much greater than the test fallout hazards." Libby did not want to imply that there were no risks, but rather that the risks from testing were no greater, and indeed were less, than those naturally encountered.

Libby underscored this thesis in his section on the genetic effects of testing. Quoting from a May 1955 report of the advisory committee on biology and medicine, Libby conceded that radiation produced by fallout from tests as well as from the peaceful application of atomic energy would produce additional mutations in human genes. But there would be "no measurable increase in defective individuals" as a result of the weapon tests because the small number of additional cases would not measurably change the ratio of forty thousand defective children to four million annual births. Of course, both somatic and genetic damage caused by all-out nuclear war could be catastrophic, an estimate Ralph Lapp confirmed simultaneously in his June 1955 article published in the *Bulletin of the Atomic Scientists.*[72] At the conclusion of his Chicago speech, Libby mentioned both the study by the National Academy of Sciences funded by the Rockefeller Foundation and a similar study in England by the Medical Research Council under the chairmanship of Sir Harold Himsworth. Without mentioning Lodge's proposal for a United Nations project, Libby simply expressed his hope that the American and British studies would be fully coordinated.

Finally reconciling the Commission and the Department of Defense to the wisdom of an American initiative at the United Nations, Lodge announced the United States proposal for an international pool of fallout data at the United Nations' tenth anniversary celebration in San Francisco. Approved in advance by several nations, including Britain and Sweden, Lodge's plan was to assemble all available information on the effects of nuclear test fallout "so that all nations can be satisfied that humanity is not endangered by these tests." Giving credit to the influence of Libby's June 3 speech in Chicago and thereby offering the Commission some welcome publicity, Lodge reaffirmed his conviction that fears about fallout had been greatly exaggerated. Because military topics were not to be considered at the Geneva peaceful uses conference in August, Lodge intended formally to introduce the American resolution to the General Assembly when it reconvened in September.[73]

THE INSEPARABLE LINKAGE

The *Bravo* shot unexpectedly had forged inseparable links between the fallout issue and international demands for a nuclear test ban. With the exception of Murray, the Commission labored in vain to break the two issues apart. But as in tempering steel, the more the Commission threw cold water on the linkage, the harder it became. If anything, the Commission's February 15, 1955, statement on fallout and its spring public relations campaign on the safety of testing had only reinforced the interrelatedness of the two issues. The chain of circumstances that led inexorably to the nuclear test moratorium in 1958 was not singularly, or even primarily, the making of the Atomic Energy Commission. In fact, the Commission consistently opposed a nuclear test ban. Nevertheless, the Commission's role was not one of simple, mindless opposition; rather it was complicated by the fact that it served as the President's main source of scientific and technical information on nuclear issues. As such, the Commission was often obliged to provide information and opinions that actually facilitated test ban negotiations. The ambiguousness of the Commission's task was especially revealed in its relationship to Harold E. Stassen, whom Eisenhower appointed as special assistant for disarmament on March 19, 1955.

Eisenhower's decision to make a Cabinet-level officer responsible for developing basic disarmament policy was unprecedented. Stassen had become something of a political *wunderkind* after Minnesota elected him the nation's youngest governor ever at the age of thirty-one. Thereafter, he served as an American delegate to the San Francisco United Nations conference in 1945. Beaten by Thomas E. Dewey for the Republican presidential nomination in 1948, Stassen had vigorously supported Eisenhower in the 1952 elections. Subsequently, he was chosen to head the Foreign Operations Administration. Following Stassen's disarmament appointment, Eisenhower was delighted when the press referred to the former governor as the "Secretary for Peace."[74]

Stassen was given a delicate assignment requiring utmost skill in balancing conflicting interests represented by the State Department, the Pentagon, and the Commission, as well as by the Soviet Union and America's North Atlantic Treaty Organization allies. Stassen's appointment was announced in the midst of the London Disarmament Conference, which had convened in February 1955 only to be quickly deadlocked. Hoover, Acting Secretary of State while Dulles was in Bangkok, viewed the discussions as "only a debating exercise with the Communists using it for their usual propaganda purposes." Thus, Stassen was called upon to conduct a comprehensive review of American policy and strategy.[75]

In addition to his immediate White House disarmament staff borrowed from various agencies, Stassen established eight task forces to study the requirements and methods of effective international inspection and control. Ernest O. Lawrence headed the task force on the inspection and control of nuclear materials. Others included General James H. Doolittle on aerial inspection and reporting, General Walter B. Smith on inspection and reporting of Army units, Walker L. Cisler on power and industry, and James B. Fisk of Bell Laboratories on communications. The entire effort would parallel the Commission's search for international control of the peaceful uses of atomic energy.[76]

Stassen had hardly begun his work when the Soviet Union offered a new proposal to the London Disarmament Conference on May 10, 1955. At first American negotiators were uncertain whether the Russian initiative was genuine or simply another propaganda ploy. Nevertheless, the imperatives of the thermonuclear age seemed to require that the Russians be given the benefit of the doubt until otherwise proven disingenuous. The

Soviet proposals, which indicated much greater flexibility than ever before, essentially accepted the Anglo-French formulas for reductions in conventional and nuclear weapons and in armed forces. In addition the Soviet proposal called for the cessation of nuclear weapon tests as part of a ban on nuclear weapons. Although the Soviet Union continued to demand the elimination of United States bases abroad as well as abolition of nuclear weapons, the new proposal also recognized the scientific difficulties in accounting for nuclear material and in guarding against surprise attack.[77] From the American point of view, the Soviet initiative was unacceptable because it lacked provisions for effective safeguards and inspection.

By May 26, Stassen had prepared for the President his first report, which included an analysis of the Soviet proposal. Stassen believed that the Russians had placed disarmament in a "political package" that hinted at the possibility of a Russian withdrawal from central Europe in return for a United States pullback from Europe and the Far East. Although the Soviets had called for abolishing nuclear tests and weapons, the Russian plan did not provide for ceasing nuclear production. Furthermore, Stassen noted, the Soviet proposal offered only a "Korean-Armistice-Commission type of control over 'big' ports, railways, airdromes, etc." that was supposed to provide a crosscheck on nuclear capabilities and a warning against surprise attack. Significantly, however, Stassen did not dismiss the Russian overtures out of hand. Rather, he stressed the importance of finding some means of ending the arms race on terms compatible with American security interests.[78]

On June 30, 1955, having already received unfavorable comments from the Commission, the Department of Defense, and the Joint Chiefs of Staff, Stassen briefed the National Security Council on his suggestions for a United States disarmament policy. Stassen recommended that the United States seek an agreement with the Soviet Union to end the arms race by leveling off armaments, ceasing nuclear tests and weapon production, and establishing an International Armaments Commission to supervise an arms control agreement.[79] Eisenhower, generally sympathetic with Stassen's plan, thought the United States had to gain considerably more support from its allies, especially the United Kingdom, before any agreement could be reached with the Russians.

Defense Secretary Wilson explained that the Pentagon did not expect to settle all major issues with the Soviet Union before signing an arms control agreement. Nevertheless, without a significant change in Russian attitudes and policies on inspection and supervision, Wilson believed no agreement would be possible. The first order of business, Wilson suggested, should be to crack the Iron Curtain, perhaps through a movement toward free trade.[80] Speaking for the Joint Chiefs of Staff, Admiral Arthur W. Radford expressed their solid opposition to the Stassen proposal. He declared that the plan was unworkable unless it included Communist China as well. Otherwise, Stassen's project would lead to the military inferiority of the United States.

Replying with some warmth, Eisenhower reminded the council that the Joint Chiefs of Staff had also rejected the Baruch plan in toto. As far as Eisenhower could see, Radford believed that the United States "should proceed as at present in the arms race despite the fact that this was a mounting spiral towards war." With withering scorn, Eisenhower wondered why the Joint Chiefs did not at once counsel preventive war with the Soviet Union. Taking another tack, the President argued that if the Russians failed to "play straight" on inspections, the United States could always abrogate the disarmament agreement. Radford demurred, by granting the theoretical possibility of the President's argument, but he doubted whether public opinion at home or abroad would allow the United States to counter Russian violations. Somewhat more patiently Eisenhower admitted that Stassen's proposal raised problems, but it also had the virtue of being a creative starting point for negotiations. Then essentially concurring with Wilson and Radford, he agreed that the crux of the problem was inspection.

Now Dulles captured the lead in the debate. If the United States did not make some bona fide move towards disarmament, Dulles predicted that Americans would lose allies and the right to use foreign bases. Not only was it impossible to stand still, but the United States could not wait for the settlement of political issues in Europe and the Far East. In Dulles's opinion, disarmament and political settlement had to proceed concurrently. Agreement was possible, the Secretary of State believed, because the Russians genuinely wanted some reduction in the arms race in order to deal more effectively with internal problems. Granting that inspection was the central issue, Dulles thought that no one had sufficiently studied the matter, including Stassen. Would the United States really be willing to allow Russian inspectors into American industrial and military centers? Dulles was skeptical and reminded the council that policing had seemed impossible to Baruch's planners. Since disarmament negotiations would most likely break down at this point, inspections would be the area in which the Department of State would put its greatest effort. Eisenhower was satisfied with Dulles's approach. Noting that the problem of inspection could not readily be separated from the substantive issues of disarmament, the President concluded with the obvious: the type of disarmament plan adopted would clearly dictate the type of inspection needed.

Throughout the debate Strauss sat glumly quiet. Opposed to a nuclear test ban, a key feature in Stassen's proposal, Strauss sought some means of supporting Wilson and Radford without incurring the wrath of the President. Finally he spoke pessimistically. Was it not possible, Strauss speculated wistfully, to pursue the approach first suggested by the President in his Atoms-for-Peace speech? Because the Russians could not be trusted, Strauss thought the best approach was the atomic pool that would drain off fissionable material from weapon stockpiles; this approach would take the heat off the United States while placing the Russians at a strategic disadvantage.

As the meeting concluded, Eisenhower ignored Strauss's irrelevant comments by returning to the main issue and asking Stassen to adjust his plan to an acceptable inspection system. Vice-President Nixon concurred with the comment that nothing was more important from a political point of view than an inspection system that would penetrate the Iron Curtain. The inspection issue, according to Nixon, was also the United States' most effective propaganda issue.

THE GENEVA SUMMIT CONFERENCE

Always suspicious of Russian motives, Dulles had responded to the gradual thaw in relationships with the Soviet Union by remaining cool himself to a summit meeting until after the Soviets had demonstrated their sincerity by concluding an Austrian peace treaty. In May 1955, the Russians, as part of their post-Stalin revision of foreign policy, suddenly signed an Austrian treaty. Now on the spot and fearful that the Soviets might achieve a significant propaganda victory from their talk of "peaceful coexistence," Dulles, with the backing of the National Security Council, nevertheless continued to believe that the Russians would not deviate from their attempts to disrupt the North Atlantic Treaty Organization unity and to expand their influence, principally by subversion and insurrection, while avoiding direct confrontation with the Western powers. Dulles predicted that the Russians would use the Geneva summit conference, now scheduled for July 1955, to achieve considerable gains in moral and social stature over Western leaders. Unless the conference ended in utter failure, Dulles estimated that the Soviets would partially succeed in relaxing efforts at NATO build-up and German rearmament. In contrast, he did not believe that the Russians would achieve their disarmament goals by emphasizing "ban the bomb" at the expense of "the painstaking procedures needed to assure adequate safeguards." Dulles's confidence in the American ability to parry Russia's disarmament thrust was bolstered by the United States' plan to offer its own proposal designed to counter Soviet "ban the bomb" propaganda.[81]

Speaking directly to Soviet Premier Nikolai Bulganin at the summit meeting in Geneva on July 21, 1955, Eisenhower offered his Open Skies plan, which called for exchanging blueprints of military facilities and establishing bases for aerial photography and reconnaissance in each country. If adopted, Eisenhower's plan would have greatly lessened the danger of surprise attack. The President envisioned Open Skies as a confidence-building first step toward ending the arms race. Similar to ideas coincidentally developed by Nelson A. Rockefeller, the Open Skies proposal directly addressed the central issue of safeguards and inspection that the National Security Council held as the Administration's first priority. Because the Russians would almost certainly reject the Eisenhower plan on the grounds that it violated national sovereignty, Open Skies may have had a second purpose: to quiet European fears over stationing American nuclear warheads in Europe.[82]

On the same day that Eisenhower proposed Open Skies, Bulganin reiterated the Soviet proposal for establishing control posts at major sea and air ports, at railway junctions, and along main highways in order to prevent surprise attack. Khrushchev, on the other hand, virtually rejected Open Skies outright as nothing more than a spy system. The Russians, however, offered no new disarmament proposals at Geneva.

"OPEN SKIES" OVER NUCLEAR FACILITIES

From the Commission's point of view, it was just as well that the Russians did not embrace the Open Skies proposal because the Commission had its own serious reservations about the President's plan. The Commission's concerns came to light when Arkady Sobolev, Soviet representative to the disarmament subcommittee, inquired whether nuclear weapons were included in Eisenhower's plan. The Russian's question was reasonable and, as Sobolev explained, consistent with the Soviet Union's desire to outlaw atomic and hydrogen weapons and to discontinue nuclear testing. Stassen, recently appointed to the U.N. Disarmament Subcommittee by the President and uncertain how to respond, announced that the United States had placed a "reservation" on all of its "pre-Geneva substantive positions" pending review of United States policies. Stassen's announcement was certainly candid, but it also squandered some of the President's hard-won propaganda victory by throwing in doubt American policies and Western solidarity.[83] Ironically, both the Russians and the Commission were able to exploit the uncertainty created by Stassen's faux pas.

When Stassen admitted that American disarmament policy was under review, he all but announced that the United States held "reservations" concerning its previous support of French and British positions. This apparent break in Western solidarity allowed the Russians to regain the initiative by offering numerous "first steps" to disarmament, confident that the North Atlantic Treaty Organization allies were in no position to respond positively. In his formal reply to Eisenhower on September 19, Bulganin pointedly noted that Stassen had been unable to clarify the American position. Did the United States still accept the 1952 Anglo-French proposals on force reductions? Was the United States willing to discuss control of atomic weapons? Would the United States also consider Soviet proposals for ground control posts? All Stassen would discuss, Bulganin complained, was aerial photography and exchange of "blueprints," which unfortunately included only the United States and the Soviet Union. To be workable, Bulganin suggested, Open Skies would have to include all allied nations, East and West.[84] By sly implication, Bulganin tweaked the Americans for refusing to recognize the Chinese communists and excluding them from the disarmament negotiations.

Sobolev's question and Stassen's "reservations" also enabled the Commission to seek exemption for its facilities and programs. First, Strauss was especially worried that if the United States were obligated to disclose nuclear stockpile figures, the Russians would be able to calculate production rates by extrapolating from any two stockpile reports. Second, Strauss was afraid that the Soviets might be able to improve their bomb design significantly by studying photographs of American thermonuclear weapons. He asked that the President be alerted to these problems so that Eisenhower's intentions for Open Skies could be clarified.[85] Before Strauss could take his questions to the President, disaster struck the Administration. On September 24, while on vacation, Eisenhower suffered his first heart attack.

Stunned, the National Security Council nevertheless met on October 13 to hear Stassen's recommendations based on his discussions with the disarmament subcommittee. It was possible, Stassen thought, that the Russians might initially accept limited Open Skies over a band of territory one hundred to two hundred miles wide. Under the circumstances, Strauss was hardly in a position to press vigorously the Commission's case against including nuclear weapons and facilities.

Dulles demurred, however, and virtually answered the Russians and the Commission by expressing doubt whether the President's Open Skies concept was "divisible." The problem with limited air inspection, Dulles suggested, was that the Russians might accept a modest plan with the hope that it would never have to be expanded. Obviously melancholy, perhaps discouraged, Dulles compared Open Skies with Atoms for Peace. Both ideas had been offered by Eisenhower primarily with the hope of improving the climate of international relations. In neither instance had the President fully appreciated the technical difficulties his proposals raised for inspection and safeguards. Vast technical problems would have to be solved, Dulles predicted, before any kind of worldwide system for arms inspection and control, including the exchange of blueprints and other military information, could be established. All the same, Dulles mused, the President's Geneva offer had "put the Russians on the hook." Dulles wanted to keep them there and thought it inappropriate to make any limited deal with Moscow until Eisenhower could make his own views of the matter known.[86]

Just prior to the Geneva foreign ministers' conference called in November 1955 to discuss arms control, Stassen submitted to the National

Security Council his "Proposed Policy of the United States on the Question of Disarmament." Stassen identified three priority objectives of the United States: (1) to open up the Soviet Union and other communist-controlled countries to effective inspection; (2) to prevent the proliferation of nuclear weapons to other nations; and (3) to inhibit the Soviet Union's development of intercontinental missiles capable of delivering nuclear weapons. To achieve these aims, Stassen endorsed Open Skies, a modest reduction in conventional armed forces, the prohibition of the production of nuclear material for any purpose other than peaceful uses, and expanded scientific and cultural exchanges. Stassen also suggested that space satellites and intercontinental missiles be developed only through international collaboration for peaceful purposes, precluding weapon testing and production. Although the United States should agree neither to reduce nuclear stocks nor to withdraw from overseas bases, Stassen recommended that a ban on

nuclear testing should be part of a comprehensive agreement.[87]

Stassen's support of a nuclear test ban virtually insured that the Commission would seriously object to the proposed disarmament policy. The Commission supported Stassen's basic principles and premises, although Strauss noted that Stassen had not made clear whether his three priorities were offered in addition to, or as a substitute for, policy objectives outlined in previous reports. Confusion, however, was not the Commission's major concern. Writing on behalf of the Commission, Strauss outlined the chief deficiencies of Stassen's plans. Surprisingly, the Commission's first objection was that Communist China was not included in the proposed agreements. The Commission's motives in raising this sensitive issue may have been mixed. On the one hand, the Commission was on solid ground when it argued that no comprehensive inspection and control system could exclude the People's Republic of China. On the other hand, given the Administration's intransigence over diplomatic recognition of Communist China, the Commission's insistence that an effective agreement required Chinese participation virtually precluded a comprehensive treaty. Although the Commission's argument for including Communist China may have been a gambit designed to impede negotiations (the Russians had used the same tactic), the Commission was supported in this position by Allen Dulles of the Central Intelligence Agency.[88]

Strauss's second reservation touched closest to the Commission's fears. For political reasons, the Commission could not categorically oppose a nuclear test ban, but Strauss forcefully argued "that the suspension of nuclear tests should be listed as one of the items to which the United States will *not* agree except as part of the final phase of a comprehensive program for the limitation of armaments." On this point, the Joint Chiefs of Staff essentially concurred with the Commission, while Secretary of Defense Wilson more obliquely urged the implementation of Open Skies as the first and central objective of United States disarmament policy, subordinating all other goals to that end.[89]

On the question of inspection and verification, Strauss and the Commission were in accord with other commentators. Specifically, Strauss predicted that Stassen's plan would place too great a burden on the International Atomic Energy Agency, whose goal would include establishing safeguards to prevent use of nuclear materials for military rather than peaceful uses. Here, John Foster Dulles was closest in agreement with the Commission. Stassen's outline of an inspection and control system was so general, Dulles complained, that it did not provide the necessary details to evaluate the policy suggestions that should have been derived from the effectiveness of the inspection system itself.[90]

At the tenth General Assembly of the United Nations, Henry Cabot Lodge echoed Dulles's sentiments publicly. Inspection and control were the central issues in disarmament, Lodge stated, and had been ever since 1946. Lodge emphasized that the problem had now become more difficult and urgent because large stocks of nuclear materials could be hidden beyond the range of any known detection device. Nevertheless, India's delegate, V. K. Krishna Menon, introduced a resolution calling for the immediate suspension of nuclear testing. Although the General Assembly did not adopt the Indian resolution, it unanimously accepted one sponsored by the United States and seven other nations proposing that the United Nations establish a committee to study the effects of atomic radiation on human health. Thus, Lodge succeeded in his attempt to use a resolution to diffuse international anxiety over the health effects of radioactive fallout. By and large the American goals were achieved on December 16 when the General Assembly, by a vote of 56 to 7, against Russian opposition, urged the Disarmament Commission's subcommittee to give priority to such confidence-building measures as Eisenhower's Open Skies plan and Bulganin's ground inspection proposals while continuing to search for feasible measures that adequately safeguarded disarmament agreements.[91]

In the midst of the United Nations debate on disarmament Strauss urgently appealed to Eisenhower and Dulles not to endorse a test ban except as part of the final phase of disarmament negotiations. Strauss stated his unequivocal belief that the Soviet campaign for a testing moratorium was a "coldly calculated maneuver" to overcome America's superiority in nuclear weapons. Although Strauss believed that the United States held a lead over the Soviet Union in nuclear weapon technology, in event of a test ban he predicted that the Russians could overtake the United States through espionage, unimpeded research and development, and clandestine testing. Meanwhile the momentum and vitality of the American testing program would be lost. If a test moratorium were adopted as a first phase of disarmament, Strauss feared the Soviets would deliberately stall subsequent negotiations as a tactic to gain time for their own arms build-up. Even should the United States detect a violation of the test moratorium, Strauss believed it would be politically impossible to convince the world of Soviet duplicity in the face of denials from the Kremlin. Consequently, Strauss recommended aggressive opposition to a test ban until a "comprehensive program for the limitation of armaments" had been negotiated.[92]

Strauss's appeal contrasted sharply with that of Pope Pius XII. On December 24, 1955, the Roman Catholic pontiff called for an end to the nuclear arms race in his Christmas message to the world. According to the Pope, the great powers had to take three steps simultaneously: ban nuclear testing, outlaw the use of nuclear weapons, and control conventional armaments. The Pope's plea to end nuclear testing embarrassed the Commission. For once, Strauss could not dismiss a proposal as politically or ideologically motivated. In 1956 the question of a nuclear test ban would become a pressing public issue.

CHAPTER 11

SAFEGUARDS, EURATOM, AND THE INTERNATIONAL AGENCY

According to Lewis Strauss's recollection, President Eisenhower was the first head of state personally to operate a nuclear reactor. On July 20, 1955, in the midst of the historic Geneva summit meeting, the President visited the American research reactor assembled on the grounds of the Palais des Nations in preparation for the forthcoming conference on the peaceful uses of atomic energy. The reactor, which had been flown to Geneva from Oak Ridge, Tennessee, was the first nuclear reactor ever built in Western Europe. The President's inspection of the pool-type reactor created unusual excitement among the reporters, who were given their first opportunity to get close to the President since the opening of the Big Four meeting. In the noise and confusion, reporters and photographers jostled one another for a vantage point and even had to be restrained from climbing the platform on top of the reactor itself. Inside the glass-enclosed control booth where the President was insulated from the crowd, Eisenhower gradually withdrew the control rods by pressing a button. Slowly power built up in the reactor—first to ten kilowatts and eventually to one hundred.[1]

The President was delighted. He had always wanted to witness a nuclear weapon test but had never thought it politically advisable to do so. At Geneva Eisenhower could publicly express his interest in nuclear technology without associating himself in the slightest with atomic weaponry. Watching the control panel where three red sticks simulated the movement of the control rods, the President listened attentively while Oak Ridge scientists explained the principles of the controlled chain reaction, evidenced in the bottom of the cisternlike tank by the glow caused by the Cerenkov effect. At the conclusion of the demonstration, Eisenhower expressed his hope that private business and professional men throughout the world would assist in finding ways to employ the peaceful atom. In the meantime, he was confident that the demonstration reactor would teach all who saw it "that there are really many, many ways in which atomic science can be used for the benefit of mankind and not destruction."[2]

THE DILEMMA OF PROMOTION AND CONTROL

As he stood at the controls of the first nuclear reactor exported to a foreign country, Eisenhower symbolized the dilemma of America's Atoms-for-Peace program. The President fervently believed that the world was doomed unless it could find peaceful uses for atomic energy. But thoughtful Americans also realized that without satisfactory controls and safeguards, the peaceful atom, especially when employed in research and power reactors or related technology, could also serve military purposes. During the two weeks of the 1955 Geneva peaceful uses conference several other political leaders and foreign scientists also operated the reactor under the watchful eyes of American technicians. It would be more difficult, however, to control nuclear technology, once peaceful uses had been successfully promoted throughout the world.

In 1955 and 1956 the Atomic Energy Commission and the State Department, with the guidance of the National Security Council, attempted to balance the President's Atoms-for-Peace policy against his determination to end the nuclear arms race. To this end, the United States enthusiastically supported numerous approaches to developing the peaceful atom: "selling" the nuclear option at Geneva, making nuclear technology and reactors available abroad, negotiating bilateral agreements that would assist other nations, pushing for an international atomic energy agency, and achieving the preeminence of the United States in atomic energy matters, particularly with respect to the Soviet Union, but also in terms of Britain and France. All these endeavors would promote the President's dream of redirecting nuclear research and resources from weapon activities to peaceful pursuits.

Nevertheless, under the President's direction, the United States' peaceful nuclear diplomacy was basically Europe-oriented. To some degree, the American policy was concerned with European and worldwide energy needs. The Suez crisis in fall 1956, and to a lesser extent the Hungarian revolution of the same year, would bolster Atoms for Peace by emphasizing Europe's need to develop atomic energy as rapidly as possible as an alternative to Middle Eastern oil. For the most part, however, the policy was born in the Cold War and was designed primarily to supplement American military security. Following the precedent of the Marshall Plan, Atoms for Peace was expected to forge even stronger economic and technical bonds between Europe and North America. Atoms for Peace, if coupled with an enforceable international moratorium on weapon development, would allow the United States to guard its near-monopoly over the military atom while promoting the peaceful atom.

At the same time, international control of atomic energy, a conflicting objective, required as much attention and effort as did promotion, even though nuclear management was less a topic for public discussion. If promotion of peaceful uses would inevitably place nuclear technology into more hands, it followed that the proliferation of knowledge would also increase the possibilities that the technology could be used for military purposes inimical to American interests. By its nature, control of atomic energy was negative and thus less attractive as an instrument of foreign policy. For that reason, and because it had implications for national security, the control objective was necessarily less visible. But behind the scenes, and to some extent in the public debate, control was a matter of serious concern to American leaders.

The problem was that international promotion and control of atomic energy were contradictory; the success of the one tended to hurt the cause of the other. After the Geneva conference the United States found it impossible to follow a consistent and steady course toward Atoms for Peace. Rather, the path that led toward one goal inevitably required a recharting of steps to reach the other. Consequently the search for a consistent policy on peaceful uses was hampered by apparent indecision within the Administration confronted with conflicting proposals, disagreements, and confusion about goals.

The turmoil and trials of the Atoms-for-Peace debates, however, were from a larger perspective dramatic symptoms of the deep moral question with which American leaders were struggling at the time. The specter of Hiroshima and Nagasaki, and more recently the *Bravo* shot and the *Lucky Dragon* incident, cast a shadow over the American conscience. The United States, in its drive to win World War II and save the world from totalitarianism, had developed the power of the atom for military purposes. Not until Hiroshima and Nagasaki were in ashes and the *Lucky Dragon* crew arrived in Yaizu, Japan, did the American people begin to understand the far-reaching implications of their accomplishments. Atoms for Peace was a sincere yet almost desperate effort to find some redeeming value in what seemed a uniquely American engineering triumph. This moral imperative provided a special incentive for the Atoms-for-Peace program. Without it, Atoms for Peace and Eisenhower's extraordinary dedication to that idea were not really understandable. At the same time, the sobering realities of thermonuclear warfare made international control of the atom a matter of paramount concern. The dilemma was that the two conflicting goals could not be separated.

LAUNCHING THE INTERNATIONAL AGENCY

On his return from Geneva, Gerard Smith observed that the scientific conference had confirmed American leadership in the peaceful uses of atomic energy while refuting the Soviet allegation that the United States had concentrated exclusively on military applications. Although American dominance in peaceful uses of atomic energy was not as great as its leadership in atomic weapons, the United States' participation established a political fact that was expected to ease, somewhat, resistance to American economic promotion of nuclear energy.[3] Russian participation, however, had also been surprisingly strong, a fact noted by almost all American observers. Strauss and Libby, for example, reported that the Soviet Union had enjoyed disquieting success in training nuclear scientists and engineers.[4]

Smith also recognized that the Geneva conference, by increasing worldwide expectations for developing nuclear power, made it more difficult for the United States to limit its assistance programs. As he noted, the echoes from Geneva called for deeds rather than more words in the field of peaceful atomic development.[5] Realizing this fact, Commissioner Libby, on the last day of the Geneva conference, had outlined the steps already taken by the United States to implement Atoms for Peace. In addition to highlighting the various training programs sponsored by the Commission, Libby noted proudly that the United States had given the large technical library exhibited at the conference to the United Nations in Geneva. This same library, similar to a collection already presented to the European Center for Nuclear Research, would be provided to nations willing to share their collections of unclassified official papers.[6]

Although attracted by American training programs and libraries, most participants at the Geneva conference were more interested in obtaining direct American assistance than in sponsoring multilateral controls through the International Atomic Energy Agency. During and immediately after the conference, Smith reported that the United States had been approached by several countries, including India, France, the Netherlands, Italy, and Australia, seeking agreements for cooperation to build power reactors. In addition, the council of ministers of the European Coal and Steel Community had previously agreed in June 1955 to explore establishing a European common market and to discuss preliminary plans for EURATOM, a multilateral organization that would integrate European atomic energy development. At this same time, in part responding to Eisenhower's speech at Pennsylvania State University, the Organization for European Economic Cooperation, established in 1948 under the Marshall Plan, appointed a working group to study European cooperation in the areas of nuclear power and distribution.[7]

Even the Russians, according to Smith, had jumped on the peaceful uses "bandwagon." To Smith's surprise, politics were virtually absent from the scientific conference. Smith suspected, however, that the freedom with which Russian scientists had discussed their specialities was less attributable to the "Spirit of Geneva" than to a prior decision by the Kremlin to ride the "surge" of world interest in peaceful uses of atomic energy. His interpretation was borne out, Smith believed, by the course of negotiations between the United States and the Soviet Union on the International Atomic Energy Agency.[8]

Initially, the Russians opposed Eisenhower's plan for the agency by arguing that promotion of nuclear power around the world could only follow a ban on nuclear weapons because the widespread use of nuclear power would result in the proliferation of weapon-grade material. For its part, the Eisenhower Administration had contended that an "atomic pool" would siphon off weapon-grade material from national stockpiles, thus reducing theoretically the amount of enriched uranium available for nuclear weapons. Nevertheless, Eisenhower could hardly announce the Administration's subsequent position publicly without being accused of suggesting an atomic pool solely for the purpose of gaining control over Soviet fissionable materials.[9]

Having decided to establish the international agency without the Soviet Union, the United States limited its discussions to seven countries that had either developed raw material resources or maintained advanced atomic energy programs—namely, the United Kingdom, France, Canada, Australia, Belgium, the Union of South Africa, and Portugal. Anxious for his Atoms-for-Peace initiative to bear fruit, Eisenhower had asked Ambassador Morehead Patterson on September 15, 1954,[10] to negotiate the statute for the new agency while he also continued to conduct the bilateral negotiations. With Patterson responsible for both tasks, it had been evident that prior to the Geneva conference the Administration had not yet reconciled the inherent contradictions between international promotion and international control of atomic energy.

Patterson's job was to establish the international agency as quickly as possible while coping with the complicated details in the agency statute. His strategy was to support a constitutionally broad statute embodying general principles, leaving to a later date the solution of more technical problems that might delay the agency's establishment. Among the problems left for the agency itself to solve were the location of its headquarters and the functions it might assume under its broad grant of authority. On the basis of a British draft, the United States, the United Kingdom, and Canada adopted an initial outline that was presented to the entire working group on March 29, 1955.[11] It became clear as negotiations proceeded that, with the possible exception of France and Canada, and of course the United States, no member of the working group really wanted an international agency.[12]

At this juncture only the United Kingdom might have been able to scuttle the project. With Patterson concurrently negotiating the bilateral treaties, he assured the President that the British were not inclined to frustrate the American determination to implement Eisenhower's program. Also, Patterson successfully kept the points of disagreement between Washington and London to a minimum. He defined the agency's mission so broadly that both the United Kingdom and the United States could agree that the agency's principal task would be to act as a clearinghouse rather than an effective regulator.

Then on July 18, 1955, the Russians indicated their interest in joining the discussions. As an expression of good faith, Moscow offered to deposit fifty kilograms of fissionable material with the new agency as soon as its charter was approved. This offer confirmed Premier Bulganin's announcement made a few days earlier at the Geneva summit meeting that the Soviet Union would be willing to contribute fissionable materials. Despite their unexpected generosity, however, the Soviets also seemed to favor a clearinghouse rather than a "banking" function for the international agency.[13]

DEFINING THE SAFEGUARD PROBLEM

As long as the Russians remained uninterested in the international agency, the control issue had not particularly troubled planners at the Commission or the State Department. Without Russian participation, in all likelihood there would be no international pool of nuclear materials requiring safeguards. It seemed that an effective system could be adequately established later on a bilateral basis. After the Soviet Union expressed a positive interest in joining the negotiations, however, the matter of controls took on new importance. From the outset, the Soviet Union had identified safeguards as a principal concern in promoting international cooperation in peaceful uses. Originally, Americans suspected that the Russians had merely seized the issue as a means of obstructing negotiations, or even of gaining greater technical insight into the American atomic energy program. The evident seriousness of the Soviet position had been underscored, however, when the Russians earlier agreed to meet with a panel of experts, as suggested by the United States on November 3, 1954, primarily for the purpose of discussing technical issues.[14]

Thus, in winter and spring 1955, while the National Security Council was hammering out its new policy on nuclear reactors abroad, the American Atoms-for-Peace initiative advanced on four broad but loosely coordinated fronts. As the Commission organized its exhibits and presentations for the peaceful uses conference in Geneva, Patterson was aggressively pursuing both bilateral and agency negotiations. Now with the Russians surprisingly receptive to a technical conference on safeguards, both

John Hall at the Commission and Gerard Smith at the State Department turned to drafting a tentative agenda for the proposed technical conference.

Already moving beyond the general policy on safeguards that the National Security Council would adopt, Hall had concluded in February 1955 that the size and number of research reactors requiring supervision from the international agency would be small. Furthermore, the stocks of weapon-grade material produced by the operation of research reactors would not be appreciably increased (and might well be slightly reduced). Nevertheless, some international supervision over the fabrication and reprocessing of fuel elements, even from research reactors, would be required to insure that the materials were not diverted for unauthorized purposes. More important, although the United States might not export power reactors for years, Hall realized that the Commission could no longer postpone formulating a comprehensive safeguard strategy.

Unhappily, the operation of large-scale power reactors would pose difficult control problems. For example, Hall pointed out to the State Department that reactors fueled with slightly enriched uranium produced significant quantities of plutonium, which could be diverted to weapons. In addition, it would be necessary to insure that neither thorium nor natural uranium was surreptitiously placed in the reactor for the production of uranium-233 or plutonium. In cases where power reactors were fueled by plutonium, uranium-233, or highly enriched uranium-235, safeguards would be required to prevent diversion of fuel in all stages of the fuel cycle from shipment and loading through removal and reprocessing. Consequently, Hall warned, the international agency would have to exercise very close supervision over reactor design, construction, and operation, maintaining even more stringent controls over preparation and extraction of fissionable materials.[15]

On April 14, 1955, in the midst of feverish preparations for Geneva, the United States finally suggested a tentative agenda for the technical discussion of safeguards. The Russians did not accept the American agenda until they simultaneously expressed their interest in participating in the international agency on July 19, just three weeks before the peaceful uses conference opened. Moving now with unusual swiftness, the State Department, with Commission concurrence, proposed that preliminary technical discussions on safeguards be conducted at the close of the peaceful uses conference. Although Strauss was worried that the safeguard discussions followed too closely after the larger scientific conference, the Commission consented to provide necessary technical support with the understanding that the talks would last no more than five days and would be scrupulously confined to technical issues, excluding all references to either the organization and the function of the international agency or disarmament.[16]

Initially, the Soviets asserted that peaceful applications would in fact increase the world's supply of weapon-grade materials. Although this fact was obviously true in a technical sense, no one was certain what kinds of specific controls would be required to prevent unauthorized diversion. In view of the short time available to prepare for the talks scheduled to begin on August 22, the Commission found itself confronted with several serious questions of tactics. For instance, concrete discussions of procedures for safeguarding advanced reactors might well instruct Russian scientists on the status of American programs, both peaceful and military. Furthermore, to outline prematurely the extent to which maximum assurance against diversion of materials would require supervision over design, construction, and operation of the reactors as well as the preparation and possession of fissionable materials might well discourage "have-not" nations from joining the international agency. Most embarrassing, perhaps, was the fact that the Commission itself had considered the matter only theoretically.[17]

General advisory committee chairman Isidor I. Rabi, already in Geneva attending the peaceful uses conference, was not officially appointed head of the American delegation until August 19, three days before the first technical session. Just three days before that, the Americans had assembled in Geneva to develop a technical position on monitoring power reactors. Rabi's group was instructed to explore with representatives from the Soviet Union, Canada, France, Czechoslovakia, and the United Kingdom technical safeguards that emphasized physical security of fissionable materials and detection of procedural violations as established by the international agency.[18] From the distinguished American delegation then present in Geneva, Rabi was able to obtain advice or assistance from Commissioner Libby, Warren C. Johnson, Eugene P. Wigner, and Richard W. Dodson, members of the general advisory committee; W. Kenneth Davis, director, division of reactor development; Alvin M. Weinberg, director, Oak Ridge National Laboratory; Walter H. Zinn, director, Argonne National Laboratory; several other top scientists from Oak Ridge and Argonne; and Gerard Smith, representing the State Department. The group agreed that continuous monitoring of small reactors might be feasible, but it conceded that it would be difficult to monitor large power reactors. Safeguarding fuel element fabrication posed an even greater problem, while satisfactory monitoring of chemical reprocessing was the most difficult, if not impossible, task. By and large, Rabi's working group advocated a stringent system of inspection and detection supported by tight physical security, accounting, and "leak" monitoring procedures.[19]

Consensus was frustrated, however, when Zinn expressed skepticism that the proposed "system" was practical. Zinn vigorously challenged the group's position, stating that most techniques attempting to trace elements through the fuel fabrication and reprocessing cycle were unreliable. He conceded that a material accounting system, based on the United States model, might be feasible for safeguarding reactors. Yet even if adequate inspection and accounting procedures were technically possible, he thought the proposed safeguard plan "would require a tremendously complicated, elaborate, irritating, and expensive physical security system." Zinn predicted that the cost of maintaining such a system would place a severe economic burden on power production, perhaps doubling operating costs beyond the purchase of expensive nuclear fuel. Besides, Zinn concluded, "physical security is notoriously difficult and uncertain."[20]

Although not everyone agreed with Zinn, his critique of the safeguard proposals only five days prior to the technical conference's opening revealed to American scientists that the United States did not have a comprehensive plan it could confidently defend. In order to have something concrete to present to the technical conference, Zinn and others met in closed hotel rooms, usually at night, to thrash out a new American proposal for safeguarding the fuel cycle.[21] They discussed various means of tagging or "spiking" fissionable materials with an energetic gamma emitter so that the flow of nuclear fuel could be tracked through both the fabrication and reprocessing steps. The advantage of using an energetic gamma emitter over other tracing elements was that it would be almost impossible to shield the tagged fuel from detection. The American scheme, conceived in a Geneva hotel room, would use uranium-232, which decayed with the emission of a sufficiently "hard" gamma ray so that instruments, rather than personal search, might insure that what passed into the system eventually returned.[22]

GENEVA SAFEGUARD CONFERENCE

On August 22, 1955, the opening day of the technical conference, Rabi was tired, a little irritable, and perhaps somewhat anxious. In preliminary discussions, Rabi had not succeeded in convincing the British of the need for infallible controls, nor was he certain that the British would support the tracer idea.[23] Indeed, the American proposal was so novel that when Dmitrii V. Skobel'tsyn, head of the Russian delegation, first learned of it on the morning of August 22 he was unfamiliar with the decay chain of uranium-232. Incredibly, the United States proposal would receive its first systematic analysis during the course of the six-nation conference.[24]

The American position presented by Rabi described a system of physical security supplemented by accounting procedures and detailed knowledge of plant configuration and operation. Although Rabi admitted it was extremely difficult to account for all material within a given site at a given time, a properly designed system would prevent unauthorized materials from entering or escaping the site. In the Americans' opinion, accounting systems were essentially supplementary; therefore, the tagging scheme was not intended to assist quantitative control but to facilitate security at a control point.[25]

Throughout the five-day conference, Skobel'tsyn pressed Rabi for details and concrete examples of how the American system, and especially the tagging idea, would work. The Russians' most aggressive questioning focused on the "dead period" in the decay chain of uranium-232. Skobel'tsyn noted that neither uranium-232 nor its daughter element thorium-228 are hard gamma emitters; not until the decay chain reached radium-224 would a sufficiently energetic gamma be released. Thus, if the thorium were removed by chemical separation, the marker would disappear for a considerable time. Although the Russians did not flatly reject the American idea, Skobel'tsyn was clearly skeptical that "spiking" would materially advance safeguard procedures. The main difficulty with the American proposals, Skobel'tsyn intimated, was that they relied too heavily on physical security

(and consequently inspection) without providing effective quantitative controls for nuclear materials.[26]

The Russians were also disturbed by the fact that the American proposals were comparatively short range. In his opening remarks, Rabi stated that the intention of the safeguards was "to prevent diversion of sufficient amounts of nuclear material to constitute a hazard to world peace within a reasonable time, such as ten years." Skobel'tsyn questioned Rabi closely as to what the United States meant by this ten-year forecast. Rabi replied, somewhat vaguely, that the United States could not predict what technical developments might take place over the subsequent decade. In any system of inspection and control, Rabi admitted, there was always a possibility, because all human effort is fallible, of some sort of diversion. The United States sought a period of reasonable assurance, Rabi explained. "Ten years, it seemed to us, was a nice round number. . . . Clearly, one year is too short and one hundred years too long."[27]

SAFEGUARDS REEVALUATED

If the peaceful uses conference had been a brilliant success, the discussions of safeguards proved something of a disaster. On their return from Geneva the Americans realized they no longer had an adequate safeguard policy. Smith candidly noted that the United States government had only a limited appreciation of the safeguard issue. The technology discussed at Geneva was, after all, common to both military and peaceful uses. As nations developed independent competence in nuclear power generation, they also became potential producers of atomic weapons; Smith emphasized that the Administration had not yet squarely confronted this major security problem.[28]

Although Smith had not entirely given up on the "spiking" technique, he observed that the talks had compelled the United States "to consider a number of difficult technical problems which will have to be solved if U.S. participation in an international atomic energy agency is to be consistent with U.S. security."[29] It was the first hint from the Department of State that United States membership in the international agency depended upon a successful technical solution to the safeguard problem. Indeed, Smith was even convinced that the safeguard issue should be resolved before the United States supported the construction of any nuclear power plants abroad on a bilateral basis. The next step, Smith recommended, should be an engineering study that developed the United States' technical control plan in greater detail.[30]

As Smith advised Dulles, Rabi had already suggested such an engineering study to Strauss. Rabi had returned from the safeguard conference no less shaken than Smith. Although he continued to believe that the American policy based on physical security supplemented by accounting procedures was feasible, Rabi stated that more data were necessary to make the American position secure. With W. Kenneth Davis, he bluntly informed Strauss that it was a matter of highest priority for the Commission to sponsor scientific and engineering studies on safeguard techniques before another such conference was held.[31] The Russians had been nit-picking, almost inquisitorially, Rabi felt, and had steadfastly refused to offer a safeguard proposal of their own. Still, the talks had been surprisingly free of politics; the Russians were especially careful to avoid any direct conflict so that the door would be left open for later agreement. In retrospect, both the United States and the Soviet Union had been unprepared for serious technical discussions.[32]

Despite inadequate technical planning, Rabi was confident in the strength of the American position—in terms of both the United States' near-monopoly of enriched materials and its ability to lend technological assistance. Unless the United States established firm controls to begin with, the situation would "shortly get out of control," Rabi predicted. Furthermore, he was confident that the United States and the Soviet Union shared a community of interest. Thus, he agreed with Smith that further planning for the international agency required technical engineering study by the Commission, accompanied by parallel political study on the feasibility of controlling diversion.[33]

For the engineering study, the Commission asked the Vitro Corporation to analyze the technical and economic limits of safeguard controls, to evaluate control techniques, and to recommend the best procedures to the Commission. Libby, who claimed credit for the "spiking" idea, was particularly anxious that the Vitro study be completed in time to assist American negotiators at the working conference drafting the international agency statute.[34] Unfortunately, the final Vitro report in September 1956 offered the Commission little technical comfort. Even with a 90 percent probability of detecting unauthorized diversion of nuclear materials, Vitro estimated that within five years it would be possible to divert sufficient plutonium from a power reactor to build an atomic bomb. From a technical perspective, Vitro's conclusions questioned "the feasibility of any control scheme except for the initial years of operation."[35]

It became more and more apparent to both the Commission and the State Department that solutions would have to be political and diplomatic as well as technological. At the request of the Commission, the general manager appointed a broadly representative special task force to delineate policy issues relating to power reactor development at home and abroad. The task force subsequently reported that there was a "grave military problem inescapably bound up with the advancement of the atoms-for-peace program," especially as it related to building power reactors in foreign countries. The task force virtually conceded that any large or rich nation with sufficient commitment could eventually build a nuclear arsenal. More shocking was the conclusion, which the Russians had warned of all along, that Atoms for Peace might actually contribute to the proliferation of nuclear weapons among underdeveloped or small countries.[36]

Among its findings the Commission's task force concluded in December 1955 that the National Security Council's policy on safeguards was deficient in several respects. The National Security Council, anxious to woo potential customers away from the less restrictive Soviet Union or United Kingdom, had not examined how the United States would prevent the direct diversion of nuclear materials from power reactors. Furthermore, the council had failed to realize that direct diversion was not the most important source of a weapon potential. Rather, the task force noted, large quantities of fissionable material could be obtained from a blanket of readily available natural uranium or thorium that could capture neutrons escaping from the reactor core. Anticipating the Vitro study, the task force also doubted that the United States could achieve absolute protection against diversion. Even maximum assurance could be obtained only with an intensive and complete inspection system that included access to "*all* facilities, areas, and records of the country, and rights of unlimited aerial photography."[37] Obviously, such a safeguard system would entail an unprecedented infringement upon governmental, industrial, and personal privacy, unacceptable to both the United States and other countries.

In stark terms, the task force outlined the dimensions of the diversion problem. It was unlikely that fuel rods limited in enrichment to 10 percent would be diverted directly to weapon production. Rather, direct diversion would likely involve plutonium generated either in the fuel rods or more subtly in a blanket of natural uranium. If a foreign power reactor generated 100 megawatts of electric power, roughly 100 kilograms of plutonium could be produced each year. The most stringent controls involving round-the-clock surveillance of the facility would be required to prevent the diversion of 15 to 20 percent of the plutonium produced, enough to build several nuclear bombs per year. In order to monitor a moderate-sized chemical plant employing two hundred workers on a twenty-four-hour shift, the staff estimated a full-time force of forty inspectors would be required. But even then the task force conceded "that a practical control system which accounts completely for all fissionable materials cannot be devised."[38]

Despite its pessimism about the feasibility of safeguard systems, the task force did not regard diversion of special nuclear materials as the most serious danger of proliferation. By far the greatest threat to international security resulting from the Atoms-for-Peace program came from training nuclear scientists and engineers in reactor construction and operation and in the technology of plutonium separation. Likewise, engineers and reactor technicians trained in nuclear power plants could be diverted to the construction and operation of plutonium production reactors using natural uranium.[39]

THE RISKS OF ATOMS FOR PEACE

Ironically, the Atoms-for-Peace program, designed originally to circumvent the stalled disarmament talks, now confronted the old problems of inspection and control. The Russians, of course, had argued all along that Atoms-for-Peace discussions could not be conducted separately from disarmament considerations. The Americans, however, had assumed that peaceful development of atomic energy need not wait on disarmament because safeguards could be established to protect against nuclear proliferation. In the wake of the safeguard conference, when the Russians had finally abandoned their insistence on linking disarmament and peaceful uses negotiations, American officials admitted to themselves that the two issues were more closely related than they had earlier supposed. A basic difference, as Smith pointed out, was that safeguarding disarmament required universal control over international atomic energy programs, while detecting diversion from peaceful activities demanded, to a degree, less comprehensive measures.[40] But the tasks were similar, the chances of success were about the same, and the risks incurred differed only in magnitude.

Given the Commission's awareness in fall 1955 that atoms for peace could also provide atoms for war, did no one express serious reservations about the President's program? Actually John Hall met the question head-on: "In these circumstances, should the U.S. withdraw from its announced intention of furthering atoms-for-peace throughout the world?" The answer was clearly, "No!" The reasons given were not confined to the fact that a retreat from Eisenhower's offer would involve a serious loss of face for the President. Rather, withdrawal by the United States, according to the report, would merely leave the field open to the Soviet Union, the United Kingdom, and perhaps Canada, causing the United States to default on its political and economic advantages while watching the danger arise anyway. The problem, as defined at this time, was not how to abandon the goals set forth by the President before the United Nations but how to devise a way of achieving them that minimized the proliferation of nuclear weapons throughout the world.[41]

In December 1955, with Hall and Smith unable to resolve all differences of opinion, the Commission formally debated the safeguard issue. In view of the uncertainties, Libby inquired, was the United States firmly committed to "atomic foreign power?" Strauss thought "committed" was too strong a word; rather, the United States was "dedicated" to the worldwide use of atomic energy, carefully safeguarded. Should adequate safeguards prove impractical, the entire program would have to be restudied, the chairman believed. That was just the point, Libby asserted. "You see, sir, I rather think we are in that position."[42] For Libby, it was clear that even if a "perfect" safeguard system could be devised, it would be too expensive to be practical. He concluded, therefore, that the Commission should not delude itself by pursuing such an impossible goal.

Commissioner John von Neumann believed that international inspection and control should be administered by the international agency so that the onus of enforcement would not fall on the United States. Libby agreed and further suggested that inspections required under United States bilateral power cooperation agreements be conducted by the agency. Apparently believing that inspections were inconsequential anyway, Libby was inclined to rely upon atmospheric detection of weapon testing as the primary means of determining whether a nation was developing nuclear weapons. The Commissioners discussed at length the difficulties of conducting broad and elaborate inspections, as well as the problems of administering such an inspection system and insuring its long-term success. Von Neumann, supported by several staff members, even wondered about the practical wisdom of expecting the agency to fulfill these functions. Having called into question the United States' safeguard policy, the Commission decided to bring the matter to the President's attention rather than to proceed with further attempts to reach agreement with the State Department. To this end, Strauss suggested that Hall prepare a study outlining the major questions that should be presented to Eisenhower.[43]

In response, Hall noted that safeguards had not even been a major issue just six months before. He outlined options short of canceling the Atoms-for-Peace program. First, Hall insisted that the United States pursue a consistent safeguard policy in considering the international agency and bilateral cooperation agreements. If the United States and other "have" countries freely entered into bilateral arrangements in competition not only with each other but also with the international agency, the prospects of the agency's playing a major role as supplier of fissionable materials were remote. This difficulty could only be removed if to some extent all subsequent cooperation agreements were brought under the aegis of the international agency. To be effective, however, control required consensus among the "haves" that some measure of inspection was required in any agreement to supply nuclear materials.

Thereafter, Hall reviewed the political difficulties in establishing a control system. It would be hard to convince recipient nations to accept control and inspection in any form, especially if the supplying countries were not subject to similar controls. Because the efficacy of any system of control would have limited duration, a double standard between "have" and formerly "have-not" nations would be untenable within a decade. But, Hall emphasized, the bargaining position of the "haves" was at its maximum in 1956. If the nuclear powers formed a united front by insisting on controls as a prerequisite of assistance in any form, the "have-nots" might be willing to accept them. Moreover, a worldwide control system might be welcomed by nonnuclear powers as insurance against an atomic arms race with their neighbors. Although any inspection system would involve some sacrifice of national sovereignty, recipient nations were far more likely to accept examination by personnel of an agency of which they were members than they were to submit to inspection by a major power.[44]

How much control would be required, of course, was the salient issue. Hall thought it impossible for the international agency to require maximum assurance; that is, nations must pledge not to engage in the production of nuclear weapons, and they must permit large numbers of inspectors to go anywhere at any time to assure themselves that forbidden activity was not occurring. More practically, he speculated that the agency could require participating countries not to produce nuclear weapons or to engage in "sensitive" operations, and to allow intensive inspection of other areas for purposes of spot checking.[45]

The Commissioners generally agreed with Hall's analysis. They were now willing to take "a calculated risk" by providing nuclear materials for reallocation by the agency. Reemphasizing the expense of a comprehensive system, Libby was willing to compromise on an inspection system that might not be completely diversion-proof. In order to achieve the Commission's goal of installing one million kilowatts of power reactor capacity in foreign countries by the early 1960s, certain risks would have to be taken.[46]

The risks, however, were uncertain and incalculable at this time. In January 1956 the Commission was confident that it had auspiciously and safely launched the President's Atoms-for-Peace program as a major, positive element in United States foreign policy. At the State Department, Smith conceded that the Atoms-for-Peace program had been successful psychologically, but he warned that the Commission had also created expectations about nuclear power and American assistance that would be hard to realize. Although American firms were already announcing plans for substantial nuclear power facilities, including an 11,000-kilowatt reactor that Westinghouse was scheduled to build for the Brussels World's Fair, Smith predicted that unfavorable economics would slow the pace of nuclear power development. Given the serious problems of safety, security, and the availability of nuclear fuel, which would take some time to solve, Smith believed the economic disincentives were fortuitous. "For most countries," he noted, "right now training is the most important assistance."[47]

EURATOM—THE GRAND DESIGN

 The time and attention devoted to the numerous bilateral cooperation agreements and to international cooperation and control through the International Atomic Energy Agency, however, did not reveal the main thrust of America's peaceful atomic diplomacy. In fact, under direction from President Eisenhower, the United States placed its greatest support behind EURATOM, the European Atomic Energy Community embracing France, West Germany, Italy, the Netherlands, Belgium, and Luxembourg. As envisioned in 1956, EURATOM would develop an atomic energy industry similar to the European Coal and Steel Community. Although EURATOM would finance and coordinate research and development, it was primarily designed to promote generation of electrical power for industrial uses. With European coal production on the decline and the best hydroelectric sites already exploited, in the long run nuclear energy seemed to offer Europe its only indigenous source of industrial power.[48] Even that 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.

Officially, the United States continued to support all approaches related to the international development of the peaceful atom—the international agency and bilaterals as well as the Organization of European Economic Cooperation (OEEC) and other regional associations—but under directions from President Eisenhower the major attention was given to EURATOM.[49] The President's determination to give EURATOM priority created severe strain between the Commission and the State Department throughout 1956 and gave credence to the charges that the Commission was "dragging its feet" on implementing Atoms for Peace.

On January 25, 1956, Dulles explained to the Commissioners the political factors underlying the President's desire, and incidentally his own, to promote European integration in the peaceful uses of atomic energy through the EURATOM approach. Eisenhower firmly believed that the unification of Europe along the lines of the North Atlantic Treaty Organization, the Brussels Pact, and the Coal and Steel Community was a prerequisite to a stable Western alliance and world peace. With the collapse of the European Defense Community, Eisenhower hoped to draw France and Germany together into a strong bulwark against the Soviet Union by giving American support to EURATOM. Additionally, Eisenhower thought EURATOM might well catch the imagination of the West Germans. Once European skills, resources, and purposes were channeled through EURATOM, the "burden of Europe" could be lifted from the "back of the United States" even if the United Kingdom did not participate in the European pool. According to Dulles, Eisenhower had first given "eloquent expression" to his vision of European unification in a speech to the English Speaking Union at London in 1951.[50] By 1956, only the Community of Six offered promise of opening the way to a genuine United States of Europe. If EURATOM succeeded, Dulles continued, the community could then proceed to other fields of activity. But if it failed, the integration movement itself would probably fall apart with little hope that it could be reconstituted, a possibility that presented a bleak outlook for the future.[51]

Dulles emphasized that the Atomic Energy Commission bore the responsibility for handling the technical aspects of the Atoms-for-Peace program, but in view of the McKinney report he also wanted the Commission to study the proposals in the broadest perspective. Anticipating legal and other objections from the Commission, Dulles asked the Commissioners not to think in terms of existing laws, regulations, or inhibitions but rather to define in maximum terms what lay within the realm of possibility. He reminded the Commissioners that if the Atomic Energy Act turned out to impede American support of EURATOM, then the law could be amended. In any event, because Congress supported European integration more vigorously than the Executive Branch itself, Dulles was confident Congress would approve a sound and prudent program sponsored by the Atomic Energy Commission. Livingston Merchant, Assistant Secretary of State for European Affairs, punctuated the Secretary's remarks by concluding that the Europeans were evidently determined to achieve atomic independence with or without the help of the United States. In that sense, American assistance to the Europeans was a wasting asset that bureaucratic dawdling could fritter away.[52]

THE COMMISSION DISSENTS

Dulles's remarks were undoubtedly aimed directly at Lewis Strauss as well as the Commission. The Secretary's atomic energy advisers, principally

Smith, believed that Strauss was not fully sympathetic to the Administration's EURATOM policy. Although no one within the Administration publicly accused Strauss of thwarting the program, Smith and others were frustrated over the United States' failure to exploit fully its leadership in atomic energy affairs because the Department of State and the Commission had not spoken with one voice. How could Europeans or the American public know what the United States wanted when the State Department pressed for a supranational organization of atomic energy programs in Europe while the Atomic Energy Commission simultaneously encouraged the same European nations to come forward for bilateral negotiations?[53] Indeed, initial discussions of EURATOM at the Commission had raised the question of whether the United States could execute an agreement for cooperation with a group of European nations under Section 124 of the Atomic Energy Act. Obviously, such confusion provided ideal fuel for the political fires lit by the McKinney panel report and ultimately fanned by Anderson and Kefauver.[54]

In reply to Dulles, Strauss was forthright in stating the Commission's reservations about EURATOM. The Commission had already expressed considerable willingness to compromise on the safeguard issue, at least with respect to the proposed International Atomic Energy Agency. The Commission's comparative flexibility on the international agency had enabled the State Department to plan for the twelve-nation working conference—now including the Soviet Union, Czechoslovakia, India, and Brazil—scheduled to convene in Washington on February 27, 1956, to consider the latest draft statute of the International Atomic Energy Agency.

Strauss, however, was troubled that the United States by treaty would have to supply special nuclear material and technology to an entity that would not be a member of the international agency. More than likely, Strauss believed, an agreement with EURATOM would provide for transfer of classified information as well as nuclear materials. Under existing laws and regulations, the Commission had been unable to execute a power bilateral with France because French security procedures did not meet American standards. In negotiating a security agreement with EURATOM, Strauss observed, the United States might find that the Europeans insisted upon restrictions no greater than those acceptable to the French. Furthermore, to counter Dulles's veiled criticism, Strauss reported that the Commission objected to any "foot dragging" in the handling of the bilateral negotiations, but he assured Dulles he would cooperate with the State Department "to the hilt" within the legal limit.[55] With Eisenhower's directive backing him up, however, Dulles reiterated his request to the Commission that it not now concern itself with legal problems in order to consider all suggestions for United States cooperation, leaving for subsequent determination any decisions concerning what was safe, prudent, and lawful for the United States.[56]

Ironically, it became more and more difficult to distinguish "hardliners" from "softliners" on the safeguards and control issue. The Commission had been toughest on its stand concerning EURATOM given the likelihood that the industrialized nations, especially France, would obtain technical information that would directly aid weapon programs. Surprisingly, the Commission was not nearly so nervous about the International Atomic Energy Agency, no doubt because the agency would provide no competition, either commercially or militarily, to the United States. At a high-level meeting including Dulles and Strauss on February 3, Smith stated that the United States faced two basic policy choices concerning the international agency: whether to maintain limited controls designed to prevent diversion of nuclear materials for military purposes or whether to proscribe "fourth countries" from developing nuclear weapons. Strauss quickly responded that in the Commission's view, the international agency should require only minimum controls. The so-called "no-weapons pledge" that Smith sought would not be feasible, particularly because France would not accept it. More to the point, perhaps, Strauss observed that the United States would not accept sufficiently strict inspection and control of its own programs to satisfy prudent requirements for safeguards abroad.[57]

Arguing for strict controls, Harold E. Stassen, special assistant to the President on disarmament, believed the United States should try to prevent or retard the development of nuclear weapons in "fourth countries." From Stassen's perspective, the Americans should sponsor a comprehensive control system and let the Soviet Union bear the onus of rejection. In addition, Smith pointed out that the minimum controls advocated by the Commission might simply allow recipient nations to pursue peaceful uses with resources of the international agency while developing nuclear weapons of their own. In return for the "no-weapons pledge," Smith suggested that the United States should promise not to use plutonium recovered from foreign power reactors for military purposes.

Dulles, however, in support of Strauss, stated that it would be difficult to convince nations to forego permanently their right to build nuclear weapons while the United States, the Soviet Union, and the United Kingdom continued to make them. Furthermore, he was convinced that countries would not join the international agency if they were required to commit themselves to forego nuclear weapons for all time. The best the United States could do, Dulles thought, was to ask participating countries, as a matter of self-denial, not to complicate nuclear disarmament negotiations by manufacturing atomic weapons while the great powers tried to bring their own stockpiles under control.[58] Essentially, Dulles supported the Commission's position on safeguards, which required high reliance on the integrity of the nations participating in the international agency not to engage in clandestine nuclear weapon development. In order to exploit America's "wasting asset" of nuclear technology while its bargaining position was relatively strong and to fulfill the President's unswerving determination to find a peaceful alternative to the military atom, there seemed no choice but to plunge ahead with the Atoms-for-Peace program.

Toward this end, Eisenhower in February 1956 agreed to a second allocation of 20,000 kilograms of uranium-235, this time for foreign distribution.[59] The purpose was to implement the bilateral agreements, but the allocation also provided the President an opportunity to endorse both the international agency and EURATOM. Yet even as the Administration took steps to accelerate its promotion of international nuclear power, the Commission warned Eisenhower of the proliferation dangers inherent in the Atoms-for-Peace program. In a forceful letter written just two days before the public announcement of the allocation, Strauss expressed the Commission's apprehension. "The Commission wishes to point out," he wrote the President on February 20, "that the transfer of U-235 abroad and the subsequent production of fissionable material in power reactors increases the possibility of the development of weapon potential by those who receive our assistance." Nevertheless, having discharged its duty to warn the President, the Commission also expressed its determination to require "as a minimum, assurances and guarantees against diversion to other than peaceful uses."[60]

Reluctantly, the Commission fell in behind the Administration's policy as ordered by the President and the Secretary of State, who would assume leadership in formulating Eisenhower's nuclear foreign policy during the forthcoming election campaign. Although Strauss still functioned as the President's special adviser on atomic energy, Strauss, after EURATOM became a cornerstone of Eisenhower's grand design for a United States of Europe, increasingly relayed only technical and administrative assistance offered by the Commission. Even after the President had allocated 20,000 kilograms of uranium-235 for foreign power and research programs, Strauss, speaking for the Commission, insisted on two caveats: first, the Commission was not committed to specific programs such as EURATOM without additional discussion with the State Department, because, second, the Commission doubted that all proposals conformed with the Atomic Energy Act and National Security Council directives.[61]

When Eisenhower presented his Atoms-for-Peace proposals to the United Nations on December 8, 1953, he had prefaced his remarks with the observation that the world lived under the threat of nuclear danger—"a danger shared by all." The peaceful atom pointed the way "out of the dark chamber of horrors into the light . . . by which the minds of men, the hopes of men, the souls of men everywhere, can move forward toward peace and happiness and well being."[62] As he reflected on the world's collective hopes and fears for atomic energy, even Eisenhower could not have known just how prophetic he would be in his warning of universal dangers from atomic energy. In the aftermath of the *Castle-Bravo* shot, even as the President vigorously championed his Atoms-for-Peace program, the specter of global contamination from radioactive fallout revealed still another peril in the nuclear chamber of horrors from which Eisenhower sought escape. The light, toward which the President resolutely strode, was shadowed by an ominous radioactive cloud.