A History of the United States Atomic Energy Commission

Volume II
1947/1952

Atomic Shield

Richard G. Hewlett / Francis Duncan

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CONTENTS

FOREWORD BY THE CHAIRMAN, HISTORICAL ADVISORY COMMITTEE

We, the members of the Historical Advisory Committee of the United States Atomic Energy Commission, have read this volume with pleasure and profit. We have not examined in detail the massive documentation on which the authors' narrative and judgments are based, and we do not as individuals or as a body attempt to add any authority to the ideas herein expressed. But we have followed the book in its making. Most of us met with the authors in six conferences during which we discussed at length the moot points concerning substantive information and interpretation. We are convinced that the authors have written as responsible and informed historians—that they have enjoyed access to virtually all of the pertinent materials and have said what they have wished to say without guidance or restraint from the Commission, save in matters which touched on national security. In a few instances beyond the jurisdiction of the Commission, the authors have not had access to all relevant materials. Where denial of access stems from considerations other than those of a present security danger we as historians regret the policy of withholding information, but we feel that the instances have not been numerous enough to affect severely an otherwise excellent study. Incomplete access to all of the relevant materials is one of the costs of writing history soon after the events, but there would be a much heavier cost in loss of information should the authors have left the task to a later generation. We heartily endorse their decision to go on with the job now and applaud the success with which they have followed that course.

George E. Mowry, Chairman

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* Succeeded Dr. James P. Baxter, 3rd, as chairman in July, 1967.

PREFACE

Atomic Shield, the second volume in a historical series, begins in January, 1947, when the Commission assumed responsibility for the nation's atomic energy program; it ends with the detonation of the first thermonuclear device and the Presidential election in November, 1952. Thus it covers in a political sense most of the Truman Administration and in the international realm the chaotic years of the Marshall Plan, the Berlin blockade, and the Korean War.

In 1947 the nation's atomic energy establishment amounted to little more than the remnants of the military organization and facilities which had produced the world's first atomic weapons. By the end of 1952 the Commission's domain included an arsenal of nuclear weapons, a refurbished and greatly enlarged complex of research and production facilities, and a dozen experimental or research reactors. Even more significant, the Commission's activities were no longer completely isolated from the rest of American life, as had been the work of the Manhattan project during World War II. By 1952 hundreds of nuclear scientists were receiving financial support from the Commission for research in their own laboratories, and private industry was beginning to take an active part in developing nuclear power. The Commission itself was no longer unique among Government agencies in terms of its independence and special status; it was becoming an integral part of the Executive Branch.

Our task—to explain how this transformation occurred—proved more difficult than the one faced in Volume I. In place of a concentrated effort focused on a single goal, we were confronted by a variety of complex forces, by a rapidly expanding and evolving program which was documented by a mass of records several times that available for Volume I. Although we felt a temptation to adopt a topical and analytical approach, which several of our advisers urged upon us, we rejected this form of organization in favor of

the narrative, chronological style of Volume I. A string of loosely joined essays would have been easier to write, but we thought it our duty as historians to attempt a more fundamental synthesis. We are content to stand on the position set forth in the Preface to Volume I: "Whatever the subject, whatever the essential significance of the event, whether and how we relate that event depends on its relevance to the central perspective. We think this criterion makes for good history. Indeed, the complex interrelationships of modern science, industry, and government make it impossible to take any other approach if history is to be kept within reasonable bounds."

The central perspective of Volume II was clearly to be that of the five Commissioners, but it was more difficult to define the unifying theme of a book encompassing a spectrum of subjects from radiation genetics to cost accounting and from community management to foreign policy. No one theme could bridge all these topics, but we soon detected in the documents

a strong undercurrent of development around which most of our material could be organized. This central idea was the inexorable shift in the Commission's aims from the idealistic, hopeful anticipation of the peaceful atom to the grim realization that for reasons of national security atomic energy would have to continue to bear the image of war. Hence our title, *Atomic Shield*, a phrase used by scientists, military leaders, and the Commissioners themselves to justify, or perhaps to rationalize, the nation's expanding nuclear arsenal.

In selecting the title *Atomic Shield*, we do not mean to suggest a definitive interpretation of the post-World War II period of American history. Not enough time has passed for that. But we do believe our title reflects a common perspective shared by American leaders during those years and that it will help the reader to perceive the broad currents of historical change running through our narrative.

In organizing our chapters we tried to weave as many topics as possible into a single strand of narrative. The first three chapters are essentially one chronological account covering all aspects of the Commission's activities during the first half of 1947. Chapter 4 continues that thread through 1947 for all topics except weapon development and the production of fissionable materials, which are the theme of Chapters 5 and 6. The wide range of research and development supported by the Commission is similarly handled in chronological arrangement in Chapters 7 and 8. Chapters 9 and 10 stand by themselves as a history of international developments in atomic energy down to early 1950. Efforts at international control in the following three years were so unproductive that we chose to leave that subject for summary in a later volume. Chapter 11, describing the Commission's administrative activities down to the middle of 1949, completes our presentation of the Commission's first thirty months in power.

We early detected a clean break in most of the threads of historical development in the summer of 1949. The Hickenlooper hearings and the

first Soviet nuclear detonation mark the beginning of the end of the Lilienthal era, during which military requirements progressively overshadowed the nation's initial hopes for the peaceful development of atomic energy. Chapters 12 and 13 cover the transition period from September, 1949, to June, 1950, beginning with the debate over development of a thermonuclear weapon, following events accompanying Lilienthal's resignation, and ending with the outbreak of the Korean War. Chapter 14 describes the new Commission under Gordon Dean's chairmanship and administrative developments in the later period, as did Chapter 11 for the earlier years. Chapter 15 likewise continues the story of research and development from the ends of Chapters 7 and 8. Reflecting the Commission's ever-increasing stress upon weapon development and the expansion of production facilities after 1950, Chapters 16 through 18 follow that theme in one chronological narrative to the end of 1952.

For our research we were granted complete access to all records in the files of the Commission and its contractors. Never was our access questioned, and in several instances the Commission's staff took the special action necessary to open for us records which had been sealed since the time of their creation. Most other Government organizations were equally cooperative. Neither at any time did the Commission require us to revise, delete, or change the interpretation of our manuscript, except for classified information which would adversely affect the national security.

This exception, however, is an important one and deserves special comment. The restrictions of classification have unavoidably blemished our work on some topics, mainly on those related to the production of fissionable materials and the design and production of nuclear weapons. Throughout the book our descriptions of the debates over weapon requirements lack the specific numbers needed for a full evaluation of these decisions. We ourselves have seen all the evidence and we have done our best to make our narrative as clear and accurate as possible within the limits of classification. We believe that even with these deletions our narrative accurately portrays the context of decisions; all the important factors in decisions have been explained or at least hinted at.

The most troubling deletions come in sections describing weapon development. Here again we think our narrative is not misleading, but the deletions and glossing over of details blunts the truth and fails to present the best case for the individuals involved. The best example of this problem is our description of the development of the thermonuclear weapon. Classification did not permit us to convey accurately the fundamental differences between the "Super" and the "New Super" (the latter a term we were obliged to coin to conceal the true name, which is still classified). Nor have we been able to tell all of the fascinating story of how new ideas evolved at Los Alamos in early 1951 to create the "New Super." We have studied at great length the contributions of Stanislaw Ulam and Edward Teller to this

achievement, but we know that the unclassified version in Chapter 16 does not contain the evidence to support our conclusions. In this respect we have not given proper credit to either man. This is the price the historian of recent events must pay, but we believe that our own truncated version is better than nothing at all. It may still be decades before all the important facts become public knowledge; in the meantime the American people are entitled to all the information that can be released on these vital decisions.

After six years of research and writing it is almost impossible for us to acknowledge the assistance and encouragement of all those who have eased our task, but we wish to thank individually those whose efforts clearly have gone beyond their official or professional duties. First we express our gratitude to the members of the historical advisory committee, whose names appear in the foreword. Serving without compensation, they have patiently endured arduous trips, long meetings, and many hours of reading and criticizing the

manuscript. For any remaining errors we alone are responsible, but for some of the better qualities of the book they deserve credit. We wish especially to express our appreciation to James P. Baxter, 3rd, president emeritus of Williams College and for a decade chairman of the advisory committee. As much as any other man, he was the first sponsor of this historical series. George E. Mowry, our present chairman, has admirably carried on the task of explaining the needs and purposes of the historian to Government officials.

During these six years the members of the Atomic Energy Commission not only took an interest in our work but also stood firm on the principle that the historian should have complete freedom to draw his own conclusions. We are grateful to Mary I. Bunting, Leland J. Haworth, Wilfrid E. Johnson, John G. Palfrey, James T. Ramey, and Gerald F. Tape, who as Commissioners during these years gave us the support we needed. We are especially indebted to Glenn T. Seaborg, who served as chairman of the Commission during the entire period of preparation of this book. His sense of history and his commitment to the value of historical research provided the kind of stimulus that few Government historians have experienced. We must also acknowledge our continuing debt to Woodford B. McCool, Secretary to the Commission, who established this project within his staff in 1957. Under his wing we have been able to do our work with exceptional freedom, not only from administrative restraints but also from pressing current assignments which he might have asked us to undertake.

We express our personal thanks to the members of our own staff who performed many of the tedious but important tasks of historical research. Among our research assistants, Ellen A. Thro, Millicent H. Brandenburg, and Joanna S. Zangrando assisted us on the early chapters. Alice L. Buck and John V. Flynn bore the brunt of our demands for the second half of the volume. Betty J. Wise typed the entire manuscript in more than a few drafts and checked editorial style and references. Without the skill, loyalty, and teamwork of these people our task would have been overwhelming.

Surely no historians have received greater cooperation from their associates than have we from the Commission's headquarters staff. From Robert E. Hollingsworth, the general manager, to messengers in the mail room, literally scores of Commission employees have followed with interest the progress of our work and, to meet our special needs, have done more than we could expect. At the risk of offending those we cannot mention, we express our thanks to those who took many hours from their other work to hunt for documents and references in the Commission's files: Carol Alexander, Velma E. Early, Opal L. Kirschman, Lester C. Koogle, Jr., Ulysses Marshall, James D. Nuse, Andrew J. O'Neill, Mary G. Thomas, Lillie B. Turner, Severina M. Tuttle, and Margaret N. Young. Charles F. Knesel, Robert L. Morgan, and Murray L. Nash helped us with classification problems. Helen Anderson prepared some of the line drawings. Morris Coles and Joseph G. Gratton handled publication arrangements. Elton P. Lord and James E. Westcott assisted with photographs.

In writing the history of an agency as decentralized as the Atomic Energy Commission, we found research in the field essential. There we could rely on the expert knowledge and cooperation of both Commission and contractor personnel: at Albuquerque Operations and the Los Alamos Office, Marjorie Allen, Richard G. Elliott, Lillie J. McConnell, and Lola W. Sissel; at Argonne National Laboratory, John H. Martens and E. Newman Pettitt; at Brookhaven National Laboratory, Marriette K. Kuper; at Idaho Operations, Mack C. Corbett and William L. Ginkel; at the Lawrence Radiation Laboratory, Eleanor Davisson, Harold A. Fidler, and Daniel M. Wilkes; at Los Alamos Scientific Laboratory, David A. Heimbach, Robert D. Krohn, Pat M. McAndrew, Gilbert R. Ortiz, and William H. Regan; at Oak Ridge Operations, Floyd F. Beets, Jr., James R. Langley, and Herman M. Roth; at Oak Ridge National Laboratory, Nathaniel T. Bray and Florence H. Evans; at Richland Operations, Ralph V. Button and Milton R. Cydell; and at Savannah River Operations, George O. Robinson, Jr.

Employees of other Government agencies were indispensable in finding records for us. We are especially grateful to Thomas E. Hohmann and Wilbur J. Nigh of the National Archives, William M. Franklin and Arthur G. Kogan of the Department of State, Rudolph A. Winnacker of the Department of Defense, Philip C. Brooks of the Harry S. Truman Library, and Ward A. Minge of the Air Force Special Weapons Center.

Hundreds of individuals offered us their personal recollections or private papers. For the use of private papers we wish to thank David E. Lilienthal, John H. Manley, Michael V. Forrestal, and Lewis L. Strauss. The many people who subjected themselves to our questions in interviews are listed in the note on the Sources.

The writing of contemporary history, especially of a large institution such as the Commission, presents unusual difficulties for the historian, but it also offers priceless advantages. The opportunities to talk with people who

participated in historical events, to consult files documenting events to a degree beyond the imagination of previous generations of historians, and to visit the scenes of great accomplishments in the history of science and technology are rewards few historians have enjoyed. Forging the Atomic Shield was a great adventure. We hope our recording of it has captured some of that quality.

Richard G. Hewlett

Francis Duncan

Germantown, Maryland
May, 1969

THE TERRIBLE RESPONSIBILITY

CHAPTER 1

On the last Monday in January, 1947, a noisy crowd of reporters and spectators jammed Hearing Room 312 in the Senate Office Building in Washington. A dozen senators and representatives gathered on the horseshoe-shaped dais at one end of the room. Within the horseshoe stood a tall, balding man in his late forties. He chatted with six or eight of his associates, most of whom looked much younger than he. Exchanging a few pleasantries with the reporters, he tried to ignore the popping flashbulbs which seemed to be concentrated on him and on an elderly senator sitting quietly at the long desk on the left side of the dais.[1]

The chairman, standing under the large gilt mirror behind the center of the desk, banged his gavel for order. As quiet fell, Senator Bourke B. Hickenlooper of Iowa announced that the Senate section of the newly formed Joint Committee on Atomic Energy was meeting to consider President Truman's nominations to the Atomic Energy Commission.[2] The senator sensed something special about the occasion. He spoke of "a pioneering field," of "a new venture." He said the hearings would go on for several days.

The elderly senator to his right roused himself and asked about the schedule for the hearings. Kenneth D. McKellar of Tennessee, a senator since 1917 and until recently president *pro tempore*, glowered across the desk. He hoped, he said, it would be possible for him to attend both these hearings and those being held before the Senate Public Works Committee on the nomination of Gordon R. Clapp to be chairman of the Tennessee Valley Authority. Everyone in the room probably knew why. His interest here was David E. Lilienthal, who had resigned as chairman of TVA to accept a similar position with the new Atomic Energy Commission. A decade earlier Lilienthal had checked McKellar's attempt to exercise his patronage powers within TVA. With a mind warped by age and a smoldering hatred, McKellar was determined to prove a charge which the Dies committee had rejected a decade

earlier: that Lilienthal and Clapp were the nucleus of a large Communist cell in TVA.[3]

Hickenlooper showed proper deference toward his senior colleague. He recognized the senator's right to question the nominee even though the senator was not a member of the committee. He would do his best to accommodate the senator, but he made no promises. For Hickenlooper, this was a moment of personal triumph. Elected to the Senate in 1944, he had won himself a seat on the Special Committee on Atomic Energy in 1945 and had had a prominent role in drafting the Atomic Energy Act of 1946.[4] Now, with Republicans in control of Congress for the first time since 1933, Hickenlooper found himself chairman of one of the most important committees of Congress. He could not afford to bow too deeply to the wishes of the aging Democrat from Tennessee.

Lilienthal leaned forward to catch Hickenlooper's questions. There
2 were the usual biographical data: born in Illinois, educated in Indiana public schools and DePauw University, graduated from Harvard Law School in 1923, practiced law with Donald R. Richberg in Chicago, served as a member of the Public Service Commission of Wisconsin, and appointed to TVA in 1933. His study of the international control of atomic energy in early 1946 had won acclaim as the Acheson-Lilienthal report and had paved the way for his nomination to the Commission.[5] He said he had no scientific or technical background worth mentioning, but he had learned something about technical enterprise at TVA.

Following Hickenlooper's easy pace, Lilienthal helped to move the dialogue into a philosophic vein. He said he believed the Commission's primary responsibility at the moment was to make atomic energy a weapon of war, but the most important fact in his mind was that it could be used either for peaceful purposes or for destruction. The new commission would have in its control a new source of energy with a potential unparalleled in human history. At the risk of sounding a little stuffy, Lilienthal called his "really a terrible responsibility; not only because of the great scope of powers vested, but because errors of judgment, serious errors of judgment, can mean missed opportunity for the people of this country—and even worse." [6]

These dramatic statements led Lilienthal to his main point. Neither the Commission nor the Congress could risk treating atomic energy as just another routine matter. The Commission was bringing to bear on the subject the best minds it could find to serve on both its staff and the several advisory committees it was organizing. Lilienthal did not hesitate to suggest that the Joint Committee take its responsibilities just as seriously.

Lilienthal's technique was obvious but he was using it well. He was flattering the senators and at the same time carefully holding the initiative, a tactic he had found effective in his long experience with Congressional committees. Even when McKellar interrupted with a few questions which attempted to disparage his knowledge of atomic energy, Lilienthal fended

them off like a veteran. Only when Arthur H. Vandenberg joined the discussion did Lilienthal straighten again in his chair. Vandenberg, the new president *pro tempore* and chairman of the Foreign Relations Committee, was not to be dealt with lightly. Just a year earlier, he and Eugene D. Millikin had stepped into the sagging Senate hearings on atomic energy legislation, recast major sections of the bill to their own satisfactions, and then carried the bill through the Senate-House conference.

Now Vandenberg and Millikin seized on the pivot of the legislative debate: the role of the military in the Commission's affairs. Vandenberg asked how often the Commission had consulted with General Leslie R. Groves, who had directed the Army's Manhattan Engineer District until the Commission had taken over on January 1, 1947. Lilienthal admitted that he had not met with Groves since the day of the transfer; but he mentioned frequent discussions with the Military Liaison Committee, which Vandenberg had created by his famous amendment to the atomic energy bill. Millikin probed further. Were members of the committee attending all Commission meetings? Lilienthal was astounded. The idea had never occurred to him and he did not think it practical. The senators disagreed and Vandenberg made the point: ". . . in my opinion it will not be satisfactory if there is anywhere a single closed door to the military liaison or congressional committee. The responsibility is too great." [7]

Vandenberg's declaration punctured Lilienthal's optimism. When the day's session ended, he wondered whether the nominees might be forced eventually to withdraw their names.[8] But, as usual, reflection softened Vandenberg's position. Returning to the subject the next day, he explained that he did not really expect the military group and the Joint Committee to be in "constant attendance," but he believed they should be represented when they thought it necessary. Lilienthal for his part reiterated his conviction that both committees should have all the information they thought necessary. He had been concerned only about the administrative difficulties of meeting the senator's demand of the previous day.

Lilienthal's adroit explanation reassured Vandenberg, who confessed that he had oversimplified the issue. He even went so far as to express the hope that members of the Joint Committee "would never know any of the atomic secrets." [9] Brien McMahon, the enterprising young Democrat who had made his reputation in the Senate as the sponsor of the Atomic Energy Act of 1946, accepted Lilienthal's position, but he was not ready to forego his right to any information he thought he needed as a member of the committee. The discussion drifted off to other topics, but Lilienthal brought it back sharply to the question of security. He stressed the importance of security, and the difficulty of maintaining it in the relaxing atmosphere of peacetime. The Commission's task had been complicated, he said, "by some serious authorized breaches of security."

McMahon did not miss the allusion. Was not Lilienthal referring to

the Smyth report, which the Army had released in 1945 shortly after the attack on Hiroshima? Lilienthal admitted the fact. Who authorized release of the Smyth report? Lilienthal suggested General Groves and "the President, I have no doubt." The barb was directed straight at Groves and the military. Lilienthal was tired of the committee's insinuations that the "secrets of the bomb" were safer with the Army than with a civilian commission. Perhaps in his annoyance he overlooked the fact that the report had been carefully written to release only that information which could not reasonably be held from the public.[10]

The front-page stories the following morning elated Lilienthal. The Commission was beginning to build its public image, something it needed in the national political arena. Unless the public understood the Commission's position and its aims, its accomplishments would be judged against public statements by others, perhaps even by Senator McKellar. Lilienthal regretted
4 that in his testimony he had stepped on some toes. Groves, President James B. Conant of Harvard, under whose direction Smyth had written the report, and many of the scientists were unhappy with Lilienthal's statement. This he had anticipated, but the severity of Conant's displeasure surprised him. A few days later Conant explained his feelings. He told Lilienthal he thought McMahon's question had been a trap laid by such dissenting scientists as Leo Szilard to discredit the wartime leadership of the atomic energy project. Lilienthal was amazed to discover such a deep-seated feud at this level in the organization.[11]

For a few days the spotlight turned away from Lilienthal as the Joint Committee questioned the other nominees. The first was Robert F. Bacher, a 41-year-old nuclear physicist from Cornell University. After performing some early experiments on neutron reactions in 1941, Bacher had joined the radar project at the Massachusetts Institute of Technology. When Robert Oppenheimer established the new weapon laboratory in 1943, Bacher went to Los Alamos as a division director. After the war he had served as a technical adviser to Bernard M. Baruch at the United Nations Atomic Energy Commission and as chairman of the planning committee for the new Brookhaven National Laboratory, which the Commission would build at Upton, Long Island. In the midst of organizing a nuclear physics laboratory at Cornell, Bacher was not eager to accept appointment to the new commission. He did so only out of the conviction that if he did not, there would be no scientist appointed. He reassured the Joint Committee that he appreciated the need for close liaison with the military services and that he was not among the scientists who had protested the adoption of the Vandenberg amendment in 1946.

Lewis L. Strauss, ten years older than Bacher, was experienced in Congressional hearings. Starting his career in his father's shoe business in Virginia, he had had great aspirations. During World War I he offered his services to Herbert C. Hoover in the food relief program, became Hoover's

private secretary, and attended the European peace conferences. Joining the investment firm of Kuhn Loeb in 1919, young Strauss quickly found success on Wall Street. In the late thirties he developed a philanthropic interest in scientific research, particularly in nuclear physics which he hoped would provide a cure for cancer, the disease that had afflicted both his parents. A member of the Naval Reserve since 1925, Strauss began active duty in 1941 in the inspection service. Concentrating on procurement, he became special assistant to Secretary of the Navy James V. Forrestal and left active duty in 1946 as a rear admiral. His nomination to the Commission brought him back to Washington just as he was resuming his financial career. As a Republican, a financier, and an admiral, Strauss had no trouble convincing the Joint Committee of the soundness of his views on the military significance of atomic energy and the importance of cooperation between the civilian and military authorities.[12]

In some ways Sumner T. Pike's background was similar to Strauss's. 5
He too had been a small-town boy who had found success in New York. Although Pike had had the advantages of a college education at Bowdoin, he had largely on his own resources made his way from a small fishing village on the Maine coast to a Wall Street investment firm in 1928. Retiring with a comfortable fortune in 1939, he had come to Washington as a business adviser to the Secretary of Commerce and had served as a member of the Securities and Exchange Commission and the Office of Price Administration during the war. In 1946 he had once again retired briefly to Lubec, Maine, where he lived in a large white frame house filled with shelves of well-read books on a variety of subjects. Pike's business career had given him some practical knowledge of mining and the petroleum industry and some understanding of geology; but he confessed to the Joint Committee that he had no technical or scientific training that would be of much help in the work of the Commission. After three months on the job, Pike said he had less confidence in his understanding of the Commission's function than he had had when he accepted the appointment.

William W. Waymack at fifty-eight was the oldest member of the Commission. Like Pike, he was a son of rural, Republican America. Born and educated in Iowa, he had been editor-in-chief of the Des Moines *Register* and *Tribune* and deputy chairman of the board of the Federal Reserve Bank of Chicago at the time of his appointment to the Commission. His interests in international relations and in agriculture involved him in the activities of many organizations, including the Carnegie Endowment for International Peace. Waymack's membership on that organization's atomic energy committee in 1946 provided Senator John W. Bricker with an opportunity to explore the Government's policy on international control. Waymack patiently explained to the Joint Committee that he supported Baruch's proposals before the United Nations even though they did not agree with the recommendations of the Carnegie report. There were moments when Lilienthal thought Way-

mack was taking unnecessary risks as he discussed controversial policy issues with the senators in his usual open and unassuming way, but he finally concluded his long testimony unscathed.

Carroll L. Wilson was the last nominee to be heard. A graduate of MIT in 1932, he had served as assistant to President Karl T. Compton in administering the institute and in Compton's work as chairman of the Government's Science Advisory Board in the early thirties. Wilson's experience as Compton's assistant on the National Research Council's patent-policy committee had led to his appointment in 1936 as special adviser to Vannevar Bush, who was then vice-president and dean of engineering at MIT. In 1940 Wilson had followed Bush to Washington and had helped him organize the National Defense Research Committee and its successor agency, the Office of Scientific Research and Development. Wilson's activities during World War II had given him little direct contact with atomic energy, but early in 1946 he had served as secretary to the State Department's board of consultants, which prepared the Acheson-Lilienthal report. Later in the year Lilienthal had asked Wilson to help organize the new Atomic Energy Commission, and Wilson had been nominated as general manager on December 30, 1946.

Wilson, who was only thirty-six and looked even younger, could expect the Joint Committee to ask some pointed questions about his experience and qualifications. Hickenlooper established that Wilson considered himself the chief executive officer of the Commission. Wilson said he met regularly with the Commissioners and prepared the agendas for their meetings. He recruited most of the senior staff, although he admitted that the principal appointments were subject to the Commissioners' approval. Wilson was in fact the chief administrator for a large enterprise involving a dozen installations and thousands of employees. Senator Edwin C. Johnson of Colorado asked Wilson if he had ever met a payroll. Wilson said his only experience in private industry had been the eight months he had spent in 1946 as vice-president and financial director of a research corporation with 150 employees.

Public interest in the hearings increased again on Monday, February 3, when both McKellar and Baruch were present. Baruch's testimony was especially important to Lilienthal. Not only did the elder statesman have enormous influence with Congress, but it was common knowledge that Baruch and Lilienthal had clashed in 1946 when Baruch became the United States representative on the United Nations Atomic Energy Commission. Now, however, Lilienthal was on good terms with Baruch. In a long telephone conversation on January 10, Baruch had told Lilienthal of his conversations with senators who intended to vote against Lilienthal's nomination and who seemed to be impressed by Baruch's reassurances.

Baruch's testimony on Monday, February 3, was about what Lilienthal expected. On the positive side, Baruch steadfastly supported Lilienthal as well qualified to be chairman, and adroitly parried the venomous implications of McKellar's questions. But it distressed Lilienthal to hear Baruch's reserva-

tions on complete civilian control of atomic energy, his praise of General Groves, and what Lilienthal considered a staged endorsement of General Thomas F. Farrell for the position of general manager. The final blow to Lilienthal was the committee's decision to remain after the public hearing late in the morning to hear Baruch in executive session. Lilienthal and his fellow Commissioners were pointedly excluded.[13]

Later Lilienthal admitted to his journal that Baruch had been "really helpful," and it was hard to see anything exceptionable in Baruch's remarks about the proper role of the military services in the development of atomic energy. Perhaps Lilienthal's sensitivity on this point had been heightened by discussions with Secretary of War Robert P. Patterson and General Lewis H. Brereton, chairman of the Military Liaison Committee. The Secretary had called Lilienthal late on Friday afternoon to sound out the Commission's reaction to the idea of appointing Groves to the Military Liaison Committee. Lilienthal, after making clear that the appointment was Patterson's responsibility, observed that appointment of a man who had formerly been in complete charge of the project to a quasi-supervisory or advisory position would probably create problems and might reopen old controversies. On the morning after the Baruch hearing, Brereton told Lilienthal that he had first learned of Groves's appointment to the committee on Thursday. Lilienthal doubted that Patterson himself had known this when he had called Lilienthal on Friday, but the affair did not inspire confidence.[14]

Lilienthal went home tired and discouraged on Monday night. He saw little hope of a favorable outcome in the face of the continuous pressure from those favoring military control, the committee's criticism of Wilson and the staff, the threat of communist espionage, and security leaks. These visions of despair, mingled with a diabolical specter of McKellar, defeated his desperate efforts to sleep. On Tuesday morning he was exhausted and near panic. Struggling through a long morning in his office, he lay down at intervals to recover his strength. At lunch in the cavernous cafeteria in the basement of the Interior Building, he stood holding his tray for ten minutes waiting for a table among scores of Government employees.[15]

When Lilienthal entered the hearing room, President Conant of Harvard was about to testify. At Baruch's suggestion in the executive session on Friday, Hickenlooper had called Conant to speak on behalf of Wilson. Conant described his almost-daily contacts with Wilson during the war and stressed the importance of Wilson's experience in serving as Bush's assistant. McKellar, foreshadowing what was to come, persisted in a long rhetorical discussion full of implications that Lilienthal had communist sympathies.

The spectators stirred in their seats as Hickenlooper called Lilienthal to the witness chair. He squirmed between the crowded tables of reporters, replaced the swivel chair with a straight-back model, nodded to the chairman, and turned to face McKellar, scowling over the long desk on his left. McKellar quickly turned to a question he had raised the previous week, the birthplace

of Lilienthal's parents. Lilienthal knew it had been in Austria-Hungary but he did not recall the precise location. Having looked it up over the weekend, he could now say that it was in the vicinity of Pressburg, in what was now Czechoslovakia. "And under the domination of Russia, is it not?" The distasteful implications of that question made Lilienthal strain for self-control, but McKellar soon began rehashing the stale arguments about TVA administration. His intent was to demonstrate that Lilienthal had encouraged TVA to enter a variety of enterprises which would bring the Government into competition with private business. At last McKellar came to the point: "Your sympathies are very leftist, are they not?"

It was a moment of truth and Lilienthal seized upon it. Before his hearers knew what was happening, he was well launched on a broad definition of democracy. Democracy was an affirmative doctrine, not a negative one. The fundamental principle of democracy and of government under the Constitution was the integrity of the individual. One of the tenets of democracy was a deep belief in civil liberties and their protection "and a repugnance to anyone who would steal from a human being that which is most precious to him, his good name, by imputing things to him, by innuendo, or by insinuation." This kind of attack could tear the country apart and destroy it. "I deeply believe," he said, "in the capacity of democracy to surmount any trials that may lie ahead provided only we practice it in our daily lives."[16]

For once Lilienthal had let a surge of emotion rather than calculated reason rule his speech. As he concluded he realized that he had no clear sense of his exact phrases and sentences, but he saw signs of his effectiveness. The dramatic moment of silence in the hearing room at the end of his remarks, the solemn approbation from Senator McMahon, and the warm congratulations from the other senators, including Bricker and William F. Knowland after the session, all suggested a decisive victory. The front-page stories the following morning in the Washington *Post* and the New York *Times*, the extensive coverage by radio commentators, and then the flood of letters from the public helped to turn a moment of despair into a triumph. And, as Lilienthal wrote in his journal the following weekend, his statement "came at the right time—when hysteria was on its way to a frenetic pitch, and in a setting made to order—the voice of sanity and the appeal to reason from the pit of the inquisition." [17]

Hardly so dramatic, but far more dangerous to Lilienthal's cause than McKellar's attack, were new developments on the political scene. There had for weeks been rumors of a Republican attempt to reject the nominations, but the political guns had been notably silent during the first two weeks of the hearings. Except for daily accounts in the Washington *Times-Herald*, the McCormick and Hearst papers scarcely mentioned McKellar's charges. But on February 8, Lilienthal learned the truce was about to end. The opening salvo came from Senator H. Styles Bridges in a prepared statement released on Sunday afternoon for publication in Monday morning's papers. Stressing

political issues, Bridges argued that the American people in the recent Congressional elections had rejected the brand of "extreme New Dealism" which Lilienthal espoused. "As with all left-wingers, it is indicated Lilienthal is sympathetic toward Russia, which is Communist-controlled." Bridges was careful to disassociate himself from McKellar's unsubstantiated charges that Lilienthal himself had associated with Communists, but he and some conservative newspapers made effective use of McKellar's campaign by tying New Deal philosophy to communism.[18]

An attack on the New Deal by a Republican Congress after fourteen frustrating years as the minority party was understandable, but Lilienthal was more sensitive to another argument in Bridges' statement. Lilienthal had, Bridges said, "directed the TVA, a social experiment, which is a wide departure from the American system of private ownership of property." For Lilienthal, these words had a familiar ring: he considered Bridges "an old enemy of TVA and . . . spokesman for the lowest of the private utility crowd." Not waiting for further attacks, Lilienthal took countermeasures on Monday, February 10. An article in the Washington *Post* announced that the Commission was approaching leading utility companies about participating in the early phases of studies for eventual development of power from atomic energy. At the hearings that afternoon Lilienthal had arranged for Walker L. Cisler to vouch for the loyalty of Herbert S. Marks, a former TVA attorney who was now the Commission's general counsel. The fact that Cisler was chief engineer of the Detroit Edison Company suggested that not all private power officials looked upon Lilienthal and his TVA associates as dangerous socialists.[19]

As the hearings ended on Monday afternoon, February 10, Martin Agronsky, the radio news reporter, rushed up to Lilienthal and McMahon with a report that Senator Robert A. Taft would oppose Lilienthal's confirmation. As chairman of the Republican policy committee and a leading contender for the Presidential nomination in 1948, Taft could swing the party against Lilienthal. Back in his office, Lilienthal found unmistakable signs of such a trend. The afternoon edition of the Washington *Times-Herald* carried the banner headline: "Lilienthal Branded Appeaser of Russia." Senator Kenneth S. Wherry, the Republican whip, echoed Bridges' charges. Lilienthal's colleague, Lewis Strauss, was disturbed by the rumor of a Taft statement and went to see his old friend. Strauss returned with nothing reassuring. There was to be no Taft statement immediately, but Taft apparently told reporters off the record that he agreed with Bridges and did not think Lilienthal should be confirmed.

Before leaving his office, Lilienthal called Presidential aide Clark M. Clifford at the White House. Clifford had discussed the day's events with President Truman, whose only concern was that Lilienthal might be thinking of giving up the fight. Lilienthal said he would gladly withdraw whenever the President wished, but he had no intention of doing so otherwise. He wanted

the President to know that none of McKellar's charges had been supported by evidence and that the press, except for the Patterson-McCormick papers, had been supporting him.

Lilienthal lost no time in organizing his forces. On Wednesday, February 12, he discussed strategy with Clifford at the White House. On Thursday the President at his regular press conference told reporters that he considered Lilienthal fully and unusually qualified as chairman and that he thought McKellar's charges "absolutely unfounded." Meanwhile, there emerged other forces reminiscent of the battle of the previous year over the atomic energy bill. Harold C. Urey, the outspoken champion of the scientists, pleaded for Lilienthal's confirmation in a statement issued at the University of Chicago. Messages of support arrived from farm organizations and labor unions. Alfred Friendly kept up his daily barrage of feature stories on the front page of the Washington *Post* just as he had done a year earlier in supporting the
10 McMahon bill. The Federation of American Scientists, which had rallied support for the McMahon bill, urged confirmation of Lilienthal in a letter from Robert R. Wilson. Likewise, the Reverend A. Powell Davies of All Souls Unitarian Church in Washington again took up the battle in gathering support for Lilienthal among a score of religious, educational, labor, women's, and veterans' groups.[20]

Other forces were operating behind the scenes. Dean G. Acheson, Under Secretary of State and a close friend of Lilienthal's, suggested to Secretary George C. Marshall that he warn Vandenberg that "further delay in the confirmation of the Atomic Energy Commission may damage our national security." Important policy questions related to international control of atomic energy were hanging fire until the Commission could get down to business. On Friday, February 14, Marshall discussed the appointments with the President at a Cabinet meeting and later met with Vandenberg and Senator Tom Connally, ranking Democrat on the Foreign Relations Committee. That same afternoon Vannevar Bush met in secret session with the Joint Committee to make a similar plea for quick action.[21]

Much of the outcome rested on the decisions of Vandenberg and Taft. Neither had yet declared himself publicly, but both had given some indications of their feelings. Vandenberg had not been able to conceal his contempt for McKellar's performance and he had stood firmly behind the Acheson-Lilienthal report when it had been attacked by Senator Johnson of Colorado, who was a Democratic member of the Joint Committee. He had been impressed too by the appeals of Marshall and Bush. The following week he wrote to an old friend in Michigan that he considered McKellar's charges against Lilienthal "a fantastic fabrication highly remindful of the 'lynch law.'" This left for criticism only Lilienthal's New Deal philosophy and his interest in public ownership, and Vandenberg found these poor reasons for opposing confirmation. Until there was some international agreement for control of atomic energy, the nation had no choice but to place its development and use

in public hands. In this light Vandenberg found Lilienthal's liability a temporary asset. Furthermore, Vandenberg feared that rejection of Lilienthal would probably result "in the wholesale retirement of our scientists from our atomic organization" and the loss of another precious year in developing atomic power. Vandenberg conveyed these same fears to the Joint Committee in a public session on February 21, when he read a forceful letter from President Compton of MIT. Compton thought Lilienthal the best man for the job and predicted that failure to confirm him would be "a very serious blow to our future progress in the atomic energy field." [22]

It was probably not a coincidence that Taft made his position clear later the same day. In a blunt statement which rated banner headlines in conservative newspapers, Taft said that he found Lilienthal "temperamentally unfitted to head any important executive agency in a democratic government, and too 'soft' on issues connected with communism and Soviet Russia." He repudiated Vandenberg's argument, which he thought implied "the ridiculous proposition that Lilienthal is the indispensable man." Lilienthal was "a typical power-hungry bureaucrat," one of those who had dominated the Government and defied the wishes of Congress for years. He thought Lilienthal had managed TVA in an arbitrary and secretive manner, that he had unfairly driven Arthur E. Morgan from the TVA board and had covered up his action by repeatedly changing TVA minutes. There was no doubt in Taft's mind that Lilienthal had tolerated Communists in TVA and that the Acheson-Lilienthal plan would have given the Russians the atomic bomb.[23]

Taft, in other words, had embraced the arguments of McKellar, Bridges, Wherry, and the conservative press. Strauss was angry; he had been convinced that his friend would never make his opposition to Lilienthal explicit. He agreed with Lilienthal that Taft's sweeping attack made confirmation virtually impossible. A fight might split the Republican party, but Strauss was in a fighting mood. If they lost, they could always go into business together. Despite their different political backgrounds, Lilienthal and Strauss had become close associates during their first three months on the Commission, especially after McKellar's questions about Lilienthal's parents and other incidents which indicated the force of anti-Semitism in the opposition to Lilienthal.[24]

One consolation for Lilienthal was the fact that the hearings were nearing an end. Hour after hour, day after day, week after week McKellar had fumbled his way through the voluminous and inconclusive testimony presented to the House Committee on Un-American Activities in 1940. Former investigators for the Dies committee, Lilienthal's former assistants at TVA, local law enforcement officers from Tennessee, Knoxville businessmen and attorneys, dismissed TVA employees, former members of the Communist party in Knoxville, local busybodies, and cranks joined the parade of witnesses. So pointless and repetitious was the testimony, so "outrageous" was McKellar's conduct that Vandenberg chose to stay away. At one point Senator

McMahon exploded in a heated denunciation of the "lot of rag, tag, and bobtail that the Senator from Tennessee has produced." At last, on February 26, five weeks after the public hearings began, Senator McKellar announced that he had no more questions. Senator Hickenlooper, who had maintained a strict attitude of impartiality during the ordeal, hastily adjourned with the hope that this session would end the public hearings.[25]

McKellar, however, had not quite run out of ammunition. On February 28, he scored a victory when the Senate Public Works Committee rejected Clapp's nomination as TVA chairman by a vote of 7–5. He had also sent every member of the Senate a letter charging Lilienthal with misconduct in accepting payments from a commercial venture in Chicago at the time he was serving on the Wisconsin Public Utilities Commission. Hickenlooper had no choice but to reopen the hearings on March 3. Categorically disproving McKellar's charges on every point, Lilienthal dominated the two days of hearings and emerged with renewed confidence in his chances for a favorable vote in the committee.[26]

Lilienthal's last hurdle was two closed sessions before the Senate section of the Joint Committee early in March. Here, at least, the discussion could proceed without McKellar's maddening intrusions. Although the conversations were informal and sometimes candid, they revealed disagreements, mainly between Lilienthal and Hickenlooper. First, Hickenlooper was concerned that the Commission had used its statutory exemption from Civil Service regulations to grant what he considered unusually high salaries to the principal staff. For example, Marks as general counsel was receiving $14,000 per year, or $4,000 more than the assistant attorney general. Carroll Wilson observed that Marks's job was comparable to those of the statutory division directors, whose salaries the Congress had established at $14,000. Taking a broader view, Lilienthal argued that the novelty and importance of atomic energy demanded the very best talent available, regardless of cost. Strauss and McMahon supported Lilienthal, but Hickenlooper and Millikin could not accept the fact that the Commission, by their interpretation, had used authority granted for exceptional cases to establish a separate personnel system that would undermine the Civil Service program.

Hickenlooper's second concern was security. McKellar, in the course of his campaign against Lilienthal, had cast suspicions on a number of former TVA employees who now held key positions on the Commission's staff. Unwilling to take chances, he asked Lilienthal to send the committee FBI reports on the Commission's principal appointees. Hickenlooper was first annoyed that the Commission sent reports on only a few of its staff; later he was troubled by the information he found in some of the reports. Charges of "associations" with "communists," of "communist tendencies" were disturbing even if unsubstantiated or vague. Could not the Commission find some people who were "above suspicion?" [27]

Despite his own reservations and the growing uncertainty within the

committee, Hickenlooper hoped to get a vote on the confirmations by Friday, March 7. The press had guessed Hickenlooper's intentions, and the Commissioners were impatiently awaiting the verdict. But the closed session on Friday morning dragged on inconclusively, as the senators attempted to evaluate the derogatory information in the FBI reports. Bricker especially was agitated about charges against Marks and other former TVA employees. Even some vigorous reassurances from Bush failed to calm fears. Bricker contained himself until Bush left, but no longer. He had not let McKellar's charges about communism in TVA color his judgment of Lilienthal; he did not see how Bridges's charges of New Dealism disqualified Lilienthal. But the FBI reports raised new doubts; Bricker would have to give further thought to his vote.[28]

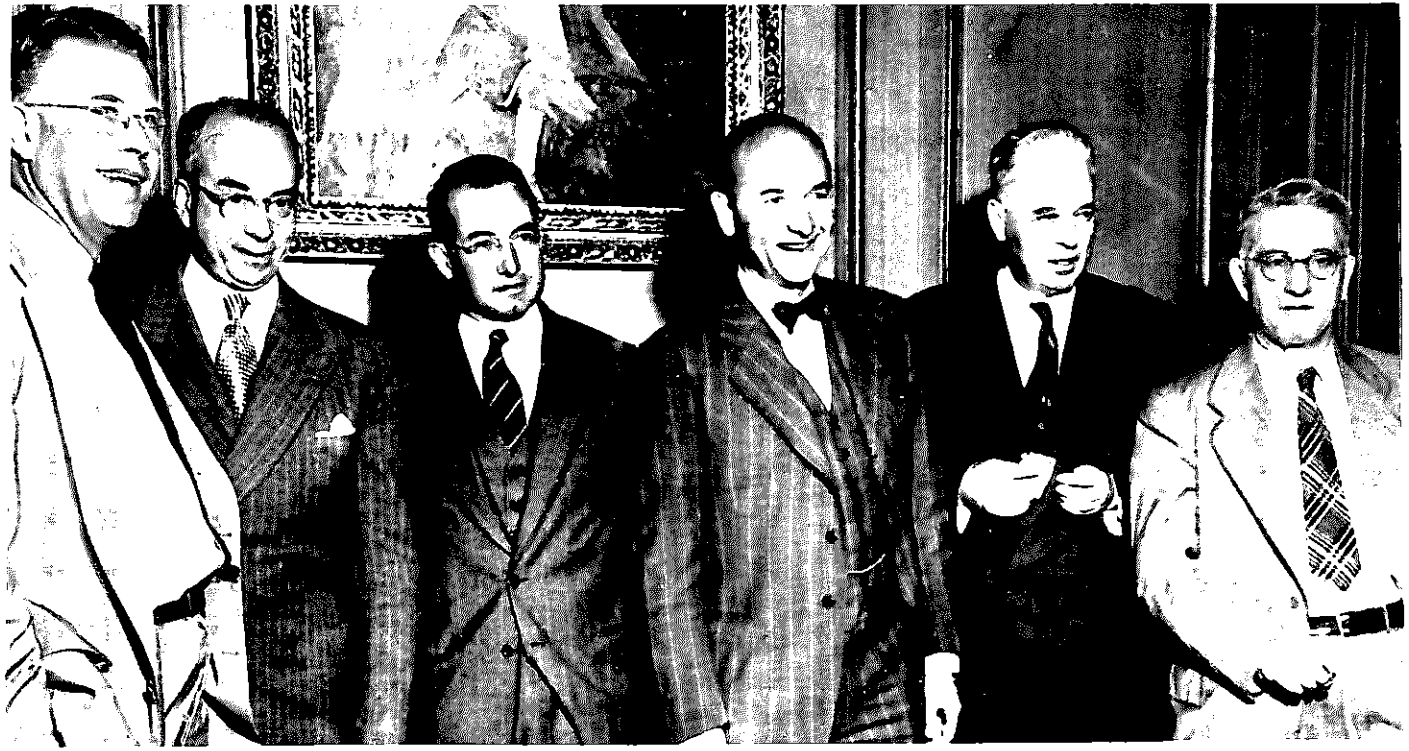
Hickenlooper, too, was upset. He went to Forrestal's home and told the Secretary of the Navy that he was disturbed by Lilienthal's "intransigence and inflexibility" on the matter of staff salaries. This had made Hickenlooper's task especially difficult at a crucial moment in his fight for confirmation. He was also distressed that Lilienthal had made important appointments without consulting the FBI files. At Hickenlooper's suggestion, Forrestal discussed these concerns with the President and with Strauss.[29]

Lilienthal appeared to hold the edge on Monday, March 10, as the Senate members of the Joint Committee assembled to vote, but the revelations of the previous week cast some uncertainty on the outcome. No one was in a mood for further discussion, and Hickenlooper quickly put the question to a vote. For Lilienthal, the vote was 8–1, only Bricker voting against. Senator Connally said he would vote only on the Lilienthal nomination because he did not know the other nominees. Thus for Bacher and Waymack the vote was 8–0; for Pike and Wilson, it was 6–2, with Bricker and Johnson voting in the negative.[30]

The vote was a triumph for Lilienthal and the Commission and perhaps, as the liberal press claimed, for democracy and the civilian control of atomic energy. But the margin of victory was really no more than a whisper. Over the weekend Lilienthal received from the FBI a shocking report which at first glance seemed to throw a heavy shadow of suspicion over Robert Oppenheimer, the wartime director of the Los Alamos weapon laboratory and a member of the board of consultants which had prepared the Acheson-Lilienthal report; he had recently been appointed on the Commission's recommendation to be chairman of its General Advisory Committee.[31] The file revealed that Oppenheimer's brother had been a Communist and that Oppenheimer's wife had a radical background. Even as the committee was meeting on Monday morning to cast its vote, the Commissioners were closeted in secret session trying to evaluate the dismaying information in the FBI file. Conant and Bush assured Lilienthal that General Groves had known these facts when he had selected Oppenheimer to head the weapon project in 1942, but Lilienthal probably thought that one word to the committee about the

Oppenheimer file would plunge the confirmation issue back into the sea of hysteria from which it was at last emerging.

Even if the Commission could exonerate Oppenheimer and keep the contents of the file from becoming public knowledge, the chances for confirmation were not clear. Bricker and Taft promised a long, hard fight in the Senate.[32] And even if they emerged victorious, the Commissioners would still face what Lilienthal, with some accuracy as well as exaggeration, had called the terrible responsibility.



OAKLAND TRIBUNE

THE COMMISSIONERS AT BERKELEY, AUGUST 1947 / After visiting the Bohemian Grove the Commissioners met with Ernest O. Lawrence in the regents' room in the administration building at the University of California on August 20, 1947. Left to right: Lawrence, Lewis L. Strauss, Robert F. Bacher, David E. Lilienthal, Sumner T. Pike, and William W. Waymack.

WIDE WORLD

CONFIRMATION HEARINGS BEGIN / David E. Lilienthal appearing before the Senate section of the Joint Committee on Atomic Energy on January 27, 1947, to answer questions on his qualifications as chairman. Seated around the dais from left to right are Representative Melvin Price and Senators Kenneth D. McKellar, Edwin C. Johnson, Brien McMahon, and Bourke B. Hickenlooper.

UNCERTAIN MANDATE

CHAPTER 2

During the first three months of 1947 the Commissioners had no choice but to focus their attention on the confirmation hearings. Until the Joint Committee and the Senate settled the question of confirmation, Lilienthal and his associates had at best an uncertain mandate for leadership. By law and Executive Order, however, they were already fully responsible for the nation's atomic energy program. Occasionally the Commissioners could find time for agency matters; but until the Senate acted, the Commissioners would have to rely on the veterans of the wartime project and the fledgling headquarters staff to keep the administrative machinery going.

THE VETERANS

On Friday morning, January 3, 1947, President James B. Conant of Harvard University hurried to the New War Department Building on Twenty-First Street in Washington for the first meeting of the Commission's General Advisory Committee. Waiting to greet him were Lilienthal and Carroll L. Wilson. Robert F. Bacher, the only Commissioner whom Conant knew well, had been delayed by a snowstorm in his flight east from Los Alamos, where he had been inspecting the nation's stockpile of atomic weapons. Also stranded on the way east were two members of the committee: Lee A. DuBridge, the new president of the California Institute of Technology, and Robert Oppenheimer, who was resuming his academic career at the same institution.[1]

Among the committee members present Conant found many friends: Enrico Fermi, the renowned nuclear physicist at the University of Chicago; Hood Worthington of the du Pont Company, who had helped to build the

production plants at Hanford, Washington; Isidor I. Rabi, the Nobel laureate in physics and wartime leader at the MIT Radiation Laboratory; Hartley Rowe, one of Conant's division directors at NDRC and valuable consultant at Los Alamos; Cyril S. Smith, the British-born metallurgist who had a key role in weapon fabrication at Los Alamos; and Glenn T. Seaborg, the enterprising young chemist whose wartime research team had discovered plutonium and devised the chemical process used for its recovery for the Alamogordo test and the Nagasaki weapon.

Lilienthal began by distributing the Presidential commissions "with all the privileges and headaches appurtenant thereto." [2] Conant nominated Oppenheimer as chairman of the committee during 1947 and Rowe to serve as temporary chairman until Oppenheimer arrived. Not knowing where to begin, Rowe suggested that Lilienthal explain the role of the committee and its relationship to the Commission. Lilienthal's easy conversational manner stimulated discussion, and the committee members were soon adding their own thoughts on the subject. They agreed the committee could not be close enough to day-to-day operations to act as a technical consulting group to the Commission but that it might properly offer advice on major policy matters. To do this, the committee would need reports on the status of research and development, materials, and production. Wilson said he expected soon to assemble the leaders of the research laboratories to plan the status report on research and development. It would be easier to get information on materials and production.

The committee moved into a general discussion of the problems facing the Commission, not only with an air of congeniality among the group but also with special understanding of the existing program and the people who manned it. Every member of the committee, unlike most of the Commissioners and staff, had had a part in the wartime program. It would not have been hard for Conant to imagine as he sat there that he was reliving one of the many conferences he had attended during the war project. In addition to experience, the committee also commanded some of the best scientific and technical talent available in the nation. Certainly the Commission would rely heavily on the committee, at least until the Commissioners learned their jobs and Wilson had assembled and trained his staff.

After lunch the committee turned to substantive matters. Wilson was seeking a director of research, and the committee had a number of names to suggest. Then Wilson explained two legacies from General Groves: the new atomic energy laboratory which the General Electric Company had been promised when it had agreed to take over operation of the Hanford plant, and the new Brookhaven National Laboratory to be established as a regional research center for universities in the Northeast. In the closing weeks of 1946, the Commission had had little success in formulating policy for these new laboratories; now it could call upon the expert knowledge of the committee.[3]

Beyond merely giving advice, the committee demonstrated a willing-

ness to take the initiative. During the afternoon Seaborg discussed some practical difficulties he had encountered in laboratory administration and proposed some actions the Commission could take to remove them. Seaborg was mostly concerned with the prompt declassification of technical data and the exemption of some laboratory employees from security clearances.

Before Oppenheimer arrived for the Saturday morning meeting on January 4, Conant proposed that the new chairman establish three subcommittees to study the information to be furnished by the Commission in the areas of research and development, materials, and production. Oppenheimer, when he finally arrived, had time to do little more than find out what had happened and establish the date of the next meeting, to be held on February 2.

Conant and Oppenheimer had much to discuss during the lunch hour. At two they would go to the Pentagon for the first meeting of the Atomic Energy Committee of the Joint Research and Development Board. The complicated title accurately reflected the complex organization which had evolved from Vannevar Bush's efforts to coordinate postwar research in the military services. As early as the summer of 1944, Bush had been concerned that, with the disbanding of the Office of Scientific Research and Development at the end of the war, the research and development activities vital to a modern defense establishment would soon disappear. Proposing a grand plan for Government-supported research which he announced in his report, *Science, The Endless Frontier,* Bush set about the task, even before the war was over, of establishing a National Research Foundation. He envisioned the new agency as having responsibilities for basic research in the physical and biological sciences as well as in applied research for the military services. In fact, Bush intended its authority to extend over all research and development activities supported by the Government, with the exception of applied research in atomic energy, which, largely for reasons of security, would be assigned to the new Commission.[4]

Although the bill for the National Science Foundation, as it came to be called, had bogged down during 1946 in endless political debate from which atomic energy legislation had barely escaped, Bush had hopes that the new Congress would soon create a science foundation. In the meantime, he was attempting to coordinate the research and development activities of the military services through a temporary instrument called the Joint Research and Development Board. As he explained to the Secretaries of War and the Navy in May, 1946, the new organization would have no authority over the internal affairs of either department but would assist in "the allocation of responsibility on matters of joint interest." Thus the joint board would help the services to decide which would develop a particular weapon. The board would not establish priorities, justify projects, or terminate them; it would, however, help to reduce duplication of effort and perhaps prove a step toward service unification.[5]

If, as Bush explained, the joint board was to function "as a court of

arbitration," it would have to represent the interested parties equally. The charter called for a civilian chairman (Bush), designated by the two service secretaries, and two representatives for each military department. Day-to-day administration was the responsibility of the executive secretary, Lloyd V. Berkner, a physicist and radar specialist who had worked for Bush at the Carnegie Institution in Washington. Under Berkner's direction, the joint board in 1946 had organized six committees, each a miniature of the parent group and each responsible for one technical area of interest to the armed forces. The charter of the atomic energy committee, only recently established, bore the familiar requirement for equal representation. The three civilian members were Conant (chairman), Oppenheimer, and Crawford H. Greenewalt, a vice-president of the du Pont Company, who had sparked the company's efforts in building the plutonium production plant at Hanford. The six representatives of the Army and Navy were all members of the Military Liaison Committee.

Thus, Conant again found himself among friends as he introduced Bush to speak to the members of the new atomic energy committee. Bush explained the committee's charter and functions, and the group decided that it would use the Military Liaison Committee as its channel of communication with the Commission. Its immediate job was self-education, since most of the military members had no background in atomic energy. Conant asked Oppenheimer to make some recommendations for educating the committee.[6]

Conant must have felt a certain satisfaction on Saturday afternoon when the committee adjourned its first meeting. The task of rebuilding the nation's atomic energy program would be a big one, but at last there was a base for operation. While the new Commission was organizing itself, the General Advisory Committee could begin to define the policy questions, if not the solutions, and the atomic energy committee in the Pentagon could begin to acquaint the nation's military leaders with the facts of atomic energy. In the meantime, Bush and Conant were still on the scene, their authority somewhat concealed from public view but with the same firm hands in control of the project they had guided since the black days of Pearl Harbor in 1941.

THE HUMAN EQUATION

The presence of Bush and Conant must have been reassuring to Carroll Wilson, their young protégé who had just assumed the awesome duties of the Commission's first general manager. The new job gave him control of the Army's nation-wide complex of production plants, laboratories, and administrative offices in thirteen states from New York to California and from Washington to Tennessee. Manning these facilities at the time of the transfer were more than 2,000 military personnel, 4,000 civilian Government employees, and 38,000 contractor employees. By far the largest concentration was at

Oak Ridge, Tennessee, the headquarters for the Manhattan Engineer District and the location of two major production plants and a large research laboratory. Oak Ridge, including a Government-owned town of 40,000 people, alone absorbed half the Commission's civilian and contractor employees. The laboratory at Los Alamos, New Mexico, ran a poor second in size to Oak Ridge. Still operated for the Commission by the Manhattan District, most of its 2,000 Government employees were military personnel; most of the 6,000 contractor personnel were scientists and technicians in the weapon laboratory. The Hanford production plant and community at Richland, Washington, could claim almost 600 Commission employees, of whom about half were military. The 5,000 contractor employees all worked for the General Electric Company, which operated the plants and the community. The Commission's New York and Chicago offices, which administered research and procurement contracts, accounted for most of the remainder.

One striking feature about these statistics was the scattered nature of the Commission's operations. Another was the relatively small number of Government employees in contrast with contractor employment. Both these facts were the result of wartime policy decisions. To avoid the perils of possible enemy attack, sabotage, espionage, or operating accident, diversification and isolation were cardinal factors in selecting plant sites. General Groves's extraordinary pressure for progress in plant construction and operation required that private contractors rather than Government employees do most of the work. The small groups of military officers and civilian employees at each site were only large enough to administer the contract, maintain security, and oversee the work for Groves. Under the Atomic Energy Act the Commission could have reversed both trends, for it was empowered to operate all its facilities with direct Government employees. In fact the Commission would soon consider the advantages of centralizing its research laboratories; but even before the Commissioners assumed responsibility on January 1, they had decided to retain both principles. For one thing, they had enough problems without trying to modify the fundamental structure of the enterprise. Secondly, and more important, Lilienthal and his colleagues accepted decentralization and contractor operation as good practices in public administration.

For Lilienthal, decentralization was more than a management technique; it was essential to the operation of democracy in a modern society. During a decade in the Tennessee Valley he had seen firsthand how decentralization had revitalized not only the physical resources and economic institutions of the region, but also local governments and individual citizenship. Just as TVA had brought Tennessee farmers into consultations with its engineers, so had the federal agency, in cooperation with state and local governments, helped to rebuild democracy "at the grass roots." Summing up his argument in 1944, Lilienthal had said: "The task of harmonizing and from time to time adjusting the intricate, detailed maze of pieces that make up the unified development of resources in a world of technology is something that simply

cannot be done effectively from some remote government or business headquarters." [7] This conviction underlay his long fight against Secretary Harold L. Ickes's efforts in the thirties to centralize all the power programs of the Federal Government in the Department of the Interior. He did not intend to surrender the principle in establishing the Atomic Energy Commission.

Groves himself had followed a similar course in the Manhattan project by placing the headquarters at Oak Ridge. His own office in Washington had always been small, never containing much more than thirty people during the war. There had been some growth in 1946 to perform functions not required in a secret wartime organization; but at the time of transfer there were scarcely more than a hundred employees in the Manhattan District's offices in the New War Department Building. By that time Wilson had acquired no more than a dozen employees in the temporary Commission offices in the same building. The two groups combined would be well within the limits which Lilienthal and Wilson envisaged for the Washington headquarters.

However, decentralization, as Lilienthal had often said in his speeches on the subject at TVA, meant much more than keeping the Washington headquarters staff small. Unless the agency's field offices had authority to make important decisions and had the talent necessary for these responsibilities, decentralization was nothing but a sham. In this respect, the Manhattan inheritance was not very helpful. Although there was a limited dispersion of authority common to Corps of Engineer projects, there was no real decentralization by Lilienthal's standards. The area engineers at New York, Chicago, and Hanford had very limited authority. General Kenneth D. Nichols's headquarters at Oak Ridge made all important administrative decisions, and Groves initiated all policy in Washington. To have expected any less authoritarian system of a military organization in wartime would have been unreasonable, but the same system obviously could not serve as the administrative framework for a peacetime enterprise emphasizing civilian control and "grass roots" democracy.

For Lilienthal's purposes, the main deficiency in the wartime organization was the concentration of authority at Oak Ridge. Military organization defined the relationships between Oak Ridge and the other installations. Military officers, most of them contemplating new assignments in late 1946, were directing the work of the area offices. In January, 1947, the atomic energy program would have collapsed without them. For the moment there could be no thought of anything but continuing operations under the military organization. From the Commission's point of view this was not an ideal arrangement, but circumstances would permit no other.

The Manhattan District organization had one further disadvantage for Wilson. His small Washington staff in January, 1947, consisted mostly of administrative personnel who could not be expected to assist him in operating decisions. Until he could assemble his own personal staff of men who had a working knowledge of nuclear science and technology, he would have to rely

on the existing organization. And that group, by the very fact that it had been created for a specific wartime purpose, would be unable to begin the difficult process of adapting the enterprise to the more diffuse and complex demands of a peacetime, civilian environment.

Recruiting a complete staff for a Government agency was never easy, and putting decentralization into practice would complicate the task. Wilson needed not only capable people for top positions in Washington, but also unusually competent managers for the field offices. In his limited experience Wilson had never had the occasion, as did Lilienthal, to develop a full-blown philosophy of decentralization; but from the first he sensed the practical point that really strong field managers would insist on reporting directly to him. This meant that the Washington division directors could not be in the line of command between him and the field but would have to operate rather as members of his staff. Wilson first made this point in defining what he considered to be the qualifications of the director of military application. He thought the job required much more than competence in weapon technology. The director would not simply control the Commission's weapon activities; as a member of the general manager's staff his job would be to see that military requirements were considered in all aspects of the Commission's activities.[8]

With no direct experience in managing a large enterprise, Wilson had to rely upon intuition, common sense, and good advice in organizing the Commission staff. Fortunately he was well provided for in the last respect. On general approach he could count on the help of Bush, Conant, Lilienthal, and the other Commissioners. On the details he came to rely on one of his assistants, Richard O. Niehoff, a former TVA official and wartime director of administrative relations at the National Housing Agency. About to transfer to the State Department in October, 1946, Niehoff became interested in the Commission after reading about Lilienthal's appointment. Within a few days after reporting to State, he found himself on loan to the Commission and deeply involved in the hectic activities leading to the January transfer.

Without title, Niehoff was in effect the Commission's director of organization and personnel in the closing weeks of 1946. He organized the panel of consultants who selected Wilson as the first general manager and became his special assistant on organization and personnel recruitment.[9] Although Wilson never deferred to his assistant on matters of substance, Niehoff influenced the patterns of development by reinforcing his superior's intuitive convictions with an operating rationale learned in Lilienthal's TVA system. This rationale involved reliance on individual talent, initiative, and responsibility rather than the cramped regulations of the Civil Service Commission as the answer to effective administration in modern government. In practical terms it meant decentralization and an independent personnel system.

One of the intriguing possibilities Niehoff saw in the Atomic Energy Act was Section 12a(4), which authorized the Commission "to the extent

the Commission deems necessary" to employ personnel and fix compensation without regard to Civil Service laws. Taking a cue from the act itself, which fixed Wilson's salary at $15,000 and that of the division directors at $14,000, Niehoff suggested that the salaries of division directors could range from $10,000 to $14,000, which would be far above the rates for comparable positions under Civil Service.[10] From this point it was only a short step to the question of whether the provision in Section 12 would justify exceptions for all positions in the Commission, or in effect an independent personnel system. This question had been high on the Commission's agenda in November, 1946, when Niehoff had requested Wallace S. Sayre, a professor of public administration at Cornell University, to study it.

Sayre was an admirable choice for the assignment. In addition to his academic experience, he had a working knowledge of government personnel systems, first at the municipal level for Mayor Fiorello H. LaGuardia of New York and later at the federal level during World War II as director of personnel for the Office of Price Administration. Like many of his colleagues, Sayre had seen the independent personnel system of Lilienthal's TVA as a beachhead in the long struggle to modernize the federal civil service. Having made the most of the relaxation of Civil Service regulations during the war, Sayre looked upon the Veteran's Preference Act of 1944 as an effort by conservative forces in the Congress, the permanent staff of the Civil Service Commission, and veterans' organizations not just to reimpose prewar restrictions but also to wipe out the modest gains of the Roosevelt Administration. A typical although probably exaggerated reaction to that possibility appeared in an article in *Harper's* magazine, which argued that the spoils system was preferable to the inflexibilities of Civil Service.[11]

With this background, Sayre did not need much explanation of his assignment, and within a few weeks he had his recommendations in draft form. Sayre contended that the Atomic Energy Act was "an unprecedented charter both in program and administration." [12] Because the Commission was charged with developing "pioneer ideas," with difficult types of experimentation, and the exercise of delicately balanced and responsible judgments, the success of the Commission was "uniquely dependent upon the quality of its staff." The Commission would have to recruit and retain "a creative staff of the highest intellectual quality, imbued with the scientific and the cooperative spirit—imaginative, flexible in thought and action, highly motivated yet capable of self restraint, and possessed of a genuine sense of dedication to the Commission's programs." An ordinary personnel program using routine techniques could not find such people. Furthermore, Sayre thought the Civil Service system would be too inflexible and too insensitive to the special qualities the Commission was seeking for it to be practical for recruiting. He cited the language of Section 12, which suggested that exemption from Civil Service regulations was to be the exception rather than the rule. But after discussing the legislative history of the section with the Commission's law-

yers, he concluded there was statutory authority for a personnel system completely independent from Civil Service. He recommended an independent system which would meet the Commission's special needs but which would conform to Civil Service standards and procedures at all other points.

When Sayre discussed his study with the Commissioners early in January, 1947, he found he had little trouble convincing them of the advantages of an independent personnel system. Lilienthal's reaction was predictable from his TVA experience; Pike was aware of the advantages OPA had enjoyed during its temporary exemptions from Civil Service regulations during the war; and Bacher expressed the opinion of many scientists that Civil Service inspired industrious mediocrity. Strauss and Waymack had no strong feelings on the subject, and Wilson's opinion was close to Bacher's. For the moment, however, there was no thought of formal action. The traditional opposition to independent merit systems in Congressional committees and in the Civil Service Commission staff suggested proceeding cautiously. Certainly Wilson contemplated no action until the confirmation hearings were completed.

In the meantime Niehoff pushed ahead with plans for recruiting key personnel under the exception provided in Section 12. During Christmas week, 1946, he organized a panel to select a director of organization and personnel. Within a few weeks the panel had worked its way through a long list of candidates, and before the end of January, the Commission announced the appointment of G. Lyle Belsley, an assistant administrator at the National Housing Agency. No panel was necessary to recruit the initial cadre of the legal staff. Herbert S. Marks, who had worked with Wilson on the Lilienthal board of consultants, had been managing the Commission's legal affairs since November and was appointed general counsel on January 23. His deputies were Edwin E. Huddleson, Jr., also formerly with the State Department, and Joseph A. Volpe, Jr., formerly a special assistant to General Groves. Paul W. Ager, whom Lilienthal had brought from TVA to handle the financial aspects of the transfer, was appointed the Commission's budget officer. Other key administrative posts, in security and intelligence, public information, auditing, accounting, and administrative services, were still to be filled; but for the moment Wilson could begin to organize his headquarters staff around a strong nucleus.[13]

PERSONNEL SECURITY

To a large extent, the success of Wilson's efforts in recruiting personnel and organizing his staff would depend upon his ability to establish quickly an effective system for processing security clearances. As in other areas, the Commission's inheritance from the Army in the security field involved some liabilities as well as assets. In November, 1946, General Groves told Lilienthal

that the pressures of war had forced him to hire some people of questionable backgrounds and associations. The Atomic Energy Act required complete security investigations by the FBI not only for new employees but also for all those inherited from the Army. From Groves's point of view, the new requirements of the Act provided a good justification for terminating the questionable employees.[14] The suggestion put the Commission in a difficult position. There would surely be political repercussions if the Commission in peacetime set about terminating employees who had devoted themselves to the project during the war. Even more to the point, some of these cases had not been settled precisely because they were difficult to judge, and the Commission as yet had no criteria for evaluating these or any others.

There had been little time to investigate, let alone provide for this situation in the closing days of 1946. The best Colonel Charles H. Banks, one of Groves's intelligence officers, could do was to draft a brief directive
24 prescribing a skeleton plan making effective the new provisions of the Act. For the moment the plan, which was to take effect on January 13, 1947, would apply only to new Commission and contractor employees. Reinvestigations of Manhattan District personnel would have to come later. Since the FBI by law had to perform the investigations, Banks saw the need to send all clearance forms to Washington and therefore to replace the Army's local security files with a central control system. He also proposed a new Personnel Security Questionnaire, known henceforth in the trade as the "PSQ."[15]

Even before Banks's directive could go into effect, however, it was clear that the administrative machinery could not be set up in time. In an all-day meeting in Washington on January 7, security officers from the field agreed that they would have to use the Army procedures until the Commission could set up its own. After the meeting Volpe, with the help of some of the security officers, drafted a memorandum setting forth a tentative security procedure for review by the field offices. This review would take time. Meanwhile the Commission would be reluctant to hire anyone who had not been cleared in the Manhattan project. Volpe as a stand-in had every motive for finding a director of security as quickly as possible. On January 21, Wilson presented to the Commission a slate of names and won permission to approach the person at the top of the list. The Commission also authorized Wilson to hire Thomas O. Jones as a special assistant on security. Jones had been Groves's security officer at Los Alamos during the war and also at the Bikini weapon test in the summer of 1946.[16]

Jones, a quiet unobtrusive young man with little experience in high-level administration, quickly found himself in a beehive of activity. The first task was to draft some interim clearance procedures for the Washington headquarters until the formal agency regulation could be adopted. Belsley's appointment as director of organization and personnel provided a central point of control over recruitment at headquarters. Wilson directed him to hire no one without a full investigation by the FBI. If this proved impractical, he

could hire former Manhattan District employees without FBI investigation; only with Wilson's written consent and a full written justification could he make emergency appointments with only a preliminary FBI file check.

During the following two weeks Jones spent much of his time working out the final version of the first formal security regulation, which Wilson approved on February 14. Closely resembling the earlier drafts, the new regulation established three types of clearances based on the degree of the individual's exposure to Restricted Data, as defined in the Atomic Energy Act. Certain contractor employees having no access to Restricted Data or to exclusion areas where such information was used were granted "P" clearances immediately and were subsequently subject to an FBI file check. The "S" clearance was reserved for frequent business visitors to Commission installations who would not have access to Restricted Data. All Commission employees, regardless of access, and all contractor employees with access to Restricted Data or exclusion areas would need the "Q" clearance, which required in advance of employment a full FBI security investigation. All Personnel Security Questionnaires were to be forwarded to the FBI through the Commission's central personnel clearance office in Washington.[17]

The February 14 directive made possible some orderly procedures, but it far from provided an efficient security system. Jones first estimated that the FBI investigations would take four weeks, but the Commission's requirements soon outran the resources. Investigation time soon dragged out to six weeks or more as thousands of PSQ's poured in from the field offices. Once the FBI had completed its investigations, the Commission had to evaluate the findings and grant the clearances. In the overwhelming majority of cases, there was no disturbing information, and clearances were quickly granted. But when some possibly derogatory information turned up, careful study was necessary. The mere presence of such information in the FBI file was not sufficient grounds for denying a clearance. Jones thought the tedious job of evaluation might require a full-time panel of reviewers. The need for a panel might prove even more pressing when the security division could get around to reinvestigations of former Manhattan District personnel.[18]

For a few weeks Jones went about his work with the expectation that the Commission would soon select a director of security to take over most of his responsibilities, but as February faded into March that hope disappeared too. In the meantime Jones worked out procedures for reporting security violations to the FBI and organized a panel of former Manhattan District security officers to draft a security manual for the Commission. There was also the task of developing security measures for the new headquarters building and compiling a list of former Army employees whose files contained questionable information and who thus would be given priority in reinvestigations. Late in March the Commission's leading candidate for the post of director of security declined to accept, and the Commission asked Jones to take over as acting director. It was not an enviable assignment, what with the

growing lag in FBI investigations and the lack of a board to evaluate the findings. Jones sensed that the worst was yet to come, but he knuckled down to doing his job one day at a time.

LABOR CRISIS

There was much to be said for caution in the first weeks of 1947, but at times there was a need for action. None was more compelling than that for a decision on labor policy at the major production sites. During the war General Groves had persuaded the national labor unions not to attempt to organize the Manhattan District facilities, on the understanding that after the war the Army would permit collective bargaining elections in the plants under

the provisions of the National Labor Relations Act. Keeping its word, the Army authorized elections at Oak Ridge in the summer of 1946—with unpromising results. In a struggle for power, the Congress of Industrial Organizations succeeded in winning the election in the K-25 gaseous-diffusion plant, operated by the Carbide and Carbon Chemicals Corporation, by only 25 votes in almost 4,000. The American Federation of Labor won decisively at the Clinton Laboratories, operated by the Monsanto Chemical Company, and carried the biggest union vote in the Tennessee Eastman Corporation's Y-12 plant, which elected not to organize. Not only were there hard feelings between the unions after the elections, but also the contracts negotiated by the companies with the two unions were different in important respects. Although the War Department thought the contracts were acceptable, the Army decided to leave formal approval to the Commission.[19]

Lilienthal had anticipated the need for quick action. Weeks earlier he had set about appointing a panel of industrial relations consultants. On January 3, the Commission announced the appointment of George H. Taylor, professor of industrial relations at the University of Pennsylvania; Lloyd K. Garrison, a New York lawyer and former general counsel of the War Labor Board; and David A. Morse, Assistant Secretary of Labor. Lilienthal saw the panel in his office the same day and within a week had a report on the situation at Oak Ridge.[20]

The panel recognized that differences in the contracts might open the way for renewed conflict between the unions, but both sides had negotiated in good faith and the wage rates in the contracts seemed acceptable. On balance, the panel thought the Commission should accept the contracts in part, with riders providing for revisions of certain sections, particularly those concerning work stoppages, security procedures, and the arbitration of grievances. The three consultants urged the Commission to discuss their problems with William Green and Philip Murray, the national presidents of the two unions,

issue a general policy statement on accepting the contracts, and appoint a full-time labor relations expert to the staff.

The following week the Commission acted. On January 13 Wilson persuaded Clark Kerr of the University of California to work out a general policy statement for revising the Oak Ridge contracts. In the meantime, Wilson sent Ralph Seward, a labor negotiator in Philadelphia, to Oak Ridge to present the idea to the unions. On January 17 Seward got the necessary signatures on both contracts, a move which promised to allay the worst fears of the panel members. Kerr, with the help of John J. Flaherty, a Commission employee at Oak Ridge, completed a study which recommended Commission action on five articles in the Carbide contract and four in the Monsanto agreement.[21]

The panel accepted Kerr's recommendations early in February, and Belsley urged immediate discussion with the top leadership of the two unions. Although sympathetic to the idea, Wilson decided to postpone the meeting with Green and Murray until the Commissioners had been confirmed. Continuing unrest at Oak Ridge made that decision a calculated risk, but quick action in summoning experts had at least averted the immediate threat to the production of fissionable materials.

WHITHER RESEARCH?

As general manager, Wilson not only had to be ready to act quickly but also had to anticipate demands. Even before the General Advisory Committee met on January 3, he had set the formulation of a research and development program as a high priority. This was not a job for the research division in Oak Ridge, which was mostly responsible for administering Manhattan District contracts, or for the handful of temporary staff in his Washington office. First, he needed a director of research, a man of stature as a scientist and experience with research policy. The General Advisory Committee had set the tone in the list of distinguished scientists it had suggested for the job. Despite the impressive roster, Wilson had little trouble picking James B. Fisk. The same age, they had been roommates at MIT during the early thirties. While Wilson was serving as assistant to Compton and Bush, Fisk had studied at Cambridge and Harvard, taught physics at MIT, and become assistant director of physical research at the Bell Telephone Laboratories at the age of twenty-nine. Although he had devoted most of his energies during World War II to electronics and radar, he had learned enough about nuclear physics before the war to outline a proposal which alerted the British to the plutonium route to the weapon. An outstanding physicist well known to members of the General Advisory Committee, Fisk in directing industrial research at the

Bell Laboratories had gained experience which would be valuable to Wilson and the Commission. Fisk accepted the appointment on January 15.[22]

This was fast action on Wilson's part, but not fast enough to help him meet the deadline for the report to the advisory committee. The directors of the atomic energy laboratories were scheduled to meet at the University of California in Berkeley late in January. Wilson asked them to reschedule their meeting in Washington on January 16 in order to draft the report on research and development.

The group which assembled in Washington included some of the brightest stars in the galaxy of scientists who had participated in the wartime program. From the Argonne National Laboratory in Chicago came Walter H. Zinn, a student of Fermi's, who had directed construction of three experimental reactors, and Norman Hilberry, wartime assistant to Arthur H. Compton at the Metallurgical Laboratory; from the Radiation Laboratory at the University of California, Berkeley, Ernest O. Lawrence, the laboratory's dynamic founder and inventor of the cyclotron, and Edwin M. McMillan, the youthful codiscoverer of neptunium and inventor of the synchrotron principle; from the Clinton Laboratories at Oak Ridge, Tennessee, Eugene P. Wigner, the theoretical physicist who had conceived many of the early design principles for reactors, and Charles A. Thomas, an industrial chemist who had coordinated development of the plutonium weapon; from Los Alamos, Norris E. Bradbury, who had directed assembly of the Alamogordo device; from the new Brookhaven National Laboratory, Norman F. Ramsey, who had helped assemble the first atomic weapon on Tinian; and from the Ames Laboratory at Iowa State College, Frank H. Spedding, who had broken the bottleneck on uranium metal production for the world's first reactor.[23]

By prewar standards, the research activities described by the laboratory directors were impressive. Totaling thirteen contracts, the entire program would cost about $60 million in fiscal year 1947. Almost half this amount would go to the Clinton Laboratories at Oak Ridge. The Argonne National Laboratory, specializing in reactor development, would require more than $11 million. The Radiation Laboratory at Berkeley and the new Brookhaven Laboratory on Long Island would need about $6 million each and the new General Electric laboratory at Schenectady almost as much.

Just as impressive, however, was the task facing the Commission. The Army had supported the laboratories to meet the exigencies of war. Once the war was over, General Groves and his assistant, General Nichols, had kept the laboratories alive by authorizing modest short-range projects which would begin the transition from strictly military work to more general research. But the War Department was understandably reluctant on the strength of its wartime authority to do much more than hold the line. In the eighteen months since Hiroshima uncertainty and lack of purpose had sapped morale, and many of the scientists had returned to academic posts. True enough, Nichols had taken some steps to turn the larger wartime projects into national

laboratories which would serve as regional research centers, but so far the changes were more in name than in fact.[24] The Commission had not inherited a research program but a collection of laboratories, all uncertain of the future and each pursuing an independent course.

If not an ideal forum for drafting a comprehensive research program, the meeting of laboratory directors at least enabled Wilson and his staff to explore the scope and diversity of laboratory activities. It was also an advantage to have the discussion led by such impressive authorities as Zinn on reactors, Wendell M. Latimer on chemistry, Wigner on physics, Lawrence on accelerators, and Spedding on metallurgy and ceramics. At the end of the meeting, Wilson asked each of them to prepare a portion of the report to the General Advisory Committee.

The biggest assignment fell to Zinn; for, as he told his staff at Argonne the following week, the Commission's research program seemed primarily a matter of reactor development. Weapon research would be important too, but the Commission intended to segregate that work in a special compartment. The Commission would need reactors not only to produce plutonium for weapons but also as a radiation source for the production of radioisotopes and for general research. There was also widespread public interest in using reactors to generate electric power.[25]

In drafting his section of the General Advisory Committee report, Zinn stressed power reactors. Here a fact of supreme importance was the shortage of fissionable material. Existing stocks of uranium ore seemed scarcely large enough to sustain production of a modest number of weapons, to say nothing of providing fuel for power plants. Zinn believed that the only hope for power reactors lay in those which would breed more fissionable material than they consumed. Such a reactor would operate on the principle that theoretically each fissioning nucleus of uranium or plutonium released on the average slightly more than two neutrons. If one neutron sustained the chain reaction, the second and the occasional third neutron might be captured by nuclei of fertile material to create two atoms of fissionable material where one had existed before. Thus a breeder reactor might produce power and at the same time augment the nation's small stocks of fissionable material.

Translating the breeder principle into practical hardware would be extremely difficult. Because the chances for breeding seemed marginal at best, neutron production and economy would be controlling factors in breeder designs. A complication was the fact that, while breeding seemed to improve with an increase in the energy of the neutrons used in the reactor, power-generating capabilities declined. Zinn described two approaches to this difficulty. At Argonne he was designing a small reactor which would use high-energy or "fast" neutrons. The new General Electric laboratory at Schenectady would try to compromise on power production and breeding by searching for an optimum intermediate-neutron energy. The low-energy or "thermal" reactor which Farrington Daniels and his associates were designing at the Clinton

Laboratories would concentrate on power production with no consideration of breeding.

Zinn's report noted that the Commission already had several reactors operating for research purposes: the rebuilt Fermi pile and a small heavy-water-moderated reactor at Argonne; two small reactors at Los Alamos; one test reactor at Hanford; and the X-10 graphite reactor at Clinton, which produced both large quantities of radioisotopes and radiation for research. None of these units, however, met the greatest need of the scientists, a reactor with a very large flux of neutrons and a number of large access ports for irradiating a variety of materials, including reactor components. The Clinton Laboratories had started designing a high-flux reactor, but Zinn predicted it could not be completed quickly. He estimated that six reactors then being developed would cost $30 million and would require an inventory of 280 kilograms of uranium 235. He guessed that the reactors would consume about
30 34 kilograms per year and might generate as much as 14 kilograms of new fissionable material.

Zinn was not entirely sure what the report should contain, and he had little time to write it. Only by working into the weekend in a Washington hotel room was he able to complete it for the meeting of the General Advisory Committee on Sunday morning, February 2.

Oppenheimer called the meeting to order shortly before ten in a huge, three-story-high conference room in the New War Department Building. In addition to all the members of the committee, three Commissioners and several members of the Military Liaison Committee were present. Oppenheimer explained why the military officers had been invited. A few days before he had asked Lilienthal to supply the committee with information on the weapon stockpile and production rates. The information was so sensitive that Lilienthal was willing to provide it only orally with military representatives present, and only with a general accuracy "within a plus or minus 20 percent." After the staff had left the room, Bacher, who had just returned from Los Alamos, related the information which a few weeks earlier had been known only to General Groves and a very few of his Manhattan District personnel. It was a dramatic moment as those present closed their notebooks and Bacher recited the magic numbers.[26]

Because the research and development report was less sensitive, the committee could consider it in written form. Oppenheimer began by describing the report prepared by the Scientific Panel to the Interim Committee in September, 1945.[27] That report had cited the greatest opportunities for progress in developing weapons, reactors, and radioisotopes for research. From the oral and written reports now before the General Advisory Committee, Oppenheimer understood that there had been "no real exploration of new weapons," either of the fissionable or thermonuclear type; no new reactor had been built and no reactor development program had been organized in the

intervening seventeen months. Only in the production of isotopes in the Clinton reactor had the expectations of the Scientific Panel been realized.

As the discussion proceeded, Oppenheimer saw the dilemma facing the committee. If the program had been weak in only one area, the committee might easily have recommended greater effort there. But a general deficiency called for either a large increase in support for all activities or a more careful allocation of available resources. After lunch, Oppenheimer began to think out loud on the subject. As well as he understood the value of weapons, he could not give reactors a second priority. Remembering the spirited discussions of the Lilienthal board of consultants just a year earlier, he dwelt on the extraordinary opportunity to transform public understanding of atomic energy from a specter of war into a promise for peace by developing reactors for the production of power. Perhaps with a top priority it might be possible to obtain some power from a reactor in a year or two.

Fermi acknowledged similar hopes for the peaceful atom, but the dangerous international situation pushed him inexorably to the conclusion that weapons commanded the first priority. He urged an increase in plutonium production, a test of existing weapons, and development of a thermonuclear weapon. The achievement of nuclear power would have good psychological effects, but it would not mean much if the Commission did not greatly increase the supply of fissionable materials. Most of the other members agreed. The discussion of the relative importance of weapons and reactors soon gave way to an exploration of the weaknesses of the weapon laboratory at Los Alamos.

Perched on a remote mesa near Santa Fe, New Mexico, the laboratory at Los Alamos was but a shell of the wartime organization which had developed the first atomic bomb. Most of the well-known scientists had left in 1945, and the dilapidated temporary buildings stood as sorry monuments to better days. Housing and community facilities, substandard even during the war, were now intolerable. Some members of the committee believed that the leadership at Los Alamos was at best inexperienced and uninspired; most of the remaining scientists, though perhaps of average ability, seemed to lack the spark of genius which had been considered a necessary ingredient for success during the war. Would it be possible to develop new weapons under such conditions? Would it be better to move the laboratory to another location? Could outstanding scientists be induced to join the laboratory staff?

Although Oppenheimer marveled at the ability of his colleagues to find the heart of the issue, he was still reluctant to accept the conclusion that the production of weapons and the development of improved models would be necessary in the postwar world. Accepting that conclusion, however disheartening, Oppenheimer argued for a strong laboratory at Los Alamos. It would do no good to move the laboratory without recruiting better leadership and staff. Perhaps, he suggested, a strong reactor program would have greater

appeal to the exceptional scientist than the development of thermonuclear weapons. Rabi feared that a reactor program at Los Alamos would spread the Commission's effort too thin. He felt there was already too much competition between laboratories.

In the end, agreement within the committee was almost unanimous. The first aim should be to revitalize Los Alamos and accelerate weapon research, especially on thermonuclear models. In reactor development both Fermi and Oppenheimer now gave highest priority to improvement of the plutonium production units at Hanford. They listed next the development of a power-breeder reactor and a high-flux test reactor, although they differed on the order of priority. For most of the members, the choice of the weapon alternative stemmed from a sense of duty, not enthusiasm. The hard realities of 1947 were fast replacing the heady idealism of 1945.

WEAPONS

The high priority assigned by the General Advisory Committee to weapon development and production would have pleased Norris E. Bradbury had he witnessed the discussion on February 2, 1947. A National Research Council fellow in physics, he had taught at MIT and Stanford before joining the Navy in 1941. As a naval officer he had had a key assignment at Los Alamos during the war and had succeeded Oppenheimer as director of the laboratory in 1945. Being Oppenheimer's successor was difficult enough, but Bradbury's position was otherwise precarious. In its discussions the committee seemed to assume that Bradbury's assignment was temporary. Either the laboratory would be disbanded or he would be replaced by a scientist of greater reputation. Some members of the committee believed that, whatever Bradbury's competence as a scientist, he lacked the stature to be director of the nation's atomic weapon laboratory.

If Bradbury sensed the uncertainty of his position, his actions did not suggest it. His determination to rebuild Los Alamos and strengthen research on weapons helped him to overcome the frustrations of poor facilities, demoralized staff, and, worst of all, indecision. Soon after the Commission was established in November, 1946, he submitted a comprehensive plan for research at Los Alamos, but there was in fact no one to receive it. The Army passed the report along its chain of command in the Manhattan District to Lilienthal, but the Commission's infant headquarters organization contained no one except Bacher with a knowledge of weapons.[28]

Essential to policy guidance on weapons was selecting an Army or Navy officer to serve as director of military application. In December, 1946, when the Commission had asked the service secretaries for recommendations, the only officer proposed was General Nichols, who had been General Groves's

deputy in the Manhattan project. The Commissioners admired Nichols's ability but wanted to assure a clean break from the wartime administration. The Commission responded by asking the service secretaries for additional names, a request which Secretary of War Robert P. Patterson referred to Lauris Norstad, an able young Army Air Force general who was chief of the plans and operations division of the General Staff.[29]

Norstad surmised that the Navy would nominate prestigious admirals like William P. Blandy, who had directed the nuclear weapon test at Bikini in 1946. He observed that both Lilienthal and Wilson were young men. Would it not be wise to propose a number of officers spanning a range of years? Thus he suggested officers ranging from Lieutenant General Wilhelm D. Styer, age 53, to Lieutenant Colonel Andrew J. Goodpaster, age 32. As Norstad expected, the Commission found the new Army list promising, but he did not anticipate the immediate result. Wilson's telephone calls to Bush during the first week of January revealed Norstad as the author of the Army list. Informal discussions with Norstad convinced Lilienthal, Pike, and Wilson that the general himself should be considered for the position.

When neither Patterson nor General Dwight D. Eisenhower would consider releasing Norstad, the Commission selected from the middle of the Army's list a young officer from Norstad's own staff, Colonel James McCormack.[30] A Rhodes scholar following his graduation from West Point in 1932, McCormack had studied engineering at MIT. He had met Wilson during the war, when he had served as secretary to the Joint Committee on New Weapons, of which Bush was chairman. An intelligent young man with broad interests, McCormack had a flexibility that would make him a good staff officer. He had been uncertain about his future in the Army and accepted his new assignment as a rare opportunity for a productive military career. On its part the Commission considered McCormack worth the two months of negotiation with the Army which his selection required. As soon as the Commission could effect McCormack's transfer to his new job as a brigadier general, he could begin to help the Commission remove the uncertainties that were crippling Bradbury's efforts at Los Alamos.

RESEARCH AND DEVELOPMENT

James Fisk, the new director of research, was on the job before McCormack had been selected. He had the advantage of attending the General Advisory Committee meeting in early February and hearing the discussions of the relative importance of weapons and reactors. But the difficulties of Fisk's assignment counterbalanced any head start he might have enjoyed. In contrast to McCormack, whose responsibility largely involved one mission at one site, Fisk had to direct a broad range of vaguely defined activities in a dozen

laboratories. To make matters worse, working conditions in many of the laboratories were chaotic and morale was low as a result of the delays in organizing postwar programs. John H. Manley, a veteran physicist in the atomic energy project and seasoned observer of laboratory operations, drew a disheartening picture of conditions at the Clinton Laboratories at Oak Ridge in February, 1947. Recently appointed the executive secretary of the General Advisory Committee, Manley described his visit to Oak Ridge in a frank report to his old friend and new boss, Oppenheimer.[31]

Manley found the disagreeable living and working conditions in the temporary buildings at Oak Ridge complicated by poor organization. At least three groups participated in policy decisions in the laboratory, and all were to some extent working at cross purposes. The scientists under Wigner's leadership were the remnants of the original team which conceived the design for the Oak Ridge and Hanford reactors during World War II. Impatient to
34 resume fundamental research in nuclear physics interrupted by the war, the scientists concentrated their attention on the high-flux reactor and tended to regard short cuts to a power reactor as stunts. They also maintained the academic tradition of regarding Government regulations as senseless interference with their work.

The second group consisted of a few scientists and a larger number of engineers brought to Oak Ridge by the Monsanto Chemical Company, which had assumed the operating contract for Clinton from the University of Chicago in the summer of 1946. The original group resented the efforts of the Monsanto leadership to consolidate activities and to regularize procedures in the laboratory as an attempt to transform them into company men. As a result, the Monsanto project to develop the gas-cooled power reactor suggested in early 1946 by Farrington Daniels was isolated from other work in the laboratory.

The third group included the Army officers and civilian employees who had administered the contract during the war for the Army and who now were employees of the Commission. With little policy guidance from Washington, they had no choice but to use the regulations established during the war or, when this proved impossible, to guess in which direction the Commission would wish to move. During the war both the mission and lines of authority were clear. As these dissolved in 1946 and early 1947, misunderstanding and frustration crippled the laboratory.

Manley believed the unfavorable atmosphere in the laboratory damaged the quality of research. As a physicist he could appreciate the efforts of Wigner, Alvin M. Weinberg, and others who were designing the high-flux reactor, but he found the prospects for the reactor difficult to judge in the absence of a clear purpose. Certainly the reactor would be an important research tool, but he heard talk of building a high-temperature region into the reactor as a power experiment. Such a facility might obviate the need for experimental power reactors such as the Daniels reactor, but would it not

reduce the reactor's value for research? In the Monsanto project, Manley had little confidence. Originally intended as a quick demonstration of the peaceful potential of atomic energy, the Daniels reactor was losing its identity as a power producer. Development studies had revealed technical obstacles which either reduced the possibility of building a practical power reactor or threatened to delay completion long enough to eliminate the advantages of early construction.

Manley found many scientists at Oak Ridge so discouraged that there was again talk of merging Clinton with the new Brookhaven Laboratory, either on the proposed Long Island site or at another location. A merger would make better use of the still-short supply of nuclear scientists and presumably would result in a laboratory better situated for contacts with leading universities and access to the skilled labor market. Some feared that the proposed merger would lead to domination by certain strong leaders in the Brookhaven organization like Rabi, a member of the General Advisory Committee. For everyone at the Clinton Laboratories the future was uncertain and for many it seemed hopeless.

FIELD OPERATIONS

Whether the General Advisory Committee gave first priority to weapons or reactors, success would depend on an adequate supply of fissionable materials. This responsibility the Commission assigned early in January, 1947, to Walter J. Williams, an engineer with fourteen years of construction experience in the Army. After supervising the building of several ordnance plants for the Army in the early years of the war, Williams had gone to Oak Ridge to direct construction of the electromagnetic separation plant for producing uranium 235. In 1945 he became Groves's production chief at the Oak Ridge gaseous-diffusion plant and later director of all production operations for the Manhattan District. With more interest in engineering than in the Army, Williams was pleased to retire as a colonel in 1946 and take a civilian job under Groves as director of field operations. He first met Wilson in November, 1946, and soon thereafter Wilson asked him to continue in the same job, at least until the general manager could organize his headquarters staff. The Commission appointed Williams director of production, but he continued to spend most of his time in the field assignment during the winter and spring of 1947.

The variety and number of problems confronting Williams would have dismayed a lesser man. During the last three days of February he fixed policy for the disposal of surplus equipment, selected consultants to study the gaseous-diffusion plant, determined prices to be charged for radioisotopes, revised the schedule for constructing the new weapon component plant near

Dayton, Ohio, negotiated a security supplement to a major construction contract, ordered the disposal of a surplus production plant, negotiated a contract for operation of the Y-12 electromagnetic plant at Oak Ridge, approved a proposal for architect-engineering at the new Argonne National Laboratory near Chicago, ordered an inspection of the new General Electric laboratory near Schenectady, advised headquarters on personnel ceilings, established the Commission position in a labor dispute at Oak Ridge, and approved hiring forty security guards for production plants at Hanford.[32]

To all these matters Williams brought a practical realism which helped him to go about an impossibly big job with poise and determination. He understood his assignment—to maintain the steady flow of materials from uranium mine to weapon plant—and he had little time or interest for tasks not related to that goal. At times he was impatient with the organizational jockeying and groping for policy in Washington. He grumbled about the interruptions by smart young gadflies on the Washington staff, but he had a natural loyalty and simple integrity which made it possible for him to work hard and without reservation for a younger and less experienced superior. Williams sometimes thought Wilson's approach idealistic and off the point, but he appreciated his superior's willingness to listen and act on the basis of facts. Although he understood every nuance of the Army system in the Manhattan District organization, Williams did not let the system dominate him. Nor was he cowed by Nichols or Groves, with whom he could disagree openly.

Certainly the difficulties facing the huge Tennessee installation deserved more attention than Williams could give them. The Commission's quick action in taking a position on the union contracts at Oak Ridge had removed the immediate crisis, but Williams found the issue far from settled. Complaints from the CIO leaders about Carbide labor practices kept him in constant touch with Colonel Curtis A. Nelson and the industrial relations staff. The dispute seemed mostly to involve administrative details, but Williams never lost sight of the fact that a labor walkout even for a few hours in the gaseous-diffusion plant might do irreparable damage to facilities for producing uranium 235.[33]

Nor was Williams able to avoid the entanglements of community problems. The three "atomic cities" at Oak Ridge, Hanford, and Los Alamos placed upon the Commission unprecedented peacetime responsibilities for community management. The three communities were much more than company towns in the usual sense. Not only did the Government own all the land and the buildings, but the Commission had also assumed from the Army the operation of all municipal facilities, schools, commercial establishments, local transportation, and government. No one could even visit Oak Ridge or Los Alamos without a Commission pass, much less live there without permission. Beyond the short-term administrative techniques of community management

lay the task, happily unfamiliar to most Americans, of replacing a structure of total Government control with the institutions of democratic society.

In the winter of 1947 Williams's responsibilities extended to all three towns, but he concentrated his efforts at Oak Ridge. It was the largest community and had more than its share of difficulties. The Army had been able to do little to transform the hastily built temporary wooden structures on the scarred mud hillsides into a permanent town. As Colonel Paul F. Kromer reported in January, construction standards at Oak Ridge during the war had been at the barest minimum. After the war instructions were to plan ahead for only ninety to one hundred days. As a result schools were first improperly located and then overloaded, commercial facilities were inadequate, and office space, shops, service, and recreational units were substandard or too expensive for long-term operation. Since the Army had not planned the town as a permanent community, the Commission would have to begin with detailed surveys of existing facilities and a master plan for construction. Somehow Kromer had to develop plans for community improvements to be incorporated in the Commission's 1948 budget, then in preparation.[34]

BALANCING PRODUCTION AND RESEARCH

Williams's broad responsibilities as director of field operations involved him in every phase of the Commission's activities during the winter of 1947. Until Wilson could organize his headquarters staff and appoint deputy general managers to take over the field offices, Williams found himself in the curious position of making decisions which under normal circumstances would have fallen to other division directors or the general manager. As director of production Williams could be expected to take a firm hand in matters concerning the major production sites, but his responsibilities in the research area and even in some aspects of weapon production sometimes surpassed those of Fisk and McCormack. This was particularly true in administration of the laboratories. Fisk, as a personal friend and confidante of Wilson's, concentrated on policy issues and preferred for the time being to leave administration to Williams and his staff of Army officers at the various field installations. This division of responsibility had the advantage of keeping contract administration in the hands of Williams's experts. There was the added benefit that Williams, with direct control over both production and research activities, was in an excellent position to explore the fundamental question of finding a proper balance between these two cardinal endeavors.

One thing that drew Williams into research activities was the impatience of the laboratories to begin new construction after the long moratorium imposed by the Army. Because Wilson had not yet been able to organize the

division of engineering in Washington, Williams had to assume responsibility for major construction projects. This in turn involved him in contract negotiation, contractor selection, site acquisition, and procurement. At the University of California in Berkeley, Lawrence and his staff wanted new buildings and equipment for research in high-energy physics. Spedding needed a permanent building for metallurgical research at Iowa State College in Ames. The letter contract with Associated Universities, Incorporated, in January, 1947, brought new pressures on Williams to speed plans and contractual arrangements for the new Brookhaven National Laboratory. Even more pressing were the demands coming from Zinn and the University of Chicago to begin construction of new facilities for the Argonne National Laboratory, still housed in a dozen university buildings on campus. Not until January, 1947, did the Commission give up on acquiring land in the Argonne Forest Preserve south of Chicago and agree on a site southwest of the city in Du Page County. Williams's staff at Chicago needed more than a month to make plans for acquiring the 3,500 acres in the site. On March 11, Williams himself went to Chicago for construction contract negotiations with William B. Harrell, the university's business manager.[35]

As in community matters, Williams found his greatest troubles with the laboratories right at home in Oak Ridge. The sagging morale and pessimism which Manley had noted at the Clinton Laboratories in February were, if anything, worse in March. There was no reason to believe that the laboratory would even continue to exist. While waiting in vain for some sign of encouragement or decision from Fisk, Wilson, or the Commissioners in Washington, Wigner and James H. Lum, the laboratory's codirectors, endured as best they could what they saw as indifference or harassment from the military officers on Williams's Oak Ridge staff. These differences came to a head on March 12, when Williams returned from his trip to Chicago. He learned that the scientists were conducting experiments with a critical mass of uranium 235. Colonel Walter P. Leber, Williams's representative at the laboratory, had warned Wigner that the experiment violated an order issued by General Groves in August, 1946, requiring the laboratories to submit to his office for prior approval written descriptions of all critical experiments. Wigner thought that Groves's order had been superseded by the laboratory directors at their meeting in Washington in February, 1947.[36]

The report alarmed Williams. Groves's order of the previous summer was designed to prevent the recurrence of an accident during a critical experiment at Los Alamos, which had taken the life of one scientist and injured several others.[37] Late in the afternoon Williams called Wilson in Washington to report that he intended to stop the experiments until Wigner complied with the regulation. With Wilson's support, Williams the following morning called Lum to insist the experiments be halted. A few minutes later Wigner called back. Unable to conceal his anger, Wigner admitted that the laboratory had been late in forwarding a written plan for the experiment, but

he insisted the order from Groves was no longer in effect. Stopping the experiment now would cause great damage. Williams suggested that continuing the experiment might have the same result. He was disturbed that Wigner had ignored the warning from Colonel Leber. Wigner retorted that he took his orders from Charles A. Thomas and the Monsanto organization in St. Louis, not from Leber.[38]

Ultimately Wigner had no choice but to comply with the order, but his slender frame seethed with indignation. Pouring his frustrations by telephone into Thomas's sympathetic ear, Wigner decried what he saw as heavy-handed interference with scientific research. The experiment was nothing like the one which caused the accident at Los Alamos. It involved neutron measurements in a lattice arrangement of uranium 235 suspended in water. If such an elementary experiment in studies for the high-flux reactor could not be undertaken without administrative interference and delay, what hopes were there for any real development of power reactors?

In two weeks Wigner obtained the necessary administrative approval for the experiment, but the incident left its scars. It impressed Williams with the urgency of replacing held-over Army regulations and administrative practices with new, up-to-date procedures. For Wigner and the Monsanto organization, the incident shook their confidence in the future of the Clinton Laboratories. All could hope the dispute was but an isolated incident provoked by the transfer from Army to Commission control, but it could also be a forecast of more trouble ahead.

The following week brought Williams closer to the activities of other installations. On Monday morning, March 17, he was up before dawn and bounced over back-country Tennessee roads to the Knoxville airport where he boarded the converted B-25 bomber which the Commission had inherited from General Nichols. Before noon he was in Schenectady, where he inspected two buildings which General Electric was remodeling for its atomic power laboratory. Reviewing plans for the laboratory, he was surprised to learn that the ultimate cost was expected to be more than $40 million, far more than figures quoted earlier. He suggested that the company assemble its plans and ask Wilson for an appointment to discuss them with the Commission.

Williams was even more concerned about General Electric's plans for the plutonium production plants at Hanford. Harry A. Winne, a vice-president who had served on the Lilienthal board of consultants in 1946, told Williams that the company planned first to build new housing to replace some of the temporary wartime structures and to add storage tanks for the highly radioactive waste materials coming from the huge chemical plants which separated plutonium from the irradiated slugs of uranium.

Williams thought Winne's plans were inadequate. They would scarcely permit Hanford to maintain its present rate of production, which Williams viewed with growing concern. Plutonium production was a fraction of its wartime rate. Sustained operation of the three production reactors in 1945

had caused expansion of the large graphite block within the reactor shield. This expansion had distorted the aluminum tubes which contained the uranium slugs and through which the cooling water flowed. Unless some way could be found to stop this expansion, all three reactors might become inoperable within a few years. As a form of insurance, the Army had ordered the oldest reactor (B) shut down and placed on stand-by early in 1946. The two remaining reactors (D and F) were operating at reduced power to conserve their lives.[39]

Equally ominous were the prospects for separating plutonium from the slugs discharged from the reactors. The chemical separation plants built at Hanford during the war were still operating, but the process recovered only the plutonium, the great quantities of uranium in the slugs going into underground tanks with the highly radioactive fission products and wastes. There was something ironic and even alarming in the fact that the Commission, facing extreme shortages of uranium ore, was using a process which rendered most of its uranium useless. Seaborg and other chemists at the Chicago Metallurgical Laboratory had advocated developing a better process, but the Army was reluctant to authorize research which was clearly for postwar application. The Clinton, Argonne, and Hanford laboratories were all studying alternative processes on a small scale, but much greater effort would be required to stop the wasteful diversion of the Commission's dwindling ore supplies.

40

All this meant to Williams that General Electric should give top priority to the new chemical separation process called "Redox" and to plans for a new production reactor. He also wanted the company to study the possible hazards which might result from radioactive gases released from the chemical separation plants and to make plans for performing at Hanford the final steps in plutonium metal purification, still accomplished in inadequate temporary facilities at Los Alamos. Williams suggested that General Electric concentrate on Redox while he would find other contractors to help on the stack gas problem and the plutonium metal plant.

Early the next morning Williams flew to New York for meetings with Wilbur E. Kelley, a young engineer whom he had met at the Y-12 production plant in Oak Ridge during the war. Recently Williams had sent Kelley to New York to take over what the Army had called the Madison Square Area, which directed the raw materials program and handled other procurement activities in the Northeast. Information which Kelley was collecting for a written report to Wilson must have increased Williams's concern about the Redox process. Kelley estimated that to keep all operating plants going the Commission would have to provide large stocks of uranium ore to the St. Louis refinery. For the year ending April 1, 1948, the Commission could anticipate receiving 3,125 tons of uranium oxide (U_3O_8), most of which would come from the Shinkolobwe mine in the Belgian Congo. Virtually all of this concentrate would go into production channels on delivery. Since some of the material

would be used to build up stockpiles, requirements for the following year would be somewhat smaller. Williams realized, however, that a substantial increase in ore procurement was necessary.[40]

Then Williams and Kelley met with Philip M. Morse, director of the Brookhaven National Laboratory, and Eldon C. Shoup, executive vice-president of Associated Universities, a corporation of nine universities in the Northeast, which would operate the laboratory. Preliminary plans called for a research reactor similar to the X-10 unit at Oak Ridge, a "hot" laboratory for processing irradiated materials from the reactor, and several accelerators in addition to general research facilities. But so far little had been done to transform the former Army camp into a laboratory. Most of the discussion centered on plans for the accelerators and housing for the scientists. Williams, perhaps thinking of headaches in the Oak Ridge community, opposed the suggestion that the Commission build any of the housing. He also told Kelley to negotiate a definitive contract to replace the letter agreement which the Commission had approved in January, 1947.[41]

Later on the afternoon of March 18 Williams again boarded his plane for a flight to Washington to pick up Wilson before making the longer trip over the mountains to Knoxville. This was Wilson's first visit to Oak Ridge as general manager, and Williams had arranged two full days of meetings and inspections. The staff meetings on March 19 and 20 gave Wilson a good feel for the caliber and morale of Oak Ridge personnel, and visits to K-25, Y-12, and X-10 gave him an opportunity to verify reports of the superb operation of the gaseous-diffusion plants and the administrative difficulties plaguing the Clinton Laboratories. On the latter subject he found particularly helpful the discussions at dinner on March 19 with Charles Thomas and Carroll A. Hochwalt, Monsanto vice-presidents who had general responsibility for the company's operations in the Oak Ridge laboratory and in weapon component facilities at Dayton, Ohio. Wilson had gone to Oak Ridge a year earlier with Thomas as a member of the Lilienthal board of consultants and had known Hochwalt as a scientist with the National Defense Research Committee during the war.[42]

The discussion aptly illustrated the fundamental question of balancing production and research activities. Like General Electric, Monsanto was deeply committed in both efforts. Wilson, to be sure, was concerned about Monsanto's troubles in the Clinton Laboratories, but these were overshadowed by his growing anxiety over construction progress on the new weapon component plant near Dayton. The neutron initiator which Monsanto had produced for the Army during the war was a critical part of the atomic weapon. The temporary wartime facilities had been adequate for producing on a laboratory scale the few units needed to win the war, but not for normal operations on a production scale. Williams had given construction of the new plant at Miamisburg, Ohio, the highest priority, and Wilson was anxious to extend the Monsanto contract, which would expire in June, 1947. After

talking with Thomas and Hochwalt he was ready to recommend a four-year extension and amendments which would provide the company with a fee rather than payments for overhead. For strategic reasons Wilson also wanted a second production plant for the same component at another site, but to maintain secrecy he wanted Monsanto to operate it.[43]

FIRST SUMMATION

The trip to Oak Ridge had been a good change of pace for Wilson and helped him to see for himself some of the questions which were rapidly approaching decision. He was pleased that he had been able to reach an understanding on the Monsanto contract and found further encouragement on Friday morning, March 21, 1947, when Winne called to say that General Electric was acting on
42 Williams's suggestion and wanted to discuss their hopes for the Schenectady laboratory and the Hanford plant. Wilson put the meeting on his calendar for Wednesday morning, April 2. That would be just a few days after the next meeting of the General Advisory Committee, scheduled for the weekend of March 28.[44]

The intervening week proved to be hectic. It started on Saturday morning when Wilson moved into his new office in the Commission's permanent headquarters building. Just a few blocks east of the temporary offices, the building at Nineteenth and Constitution Avenue, N.W., had been built in the middle thirties for the Public Health Service and had been the wartime headquarters of the Joint Chiefs of Staff. Only recently returned to the Surgeon General, it was virtually vacant. The building had the advantage of being near the White House and the major Executive departments, but Wilson thought its best feature was its small size, which would accommodate no more than 350 people comfortably and had little room for expansion. This fact would give him a good argument against appeals for increases in the headquarters staff.[45]

Monday brought the weekly staff meeting, discussions of security matters with Jones, a short Commission meeting, and a half hour with McCormack, who brought in a vigorous objection from the Military Liaison Committee about the small amount of space available in the new headquarters building. Not until dinner with Fisk was Wilson able to consider the policy papers which the staff was preparing for the meeting with the General Advisory Committee on Friday. Tuesday was even worse, with a dozen conferences on organization and personnel matters, a Commission meeting, business over lunch with Fisk, a meeting with University of Chicago officials about the Argonne construction project, a trip to FBI headquarters to discuss security arrangements with J. Edgar Hoover, and a late afternoon session to make plans for forthcoming discussions with the British. Wednesday and Thursday were equally crowded. At dinner on Wednesday Strauss told him of

renewed complaints from the Navy about the military space assignment; on Thursday evening Wilson worked with Fisk on last-minute preparations for the advisory committee meeting.[46]

At the opening session on Friday, March 28, Wilson reported the steps he had taken to strengthen weapon production.[47] The Commission on Wednesday had approved double shifts for construction of the Miamisburg plant, and he had offered Monsanto a four-year extension of the contract which would expire in June. He had accepted McCormack's recommendation to keep the weapon laboratory at Los Alamos. He intended to strengthen the laboratory and to create normal living conditions at that remote location. He had extended the operating contract with the University of California to July, 1948. He had also discussed with the Military Liaison Committee the need for testing atomic weapons and proposed to prepare a policy paper on testing. On research activities Wilson said he had authorized Zinn to find a site at Argonne for the fast-breeder reactor, and he had told the University of Chicago that he would extend the contract for operating the laboratory for four years.

Wilson was now ready to discuss the policy papers which he hoped would lead to a solution to the Commission's most pressing operational problems. He began by describing the difficulties he had faced in taking over the project from the Army. It was one thing to understand the widespread activities the Commission had inherited; it was something else to act quickly enough. There was a real emergency in weapon production. The precarious condition of the Hanford reactors, the lack of critical weapon parts, the dreadfully inefficient plutonium separation process, the impending expiration of many operating contracts, the deplorable state of preparations for the 1948 budget, all were matters weighing on Wilson's mind. The need for quick decisions was apparent.

Wilson's policy papers reflected the sense of urgency which crept into his opening remarks. Though phrased in the tentative language of preliminary proposals, they implied some far-reaching decisions. To assure speedy action Wilson hoped the General Advisory Committee would consider his policy papers that weekend.[48]

After Wilson departed, the group heard three reports from its own subcommittees. Cyril Smith's paper suggested that the Commission concentrate on the fast-breeder and high-flux reactors and give only limited study to the General Electric and Daniels units. In reporting on weapons, Conant cited the need for tests and Fermi urged realistic theoretical studies of thermonuclear designs. Seaborg's report argued that a substantial increase in plutonium production would depend more on additional reactors at Hanford than on breeders. It was inconceivable that the Commission could continue to dump the large quantities of irradiated uranium into the waste tanks at Hanford. He explained research completed on the Redox process, which would use solvent extraction techniques to recover both uranium and pluto-

nium. As a matter of fact, Seaborg pointed out, the successful development of breeding might well depend upon a process such as Redox to separate the plutonium bred in a reactor from uranium 238.[49]

On Saturday morning, March 29, 1947, Oppenheimer began the discussion of Wilson's policy papers. The first paper proposed "that for effective concentration on urgent problems and for security," the Commission's primary activities "be conducted as completely as possible with Atomic Energy Commission facilities, essentially disentangled from nonprogrammatic, fundamental research." This idea intrigued the committee; for it seemed to be suggesting a centralized Commission laboratory. The committee retraced the arguments at the February meeting: the disadvantages of geographical separation of scientists in the existing laboratories, the difficulties of finding leadership and scientific talent for several laboratories, and the danger of harming morale by attempting to move existing groups to a central location.

Fermi in particular was concerned about the last point. He did not see how the group working on the high-flux reactor at Oak Ridge could be summarily directed to transfer to Argonne. He agreed that centralization was necessary, but did that require geographical consolidation? Would it not be better first to establish direction in Washington? Fermi was willing to approve Wilson's proposal in the general terms in which it was presented, but he was reluctant to add the more specific suggestion that the Commission consider establishing a central laboratory. Tentatively the committee decided both to approve the proposal and to add the suggestion.

One reason for a tentative decision was its relationship to the other policy papers Wilson had submitted. For example, in the second paper Wilson proposed a hard line with General Electric on its responsibilities at Hanford, in contrast with its interest in the new nuclear research laboratory at Schenectady. Wilson wanted much more effort than the company proposed on Redox, uranium waste recovery, production reactor replacement, and extension of existing reactor life and much less work on power reactors. The committee recommended a softer approach. The Commission should establish definite priorities for the work at Hanford and then explain to the company the full scope of its plans for renovating and enlarging production facilities at Hanford. If the General Electric officials understood, as the committee did, the Commission's tentative plan to replace the three existing reactors and the associated chemical separation facilities, the company would better appreciate the need to concentrate on production activities. At the same time, the committee was not so ready as Wilson was to order a reduction of effort on power reactors at Schenectady. The committee realized that the Schenectady laboratory would be a glaring exception to any plan to create a central laboratory, but the committee saw centralization realistically as a long-range goal rather than something to be accomplished in the short term.

Wilson's third paper was even more closely related to the proposal for a central laboratory. In it, the general manager suggested that the Clinton

Laboratories concentrate on the production and distribution of radioisotopes under the Monsanto contract. The new Oak Ridge Institute of Nuclear Studies would use the research facilities of the X-10 reactor as a part of a regional research center for universities in the Southeast. Weinberg's group on the high-flux reactor would stay at Oak Ridge until a new location, presumably the central laboratory, could be established. The committee agreed that the high-flux reactor was the backbone of a long-range reactor program and that Weinberg's team was a key group. But Clinton's problems would not be solved in the Oak Ridge context alone; the solution involved the decision on the central laboratory and even on the plans for studying the Redox process. The committee, for example, suggested that Monsanto might use some facilities at Clinton to develop a process for recovering the uranium in the waste tanks at Hanford while General Electric explored Redox with the chemical group at Argonne.

The conversation drifted back to the central laboratory proposal, and particularly to the question of location. There were many suggestions, but the most attractive was to use the new site for Argonne in Du Page County, Illinois, while the existing Argonne facilities would serve as a regional research center for universities in the Midwest. The new Argonne site had the advantage of being near a large metropolitan area and at the same time seemed to be big enough to accommodate both the fast-breeder and the high-flux reactors. As Oppenheimer later explained to the Commissioners, the committee hoped to make the best possible use of limited scientific manpower, and it wanted a well-directed, well-understood development program. This goal seemed impossible while the work was scattered in a number of isolated laboratories, particularly when the exchange of information between them was hampered by security regulations. If the Commission had been starting out fresh without any laboratories or security restrictions, the committee would certainly have recommended one laboratory for all research, including that on weapons. Under existing circumstances, such a plan was out of the question. The committee was not prepared to urge even a partial centralization if there were strong opposition to it among the scientists. But the committee hoped the Commission would explore the idea and try to find a workable arrangement.

Wilson's paper on weapons required little discussion, for it coincided in every important respect with the committee's own conclusions. Los Alamos would have the highest priority for weapon development and testing. The committee agreed that ordnance and production activities should be transferred to Sandia Base near Albuquerque, but Oppenheimer suggested that the weapons subcommittee he had just appointed discuss details of the transfer during its forthcoming visit to Los Alamos. These matters were of interest to the armed forces and the Joint Research and Development Board. It was important that the operations at Sandia be acceptable both to the Commission and the military.

On the more technical aspects of weapon development the committee preferred to withhold judgments until its subcommittee had visited Los Alamos. There was a general concern, however, about the fact that the only weapon use for uranium 235 during the war had been in the extremely inefficient gun-type model dropped on Hiroshima. The splendid operation of the gaseous-diffusion plants at Oak Ridge and the troubles encountered with the Hanford reactors suggested the urgency of finding some use for uranium 235 in an implosion weapon as well as enlarging plutonium production facilities.

Summing up three days of discussion, Oppenheimer observed that the committee had in effect proposed a series of priorities. First above all was the need to revitalize weapon activities at Los Alamos. Second only to weapons was the need for Redox. Only a little less important than Redox was the construction of new reactors at Hanford. Then followed, with much lower priorities, the efforts to extend the operating life of the existing reactors and to recover the uranium from the waste tanks at Hanford. In reactor development, the committee gave the highest priority to the fast-breeder and high-flux reactors. General Electric's research on the intermediate-power-breeder reactor would be less important than the company's efforts on Redox and the Hanford expansion. Work on the Daniels gas-cooled power reactor at Oak Ridge would be suspended until much more fundamental studies in reactor technology could be completed.

It had been a long session. When the committee finally adjourned late on Sunday afternoon, March 30, it had discussed in one way or another every aspect of the Commission's activities. The committee's suggestions were not always clear nor were its recommendations always consistent, but it spoke with the voice of authority. Its distinguished membership would have assured effectiveness in almost any situation; in the absence of strong Commission leadership in March, 1947, the committee's opinions were almost overriding.

REPORT TO THE PRESIDENT

If the General Advisory Committee for the moment was setting the course of the Commission's technical program, ultimate authority for the production of fissionable materials and weapons remained with the President. Congress had established this fact in the Atomic Energy Act, which provided that at least once each year the President should determine how much of these materials and how many weapons and weapon components should be manufactured. One of the Commission's first actions in January, 1947, was to request its staff to prepare a joint recommendation for the calendar year 1947 by the Commission and the Secretaries of War and Navy.[50]

During the hectic weeks of the confirmation hearings and the transi-

LOS ALAMOS SCIENTIFIC LABORATORY

MEMBERS OF THE GENERAL ADVISORY COMMITTEE VISIT LOS ALAMOS / Shortly after landing at the Santa Fe Airport, April 3, 1947. Left to right: James B. Conant, Robert Oppenheimer, General James McCormack, Hartley Rowe, John H. Manley, Isidore I. Rabi, and Roger S. Warner. Manley was the committee's executive secretary. McCormack and Warner were members of the Commission's staff.

LOS ALAMOS SCIENTIFIC LABORATORY

SCIENTISTS AT LOS ALAMOS / Many of the nation's leading scientists attended the nuclear physics conference at Los Alamos in August, 1946. Left to right, first row: Norris E. Bradbury, John H. Manley, Enrico Fermi, J. M. B. Kellogg; second row: Robert Oppenheimer, Richard P. Feynman, Phil B. Porter; third row: Gregory Breit (partly hidden), Arthur Hemmendinger, Arthur D. Schelberg.

tion from Army control, there was little time for such formalities as the Presidential directive. Not until early in March did Lilienthal find time even to write to Lieutenant General Lewis H. Brereton, chairman of the Military Liaison Committee, to apologize for the delay in calling the Commission's first meeting with the committee.[51] Not until a month later had Williams and McCormack assembled the information necessary to discuss the directive with Brereton.

The cryptic language of the draft directive approved by the Commission on March 27 suggested that its purpose was to record a decision rather than convey information.[52] It began by declaring that the service secretaries and the Joint Chiefs of Staff found "the present supply of atomic weapons . . . not adequate to meet the security requirements of the United States," but it gave no indication of the size of the stockpile. After urging that the use of fissionable materials for nonweapon purposes be limited to essential research which might lead to improvements in the production of materials and weapons, the authors recommended the maximum number of kilograms of fissionable material that should be diverted from weapons; but the written document contained only blank spaces where the numbers should appear. The statement concluded with the recommendation that the President "approve continuation of the current production program," but it did not tell the President what that program was. Obviously the Commission considered the report so sensitive that it would give the details to the President only in oral form.

The General Advisory Committee held its three-day meeting over the weekend. By Wednesday, April 2, 1947, Secretaries Patterson and Forrestal had joined Fleet Admiral William D. Leahy and Lilienthal in signing the document. At five o'clock on Thursday afternoon Lilienthal took the Commissioners to the White House for a briefing with President Truman. The subject for discussion was not the April 2 report, which the President had not yet seen, but a more general summary of the existing situation, dated April 3, 1947.[53] At Lilienthal's suggestion, Truman started to read the brief report: "After three months of authority over the American Atomic Energy enterprises, with access to sources of information and opportunity gradually to fit facts together, the Atomic Energy Commission must report to the President certain serious weaknesses in the situation from the standpoint of the national defense and security: 1. The present supply of atomic bombs is very small. The actual number for which all necessary parts are available is———."

As the President came to the blank, Lilienthal supplied the number. The shock was apparent on Truman's face. He went on reading: "None of these bombs is assembled. The highly technical operation of assembly hitherto has been effected by civilian teams no longer organized as such. Training of military personnel to effect assembly is not yet complete."

A solemn silence pervaded the office as the President continued to read. As he turned the pages, the Commissioners followed him on their copies. There was an explanation of the need for weapon tests, the need for a weapon

making better use of uranium 235, the dangerously small inventory of certain critical bomb parts, the precarious state of the Hanford reactors, the wasteful plutonium separation process, and the shortage of raw materials.

Lilienthal wondered how the President would take the news that the nation had no nuclear weapons immediately ready for use. When Truman looked up at the end of the document, Lilienthal thought he looked grim and gray, the lines of his face visibly deepened. What did the Commission propose to do? He realized the difficulties the Commission faced, especially as the prolonged Senate debate on confirmation deprived it of a firm mandate for decision.

Just as Lilienthal began to explain some of the proposals in the April 2 report, White House Secretary Charles G. Ross interrupted to say that the Senate had just voted down a motion by Senator Bricker to recommit the nominations to the Joint Committee. The news broke the spell. Lilienthal's
48 thoughts careened to the bitter fight that had been going on in the Senate for almost a month. He found himself without words; the policy decisions would have to wait for another day. Perhaps if the long agony of confirmation were soon to end, the Commission could get on with its business.

CONFIRMATION

The vote on the Bricker motion on April 3 marked a climax of an ugly debate on the nominations in the Senate. Early in March, following the favorable action by the Senate members of the Joint Committee on Atomic Energy, Lilienthal had hopes of an early if lively debate, but the Senate was preoccupied for weeks with legislation sponsored by Senator Taft to curb what the Republicans saw as the excessive power of organized labor. There was also a high priority on President Truman's proposals for aid to Greece and Turkey as a response to increasing Soviet pressure in the Middle East.

As a result, Senator Hickenlooper had no opportunity to start debate on the nominations until March 24. He began with a long historical discourse stressing the crippling effect of the delay, first in adopting atomic energy legislation and then in acting on the President's nominations.[54] Without mentioning Senator McKellar by name, Hickenlooper complained about the "burdensome rehash" of the earlier Dies committee testimony to which he and his colleagues had been subjected. The delay had paralyzed the Commission; the national security required timely if deliberate action in the Senate.

Hickenlooper followed this plea with a courageous and honest defense of the Lilienthal nomination. He not only dismissed the charges of communism against Lilienthal but also declared him to be fundamentally committed to Americanism, a man of high intelligence and administrative ability, with a

deep devotion to human rights and the atomic energy enterprise. Hickenlooper seemed fully convinced of Lilienthal's qualifications, but he was also aware that he was vulnerable to attacks from his own party for coming to the defense of a Truman nominee. This attack came quickly as continual interruptions by Wherry and Bridges dragged the debate into a tangle of petty jibes by the time the Senate adjourned for the day.

If the harassing tactics of Bridges, Wherry, and McKellar on Monday and Tuesday, March 24 and 25, could be called a probing attack with light weapons, the speeches by Homer Ferguson of Michigan and Bricker of Ohio later that week were the heavy guns of the assault. Disdaining the sensational allegations against Lilienthal in the conservative press, Ferguson chose a loftier perspective.[55] He saw atomic energy as critical in the titanic struggle between two ways of life, democracy and communism. Lilienthal was not a Communist, but Ferguson quoted Lilienthal's books to demonstrate that he believed government domination of society was necessary and inevitable. Lilienthal saw the management expert as indispensable in modern society. To Ferguson's way of thinking, this belief made Lilienthal a "social aristocrat," a man who believed that experts must make the important decisions in government, which ordinary people could not make for themselves. These decisions, Ferguson argued, Lilienthal would make for the people's welfare, but such an approach led first to benevolent despotism and then to tyranny. Ferguson's argument was temperate and closely reasoned. Lilienthal was probably a loyal American in his own way, but it seemed outrageous that a man of his convictions could assume control of the nation's strongest defense against tyranny after the Republican victory at the polls in 1946.

Try as he would, Ferguson was not able to maintain to the end of his speech the contention that his disapproval of Lilienthal was based entirely on honest differences in their interpretation of the proper role of government. In the end he could not quite believe that the advocates of big government could be entirely honest. They could not resist the temptation to interpret the law to their own advantage, however laudable their intentions. Ferguson cited as an example of Lilienthal's lack of moral scruple the establishment of the Tennessee Valley Associated Cooperatives, Incorporated. Senator Knowland pointed out that the cooperative had been created in 1935, when Arthur E. Morgan was the TVA chairman; but the example was frequently cited by other Republicans to show that Lilienthal, as McKellar never tired of quoting from a Lilienthal speech, believed that "every government . . . is and must be a government of men and not of laws."

Senator Bricker was more ambivalent than Ferguson on the moral question.[56] He did not believe Lilienthal was a Communist, but he charged that Lilienthal had been insensitive to the dangers of Communists in TVA. As he continued, Bricker repeated most of McKellar's charges without explicitly accepting McKellar's conclusions. He was particularly concerned that the Commission had hired several men whose FBI files contained alleged infor-

mation which Bricker considered disturbing. Although Bricker considered this "proof positive" that Lilienthal "tends toward the left, wants around him employees who are radically inclined," McMahon, Knowland, Alben W. Barkley, and other Senators denied that the files supported such an allegation about the employees.

Bricker rambled on, but he seemed to have a purpose in mind. Having "proved" Lilienthal's tendencies to the left, he asked Hickenlooper whether the FBI had investigated Lilienthal and the other nominees. Hickenlooper assured Bricker there had been no investigations, but he pointed to the President's statement that the records of the investigating agencies of the Executive Branch contained no derogatory information on the appointees. This was not good enough for Bricker. He urged the Senate not to miss this last chance to "clean up" the Commission, to sweep from its ranks the left-wingers of questionable character whom Lilienthal had gathered there. He concluded with a motion that the nominations be recommitted to the Senate members of the Joint Committee and that the FBI be requested to investigate all officers and employees, including the Commissioners and the general manager.

The Bricker motion was the signal for a full-scale attack by the anti-Lilienthal forces. Although McKellar and a few others repeated the old charges of communist tendencies, the Republican leadership concentrated on Lilienthal's philosophy of government and his alleged lack of moral scruple. John J. Williams of Delaware took up Ferguson's refrain of "a government of men, not of laws." Harry P. Cain of Washington saw Lilienthal as neither a Communist, a great administrator, nor an expert on atomic energy. He asked why the Senate "had to accept a controversial, contradictory, cloudy figure." Bridges and Wherry returned to the fray with the charge that Lilienthal had not consulted General Groves and was attempting to exclude the military from any voice in atomic energy affairs.

The summation of the Republican argument came in a long speech by Senator Taft of Ohio.[57] He repeated the main points in his statement to the press on February 21, but on the Senate floor he could elaborate them in a way that left no doubt of his deep conviction about Lilienthal's unfitness. Lilienthal was a radical seeking office at the very time the electorate had repudiated radicalism at the polls. He was not a Communist but he did not regard communism as a threat to American security. Taft's elaboration of this latter charge illustrated more clearly than ever before that his objections to Lilienthal stemmed from differences in fundamental approach to modern government. That Lilienthal in the 1930's could have tolerated in TVA an avowed former Communist was enough to disqualify him from appointment to an agency into which the infiltration of one communist agent might spell national disaster. Taft also argued that Lilienthal's attitude toward communism had not changed over the years. Had he not written the Acheson-Lilien-

thal report, which proposed to turn over all American atomic energy plants to an international agency controlled by Communists?

Both McMahon and Knowland rose to answer Taft's charges, or at least to put his conclusions about the Acheson-Lilienthal report in proper context. But Taft, having made up his mind about Lilienthal, would drive home his opposition with every argument at hand. He was even in a mood to accept the suggestion of Homer E. Capehart that, in view of recent signs of communist aggression in Turkey and Greece, the atomic energy enterprise be returned to Army control. After all, Taft observed, civilians had tried to build the Panama Canal, but the Army had had to come in to finish the job.

Remarks such as these led McMahon to the conclusion that the debate was moving from a discussion of Lilienthal's qualifications to a reexamination of the thorny issues of international and domestic control which had consumed weeks of legislative debate the previous year during passage of the Atomic Energy Act. Except for the continuing attack on Lilienthal's personal integrity, the debate seemed to be moving rapidly beyond Lilienthal to a review of the atomic energy legislation of the previous Congress. To McMahon, who had struggled against great odds for more than a year to establish the Commission, this trend was appalling. There was some consolation in the firm bipartisan support of all the Joint Committee members except Bricker, but as the debates continued hour after hour, day after day, the prospects of a favorable outcome dimmed. At last, on Wednesday afternoon, April 2, Hickenlooper succeeded in negotiating with the Senate leadership a unanimous consent resolution which would bring the Bricker motion to a vote at 5:00 P.M. on Thursday. The debate on Thursday would be divided equally between Wherry and Hickenlooper, who would allot time to those speaking for and against the motion.[58]

The Senate adopted the resolution, but tension in the chamber mounted under the pressure of the clock. Millard E. Tydings of Maryland talked through the dinner hour on Wednesday in support of the nominees and the Acheson-Lilienthal report. Finally gaining the floor in his own right after days of frustration, McMahon launched upon a systematic refutation of the charges against the nominees, the Atomic Energy Act, and the report. Skillful questioning by McKellar and the Republican opposition, however, soon mired McMahon in a controversy over Lilienthal's ethics in serving on the Wisconsin Public Utilities Commission in 1931 while he was still receiving compensation from the utilities newsletter which he had published in Chicago. Wherry induced Hickenlooper to read to the Senate eight telegrams he had received from power companies in Wisconsin in response to a request for information concerning the use of Lilienthal's name to obtain subscriptions. The debate boiled higher as senators on both sides tried to draw conclusions from the telegrams. Wayne L. Morse, the Oregon Republican, was incensed by Wherry's attack. When Wherry let the Senate adjourn just before mid-

night without giving him a chance to speak, Morse stormed off the floor, and the morning papers reported a scuffle in the cloakroom.[59]

At noon on Thursday, April 3, the Senate began debating under the limitations imposed by Hickenlooper's resolution. Wherry and Hickenlooper set the pace as they cautiously granted time to those wishing to speak. Wherry's forces concentrated on Lilienthal. Hickenlooper, McMahon, Knowland, and Morse answered the charges of the preceding days and drew on testimony from the hearings to support the nominees. The speeches, first from one side and then from the other, contained nothing new or dramatic, but there was a note of excitement in the air. The previous week the Washington *Post* had tallied 49 votes for Lilienthal and 27 against. But the Bricker motion and the hot debate of the previous evening had confused the issue. Several Republican senators who had previously announced their support for Lilienthal had changed their minds. The Federation of American Scientists, in a last-ditch effort to muster support, launched another barrage of mail and telegrams on the Senate. Vandenberg had been besieged for days to speak out in support of Lilienthal.

On Wednesday Thorfin R. Hogness, the Chicago chemist who a year earlier had devised with Vandenberg the compromise which saved the atomic energy bill, hurried to Washington with hopes of repeating his earlier success. Dashing from the train to Vandenberg's office in the Capitol, Hogness learned that Vandenberg had just stepped down from the rostrum as president *pro tempore* and was addressing the Senate. Scott W. Lucas of Illinois told Hogness the outcome was in doubt. In a straw vote in the cloakrooms on Wednesday night, the Bricker motion had a slight majority. The last few hours of the debate would determine the Commission's fate.[60]

As Vandenberg rose to speak, the spectators in the visitors' and press galleries stirred in their seats. For the moment the fact that Vandenberg and Taft, two leading contenders for the Republican Presidential nomination in 1948, were facing each other on a fundamental policy issue seemed to overshadow the question of the nominations.[61]

In his customary way, Vandenberg began with a few disarming remarks. He did not have any illusions that any senators were open to persuasion after weeks and months of bitter controversy, but he wished to use this forum to answer the thousands of letters from constituents on both sides of the question. He reminded the Senate that eight out of nine of its members on the committee had voted for confirmation after hearing weeks of testimony. Reading the names of the senators on the committee, he said he thought it "highly improbable that such a jury would almost unanimously go wrong." Then Vandenberg moved to the heart of his speech. In direct and forceful language he refuted the three principal charges against Lilienthal. He found Lilienthal "no part of a Communist by any stretch of the imagination." He did not see how Lilienthal's leadership of the Commission could endanger free enterprise since the Senate had already voted unanimously to make

atomic energy a government monopoly. Nor could he accept the claim that the nominee's connection with the Acheson-Lilienthal report disclosed "a flaw in his reliability as a guardian of our atomic secrets." Dismissing the attacks on Lilienthal's moral character, Vandenberg moved to his conclusion. "In the interests of national welfare and for the sake of a square deal, Mr. Lilienthal ought to be confirmed." The galleries broke into prolonged applause.

Perhaps the tide was turning. Taft tried to introduce new evidence on the Wisconsin public utilities matter, but Vandenberg had broken the spell. Tedious moral appraisals of actions more than two decades old had lost the significance they seemed to have had on Wednesday evening. Hickenlooper confidently surrendered the remainder of his time to Senator Barkley, who added the great weight of his influence to Lilienthal's side of the scale. As the hour approached five, Bricker drew his last appeals to a close. Ninety senators answered the quorum call. The final vote was 52–38, a decisive victory for Lilienthal and the Commission. There remained only the formal vote on the nominations themselves on April 9.[62]

FIRST DECISIONS

Now that he had won the battle for confirmation, Lilienthal hoped he could soon conclude his unfinished business with the President. On April 3, 1947, the news of the defeat of the Bricker motion had interrupted his presentation of the Commission's immediate plans for producing materials and weapons. There had been no time to show the President the April 2 memorandum from the Commission and the service secretaries recommending the production and allocation of fissionable materials for calendar year 1947.

Lilienthal did not have long to wait. The week following the Senate action, Admiral Leahy called a meeting at the White House. On Wednesday morning, April 16, Lilienthal met with the service secretaries and Leahy in the President's office. Truman quickly read over the April 2 memorandum while Lilienthal supplied orally the numbers which fit in the blanks. Endorsing the document along the left-hand margin, the President asked Lilienthal to keep it in his files with the numbers added in ink. The memorandum was far too sensitive even for the White House files.[63]

The President had not forgotten the shocking news about the weapon stockpile he had received in the April 2 memorandum. He had locked it in his personal safe for future reference. The President's remarks gave Lilienthal a chance to bring up the alarming state of the production-weapon complex. Both Leahy and Forrestal were concerned about the shortage of certain critical weapon components; Lilienthal explained that the Commission had authorized an additional work shift in Monsanto's plant at Dayton, Ohio, and that additional facilities were under construction.

The conversation turned inevitably to raw materials. The long-range outlook over the next several years was difficult to determine. The principal source of ore was still the Shinkolobwe mine in the Belgian Congo, but most of the ore down to the 150-meter level would be exhausted in 1947. Then it might be necessary to shut down the mine for a year while a new shaft was sunk. Because a quasi-governmental corporation owned the mine, it would be difficult to accelerate operations at the site. Political changes in Belgium also complicated the situation. The Communists had refused to participate in the new government formed in late March and were therefore free to attack the government's policy of selling uranium to the Combined Development Trust for allocation to the United States, the United Kingdom, and Canada. The State Department also found ominous the report that the Belgians might nationalize their uranium deposits. Elsewhere the Commission would have to rely on low-grade ores, few of which could be recovered by existing processing techniques.[64]

Lilienthal's reference to the Combined Development Trust caused Secretary Patterson to ask about the allocation of Congo ores. He was aware that in July, 1946, the British after considerable pressure had forced Groves, Bush, and Acheson to accept a 50–50 allocation of all ore received between April 1 and December 31, 1946. Groves, arguing for allocation on the basis of need, had pointed out that the British had no immediate use for the ore while the Americans might have to shut down plants under the reduced allocation. The British had contended with equal logic that, since they had paid for half the ore, they should receive their share.[65] The July 31 agreement had never been popular on the American side, but in the chaos of early 1947, there was no thought of reopening negotiations. Lilienthal suggested that a better solution to the uranium shortage was the Redox process, and the Commission was going to concentrate on that.

Patterson was not to be diverted from the subject of international cooperation. He remarked that the British were becoming increasingly unhappy with what they considered an American failure to honor commitments. Leahy retorted that he did not understand the British attitude; there were no existing agreements on interchange. Patterson, no doubt remembering the hours he had spent negotiating the Truman-Attlee-King agreement of November 16, 1945, explained that most of the provisions of the wartime Quebec Agreement were still in effect, but the British had been told that the new Atomic Energy Act prevented exchange of technical information.[66] A further complication was the fact that the Senate Foreign Relations Committee had never been informed of the existence of the interchange agreement. Lilienthal said the Commissioners had worried about the failure to report the agreement since they had first learned of its existence. The longer the delay, the more difficult would be the disclosure; Lilienthal hoped that at the very least the information could come from the State Department rather than from the Commission.

The President had no doubts about the status of interchange. He said he remembered distinctly Churchill's saying that the Quebec Agreement did not extend beyond the war, and he was certain that he had made no agreement extending interchange. Leahy supported the President. Trying to be tactful, Lilienthal started to describe the comprehensive nature of the Quebec Agreement, but no one seemed to be interested. As a last resort, he suggested that relations with the British were particularly important, at least until negotiations were completed with the Union of South Africa to obtain uranium from gold mining operations. Forrestal was quick to reply that he considered any obligation to the British wiped out by the billions of dollars loaned by the United States.

The lack of understanding of the British position disturbed Lilienthal; it promised trouble for the future. But he found encouragement in the President's willingness to consider a weapon test and to support the Commission's plea to the House Appropriations Committee for additional funds. Perhaps at last the Commission could begin to act in its own right.

MISSION TO EDUCATE

Confirmation gave the Commissioners not only a legal mandate for action but also a license for leadership. During the weeks of uncertainty they had been reluctant to speak out on policy issues, and there was an understanding among them that they would avoid public speaking engagements. This restraint troubled Lilienthal, who saw in the confirmation hearings and in the public response to them an incredible lack of comprehension of the meaning and implications of atomic energy. His concern stemmed no doubt from his own ignorance of the subject in late 1945 and the revelation Oppenheimer accomplished in his lectures on atomic energy to the Lilienthal board of consultants in 1946. The Acheson-Lilienthal report was in large part the result of a vigorous exercise in self-education.

As the Senate debates neared an end in the last days of March, 1947, Lilienthal began to think about how he would take his message to the people. The opportunity came in an invitation from the American Society of Newspaper Editors to speak at their annual banquet in Washington on April 19. He had been hoping to get away on a short vacation after the final vote on confirmation, but the invitation was too tempting. As his friend Palmer Hoyt, editor of the Denver *Post*, told him, this was an extraordinary opportunity. All the influential newspaper editors in America would be there as well as many leaders of the Administration.[67]

For Lilienthal the speech took on the importance of an inaugural address. It had to be dramatic, provocative, and even a little bold in suggesting new ideas. The device for creating drama came to him quickly, but the

substance of the speech emerged only after hours of thought and several discussions with Mrs. Lilienthal. As he had often done before, he finally dashed off a rough draft in shorthand and then began the tedious job of rewriting. By the time he entered the ballroom at the Statler Hotel on Saturday evening, the speech was part of him. His step was buoyant, his self-confidence supreme. He had not misjudged the opportunity; it seemed that everyone notable in journalism and politics was in the audience.

He started with his dramatic device. Holding high a cylinder of uranium metal for his audience to see, he explained that this inanimate substance was "the central object in the councils of the world." Fission of all the uranium atoms in the cylinder would release energy equivalent to 2,500 tons of coal. Now Lilienthal had caught every eye in his audience. It was a thrill to see all those intent, upturned faces.

Incredible as these facts seemed, he said, men were only beginning to
56 understand the potential of atomic energy either for beneficial uses or for destruction. Would the United States maintain its lead or fall behind in the development of atomic energy? The answer would depend upon whether the American press could educate the people so that they would be able to understand the issues of atomic energy. What the people needed was not technical knowledge but a comprehension of the fundamental facts of existence in the atomic age. Did they know, for example, that the American atomic energy program had lost momentum since 1945? Were they acquainted with the contents of the Baruch plan for the international control of atomic energy? Did creative people in science and industry think atomic energy was important enough to command their talents and energy? Did the average citizen understand that the "secret" of atomic energy was not a simple formula which could be written on a sheet of paper and locked in a safe?

"Probably among the most important decisions in our history as a nation will be those made concerning the course and direction of atomic energy development, and the uses to which this new force is put." These decisions should not be made in secret. They should be made by a well-informed public, because they were human, not technical issues. "What I am proposing, therefore, is nothing less than a broad and sustained program of education at the grass roots of every community in the land." This was the function of the people's institutions of education and communication; it was a special responsibility of a free press.

The applause was enthusiastic, the comments warm and flattering. Supreme Court justices, senators, celebrated authors, and veteran editors came forward to congratulate him. General Eisenhower, the Army Chief of Staff, pushed through the crowd to say: "I am on your team." The speech was more than a pleasant conclusion to weeks of trial and anxiety. It announced that the Commission had at last received its mandate and intended to exercise it in the interests of the nation and mankind.

FIRST VENTURE

CHAPTER 3

Senate confirmation had at last given the Commissioners and the general manager a clear mandate for action. Freed from the uncertainties and distractions of the previous five months, Lilienthal and his associates could now hope to concentrate on their responsibilities under the Atomic Energy Act. First and foremost was the production of fissionable materials and weapons for the national defense. Almost as vital was the prompt exploitation of the nuclear sciences for human welfare. To some extent the production and development aspects were complementary; but in a finite world with limited budgets and resources, there would always be a need to balance one requirement against the other. This kind of evaluation would depend on a sound knowledge of a new and intricate technology, something which none of the Commissioners except Robert F. Bacher could yet claim.

While the Commissioners gained a better understanding of the atomic world, they could rely on the impressive experience and abilities of the General Advisory Committee for policy decisions, on Walter J. Williams for operational matters, and on Carroll L. Wilson, James B. Fisk, and James McCormack for the imagination and ideas needed to create an effective organization and program. With this kind of support, the Commissioners could embark on their first venture with some hope for success.

The spring of 1947, however, would bring difficulties and frustrations. The months of uncertainty had built up a backlog of questions relating to every phase of the atomic energy project, and many of these matters demanded immediate attention. A new directive for Los Alamos, the refurbishing of production plants for fissionable materials and weapon components, a policy for laboratory operation, a plan for developing new types of reactors, proposals for stimulating research in the nuclear sciences, and completion of the staff organization were all overdue. Even under the best of circumstances, it would have been difficult to meet these needs within a matter of months.

With the handicaps of renewed public controversy and political attack, the first venture was doomed to an inauspicious start.

ATOMIC ARSENAL

A new course for weapon production and development was for the moment the concern of Robert Oppenheimer and the General Advisory Committee. Rather than attempting to reach a decision at the committee's meeting late in March, 1947, Oppenheimer planned to return to California by way of Los Alamos with the weapon subcommittee for a first-hand view of the situation. Enrico Fermi was not able to go, but James B. Conant, Hartley Rowe, Isidor I. Rabi, John H. Manley, and McCormack accompanied him on the trip west.
58 Although this return to "The Hill," as Los Alamos was called, must have been something of a homecoming for Oppenheimer, the agenda suggested little time for socializing. The questions at issue seemed difficult to define, hopelessly interrelated, and even more difficult to answer. Before deciding to develop a new weapon design, Norris E. Bradbury asked: "What rules should be set up for the relation between the *efficient* use of active material, the *amount* of active material, the *size* of the bang, and the *availability* of active material?" What should be the upper limit on unassembled critical mass in any weapon design? Was there a need for weapons larger than the wartime models regardless of the amount of fissionable material required? To these and other general questions Bradbury added a dozen inquiries about specific weapon designs.[1]

Obviously there was no need to explain the issues to the subcommittee. In addition to Oppenheimer's intimate knowledge of the weapon art, the members had the advantage of access to a comprehensive study which Bradbury had completed in January.[2] The report, manifesting Bradbury's direct and candid approach, avoided the cryptic phrases and vague generalizations which for security reasons often muddied descriptions of weapon activities. The report began with a technical description of the wartime implosion and gun-type weapons. Then Bradbury summarized the advantages to be expected in nine new schemes which might either improve the efficiency of implosion systems or make possible more economical use of uranium 235. He also reported recent successful efforts to improve the performance of detonators, high-explosive charges, and neutron initiators in nuclear weapons, and to refine the techniques used in studying implosion systems.

Perhaps less exotic than theoretical and experimental research but equally difficult were ordnance studies performed by the laboratory's Z division at Sandia Base near Kirtland Field on the eastern outskirts of Albuquerque. Originally established at Rowe's suggestion to relieve Los Alamos of certain engineering and production responsibilities, Sandia had

borne the major burden of the Bikini weapon tests in 1946 and did not really get down to its intended task before the Commission took control in January. This included reliability tests of existing weapon components, improvements in fusing and firing units, development of ordnance aspects of new weapon models, and procurement of mechanical parts to be used in stockpiling the standard weapons. In the absence of a formal charter and seasoned leadership, however, the Sandia staff tended to operate as much on its own initiative as from coordinated directives from "The Hill."

Other engineering and production functions that might conceivably have been assigned to Sandia were scattered over a number of other sites. The final purification of uranium and plutonium metal was still the job of Los Alamos despite the long-standing intention to transfer these operations to permanent production facilities at Oak Ridge and Hanford. Likewise, certain steps in producing neutron initiators were still performed at Los Alamos. The delicate and exacting task of fabricating shaped charges of high explosive had been transferred to the Naval Ordnance Test Station at Inyokern, California, but the production of detonators was still the responsibility of Los Alamos. Certain other mechanical and electrical components were being produced by commercial manufacturers.

For the long term, Bradbury's report contained some interesting information about theoretical studies of thermonuclear reactions and plans for testing new weapon ideas. Ever since Oppenheimer's group had discovered in the summer of 1942 the theoretical possibility of a weapon based on the fusion of very light elements, there had been some interest in analyzing on paper the relative advantages of fusing various combinations of the hydrogen isotopes, deuterium and tritium. Because the extraordinary temperatures and pressures required to initiate the reaction suggested the need of a fission bomb, the idea had a low priority during the war. But Edward Teller and others at Los Alamos were still intrigued by the idea and found time to study it during the doldrums of 1946. Early in 1947 Bradbury could report that studies of thermonuclear reactions were now focused on two conceptions: an elaborate thermonuclear device called "Super" and a simpler device called "Alarm Clock," recently suggested by Teller.

Thermonuclear weapons might be important some day, but Bradbury was more concerned about testing the reliability of weapon models going into stockpile. He noted that the gun-type weapon had never been tested and had been detonated only at Hiroshima. The implosion weapon had been tested at Alamogordo, but the subsequent detonations at Nagasaki and Bikini lacked the instrumentation necessary to obtain reliable scientific data. Reestablishing production of the standard models had inevitably introduced minor changes which cumulatively might impair reliability. Bradbury thought it imperative to test stockpile models as well as potentially more efficient devices under development. Since preparations for a test would take nine months to a year, Bradbury hoped for a decision soon.

Although the subject matter of the Los Alamos conference was as sensitive as any that could have been discussed in the United States in the spring of 1947, Bradbury brought a large number of his staff with him. This was no time to apply the security restrictions and compartmentalization which an extraordinary emphasis on secrecy imposed on many discussions of Commission business. The discussion was full, frank, and highly technical. Oppenheimer and his colleagues, men of great understanding and experience, could give Bradbury and his staff sensible answers to the many questions which had been crippling the strategy of weapon development at Los Alamos for more than a year. And the same discussions helped the subcommittee members to formulate in their own thinking a feasible plan for the future.

Most of the technical details were of interest only to those at the meeting, but they added up to some general conclusions of great import for the Commission and the military services. The subcommittee was convinced
60 of the need for a scientific test in the spring of 1948 of new weapon models which would make better use of the implosion system and which would permit more efficient use of uranium 235. They were prepared to recommend the kinds of devices to be tested. They urged delay in further development of several new types of weapons suggested by the military services pending receipt of formal requirements. They also confirmed the proposal made at the March meeting of the full committee, that Los Alamos devote more effort to the study of thermonuclear reactions, with the understanding that the many practical difficulties involved made early success unlikely. As for more immediate matters, the subcommittee recommended strengthening the Los Alamos staff on the theoretical side, increasing initiator production at Los Alamos until the Monsanto Chemical Company could complete new facilities at Miamisburg, Ohio, improving the shaky capability at Inyokern for producing high-explosive components, and helping Bradbury find an associate director for activities at Sandia.[3]

After the meeting on Thursday, April 3, Oppenheimer and Manley finished their paperwork. The minutes of the meeting and a report for Conant's signature as subcommittee chairman had to be drafted. Oppenheimer also found time to finish his formal letter to Lilienthal, reporting on the meeting of the full committee the previous weekend. On Friday morning the group returned to Albuquerque for a visit to Sandia before starting home.

The Sandia installation was hardly impressive to the eye. Built on the site of the original Albuquerque airport, it consisted of a dozen ramshackle wooden buildings constructed early in World War II for an air depot training station. Since the war the Army had constructed four new buildings to accommodate activities transferred from Los Alamos, but three of these were wooden frame buildings and the fourth was a Quonset hut. There the subcommittee could see where Sandia technicians had sorted out as best they could the weapon components left over from the wartime project. Now new components were arriving for assembly and testing prior to transfer to the

ordnance section at Kirtland Field, where the high-explosive charges produced at Inyokern would be added. Finally, the completed weapons would be stored in igloos located in a large arroyo south of the runways.[4]

Oppenheimer's group probably viewed the situation at Sandia with mixed feelings. The physical facilities were obviously, almost ludicrously, inadequate. To realize that the nation's vaunted power to wage nuclear war rested on this slender reed must have been a sobering experience. At the same time, there were clear signs of initiative, enterprise, and even enthusiasm at Sandia. The technical group was making the best of a bad situation with encouraging results. The Air Force had not yet been able to establish a satisfactory working relationship with Sandia. The day before Oppenheimer arrived, Colonel John G. Armstrong at Kirtland wrote his headquarters that the future was still uncertain. Groves and General Lewis H. Brereton had not yet been able to take any action on Armstrong's proposal to establish an Air Force tactical and technical liaison committee at Kirtland to work with Sandia, a decision they could not make until the Armed Forces Special Weapons Project had its charter.[5]

Before leaving Sandia Oppenheimer called Bacher in Washington to report his impressions. In intentionally cryptic language he told Bacher he was pleased with the outcome of the Los Alamos meeting. For one thing, Bradbury had been cordial to Conant, who had earlier made some uncomplimentary remarks about Los Alamos. General McCormack was flying back to Washington that night with copies of Oppenheimer's report. He assured Bacher that every recommendation in the report deserved "hearty concurrence." At last some members of the committee were able to "see the bottom of the barrel," Oppenheimer remarked. "They realize what there is and what there is not." That realization may not have been comforting, but it was a necessary first step.[6]

On the homeward flight from Albuquerque McCormack carried with him not only Oppenheimer's report but also a legitimate concern about the status of weapon production. After further verifying the information he had picked up at Los Alamos, he summarized the situation for Wilson on Saturday, April 12. Continued production seemed tenuous on many counts, but McCormack thought the most critical items were the high-explosive castings and initiators. For the short run, emergency production operations at Los Alamos were probably the answer, even if they did delay research activities. But the ultimate solution seemed to lie in new plants. McCormack questioned the need for the elaborate design which was causing procurement delays for the new Miamisburg plant, but there seemed now to be no alternative but to continue with the present design which would place the facility entirely underground. He was investigating the possibility of some simplifications and was asking Williams to do what he could to expedite construction. In the meantime, technicians at Los Alamos and the temporary facilities at Dayton would try to meet production requirements.[7]

Conditions at Inyokern were equally bad. The existing Navy facilities had not been designed for production operations, and acceptable castings of high explosive had come only after months of failure. General Groves had approved construction of additional facilities at Inyokern in October, 1946, but construction had not yet started. McCormack was trying through Admiral William S. Parsons to get Navy action, but even if this were successful, additional production could not be expected before April, 1948. For a new plant McCormack had asked his staff to investigate several World War II ordnance installations, including the one at Burlington, Iowa.

ADJUSTING PRIORITIES

62 McCormack's trip to Los Alamos had helped to fill in details about the Los Alamos situation, but Wilson had not waited for his return to take action. The meetings of the General Advisory Committee the previous week had already confirmed Wilson's and Williams's conclusions that quick decisions were required. Wilson, Williams, and the Commissioners had spent most of Tuesday, April 1, with Charles A. Thomas and Carroll A. Hochwalt to discuss the Monsanto contract. The purpose was to keep a full head of steam behind initiator production at Dayton and at the same time to suggest to Monsanto the possibility of retrenchment at the Clinton Laboratories, should the recommendations of the General Advisory Committee be adopted.

On Wednesday there was a similar all-day session with officials from General Electric, including Harry A. Winne, Kenneth H. Kingdon, C. Guy Suits, and Harvey Brooks. Backed by the opinion of the General Advisory Committee, Wilson was firm on the question of priorities. If the Commission were going to take full advantage of using plutonium in building a weapon stockpile, it had to give highest priority to constructing two new reactors at Hanford and developing Redox. Since construction of the reactors would take at least two years and the existing units might not last even that long, the new reactors might not result in an increase in production. Everything, however, depended on Redox; for without the new process which would recover uranium as well as plutonium from the irradiated slugs, there seemed little hope of providing enough uranium feed for all the reactors. If Redox were developed in time, enriched material from the gaseous-diffusion plants could be used to compensate for the slight depreciation of the 235 isotope in the uranium which had already gone through the reactors.[8]

The implications were clear enough. General Electric would have to put its major effort into the new reactors and Redox, both at Hanford and the Schenectady laboratory. The Commission was willing to make the task as simple as possible. The new reactors and their associated facilities could resemble the existing units in all respects, except for those features which had

proven unnecessary. The company could count on help from the Commission's laboratories on Redox, and the Commission would find other contractors to work on a process to recover the uranium already in waste storage tanks at Hanford and to control the release of radioactivity in stack gas. Williams agreed to ask Carbide to take over planning of the new uranium-235 and plutonium metal refining plants to replace the temporary facilities at Los Alamos. But even to complete its scaled-down assignments, General Electric would have to alter its plans drastically. Schenectady would have to put much more of its effort on Hanford reactor design at the expense of the intermediate-power-breeder reactor. Plans for the new Knolls Atomic Power Laboratory along the Mohawk River east of the city would have to be scaled down from the company's proposal of $36 million to the original $20 million. Wilson also asked the company not to build the Van de Graaff accelerator already approved, on the grounds that General Electric should concentrate on applied research for Hanford and leave fundamental, unclassified research to the universities.

The decision was a blow to the company's hopes for an aggressive effort to develop nuclear power and the breeder reactor, but Wilson saw no alternative. The national security seemed to depend directly on the new facilities at Hanford. Furthermore, he thought a slower pace on power reactors than the company proposed would be prudent in light of sobering estimates of chances for early success coming to him informally from individual members of the General Advisory Committee.

For Wilson's three division directors the rest of April sped by in a blur of meetings, telephone calls, and train trips. Williams kept on hounding suppliers for steel for the new Monsanto initiator plant and explored with Fisk and Hood Worthington of du Pont the best ways to reenrich the depleted uranium to be recovered in the Redox process. After some discussion Williams also persuaded Clark E. Center of Carbide to take responsibility for designing the new uranium-235 and plutonium metal plants. Fisk was heavily engaged in laboratory affairs, but he had to find time to follow up on the meeting with the General Electric group. It was his task to draft the letter which finally went to the company on May 6 as the Commission's formal position regarding the shift in emphasis from Schenectady to Hanford.[9]

TOWARD A WEAPON STOCKPILE

McCormack had his hands full in April with troubles at Inyokern, Sandia, and Los Alamos. He hoped to better the April, 1948, target date for the new production facilities at Inyokern by obtaining an additional $684,000 for the project. Work at Sandia was still far from a production-line basis, but there was some satisfaction in learning that the first new high-explosive shapes

from Inyokern had been successfully assembled on April 25. That news meant that the nation would soon have ready weapons in stockpile. Prospects were also brighter for the beleaguered families of scientists still enduring life in temporary wartime facilities at Los Alamos. Before the end of April, invitations were out for bids to pave the roads in the community, and a contract had been awarded to build a commercial center with bank, drug store, theater, barber shop, and other basic services. Roger S. Warner, Jr., an engineer who had directed the work of Z division at Los Alamos and Sandia, still handled most of these contract activities in Washington with the part-time help of two Army officers, but McCormack now had enough staff in his new division to begin thinking about taking over. He had also proposed the appointment of Carroll L. Tyler, a retired Navy captain, as manager of the new Santa Fe office, which would coordinate the Commission's weapon activities in the field.[10]

Of greatest immediate concern to McCormack were plans for the first full-dress meeting with the Military Liaison Committee on April 30. Recent correspondence with the committee indicated its growing impatience to acquire an intimate knowledge of the activities and plans of his division, but the Commission took the position that all phases of its work related in some way to military applications. Thus McCormack provided the committee not just with a proposal for a series of weapon tests in 1948 but also with a long-range agenda covering the Commission's plans in production, reactor development, radiological warfare, nuclear propulsion, physical and biomedical research, and intelligence.[11]

The agenda suggested that the Commission was more than willing to meet the committee's request for information. But the Commission did not look forward to the meeting as a pleasant occasion. Ever since the War Department in January, 1947, announced Groves's appointment to the committee, Lilienthal had anticipated trouble. He took some comfort in a report which McCormack brought back when he briefed the Joint Chiefs of Staff on the weapon test plans on April 27. In Groves's presence General Eisenhower reportedly had made some kind remarks about Lilienthal's speech before the American Society of Newspaper Editors. Perhaps the Commission could count on Eisenhower's support if it encountered trouble in installing its own organization at Los Alamos and Sandia. Bradbury had reported that Groves was insisting weapons be assembled only at Sandia, a request which Bradbury thought had "political fragrance." [12]

Some of these matters cropped up in the meeting on April 30. When McCormack suggested a survey of the status of non-nuclear bomb components at Los Alamos and Sandia, Groves expressed a lack of confidence in Los Alamos and declared that the battalion at Sandia had been ready to assemble high-explosive charges since December 15, 1946. On other matters Groves questioned the practicality of the Commission's proposals, but the other members of the liaison committee considered them reasonable. Admiral

Parsons supported the Commission's plan for comprehensive testing of selected weapon components, and the committee accepted McCormack's proposal of a weapon production figure for Los Alamos. Everyone but Groves agreed on the urgent need for new production reactors at Hanford. He favored limiting work to engineering studies until an adequate supply of raw materials was assured.

As the discussion moved on to plans for weapon tests and the other items on the agenda, the new Commission and its staff must have made a favorable impression on the high-ranking members of the committee. The careful work of Oppenheimer and the General Advisory Committee, of McCormack and Bradbury, of Wilson, Fisk, and Williams, permitted the Commission to present positive ideas and support them with confidence. The Commission would press forward with its plans to increase the production of weapon components and plutonium. There would be more research on Redox and waste uranium recovery processes, and the Commission's expenditures for uranium ore exploration would increase tenfold in the coming year. Even on matters of great military import the Commissioners could now speak with some authority. Lilienthal explained plans for the weapon test series in 1948, and Strauss urged more effort on the part of the military in establishing a system for detecting nuclear tests in other countries.[13]

By the end of April, 1947, McCormack had reason to believe that he had taken the first important steps toward creating an arsenal of atomic weapons. If the plans born in that hectic month reached fulfillment, the United States would soon have at its disposal the unprecedented military power which all the world assumed lay behind President Truman's stiffening foreign policy in the face of communist aggression. There was of course no real assurance that the new reactors at Hanford, the Redox process, the Monsanto plant, or the Sandia facilities could be completed in time. And even if they could, McCormack felt a growing anxiety about the nation's ability to use its new power wisely. He agreed with Brereton's concern that strategic planners did not yet have enough background to make sound recommendations to the Joint Chiefs of Staff on military weapons. General Eisenhower had shown interest in setting up an advanced planning group in the War Department, but as yet not much progress had been made. McCormack was distressed by the hubbub that arose over publication of a War Department study which attempted to analyze the effects of the atomic bomb on national security. If there could be no public discussion of such questions, what hope was there for intelligent answers? Somehow someone would have to start some long-range planning, and McCormack hoped it could be on an interservice basis as a first step toward unification of the armed forces.[14]

Building a stockpile of atomic weapons also raised difficult questions about responsibility for the custody and maintenance of weapons. During the closing weeks of 1946, the Commission had succeeded in acquiring custody of the existing stockpile of weapon parts, with the understanding that the

question would later be considered on its merits. Not much interested in the theoretical arguments, McCormack looked upon custody and maintenance as a practical matter of having reliable weapons when and where they were needed. But he knew that Lilienthal and others saw the issue as but one aspect of the larger debate over civilian versus military control. Perhaps by keeping the discussion on practical matters McCormack could lead the Commissioners away from the old animosities which the debate on the atomic energy bill had engendered a year earlier.[15]

REORIENTING THE LABORATORIES

At its March meeting the General Advisory Committee had recognized the supreme importance of bolstering the production of fissionable materials and weapons. At the same time the committee had given almost equal stress to the need to reorganize and revitalize the Commission's research activities. Wilson and Fisk were no less aware of this need, if only because of the pressure for decision coming from the laboratories. Before Oppenheimer could complete his written report to the Commission during his visit to Los Alamos in the first week of April, Wilson and Fisk were already making decisions which would determine the course of the Commission's research effort.

The size and function of the new General Electric laboratory at Schenectady was a central part of the Commission's discussions with Winne and his staff on April 2. Indeed, the Schenectady dilemma was a good example of the larger question facing the Commission: how to give first priority to weapons and production and still strike a proper balance in research and development. Although the Commission was willing to authorize scarcely more than half the funds General Electric requested, $20 million for the new Knolls Atomic Power Laboratory represented a substantial commitment. Later the same week the Commission was equally receptive to a request from Iowa State for a new laboratory to replace wartime facilities and to a recommendation from the Manhattan District's research staff for construction of the new Brookhaven National Laboratory. The Commission's only reservation was its desire to examine the plans for the Brookhaven research reactor before construction of that facility was started. At the same meeting the Commission decided not to put a dollar ceiling on construction of the new Argonne laboratory until there was some assurance that the existing plans were adequate.[16]

The future of the Clinton Laboratories at Oak Ridge was much less clear. The General Advisory Committee had concluded the laboratory was not worth saving. As Oppenheimer had told the Commissioners on March 30, "Most of us think that the evidence is in that Clinton will not live even if it is built up." [17] His suggestion was that Clinton should be limited to research and

the production of radioisotopes with the existing reactor and that reactor development be transferred to a new central laboratory, probably at Argonne.

In discussing the committee's proposal with Fisk, Wilson admitted that in the long run a central laboratory at some site other than Oak Ridge might be the best solution, but there was no time to study such a far-reaching proposal. The Monsanto contract at Clinton was due to expire in June, and the company's decision to renew the contract would depend upon the Commission's plans for the laboratory. Besides, Wilson reasoned, the main trouble at Clinton was not the geographical location of the laboratory, as some members of the General Advisory Committee seemed to think, but rather the lack of good management. Wilson also surmised that Monsanto was not very interested in some of the projects at Clinton.[18]

Fisk and Wilson concluded that the Commission should consolidate and refocus Monsanto's responsibilities on essential projects which would stimulate the interest of the laboratory staff. This approach would mean construction of the high-flux reactor at Clinton, high-priority work on chemical engineering problems in reactor operations, heavy emphasis on processes for recovering uranium from Hanford reactor wastes, and continued full-scale production of radioisotopes. In place of designing and building the Daniels unit, the laboratory would devote some effort to studying components for power reactors. Except for construction of the high-flux reactor at Clinton, the plan followed the recommendations of the General Advisory Committee.

When Fisk presented the proposal to the Commission on April 8, he explained that he and Wilson were a long way from a decision on the central laboratory. The high-flux reactor was an important first step in any reactor development program. Would it not make sense to keep the high-flux at Clinton, where it could be built without committing the Commission on the central laboratory? Such a decision would also scotch Thomas's proposal that Monsanto build the high-flux near the company's laboratories in Dayton or St. Louis if it were not to be built at Clinton. The Commission's difficulties in fulfilling the Army's commitment to build a laboratory for General Electric at Schenectady scarcely recommended the idea of a second laboratory of that type. Furthermore, Wilson had good reason to believe that few of the scientists working on the high-flux reactor at Clinton would be willing to follow the project to a Monsanto laboratory.[19]

No one was very happy with Fisk's proposal, but for the moment it seemed the best solution. By the next morning the Commissioners had Oppenheimer's written report from Los Alamos with its strong recommendation for putting the high-flux reactor in a new central laboratory. A long discussion of Oppenheimer's report seemed to neutralize Wilson's and Fisk's arguments of the previous day. By Thursday afternoon, April 10, Fisk and McCormack could report that they had talked with Conant, who strongly opposed their idea. Conant doubted that Monsanto had sufficient interest in the project or could attract to Oak Ridge the caliber of scientists needed for

the job. Furthermore, Conant argued, building the high-flux at Clinton would commit the Commission to supporting the laboratory for an indefinite period. Oppenheimer had also told Wilson by telephone that he agreed with Conant. The weight of opinion from Conant and Oppenheimer decided the issue: the high-flux would not be built at Clinton. But neither would there be a central laboratory in the immediate future. The Commission authorized Wilson to negotiate a three-year extension of the contract with Monsanto, with no commitment on the high-flux.[20]

Fisk could only speculate what would have happened had his proposal been adopted, but he could see that the Commission's decision on April 10 would not help to lift the pall of discouragement and aimlessness which had settled over the Clinton scientists. In view of the low morale in the laboratory, Fisk could hardly expect a three-year extension of the existing contract to be greeted with enthusiasm; certainly it would not compensate for loss of the high-flux reactor. Even worse, perhaps, was the lack of decision on the future of the Daniels reactor and other central activities of the laboratory. No one wished to question the intentions or wisdom of the General Advisory Committee; but was it necessarily good that an advisory group, by the sheer weight of its prestige, could reverse the decisions of those directly responsible for operations?

REACTORS AT CLINTON

Fully to appreciate the problems of Clinton, the General Advisory Committee would have had to look at them through the eyes of Eugene P. Wigner, who had lived with them for almost a year. Clinton was every bit the strange melange of activity which Manley had described in his February, 1947, report. And yet there was beneath the surface confusion a sense of purpose and a dedication to scientific research which, Wigner thought, needed only to be channeled in the right direction. Wigner was as ready as anyone to criticize the laboratory, including his own leadership, but he believed in Clinton's potential.[21]

The center of Wigner's interest in April, 1947, was the high-flux reactor, not just because it promised to be a valuable facility for testing the components of new reactors, but because it had exciting possibilities in its own right. Far from the blueprint stage, the high-flux was still an idea for the most part, an idea that haunted the minds of the Clinton scientists in different forms at different times. Recently, however, Wigner had seen evidence that these diverse ideas were converging in one conception—that of a reactor consisting of plates of uranium enriched in the 235 isotope, around which ordinary water would be circulated as both a coolant and a neutron moderator.

What excited the scientists was the idea that one might propose to build a reactor using ordinary water as a moderator. The younger men who had heard Fermi and others lecture on the fundamentals of reactor physics during World War II knew only too well the prime requisites of a moderator: a low atomic weight, which would permit elastic collisions with neutrons and thus slow them down quickly; and a low affinity for neutrons, so that the number of neutrons available would not be reduced by absorption in the moderator. Carbon had been found good in the first respect and acceptable in the second. Heavy water (containing the hydrogen-2 isotope) was excellent in both respects. Ordinary water was excellent in the first respect but had a relatively large appetite for neutrons. At a time when it was not certain that any system would sustain a chain reaction, only the optimum designs using graphite or heavy water were considered. But in 1944, after the scientists at the Metallurgical Laboratory had passed the heaviest load of their wartime responsibilities to the engineers at Hanford, there was time to think about more daring designs. At a conference in Chicago on May 24, 1944, Fermi had suggested the possibility of dissolving a uranium salt in water, which would serve as a moderator. Wigner was impressed by some of Philip Morrison's experiments, which indicated the chances of a chain reaction in ordinary water were much better than Wigner had expected. He suggested the idea of fabricating the uranium in aluminum-coated plates which could be suspended in water.[22]

These imaginative ideas were but two of many proposed, and like many others they had receded into the background by the time the scientists at Clinton got down to the realities of reactor design in 1946. The first full-scale description of the high-flux reactor committed to paper proposed aluminum-clad, plate-type elements cooled internally by ordinary water but suspended in a lattice arrangement in a tank of heavy water as moderator. The reactor would have a power rating of 30 megawatts and would produce a neutron flux many times that of any existing facility. Apparently no longer a dream of the theoretical physicists, the high-flux was now the responsibility of the technical division under Miles C. Leverett, who predicted with some confidence in the spring of 1946 that construction could be started by July 1, and the reactor completed in about a year.[23]

Events proved, however, that others were not so settled on the design as Leverett seemed to be. The consideration of other possibilities tended to dilute interest in the established design, and July 1 passed without any decision to begin construction. One of the distracting possibilities was a suggestion from Alvin M. Weinberg, who had worked closely with Wigner in reactor design. In April, 1946, Weinberg ventured the thought that scientists had overlooked the advantages of water reactors. The relatively poor qualities of ordinary water as a moderator and its inefficiency as a heat-transfer medium at ordinary pressures had caused scientists to discount its use in power reactors. This tendency in part explained the recent emphasis on gas

cooling, which had been proposed for the Daniels reactor, and liquid-metal coolants, which were under study for the fast-breeder at Argonne and the intermediate-power-breeder at Schenectady. But what, Weinberg asked, would happen if water were used at high pressures? Tests had shown that water would perform satisfactorily at temperatures up to 374 degrees centigrade and at pressures up to 215 atmospheres. Corrosion was not severe in stainless steel and might be acceptable in aluminum. He concluded: "These facts suggest that a high pressure water power plant may be built with less development work than either the gas or liquid metal plants, and that such a plant might be very reliable." Weinberg admitted that water might not be the best heat transfer medium, but he thought hot water would probably have to be used in breeder reactors. He went even further. He thought a chain reaction might be possible in unenriched uranium with ordinary water as a moderator if the temperature of the water were high enough.[24]

Other scientists at Clinton and elsewhere had thought of the same possibility, but Weinberg was in an excellent position to bring it to bear on the high-flux design. At Clinton second only to Wigner in stature as a reactor physicist, Weinberg had his superior's confidence and support. Working closely with Leverett, Gale Young, Lothar W. Nordheim, and others in the laboratory, Wigner and Weinberg carefully weighed the advantages of the water reactor against those of the original high-flux design. Finally, on August 23, 1946, they decided to make the change. It would certainly set back the schedule for the high-flux, but the advantages were substantial. Not only did the new design eliminate the need for heavy water, still a scarce and expensive material, but it also made possible a much simpler and more compact design. Instead of placing the fuel element assemblies in a lattice, they could be stacked closely together, an arrangement which promised to increase the power density and thus the flux of fast neutrons by ten times over that possible in the heavy-water approach.[25]

Theoretical and engineering studies in the remaining months of 1946 increased the laboratory's enthusiasm for the new design. The frustrations of early 1947 and the drop in morale set back work on the high-flux as it did all other projects in the laboratory, but by the end of March Wigner was convinced that Weinberg was on the right track. A general report on the high-flux design gave impressive evidence of the accomplishments of the past year. For Wigner and Weinberg the high-flux was unquestionably the most valuable reactor the Commission could build in 1947. All the work at Clinton pointed to success. Then came the Commission's ambivalent decision of April 10, 1947, which in one breath expressed confidence in the high-flux and in the next stated the intention to build the reactor at another site, not yet determined.

If the news from Washington disappointed Wigner, Weinberg, and the former Metallurgical Laboratory scientists at Clinton, its impact must have been equally severe on Farrington Daniels, C. Rogers McCullough, and the Monsanto team which had dedicated its efforts to the gas-cooled power

reactor called the "Daniels Pile." In 1946 the project had enjoyed top priority in the Manhattan District's reactor plans. Never claiming that the reactor in a technical sense would be a practical producer of power, Daniels saw it as the answer to a critical need to demonstrate to American industry and to the world the feasibility of using nuclear energy for power generation. Starting with the technology at hand, such as the air-cooled X-10 research reactor at Clinton, Daniels thought he could attain his relatively modest goal without involving the project in time-consuming fundamental studies.[26]

By the autumn of 1946, however, almost everyone at Clinton realized the power project was in trouble. Wigner, as codirector of the laboratory, was not willing to take responsibility for the project unless some of the design features were subjected to detailed study and tests. Daniels, now only a part-time consultant at Clinton, argued that the physicists were hamstringing the project with needless detail. Even when he had to admit the need for more data, Daniels was confident enough in his own judgment to suggest proceeding with the original design pending the outcome of further study. Convincing evidence of error led often only to the substitution of a new scheme as questionable as the original.[27]

For Daniels power demonstration was the overriding consideration. He confided to McCullough in January, 1947, that he would rather have a second-class reactor in one year than a first-class one in two years. Thomas, whose experience on the Lilienthal board of consultants led him to accept Daniels's scale of values, kept Monsanto support behind the project; but he confessed to Wigner in February, 1947, that the goal of the project was becoming confused. That, he thought, might explain the difficulty in fixing on a final design. Wigner replied that he could not submit the design to routine engineering until the physicists had checked out such things as the critical size of the reactor, its response to increases in temperature, and the rate of diffusion of rare gases through the beryllium-oxide moderator.[28]

Wigner's lack of enthusiasm and the shaky foundations on which the design seemed to rest were adequate justification for the unfavorable reaction of the General Advisory Committee, Wilson, and Fisk.[29] A prompt decision to terminate the project in April, 1947, as Wilson and Fisk had advocated, might have caused an outcry from Daniels and Monsanto. But when the Commission lost track of the decision in its discussion of the central laboratory and the future of Clinton on April 10, it condemned Wigner and the laboratory to more months of indecision and permitted Daniels to keep up his fight on the strength of hopes he would never realize.

REACTORS FOR THE MILITARY

Unfortunately, the future of the high-flux and the Daniels reactors was not the only source of anxiety at Oak Ridge. Two other projects competing for the

limited resources available were not under Commission jurisdiction but were creatures of the military services. At the April 10 meeting the two efforts did not even enter the Commission's discussion of reactor activities at Oak Ridge, but both seemed to have the potential for far-reaching impact on Oak Ridge and, if successful, on the future of nuclear power.

The first of these projects bore the title of "NEPA," an acronym from Nuclear Energy for the Propulsion of Aircraft. NEPA stemmed directly from Army Air Force efforts during World War II to develop jet engines for aircraft. Jet power had immediate application in interceptor aircraft, where high fuel consumption and therefore short range did not cancel out the advantages of high speed. This development threatened to give defensive aircraft a distinct advantage over long-range bombers, a threat which became the concern of General Curtis E. LeMay's research and development staff.

In 1944 Colonel Donald J. Keirn, a jet-engine expert at Wright Field,
72 Ohio, learned that the Manhattan project was concerned with atomic energy. An inquiry to Vannevar Bush brought the abrupt reply that the Army was developing atomic energy for bombs, not for aircraft propulsion. Not until the mission of the Manhattan project became common knowledge at the end of the war was Keirn able to reopen the question. Then four aircraft manufacturers proposed to investigate the possibilities of aircraft nuclear propulsion. It would not have been easy for the Air Force or the manufacturers to break through the secrecy barriers around the Manhattan project; but with help from Air Force General Roscoe C. Wilson, Keirn succeeded in April, 1946, in winning Groves's acceptance of an agreement that the Air Force would negotiate contracts with interested companies to conduct research in existing facilities at Oak Ridge and in cooperation with Monsanto research on power reactors. As a member of Groves's staff Keirn would maintain control through review of the contracts, security arrangements, and research proposals. The Army would furnish housing and laboratory facilities at Oak Ridge; the Air Force would pay most of the costs.[30]

In an effort to satisfy Groves's continuing concern about administrative and security controls, the Air Force on May 23, 1946, granted a prime contract to the Fairchild Engine and Airplane Corporation, whose president, J. Carlton Ward, was spearheading the aircraft industry's interest in the project. Nine other participating companies, the Navy's Bureau of Aeronautics, and the National Advisory Committee for Aeronautics were to be represented on a board of consultants and would receive technical information through channels strictly controlled by the Manhattan District. The nine associated companies could also participate as Fairchild subcontractors.[31]

On paper NEPA was to be an impressive enterprise, consisting of extensive Fairchild operations at Oak Ridge supported by a variety of research activities performed elsewhere by subcontractors. Actually, the first Air Force and Fairchild personnel did not arrive in Oak Ridge until September, 1946, and not more than thirty were assigned by late November. Part of

the trouble was the lack of adequate housing and office space. For a time the NEPA technical staff hoped to move into the Clinton Laboratories near the Monsanto group working on the Daniels reactor, but eventually they had to accept much less desirable space in the abandoned thermal diffusion separation plant isolated in the K-25 production area, a dozen miles from the Monsanto group. There the NEPA group, under the direction of Gordon Simmons, Jr., undertook paper studies and calculations of various systems for transferring heat from a reactor source to conventional propeller jets, turbojets, and ramjets.[32]

From the beginning it was clear that NEPA was to be the domain of engineers, not nuclear physicists, and that the chief concern was aircraft engines and equipment, not nuclear reactors. The great variety of subjects under investigation and the leisurely pace of research at Oak Ridge did not suggest an attitude of urgency. On the other hand, so few people in the project knew anything about atomic energy that it was difficult to know where to begin. The NEPA staff seemed much more concerned about administrative procedures, tables of organization, recruiting, and public relations than about the fundamental question of whether existing reactor technology offered any feasible way of using nuclear energy in an aircraft. The implicit assumption was that in the total effort reactor design was but one of many problems, one which safely could be left for the Monsanto group to resolve. This would have been a risky assumption even if Monsanto had been devoting all of its attention to the aircraft reactor. The difficulties Daniels and the Monsanto group were facing in 1947 made such an assumption nothing but a daydream.

Conant recognized some of these weaknesses when Ward and Simmons briefed the atomic energy committee of the Joint Research and Development Board on March 10, 1947. After the NEPA group left, Conant asked Crawford H. Greenewalt to investigate NEPA in the course of his survey of reactor development projects, and Oppenheimer suggested that any information acquired be given to the reactor subcommittee of the General Advisory Committee. Beyond the question of technical feasibility, Conant raised the issue of military requirements. Development of an aircraft reactor was clearly to be a most difficult and therefore expensive enterprise. Was there in fact a sound military justification for embarking on such an ambitious effort?

This was the subject of the committee's meeting on March 31.[33] The discussion centered on written reports which Greenewalt had requested from the military officers acquainted with NEPA. Air Force General Alden S. Crawford presented a convincing analysis supporting the need for nuclear power in long-range bombers. On the assumption that an effective delivery system for atomic weapons would require a bomber with a range of 12,000 miles at speeds exceeding 450 miles per hour, Crawford concluded that only nuclear-powered aircraft would be able to carry sufficient fuel. To conserve the nation's small supply of fissionable material, he suggested that initially efforts be concentrated on applying nuclear energy in turbojet systems even

though the Air Force might later want applications to ramjets and rockets for guided missiles then under study in Project RAND. Admiral Leslie C. Stevens of the Navy's Bureau of Aeronautics in his own paper confirmed Crawford's conclusions about the unique advantages of nuclear power in long-range bombers, and supported NEPA's contention that such an airplane was at least theoretically possible.

Conant, however, remained unconvinced and Oppenheimer suggested additional study of such questions as the amount of time, fissionable material, and scientific effort that might be required. Privately both men had grave doubts about the chances for success within reasonable time and cost, but it would take more than opinion to stop NEPA and the Air Force's bid for a place in atomic energy development.

Like the Air Force, the Navy also had developed an interest in the possibilities of nuclear propulsion before the end of World War II. The fact
74 that Navy interest went back to 1939, before the Army or Groves knew anything about atomic energy, was a point Navy officers often recalled. Ross Gunn and Philip H. Abelson at the Naval Research Laboratory had never forgotten the abrupt termination of their contacts with the Manhattan project in the summer of 1943 after they had offered the Army results of Navy research which contributed to the production of uranium 235 for the Hiroshima weapon. Nor did Gunn abandon his determination to establish a completely independent Navy project to study nuclear propulsion for naval vessels, particularly submarines.[34]

Early in 1946, this determination took the form of a demand for copies of all Manhattan District technical reports and for wholesale clearances of Navy personnel for access to atomic energy information. Unfortunately for Gunn and his associates, they were not able to obtain full Navy support for their position. The blanket requests for clearances from Admiral Harold G. Bowen, chief of the Navy's new Office of Research and Inventions, were so far from the spirit of the tight security restrictions surrounding the Manhattan project that Groves hardly had to take them seriously. Furthermore, Groves had demonstrated his good faith toward the Navy in the summer of 1944 by clearing two high-ranking officers in the Bureau of Ships, Admiral Earle W. Mills and Captain Thorvald A. Solberg, for access to nonweapon research information in connection with their service on the Tolman committee on postwar policy. Maintaining that he was always prepared to grant clearances to individual Navy personnel who could be assigned full-time to the Manhattan project for specific purposes, Groves had permitted Abelson to spend several months at the Clinton Laboratories in the spring of 1946. There Abelson had gained a full understanding of the status of reactor development, including Weinberg's latest thinking on water reactors.[35]

Two other developments in the early postwar period helped to doom Gunn's hopes for an independent Navy project. First, by pleading Gunn's case too strongly, Admiral Bowen aroused fears in the Bureau of Ships that his

new office and the Naval Research Laboratory were trying to take over all Navy activities in atomic energy. Secondly, a preliminary proposal by Abelson and his associates in March, 1946, to build a nuclear submarine in two years by using an existing hull design and conventional turbines coupled to a reactor, convinced Mills and his associates that the Naval Research Laboratory was underestimating the time and effort required to develop nuclear propulsion for ships. Admiral Chester W. Nimitz, Chief of Naval Operations, resolved the issue early in May, 1946, by adopting the approach advocated by the Bureau of Ships. Mills, Solberg, and Parsons, who directed ordnance development of the wartime weapons at Los Alamos, had long agreed that the Navy should abandon any idea of an independent project for the present and instead should assign several well-qualified officers and civilians to the Manhattan project. Their purpose would be not to design a naval propulsion reactor but to learn the fundamentals of nuclear technology. Initially they would be assigned to Clinton.[36]

Mills saw the importance of the Clinton assignments. The job required intelligent men, well grounded in engineering, and with enough initiative and drive to maintain a Navy perspective during any extended assignment in an Army laboratory. As senior officer in the group Mills selected Captain Hyman G. Rickover, whose excellent work on shipboard electric problems had first brought him to Mills's attention during World War II. Mills had no question about Rickover's intelligence, industry, or tenacity; for these qualities he was well known. Equally well established was his reputation as an ambitious, outspoken officer who often criticized traditional Navy methods of operation. Rickover had been in Washington in April, 1946, looking for a new assignment. He had heard about the Navy's interest in nuclear propulsion and inquired about the possibility of his assignment to the project. Once Mills had explained that the future of the project was anything but certain, Rickover began to have second thoughts about it; but Mills had made up his mind. He arranged with General Kenneth D. Nichols to have Rickover assigned as Williams's assistant in Oak Ridge. On June 14, Rickover went to Oak Ridge with Nichols aboard the General's plane. Within a few days the other members of the group arrived. They included Lieutenant Commanders Louis H. Roddis, Jr., James M. Dunford, and Miles A. Libbey, Lieutenant Raymond H. Dick, and three civilians.

Theoretically the members of the Navy group were assigned to Oak Ridge as individuals, but Rickover as senior officer quickly took command and established within the group a sense of discipline and esprit de corps which became legendary at Oak Ridge. In contrast to the banker's hours and time-serving attitude of many at Oak Ridge, the Navy group had a mission and little time for anything else. They read everything they could find, attended every technical meeting and seminar offered, listened to any engineer who would talk, and wrote dozens of concise, detailed reports which soon accumulated in Navy files as one of the best summaries of nuclear technology

in existence. The reports were to the point and factual; there was no special pleading or wishful thinking. Every project, every idea was evaluated for its use in naval propulsion systems. Within six months Rickover's group had a better understanding of the technical status of many projects than did those directly participating in them.[37]

Study and report writing, however, did not constitute all the Navy effort on nuclear propulsion in 1946. Before the end of June, the Bureau of Ships had approved two research contracts with private companies to study the use of sodium-potassium alloy in heat transfer systems and had received from the General Electric Company a proposal to develop a nuclear power plant for a destroyer. Soon after the Atomic Energy Act became law on August 1, an event which numbered the days of the Manhattan project, Groves approved a request from Mills for Army support of a paper study of the destroyer plant at General Electric. In November, 1946, the Massachusetts
76 Institute of Technology submitted to the Navy an ambitious proposal for study and development of a nuclear propulsion system. In December Rickover and his assistants visited both the General Electric and MIT laboratories to discuss the work in progress and to explore the possibilities of combining the two efforts into one project at Schenectady. Agreement on a combined project proved impossible, but MIT was willing to accept research contracts on specific problems such as shielding design. At Rickover's suggestion, General Electric scaled down its effort to a power plant for a destroyer escort, in the interests of saving fissionable material. Further conferences with the General Electric staff convinced Rickover that the company was on the right track. He assured Mills that the General Electric proposal was the best hope the Navy had for a nuclear submarine within four years. The company proposed to have a sodium-cooled plant installed in a destroyer escort by September, 1948, and in a submarine by July, 1950.[38]

By the spring of 1947 Rickover and his group had learned all they needed to know at Oak Ridge and were preparing for a seven-week tour of Commission laboratories and major installations. The General Electric project looked like a promising start, but Mills warned Rickover that the new Atomic Energy Commission was not yet well enough organized to make a prompt decision on the Navy effort. In May, 1947, the Commission had more pressing issues to decide; the Navy would have to wait for its day in court.

EXIT MONSANTO

When Conant and Oppenheimer reversed the Commission's decision to build the high-flux reactor at Clinton, they imposed additional complications on Wilson and Fisk. For one thing, the shift kept alive the possibility of a central laboratory, a proposal which both men looked upon with skepticism. For another, it would make negotiations with Monsanto much more difficult.

Wilson made clear the reasons for his concern in a wide-ranging discussion with Thomas and other Monsanto officials in St. Louis on May 2, 1947. He stressed the important contributions which the company could make in producing initiators at Dayton and radioisotopes in the X-10 reactor at Clinton. He was counting on Monsanto's help in developing a process to recover uranium from the waste tanks at Hanford and Clinton and in operating Clinton as a regional research center for universities in the Southeast. But he wanted the Monsanto leadership to know that the Commmission was considering a sharp curtailment of reactor development work at Clinton. The General Advisory Committee believed that plans to construct the Daniels reactor were premature, and that construction of a power unit might be four or five years away. The Commission intended to put more effort into the high-flux, but there was a good chance that the reactor itself would not be built at Clinton. Wilson also let it be known that he was not satisfied with Monsanto management at Clinton and that he expected the company to assign one of its top officers, perhaps Hochwalt, to direct Monsanto operations at the laboratory.[39]

Thomas replied by pointing out the company's many accomplishments during the previous two difficult years. The high-flux reactor had been completely redesigned. The power group had learned much about design requirements for the Daniels unit, and the laboratory had made great strides in establishing an outstanding program in radiation biology under the direction of Alexander Hollaender. Thomas was more concerned about plans for the high-flux. He thought the laboratory needed an important assignment in physics as well as chemistry. Wilson had argued that it did not seem appropriate to permit a private company to build and control a reactor which would be a fundamental research tool for other Commission projects. Thomas had only to note that the Commission was permitting General Electric to build the intermediate-power-breeder at Schenectady.

Wilson was uneasy as he started back to Washington with Fisk on Friday afternoon. Thomas was not enthusiastic about the new arrangement, and Wilson knew the company had never been completely happy at Clinton. His premonitions proved correct. On Tuesday morning, May 6, he received a telegram from Thomas stating that the company would not be interested in the Clinton contract if it did not include the high-flux. Now the issue seemed clear-cut: the Commission had to decide whether to keep Clinton as a major laboratory or establish a central laboratory elsewhere.

Wilson presented the issue in those terms to the Commissioners later that morning. He held that the Commission was in no position to organize a central laboratory with its own employees. Both Bacher and Fisk thought most of the scientists would remain at Clinton if the company installed better management. The price would be to change course again and build the high-flux at Clinton. Wilson left the meeting to call Conant in Cambridge. Conant needed no time to consider the question. Monsanto had to be retained at Clinton, even at the price named. Conant's word was enough for the

Commissioners. After the meeting Wilson sent Thomas a telegram accepting Monsanto's condition and asking him to come to Washington for further discussions.[40]

Wilson was confident when Thomas and his associates arrived for their meeting with the Commissioners on Thursday afternoon, May 8. That morning Williams had called from Oak Ridge with assurances that Monsanto was more willing to accept a new contract than the telegram on Tuesday had suggested. Wilson put his position on paper: if Monsanto would replace the dual leadership at Clinton with a single director who was a good administrator and had the full support of the St. Louis organization, the Commission would make every effort to improve conditions at Oak Ridge and give the high-flux a top priority. The company could continue component development for the Daniels project, maintain radioisotope production, and operate the X-10 reactor as a regional research facility. The rest of the program could be trimmed to a modest scale.[41]

Thomas found Wilson's proposal encouraging, but Monsanto's position had now stiffened. Not only did the company want the high-flux, but it would have to be built either at Dayton or St. Louis. Fisk thought Thomas was simply trying to escape the Clinton contract. Wilson and the Commissioners tended to agree, but they asked Wilson to keep negotiating. Although Thomas for a time relented on his latest demand, he found other objections to the contract. At last on May 22 he wrote Wilson that Monsanto would have to withdraw. The company was willing to operate the Dayton plant under a separate contract and would still agree to build the high-flux at a company site.

The letter was sad news for the Commissioners. Lilienthal hated to see Monsanto go. He thought General Electric's success in winning the promise of the Schenectady laboratory from General Groves had led Thomas to believe the Commission would give in on the high-flux location, but Lilienthal wanted to avoid such a bargain. Still, the prospect of finding a new contractor to take over Clinton was not very good. In a moment of desperation someone suggested trying to bring du Pont back to Clinton. Lilienthal thought that would mean that the Commission would become part of du Pont rather than the other way around. Du Pont could hardly be expected to conform its management policies to a contract the Commission would have to beg the company to accept. Perhaps, Strauss suggested, the scientists at Clinton could themselves form a corporation to serve as the contractor. Other companies were already expressing an interest. Lilienthal thought something would turn up; but until a new contractor could be found for Clinton, the future of the laboratory and the high-flux would be uncertain.[42]

Coming just a few days before the fourth meeting of the General Advisory Committee on May 30, 1947, the Monsanto decision was certain to reopen the question of the central laboratory and the future of Clinton. Wilson attempted to forestall the discussion by stating to the committee the

Commission's determination not to establish a central laboratory, but the committee had no intention of dropping the subject. Wilson's arguments convinced no one that building the high-flux reactor at Clinton was a good idea. Rabi urged that MIT be asked to construct and operate the reactor at Brookhaven. Although Conant favored the Argonne site, he agreed with Rabi that Clinton would never be a strong laboratory. Nor was there any inclination to take seriously the Commission's contention that a central laboratory would conflict with Lilienthal's doctrine of decentralization. That was simply a play on words. The committee hoped the Commission would give further thought to the central laboratory and would consider building the high-flux at a site other than Clinton, if not abandoning the laboratory altogether.[43]

OPENING DOORS FOR RESEARCH 79

Oppenheimer's committee considered a broad range of topics over the Memorial Day weekend, but much of the discussion centered around the need to broaden both Commission support of basic research in the United States and participation in nuclear research by independent scientists. These interests stemmed directly from the new appreciation of the importance of science in the postwar world. Radar, the proximity fuse, and the atomic bomb were seen as the products of a vigorous and well-supported research effort during the war; many Americans considered broad Federal support of scientific research and development essential to the national welfare in peacetime as well. The question for debate was not really *whether* but *how*—how, for example, could the Federal Government support university research without restricting traditional academic freedoms? Or how could the Government exercise appropriate administrative controls in the public interest if the scientists were really free? More dramatic and emotional issues concealed these fundamental questions in the prolonged debates on atomic energy legislation and the National Science Foundation in 1946. Even in early 1947 most people found few answers to these questions in the new Atomic Energy Act, and the outcome of the National Science Foundation debate, aborted in 1946, had not yet begun to appear.[44]

As often happened when events outran policy, those officials in the best position to act were reluctant to do so. Perhaps few persons in the Government in early 1947 had had better exposure to the requirements for, and the capabilities of, modern large-scale research programs than did Wilson and Fisk. Yet, during the winter of 1947, they held doggedly to the line that scientific talent and resources had to be conserved for immediately essential activities, such as weapon design and testing, improvements in production reactors, and development of the Redox process.

While the Commission was preoccupied with these and other matters,

research proposals began coming in from universities, Government agencies, private companies, and the Commission's national laboratories. Fisk reported to the General Advisory Committee at its May meeting that these proposals, if accepted, would total more than $19 million in capital costs and more than $4 million in annual operating expenditures for the Commission. What action, Fisk wanted to know, should the Commission take? What proportion (if any) of the Commission's budget should support basic research not directly related to the Commission's program? And how would the Commission justify such support in view of the legislative history of the Atomic Energy Act, which showed that Congress had stricken from the McMahon bill the authority to award grants-in-aid? [45]

What brought these questions to a head was a proposal from the Office of Naval Research requesting the Commission to contribute $4.1 million to support high-energy physics. While scientists both inside and outside the
80 Government had been struggling with the policy issues in the debate about the National Science Foundation, the Navy had quietly undertaken to finance construction of high-energy accelerators on university campuses. Before World War II a few enterprising physicists like Ernest O. Lawrence at the University of California had been able to find support for such efforts in private foundations, but in the postwar world possession of an accelerator was no longer optional in a good physics laboratory. In response to requests the Navy had awarded twelve contracts for the construction of accelerators, most of them cyclotrons ranging in size up to that of the 184-inch machine in Lawrence's laboratory at Berkeley. Now, in the spring of 1947, the Navy was running into budget restrictions which threatened completion of the accelerators already started.[46]

The Navy request posed some tough questions for Fisk. On the one hand, it seemed ridiculous that the Navy, rather than the Commission, should be supporting research on the atomic nucleus. On the other hand, Fisk quite reasonably asked how deeper probes into the nucleus with protons from more powerful accelerators would contribute to the design of better weapons and reactors. If they would not, Fisk doubted that Commission support was justified, no matter how much such projects might contribute to man's understanding of nature.

Another research policy issue in the spring of 1947 concerned the foreign distribution of radioisotopes. Before World War II there had been extensive research using radioactive materials, and it had become customary for university laboratories in the United States to give European scientists samples of radioisotopes produced in cyclotrons. After the war the demand for accelerators was too great to permit their use for isotope production, and the Manhattan District had been able to meet all domestic needs solely by operation of the X-10 research reactor at Clinton. Scientists abroad, deprived of their prewar sources and having few of their own, began pressing for even modest samples from the materials copiously generated in the Clinton reactor.

After the Commission was appointed, scientists at Brookhaven and eastern universities began appealing to Bacher on behalf of their European colleagues. Bacher passed the appeals to Wilson, whose immediate reaction was that nothing in the Atomic Energy Act prohibited foreign distribution of isotopes and that it would be in the national interest to comply with the requests. General Nichols pointed out that the Manhattan District had carefully avoided committing the Commission on the subject. Setting aside the legal question, he saw no practical difficulty in extending distribution abroad and suggested using domestic procedures, with added provisions disclaiming Commission responsibility for the use of the isotopes and requiring foreign applicants to describe the proposed use and to report their results in scientific journals. The study of legal questions took several months, but the lawyers concluded there were no insuperable obstacles. Radioisotopes seemed to fall under the Act's definition of "byproduct material," and the Act posed no geographic limitations on the distribution of such materials. There was some uncertainty whether isotopes would come under the provisions of Section 10(a), which prohibited the "exchange of information with other nations with respect to the use of atomic energy for industrial purposes," but the lawyers thought this was a matter of judgment which the Commission should carefully document in the record.[47]

By the time these issues had been resolved in late March, the scientists were becoming restive, and renewed appeals were arriving in Bacher's office. A number of distinguished American scientists, all members of an international society called the Isotope Research Group, urged Commission action. As an illustration, they cited the denial of a Canadian request for a small sample of carbon 14, worth five cents, for radiographic tests of biologic material.[48]

Apparently the only reason for further delay was the continuing reservation expressed by Commissioner Strauss, who feared the radioactive samples might fall into the wrong hands and "provide the means to conduct research on the use of radiological poisons in warfare." If the Commission could not control the eventual disposition of the isotopes, Strauss thought "it would be best not to export them at all." Rather than risk a formal confrontation with Strauss, Lilienthal and Wilson decided to submit the proposed foreign distribution plan to the General Advisory Committee at the May meeting. The plan followed closely the administrative procedures suggested by Nichols. In order to avoid the distribution of isotopes which would further the development of atomic energy for military or industrial purposes, the list would not include any natural radioisotope above atomic number 83 (bismuth) or any artificially produced isotope above 92 (uranium), and use would be restricted to medical research and therapy.[49]

The General Advisory Committee took a strong stand on both the foreign distribution of isotopes and the accelerator proposal. The subcommittee on research under DuBridge's leadership thought the Office of Naval

Research had performed a valuable service in financing accelerator construction at a time when no other Government agency was in a position to help. The Navy had exercised discretion in awarding the contracts and had succeeded in encouraging just the sort of research that was needed. The committee argued that the completely unclassified nature of the accelerator projects suggested that a civilian agency like the Commission, rather than the Navy, should support them.[50]

On the foreign distribution of isotopes the committee "heartily concurred." It would have the effect abroad of restoring confidence in American scientists. Rather than question the proposal, the committee suggested a much more liberal policy. It questioned the restriction to medical therapy and research and urged broadening the authorization at least to include the biological sciences, if not all basic research. The committee, at Fermi's suggestion, also favored including hydrogen 3 (tritium) in the distribution list, on the security grounds that its omission would suggest that the material had special classified uses.

Oppenheimer got to the fundamental issue on May 31 in a long discussion with the Commission which Lilienthal termed "as brilliant, lively, and accurate a statement as I believe I have ever heard." Oppenheimer stated directly that the Commission would have to support fundamental research in the nuclear sciences. And by that he meant nuclear physics and chemistry and not just the compilation of data and the development of processes related to Commission activities. Furthermore, the support would have to go to scientists working in university and private laboratories.

In a diplomatic way Oppenheimer suggested that Wilson and Fisk were asking the wrong question. The issue was not what proportion of the Commission's budget should go for basic research or how many accelerators the Commission could appropriately support, but how many accelerators would meet the needs of well-qualified research teams already in existence. The competence of the research group and not the substance of its proposal should be the criterion for selection. The Office of Naval Research had proceeded in just this way and had granted liberal contracts which the scientists were happy to accept. Oppenheimer hoped the Commission would take over the Navy contracts, but only on the condition that it did so with the same criteria and as little red tape as the Navy found necessary.[51]

Bacher agreed with Oppenheimer in principle, but he thought that in a practical sense there had to be some consideration of the magnitude of support for basic research. DuBridge argued that this would be true if the Commission were thinking of building ten Berkeley laboratories, but the Navy program, which seemed fully adequate, involved a negligible proportion of the Commission's budget. Fisk said he could agree with Oppenheimer in the long term, but he was still concerned about finding enough scientists for essential work during the next several years.

As Oppenheimer continued, he revealed the committee's interest in

other positive measures to increase participation in nuclear research. He hoped the Commission would declassify broad topics in the nuclear sciences and segregate research on them from classified activities. This action would end the intolerable situation, of which Fermi complained, that required scientists to write down their ideas in the fundamental sciences and have them declassified before they could discuss them with their colleagues. Oppenheimer urged the Commission to broaden the distribution of radioisotopes to scientists abroad for uses beyond therapeutic and medical research, to take a positive stand on releasing to the public information on recent discoveries in the fundamental sciences.

Saving the committee's greatest concern until last, he stressed the need for a realistic and authoritative statement on the prospects for nuclear power. Convinced that industrial use of atomic energy was at least a decade away, the committee was disturbed by the "rather bad discrepancy between expectation and probable reality." He thought it was "very terrifying to have news releases about how there is going to be atomic power in Britain in two years." The committee believed the Commission could issue a statement on this subject without compromising classified information. In these and other ways Oppenheimer thought the Commission could take the lead in opening the doors to fundamental research in the nuclear sciences.

The committee's comments and suggestions had been helpful in a general way, but Fisk had reservations about their practicality. It was one thing to theorize about the Commission's program and its goals and something else to apply policies in day-to-day operations. The force of the committee's arguments and the prestige behind them were too great for a direct confrontation, but Fisk could bide his time. In a burst of enthusiasm on June 5, the Commission had agreed to support the Navy accelerator program temporarily until it could assume direct responsibility for the contracts, but Fisk saw no need for an immediate response to the Navy. Further discussions revealed that the Navy could finance the projects for another year. On July 17 he sent to the Commission a draft letter commending the Navy for supporting the twelve projects but declaring the Commission's inability to assume the burden. Applied research and development had to come first, and it was not yet "clear how the task of providing public funds to support such a program should be apportioned." [52]

The other proposals of the General Advisory Committee fared no better in the late spring of 1947. Fisk was reluctant to commit himself on the private research proposals and had little time to consider the broad outlines of a basic research program. Even in applied areas such as reactor development he took no immediate steps to formulate a policy which would guide the national laboratories. In May, with Lilienthal's encouragement, he appointed a research council consisting of the directors of the principal laboratories, but the group had no plans to meet until midsummer. Nor did Fisk hasten to appoint the committee recommended by Oppenheimer's group to study the

hazards of building reactors near centers of population. Finding a replacement for Monsanto and mounting the research effort on Redox were more pressing concerns of the moment; the important but less immediate goals of the General Advisory Committee would have to wait.[53]

A SOBERING DECISION

If Fisk had difficulty interpreting the General Advisory Committee's recommendations on research and development, McCormack and Williams had no trouble understanding its thoughts on weapons and production. Without prompt action on these matters, there would be little hope of building an effective arsenal of atomic weapons before the end of the decade.

On the weapon test, the weapon subcommittee had settled most of the technical issues at the April meeting in Los Alamos. There was general agreement on the numbers of shots and on the design of the devices to be tested. Now it was up to Lilienthal and the Commission to work out the policy issues at the Pentagon and the White House. Although the need for the test series was obvious, Lilienthal and others found the decision difficult to swallow. It was in a way an admission that the fervent hopes and plans for international control of atomic energy had all but vanished. Nor did the Bikini tests of the previous year make the decision any easier. The lack of scientific instrumentation and the presence of large numbers of observers at Operation *Crossroads,* although consistent with the purposes of the armed forces, made it difficult to convince scientists that the 1948 tests were really designed to produce significant data.

Since a decision on the weapon test rested ultimately with President Truman, Lilienthal faced the unfamiliar task of transforming a Commission decision into a significant Administration policy. He began on April 25, 1947, with a letter to the Military Liaison Committee explaining the need for the test and outlining the Commission's plans. A month later General Brereton could report only that he had sent a written proposal to General Eisenhower and the Joint Chiefs of Staff; there was still no formal concurrence from the military services. Progress was just as slow in the Department of State. Lilienthal raised the question in a long discussion with Secretary George C. Marshall on June 11. He explained that the proposed test would have international repercussions, especially since it would be necessary to conduct the operation outside the United States. Marshall acknowledged this difficulty, but he was even more concerned about timing. It would be most unfortunate if the test occurred at any time close to the foreign ministers' conference scheduled for London in November. Marshall seemed to accept the need for the test, but he wanted to reserve judgment until he had discussed it in the department.[54]

Meanwhile, Lilienthal, still nervous about the decision, had been sounding out the President through Admiral William D. Leahy. On June 14, he called Lilienthal to report that the President was all for the idea but wanted to discuss it with the service secretaries. The final decision came in a White House meeting on June 27. Lilienthal presented the case to the President, the service secretaries, the members of the Joint Chiefs of Staff, and Secretary Marshall. The discussion centered around the time and place for the tests. Eisenhower suggested April, 1948, which was acceptable to Lilienthal although he hoped to be ready by February. Patterson joined Marshall in expressing a preference for holding the test in the continental United States, but Eisenhower supported Lilienthal's contention that a more remote location, somewhere in the Pacific, was preferable. All agreed that the test should be conducted with no fanfare and with no foreign observers. Under Secretary of State Dean G. Acheson reinforced this opinion the following day in a discussion with Lilienthal. It was especially important to keep plans for the test a closely held secret. The public's only preparation for the event was a short sentence tucked in the Commission's semiannual report to the Congress: "The Atomic Energy Commission is establishing proving grounds in the Pacific for routine experiments and tests of atomic weapons." [55]

CONSTRUCTION AT HANFORD

Fortunately Williams did not have to await a Presidential decision to start the campaign for new production facilities at Hanford. He was already concerned about General Electric's failure to come to grips with the project and the absence of a permanent field manager at the site. A trip to Schenectady on May 16 did not alleviate his fears on either point. Although Winne, the company's vice-president, promised full cooperation, Williams found it necessary to remind the General Electric officials that they were working under a cost contract with Government funds and would have to accept firm Commission direction and control. He thought that the holdover Army officer in charge at Hanford had been too lax with the company and should be replaced by a permanent manager as soon as possible.[56]

Despite his best efforts, Williams found he could do little to improve the Hanford situation in June. The company seemed to busy itself more with words than actions, and the lack of firm Commission control at the site made it difficult for Williams to exert his authority across the continent. Finally he decided to take matters into his own hands. Over the holiday weekend in July he flew west with Fred C. Schlemmer, a Commission consultant who had been one of Lilienthal's construction engineers at TVA. Conditions at Hanford were even worse than they expected. Williams found "an air of complacency

about the whole place." Schlemmer thought the company was engulfed by procrastination, a state of mind encouraged by the local Commission staff, which seemed to be impressed by the fact that General Electric had not been enthusiastic about the contract in the first place.[57]

The greatest weakness was in design and construction of new facilities. With no experience in such a large construction enterprise, General Electric had hardly begun to make the necessary plans, much less start the actual work. The Army colonel in charge reported that not more than thirty of the estimated eight hundred technical and advisory personnel needed were on the job. Not more than 1 per cent of the purchase orders required for the $100 million project had been placed. The organization chart was a cluster of empty squares. Existing housing would accommodate only 5,000 of the estimated 23,000 construction workers needed. Schools and other community facilities were completely inadequate for a permanent town. There was no

doubt in Williams's or Schlemmer's minds that the combined responsibility for construction and operation far exceeded General Electric's capabilities. The most pressing need was for a strong resident Commission manager. Scarcely less urgent was the appointment of experienced architect-engineer and construction contractors. Williams thought work on town facilities should begin at once so that they could be completed before plant construction reached its peak. He also favored building the new production reactors as replacement facilities near existing units, where they could use the same cooling-water facilities. The Commission seemed to accept Williams's recommendations in a general discussion with the Military Liaison Committee on July 18, but it was still Williams's job to carry them out. On his success would depend the future of Hanford.[58]

TALENT SEARCH

With good reason the Commission concentrated during the spring of 1947 on plans for rebuilding and expanding the structure of both its production and research activities. As the General Advisory Committee recognized at its March and May meetings, immediate decisions were necessary to assure the production of fissionable materials and weapons and to revitalize research and development activities. Equally important for Wilson, and perhaps of even more immediate consequence, was the need to organize and appoint his principal staff.

Unfortunately the high priority given to recruitment in February had not produced results. Of the five key positions in the field, those of managers at Oak Ridge, Los Alamos, Hanford, Chicago, and New York, Wilson had succeeded in filling only the New York post with the appointment of Wilbur E. Kelley. Despite the many hours which Wilson, Williams, and Richard O.

Niehoff devoted to inquiries and interviews, a succession of promising candidates turned down the job at Oak Ridge. The variety and magnitude of the responsibilities and the isolation of the site hardly made the position attractive at the salary the Commission was offering. Wilson and McCormack had been successful in recruiting retired Navy Captain Carroll L. Tyler as manager of the new Santa Fe office, but complications in personnel regulations would make it impossible for Tyler to begin work before July. Wilson had been able to do even less on the Hanford and Chicago positions, for which no promising candidates were in sight.[59]

Wilson fully understood the growing danger of the situation. In April he had asked his friend William Webster, a distinguished engineer and New England utilities executive, to visit the field sites. On May 15, Webster reported that Los Alamos was still a mess. Organization at Hanford and Chicago, still under makeshift direction by temporary military officers, was very weak. Oak Ridge had some good people but many more problems than the other sites. Kelley, the only manager on the job, was having trouble operating without a written delegation of authority. Williams agreed with Webster's conclusions: there was little hope of implementing production and research plans until the field offices were staffed and organized.[60]

One reason for the delay in completing the New York directive was the difficulty of defining the broad powers of the manager in a decentralized organization. As finally issued on June 9, the directive assigned Kelley full responsibility for procuring source materials, processing feed materials such as uranium for the production plants, supervising all construction and research contracts assigned to the office, issuing licenses to holders of source materials, and administering the Commission's health physics and industrial hygiene program. He was authorized, without consulting the general manager, to negotiate contracts involving less than $1 million and to appoint his own staff. Hopefully the New York directive would serve as a guide for those at the other sites.

Wilson's recruiting efforts had been no more successful at headquarters than in the field. He had not even been able to define the functions of the statutory division of engineering, much less recruit its director. Despite Waymack's efforts, Wilson still had no good prospects for director of public information. Although Edward R. Trapnell was doing a good job of handling day-to-day press relations, the Commission wanted someone with exceptional talent and experience to direct its efforts to explain atomic energy to the American people. A similar consideration had made it impossible to find a director of security. No ordinary "gumshoe" would be able to weigh the subtle factors involved in devising a security system which would protect individual rights as well as atomic secrets. None of those the Commission thought qualified had yet been willing to accept. Even in the headquarters personnel office there had been uncertainty and confusion. The need to establish an executive secretariat to manage the Commission's business led to

G. Lyle Belsley's appointment first as secretary and then as assistant general manager with responsibility for congressional relations and internal management reports as well. This action left Niehoff in charge of personnel for several weeks until Wilson appointed Fletcher C. Waller, wartime director of civilian personnel and training in the War Department. In the meantime there had been little progress in developing with the Civil Service Commission an independent merit system for Commission employees.[61]

SHADOW OF SECURITY

The snags in personnel operations were disheartening, but of deeper concern to the Commission were the extraordinary requirements for security and the dangers they implied. Compliance with the Atomic Energy Act called for a system of personnel security investigations unprecedented in American Government. During World War II there had been no uniform requirements for security investigations, certainly not by the FBI. Amid the personal sacrifices of war there was little room for concern about infringing upon individual rights, and criteria for security clearances were left to the individual judgment of military commanders like Groves and the directors of other especially sensitive agencies. In peacetime Lilienthal and his associates were determined not to jeopardize individual rights in the interests of secrecy. The statutory provision for FBI clearance of Commission personnel made necessary centralized control of security investigations and hence uniform criteria and procedures. It did not mean, as the Commission had trouble convincing J. Edgar Hoover, that it would turn over its security operations to the FBI. The FBI could conduct the investigations, but the Commission would devise its own methods of evaluating FBI reports. The Commission would not even go so far as to grant FBI agents free access to its installations and files.[62]

Everything hung upon the evaluation. The Commission had to take every precaution to keep out all but the loyal and trustworthy. Too zealous a pursuit of security, however, could do irreparable harm to innocent individuals. Lilienthal thought that refusal of a clearance to a physicist was tantamount to saddling him with a police record, something which, according to the Constitution, could be done only in an open court of law. He came to dread those days when the Commission was called upon "to play God and decide on *ex parte* evidence of FBI detectives whether Mr. A.'s or Mrs. B.'s loyalty, character, or associations are such as to justify permitting them access to Commission work and facilities." Special security boards of Commission officials could handle most of the cases, but the really tough ones, especially the reinvestigations of employees inherited from the Manhattan District, inevitably found their way to the Commissioners.[63]

The security task would have been difficult enough in a placid era; in the turmoil of 1947, it was impossible. The Soviet Union's rejection of the Baruch plan for international control of atomic energy, the aggressive thrust of Communist power in Eastern Europe and the Middle East, the President's offer of assistance to Greece and Turkey, Secretary of State Marshall's speech at Harvard University in June, all served to dramatize the widening gulf between East and West. One reaction to this unhappy development was the obsessive search for the seeds of communism in every liberal movement, what Lilienthal had called "hysteria" during the confirmation fight. A second reaction, that of many of the atomic scientists, was to try harder than ever to keep open the few remaining channels of communications between scientists in the West, if not between those of East and West. As the full dimensions of the "Iron Curtain" appeared, the first group demanded a rooting out of "communist" influences and a tightening of security controls around the "secret of the bomb." The second group, concerned about the vitality of science in the West, argued that fundamentally there was no secret, that science would survive only if the traditional ways of free investigation and communication were restored. Between these two schools of thought was the fledgling Commission, its dilemma illustrated, in Lilienthal's words, by the demand that it guard closely a secret that did not exist.[64]

The ferocity of the attack on Lilienthal during the confirmation hearings and debate and the passion aroused by the communist issue should have put the Commission on guard against outside attempts to ferret out disloyal employees and lax security; but the extraordinary pressures for decision and the lack of staff had forced the Commission to rely on Army procedures and personnel. The first signs of trouble appeared late in May, when Congressman J. Parnell Thomas published an article in *American* magazine charging that most of the atomic energy patents which the Army had withheld from publication during the war were now available to the Russians and anyone else through the Patent Office. The next blow came on Thursday, June 5, when Senator Hickenlooper learned that *Liberty* magazine was about to publish another Thomas article attacking the Commission's security system at Oak Ridge. To make matters worse, Thomas claimed that his article was based on information obtained during a visit to Oak Ridge in February, 1947, with Robert E. Stripling, an investigator for the House Un-American Activities Committee.[65]

Hickenlooper alerted Strauss to the impending crisis and the two of them discussed the situation with Lilienthal on Thursday noon. Hickenlooper intended immediately to send two of his own investigators, David S. Teeple and William Sheehy, to Oak Ridge to check Thomas's story. Lilienthal called in Joseph A. Volpe and Thomas O. Jones and asked them to find out how Thomas had gained access to Oak Ridge and especially to the files of certain employees whom the Commission was finding it difficult to clear after reinvestigation.[66]

It must have seemed ironic to Lilienthal that the Thomas incident had broken on that particular day. Earlier on Thursday morning he had been pondering the whole question of protecting civil liberties in the course of security investigations. At the moment the Commission was considering a difficult case at Brookhaven involving a four-month suspension from employment pending a decision on clearance. The Commission had also to pass on a request from Patterson that it approve legislation authorizing the service secretaries and the Commission to dismiss employees summarily in the interests of national security. In this request the Commission had reluctantly agreed to concur, but only after reasserting its right to provide for administrative review of any decision to dismiss an employee. Both the Brookhaven case and the Patterson letter pointed to the urgency of establishing review procedures which would protect the rights of individual employees in security cases.[67]

The day did not end without one more security crisis. At six-fifteen Lilienthal learned that the security division had received from the FBI some highly classified weapon information which two Army sergeants had taken from Los Alamos in March, 1946, as souvenirs. The air of mystery surrounding the security breach itself aroused suspicion. Jones could only report that on April 30, 1947, the FBI had told him it had received a "tip" that documents were missing at Los Alamos. A check of the files revealed the loss and led to the identification of the two former Army sergeants as Alexander Von der Luft and Ernest D. Wallis. The FBI had recovered the documents with the help of Von der Luft, who by this time was a student at Princeton University. Since espionage did not seem to be involved, the security implications were not alarming; but, like the Thomas article, the Von der Luft-Wallis case could be a source of embarrassment to the Commission. The question was whether the Thomas article and the Von der Luft-Wallis case were merely coincidental or part of a planned attack on the Commission.[68]

Williams, who was still in charge of Oak Ridge operations pending selection of a local manager, found it hard to accept the possibility of coincidence. He never had time to run down all the details on how Thomas had obtained information from the Oak Ridge files, but he thought the time had come for the Commission to place key functions in the field offices in the hands of its own employees. He warned Wilson that unless the Commission cleaned house the combined forces of military and Congressional opponents might bring the civilian Commission to an untimely end.[69]

If the Oak Ridge incident had heightened Commission suspicions of the Army, Thomas did not help to reduce them. He admitted openly that his purpose was to turn the atomic energy program back to the Army. In his article in *Liberty* Thomas had charged that all the production plants and especially the Clinton Laboratories were "heavily infested" with "Communist suspects." He concluded "that in the present chaotic world situation our only solution is to repeal the act and return Manhattan District to the army, which

can best administer security." There were, in fact, then pending in Congress six bills for that purpose.[70]

Lilienthal's one consolation was that, despite the furor which the Von der Luft-Wallis case and the Thomas article would certainly create, the Commission and its own staff had not been guilty of any gross breaches of security. In reporting the Von der Luft-Wallis case to the Joint Committee on June 17, Lilienthal could stress the point that the incident had occurred in a military installation under Army control, long before the Commission had been created. Without going into details, he could assure the committee that he had taken steps to prevent a recurrence of the Thomas incident. Henceforth members of Congress would be permitted to visit the Commission's installations only after clearance with Washington. Furthermore, the Commission would admit only the congressman and not others in his party.[71]

Teeple's report to the Joint Committee on his recent visit to Oak Ridge tended to absolve the Commission of gross malfeasance, if not of less than concerted attention to security matters. Although Teeple and Sheehy had failed to detect the glaring laxities which the Thomas article suggested, they did find a need for more guards and better security facilities to replace the dilapidated wartime fences and control posts. They were especially critical of the Clinton Laboratories, where they considered the shabby buildings a fire hazard, security facilities inadequate, and employee morale low. They also concluded that about fifteen employees in the laboratories should be terminated for security reasons. While admitting the need for improvements, Lilienthal could again suggest that all these deficiencies had been inherited from General Groves.

It was fortunate also that the security crises of early June had had most of their impact within Government circles rather than in the public press. The Thomas article, although it contained some dramatic charges, appeared sufficiently biased and vague to cause readers to question its accuracy. Even the Hearst and Patterson papers, which usually featured security stories, gave little attention to the Thomas article. The Von der Luft-Wallis case was not yet public knowledge, a fact which gave the Commission time to put its best foot forward. Yet both incidents served adequate warning upon the Commission that it could not place too much emphasis on security. The warning was not lost. Wilson expedited the appointment of Bernard W. Menke, a former Manhattan District security officer, as security director at Oak Ridge with instructions to tighten up security operations. The Von der Luft-Wallis case involved General Counsel Herbert S. Marks in extensive discussions with the Department of Justice, since the prospective defendants could not be prosecuted under the Atomic Energy Act but only under more general statutes covering the removal of Government records and property. It was also important to make sure that the case could be tried without revealing classified weapon information.[72]

On what Lilienthal considered the more positive side, the Commission

also made some headway in June on the perplexing question of establishing adequate administrative procedures to protect individuals in security cases. He liked the General Advisory Committee's idea of appointing a personnel security review board consisting of distinguished jurists to review the more difficult cases in a judicial manner. Before taking any definite action he asked two outstanding lawyers, Archibald S. Alexander and Robert L. Finley, to examine the Commission's security operations and make recommendations. After close inspection of the procedures the Commission had used in evaluating sixty-seven security cases involving derogatory information, Alexander and Finley concluded that "substantial justice" had been done. They believed that the staff's performance manifested concern about protecting the national security and assuring that "no individual should be denied employment on vague hearsay evidence or gossip, but only for facts, reasonably well documented and indicating a security risk." By way of improvement, they suggested the need for precise, written security standards, some tightening of administrative procedures, and the need for appellate review of cases in which derogatory information seemed sufficient to justify denying or revoking a clearance. The Commission could perform this appellate function itself or establish a review board, as Lilienthal suggested. In either case the workload promised to be heavy. Estimating that the Commission would have to process 74,000 clearances in 1947, Alexander and Finley predicted 250 cases involving derogatory information. They urged in the interests of justice that some method be established to give applicants an opportunity to explain or contradict derogatory information reported by the FBI, either in written statements or in a formal hearing before the appeal board. At the same time, the consultants warned that granting such rights, especially the right to a hearing, might go far beyond existing practice in the Government and always involved the danger of compromising the FBI's sources of information.[73]

Before the Commission could act on these recommendations, a new crisis burst upon the scene. On Wednesday, July 9, 1947, the New York *Sun* proclaimed in banner headlines the theft "of highly secret data on the atomic bomb" from Oak Ridge. The article by *Sun* reporter Robert Nellor predicted the incident would rival the Canadian spy case of 1946 and would lead to a "total reorganization" of the nation's atomic energy program. The alarming revelations were likely to lead the casual reader to the same conclusion; but anyone privy to the details of the June crisis and its repercussions was likely to see suspicious similarities. It did not take much imagination to suggest that Nellor had started with the Thomas article (poor security at Oak Ridge), added to it scraps of information about the Von der Luft-Wallis case (stolen documents), and embellished it with gossip about Joint Committee concern (inspired by the Teeple-Sheehy report).

Unfortunately for the Commission, the *Sun* story, unlike the Thomas article, received major attention in the press. The Hearst and Patterson papers leaped at the opportunity to discredit the Commission, and even the

sympathetic *PM* and the Washington *Post* gave it prominent space. So interwoven were fact and fiction that Hickenlooper had no choice but to set the record straight in the course of denying the central allegation. In supporting Lilienthal's contention that nothing important had been taken at Oak Ridge, Hickenlooper found it necessary to reveal that documents had been stolen at Los Alamos but that they had been recovered without any danger to security. The result was that by the following day, newspapers unfriendly to the Commission were carrying stories of two thefts of atomic secrets, not one. These accounts left the impression that the Commission's crumbling security system had now collapsed. The implication was a pressing need to return to military control.[74]

On Wednesday when the *Sun* story broke, the New York *Times* carried reports of Joint Committee activity on the six pending bills to reorganize the Commission. On Thursday and Friday the demand for military control swelled to a chorus including the tasteless gratuities of Representative Thomas and searing criticisms from "an unnamed high Government official." The same person categorically denied that the Los Alamos incident was the source of the Oak Ridge story; "to his certain knowledge" secret documents were missing at Oak Ridge. Lilienthal's ambiguous statement that nothing important had been taken did not help much to refute the charge. A newspaper report of an interview with Menke, the new security officer at Oak Ridge, tended to confirm suspicions that the Commission was reluctant to deny that any documents might be missing. In view of the hundreds of thousands of classified documents in the Oak Ridge files, the Commission's reluctance to make a categorical statement was understandable, but it fed the flames of controversy.[75]

By the end of the week both nerves and tempers were raw. With the unfriendly press already asking questions about the Von der Luft-Wallis case, Lilienthal was uneasy about the fact that the two former sergeants were still not under arrest more than two months after the theft had been discovered. Even more alarming was the news on Friday that Von der Luft had gone to Canada, a fact which might make arrest difficult. Several telephone calls to J. Edgar Hoover and Attorney General Tom C. Clark brought Lilienthal sympathy but not much reassurance. He had still to reckon with General Groves, who had been absent from a meeting of the Military Liaison Committee on July 2 to discuss the Von der Luft-Wallis affair.[76]

Lilienthal did not have to wait long. That same Friday evening one of Grove's officers called on Volpe and Jones to demand answers: when the Commission had learned of the Von der Luft-Wallis case and why the Government had delayed prosecution so long. Annoyed by the tone of the request, Volpe asked the officer whether by chance he had learned anything about the disappearance of documents when he had been stationed at Oak Ridge. The officer did not miss the implications of that remark, nor did Lilienthal fail to see in the incident further evidence of Groves's hostility. On

Saturday morning Brereton tried to reassure Lilienthal by suggesting that Groves was merely attempting to collect information for a forthcoming appearance before the Joint Committee.[77]

Lilienthal found this explanation hard to accept, but Groves made his forthcoming appointment with the Joint Committee the reason for requesting a special meeting of the Military Liaison Committee with the Commission on July 14. Reporters had been calling him about the Von der Luft-Wallis case and about missing documents at Oak Ridge. He needed to know the facts. Lilienthal replied that the Von der Luft-Wallis case had been discussed during the Commission's July 2 meeting with the committee. What puzzled him was why a reporter would hold information of this nature until some convenient time for release instead of reporting it at once to the FBI. After further discussion of the details of the Von der Luft-Wallis case, Groves suggested that he and the Commission issue a joint statement that the violation of security regulations had not resulted in the disclosure of weapon information. Groves thought such a statement might stop the efforts of the press to drive a wedge between him and the Commission.[78]

Unfortunately for all concerned, the incidents of the preceding weeks had already had that effect. Lilienthal was convinced by Groves's remarks at the meeting that the General had talked with Thomas and the press. At five-thirty that afternoon the Commissioners and General Brereton entered Secretary Robert P. Patterson's office in the Pentagon. It was no longer possible to work with Groves, Lilienthal told the Secretary. Groves wou' have to be replaced on the Military Liaison Committee. Patterson took the request calmly. He asked only that the Commission allow him a few days until Congressional investigations at Oak Ridge had been completed.[79]

By the following Tuesday, when the Commissioners met with the Joint Committee, tempers had cooled and it was possible to examine the situation as a whole. Initially some of the members of the committee showed an impatience to learn what the Commission had done to correct the deficiencies which Teeple had reported at Oak Ridge in June, but Lilienthal was not to be stampeded. He insisted on reading a prepared statement which attempted to put the subject of missing documents in context. He explained that late in 1946 the Commission had requested the Manhattan District to provide complete inventories of all its property, including classified material. When the Army objected that it had no comprehensive inventory and could not possibly complete one before takeover, the Commission had reluctantly accepted inventories only of weapons and fissionable materials. The Commission had assumed that the District's security procedures were effective and extended them on a temporary basis. Only after some experience and investigation did the Commission discover that there were some inventories of classified documents and that these indicated some documents were missing. Lilienthal wanted to make clear that "the lax security conditions" referred to by the Joint Committee reflected a situation inherited from the Manhattan District.[80]

The discussion following Lilienthal's statement quickly dispelled im-

ages created in newspaper stories of dramatic thefts of secrets from a leaky security system. Rather, Lilienthal contended, most of these stories were distorted accounts of discrepancies which Commission personnel had themselves discovered. From the discussion emerged the understanding that the Commission now had custody of millions of documents for which only a partial inventory existed. Because no records of destruction had been made in many instances, thousands of documents presumably destroyed were still technically unaccounted for. It was also clear that some documents created by the Commission since January, 1947, also fell into these categories. There were simply too many documents too widely scattered and passing through too many hands to expect an exact accounting of every one at all times. In this context it was true that documents were missing at Los Alamos, Oak Ridge, and Chicago, but Lilienthal stressed there was no evidence that any, except those in the Von der Luft-Wallis case, had been illegally removed.

The session with the Joint Committee on July 22 seemed to calm Congressional nerves and marked at least a temporary end to sensational newspaper stories on security. That same day Representative Chet Holifield, a member of the Joint Committee and staunch supporter of the McMahon bill in 1946, in a floor speech attacked the recent attempts to discredit the atomic scientists, and especially those who had supported the McMahon bill. He denounced the Thomas article and the distortions of the Von der Luft-Wallis incident, but his main concern was a point-by-point rebuttal of a recent *Times-Herald* article attacking Edward U. Condon, director of the National Bureau of Standards. It was always reassuring to have support from Congress on security matters, and perhaps the renewed interest of Thomas's committee in the Condon affair meant that the Commission might enjoy a respite from that kind of attack. The shadow of security still hung heavy over the Commission's daily activities, but the worst of the storm seemed to be over.[81]

After their confirmation in April the Commissioners had embarked with high spirits on their first venture as directors of the nation's atomic energy program. The forthright decisions to refurbish and enlarge production and weapon facilities had been a good start, but the complex issues of research and development proved much less tractable. The conflicting demands of the laboratories, the contractors, and the public made it increasingly difficult to find clear-cut answers to policy questions. In many ways the General Advisory Committee under Oppenheimer's leadership had been of immeasurable help, but the superior experience and prestige of the advisory body also limited the Commission's freedom of action. Even more dangerous was the apparent hostility in military and Congressional circles represented by Groves and Thomas. In a few weeks the Commission had descended from the high hopes of April to the half-hidden threats and dangers of July. In the face of a challenge to its very existence, the Commission would have to do more than protect itself. Somehow it would have to prove itself capable of the leadership the times demanded.

THE PEACEFUL IMAGE

CHAPTER 4

By the summer of 1947 the Commissioners had some measure of the challenge they faced in directing the nation's atomic energy program. First, the Commission was required by law and necessity to give top priority to the production of fissionable materials and weapons. But if the Commission were to achieve any success in giving atomic energy a peaceful, civilian image, there would have to be a clearly defined, forceful plan for research and development, not only in the Commission's laboratories, but also in industry and the universities. Unlike the needs of national security, the goals of research and development were neither obvious nor tractable. In the Federal Government as a whole, research policy was still in a period of transition from the prewar system of private research grants to the new structure of the 1950's providing for massive Federal support. Until Congress could decide whether to establish a national science foundation, the Commission by default would bear a large share of the responsibility for Federal research policy; and it was always harder to break new ground than to follow familiar paths.

Devising a research and development policy would have been difficult for an experienced organization. For the fledgling Commission in the summer of 1947, it was a dismaying task. Still unresolved were the nature and function of the national laboratories, the role of basic research in the Commission's activities, the future course of reactor development, the extent of international cooperation in scientific research, and the prospects for nuclear power. All these questions would haunt the Commission during the rest of 1947.

Further complicating the Commission's task were the inevitable distractions and preoccupations of building a new organization. The administrative structure for headquarters and field operations was not yet complete, and key positions in the staff were still vacant. Without the guidance of experienced staff, troublesome gaps in administrative procedure persisted. Especially

difficult were the problems of security, raised by the requirement for large numbers of new employees and complicated by publicity over clearances and missing documents during the spring of 1947.

In the months ahead, the Commission would have to find some way, despite these handicaps, to make the peaceful image of atomic energy a reality.

INGREDIENTS OF A RESEARCH POLICY

Both the General Advisory Committee and the scientific community were sympathetic with the Commission's predicament, but impatience was fast replacing sympathy. The Commission's failure to come to terms with the broad aspects of research and development policy was provoking some private expressions of concern. John R. Dunning, the forceful leader of the gaseous-diffusion project at Columbia University during the war, was anxious to get on with a practical demonstration of nuclear power. Louis J. Ridenour, a prominent physicist who knew Robert F. Bacher personally, urged his friend to demand that the Commission speed up the declassification of fundamental research data and support independent research in the nuclear sciences.[1]

Perhaps the most damaging blow to the Commission's image was its failure to release radioisotopes to scientists in foreign countries. The General Advisory Committee had taken a strong stand on this issue, and John H. Manley in June had recommended a proposal which would be responsive to some of the Commission's concerns but still accomplish the purpose. Limited quantities of specified isotopes would be available only for research purposes, to qualified scientists in specified institutions. The scientists would be required to describe the health and safety measures they would use, to report the results of their research within six months of completion, to agree to use the materials for no purpose other than those stated in the application, and to permit other qualified scientists free access to the institutions in which the research was done.

As June slipped by without action, the scientists renewed their appeals to Bacher. In addition to a formal statement from the Federation of American Scientists, Bacher received a personal plea from his friend Charles C. Lauritsen at the California Institute of Technology. Lauritsen reported in Europe "a somewhat exaggerated idea of the control which the Army and Navy exert over science in this country." The recent American emphasis on secrecy in scientific research and the apparent American refusal to abandon its nuclear monopoly of radioisotopes for fundamental research was beginning to damage relations between American and European scientists. Albert Stone, a scientific attaché in the London embassy, related a conversation with Niels Bohr, who urged the release of radioisotopes. Even if they were only in the

form of bottle washings, Stone wrote, they would be "one of the most useful, convincing, and friendly things we can do." When the Commission took no action by late July, discontent among the scientists began to spill over into the press.[2]

Expressions of concern also came to Bacher in private conversations and correspondence with Oppenheimer and Manley. They attributed much of the trouble to a lack of rapport between the Commissioners, the staff, and the committee. The committee, meeting only once every two months, could not expect to keep up with the details of daily operations. Worst of all, the committee thought that the Commissioners had scarcely begun to understand the fundamentals which underlay the committee's recommendations.[3]

Bacher conveyed these concerns as tactfully as he could to his fellow Commissioners and to Carroll L. Wilson, individually. He wrote Oppenheimer on July 22 that he had discussed the agenda for the committee's next meeting with James McCormack, James B. Fisk, Wilson, and Manley. He had arranged for two sessions with the Commission, one at the beginning and one at the end of the two-day review. This would provide a good opportunity for full briefings by the Commission staff and for a careful exposition of committee views. Lilienthal had also agreed to permit Manley to attend Commission meetings on subjects of concern to the committee if that would help to bridge the gap.[4]

At the committee's opening session with the Commissioners on July 28, Oppenheimer turned almost at once to questions of research policy. He was particularly concerned about the Commissioners' reactions to his suggestion at the previous meeting that the Commission issue a statement giving "a realistic evaluation of atomic power." When Lilienthal questioned its purpose, Oppenheimer explained that something had to be done to counteract the growing misconception that economic nuclear power was imminent. It was bad enough when men in public affairs and representatives of industries with a potential interest in atomic energy voiced such unwarranted optimism; it was dismaying when lack of understanding brought forth such views from atomic scientists as eminent as Dunning. Lee A. DuBridge warned that the opinion was growing among scientists that there was no valid reason for the absence of practical nuclear power other than the Commission's failure to act. Lilienthal doubted that one pronouncement would correct the misunderstanding and thought it might have the effect of discouraging young people from choosing the nuclear sciences as a career. He was willing, however, to consider such a release if Oppenheimer wanted to present it in writing.[5]

Later in the morning, after the Commissioners had left, the committee came back to the power statement. All agreed that the central point was that large-scale power production would require all available nuclear fuel, which would mean perfecting the breeder reactor and then accumulating a "nest egg" of fuel while development of the power reactor continued. This would be "a long, complicated, difficult" process. So engrossed were the members in the

subject that they talked through their lunch hour and turned to other matters only when the Commissioners returned at two o'clock. Somehow during the late afternoon Oppenheimer and Manley put the finishing touches on the draft, which was then the first item discussed at the evening session. After a few comments on the wording and its possible effect, James B. Conant moved quickly to a decision to send the statement to the Commissioners the following day. Other aspects of research policy filled the evening session: declassifying basic nuclear data, determining the limits of classification, considering the possibilities of a central Commission laboratory, opening the doors to private research on unclassified subjects, and supporting such research in the universities. The committee finally adjourned for the night, almost fourteen hours after the start of the morning session.

On the morning of July 29 most of the Commissioners were at the Pentagon to discuss a draft report of the Bikini evaluation board with the Joint Chiefs of Staff. Saving the power statement until the Commissioners had returned, the committee spent the morning discussing research policy with Fisk and his aides. The committee was particularly interested in Fisk's plans for Clinton and their relation to the possibility of a central laboratory. Fisk explained that he had considered a variety of possibilities for Clinton, including management by industrial contractors like the Standard Oil Development Company and the Kellex Corporation, but he had concluded that the scientists at Clinton would work more congenially with an academic institution. The University of Chicago had operated the laboratory during the war. Many of the scientists at Clinton were originally Chicago employees or students; furthermore, a contract at this time with Chicago would also be a step in the direction of a central laboratory, since it would place both Clinton and Argonne under the same contractor. DuBridge agreed this was an excellent solution if a central laboratory were impossible. Fisk maintained that it would take too long to build additional facilities at Argonne and that many of the Clinton people would not like to move. Conant feared that Fisk's proposal would kill the chances for a central laboratory and would encourage the Clinton scientists to stay at Oak Ridge. Glenn T. Seaborg doubted that an independent Clinton would provide close enough coordination with Argonne for difficult chemical research, such as developing the Redox process. When Hartley Rowe asked whether Fisk intended the Chicago contract to be a permanent or interim arrangement, Fisk admitted that it would be permanent, but he conceded that if contract negotiations with Chicago failed, Clinton would have to be abandoned. Conant said he rather hoped this would happen because it would keep open the possibility of the central laboratory.

When Lilienthal, Pike, and Strauss returned from the Pentagon at noon, they were hardly in a pleasant mood. Most of the briefing on the Bikini report had been a bore, but they had straightened in their chairs when the Bikini board came to its recommendations. Without intending to criticize the Commission, the board urged the Joint Chiefs to reconsider whether the

military should not have a representative on the Commission, whether the armed forces should not control all fissionable material after production, whether they should participate in designing and testing nuclear weapons, and whether they should not control all information related to use of weapons.[6]

As the Commissioners read Oppenheimer's draft on civilian power, they realized for the first time its sweeping implications. In correcting the current public misconception, the committee intended to state flatly that "it does not appear hopeful to use natural uranium directly as an adequate source of fuel for atomic power." The shortage of uranium ore and the consequently even greater shortage of uranium 235 made a really significant nuclear power supply economically prohibitive. Furthermore, the cost of reenriching reactor fuel by existing means of isotope separation was likewise prohibitive. The only hopeful approach was to develop high-temperature breeder reactors, which would require about ten years of metallurgical, engineering, and chemical research. Even if this research proved successful, it would take decades to accumulate a stockpile of nuclear fuel sufficient for a strong power industry.[7]

The draft struck the Commissioners like a sledge hammer. Strauss found it so pessimistic that he doubted the Commission would ever be able to get adequate appropriations from Congress. Waymack thought the statement would mean nothing to the general public and would not advance the understanding of atomic energy. Pike, with the morning session with the Joint Chiefs clearly in mind, argued that this was no time to demolish hopes for nonmilitary applications of atomic energy. The Commission was on trial. The Atomic Energy Act had been "written in a rare moment of selflessness"; things had changed since the summer of 1946, and not for the better.

Conant and Oppenheimer, however, insisted on what was to them the fundamental point: it might take time to educate the public, but both the Congress and the people should begin to face realities. The lack of public understanding was damaging the Commission's stature and was preventing responsible leadership outside the Commission from making an accurate assessment of a difficult question.

In the long discussion which followed, Conant and Oppenheimer were willing to consider changes in wording, but they would not yield on the central idea. The Commissioners succeeded only in introducing minor revisions which made the point that raw material costs *seemed* prohibitive only *at present,* and adding a paragraph to stress that, while research on breeders continued, radioisotopes could be expected to bring many benefits to science and industry. The discussion ended only when Strauss proposed that the Commission take time to consider the statement during the two months before the October meeting.

Lilienthal had had little to say during the meeting except to insist upon the final paragraph on radioisotopes. The truth was that he was almost

too shocked to speak. Even when the statement came from such eminent men as Oppenheimer, Conant, Seaborg, and Isidor I. Rabi, he could hardly believe it was true. He recognized there were difficulties and uncertainties, but how could anyone be sure they were so great? He admitted to himself that it would be a service to the Commission to deflate the current overoptimism, but there were larger political implications. Such a statement would answer those who criticized the Commission for not making satisfactory progress in developing atomic energy and foreigners who thought the Commission was preventing them from meeting critical needs for electric power. But it would also provide handy ammunition to the advocates of a return to military control and that "might well have finished off the rather fragile life of civilian direction of this project." [8]

As if there had not been enough unpleasantness for one day, Wilson wanted the Commissioners to use the few remaining hours after the session with Oppenheimer's committee to consider the last of the reinvestigation cases inherited from the Manhattan District. Although machinery was being set up to review difficult cases as suggested in the Alexander-Finley report, the Commissioners would have to act personally on those cases which had been hanging fire since January, 1947. The subject for the afternoon was the complicated case which had been pending at Brookhaven for months. The report by a special review panel of outside experts recommended clearance but it stressed the risks inherent in such action. Lilienthal always found security sessions painful, and this one was unusually distressing since Strauss seemed about to end the Commission's enviable record of unanimity. At last, when no further discussion seemed profitable, the Commission voted four to one to accept the panel's report. The remaining cases were no easier to decide. Sandwiched in between other business, they soaked up every free moment during the last week of July and the first week of August. Of the thirteen cases considered, the Commissioners decided to defer action on four, pending further investigation, granted clearance to three individuals, and denied clearance to six, of whom three were recommended for further administrative hearings.[9]

None of the Commissioners would ever forget the anguish of those August days in the stuffy conference room on Constitution Avenue. The painful hours of discussion, the soul-searching analysis, the struggle to do justice, all took a heavy toll in physical and emotional strain. Fortunately there was promise of relief. Earlier in the summer, Lilienthal and Fisk had planned a western trip centering on the first meeting of the research council, to be held at the Berkeley laboratory. Ernest O. Lawrence had generously arranged to hold some of the meetings at the private encampment of the Bohemian Club in the redwood forests north of Berkeley, where the S-1 committee had met in September, 1942. There would be a tour of the Berkeley laboratory, probably one of Lawrence's traditional dinners at Trader Vic's, and after a year's postponement a first visit to Hanford before heading home.

COMPLETING THE ORGANIZATION

One last-minute chore before the western trip was to ratify Wilson's plans for completing the staff. With Carroll L. Tyler and Wilbur E. Kelley already on the job at Los Alamos and New York, Fletcher C. Waller, the new director of organization and personnel, had concentrated in July on filling the remaining field manager posts. Weeks of patient inquiry and interviewing had produced some promising candidates, but none of them seemed available under the $14,000 salary ceiling. After the discussion of this subject with the Joint Committee in March, 1947, Wilson was reluctant to raise the issue again, but the only alternative seemed to be to offer a higher salary. After informal discussions Hickenlooper seemed satisfied with a letter in the record explaining the Commission's predicament, and Wilson moved quickly to land his quarries. As manager of operations at Oak Ridge he had succeeded in recruiting John C. Franklin, vice-president in charge of maintenance and engineering for Trans World Airlines. Forty-three years old, Franklin had attended Stanford and Harvard Business School before entering the business world. Wilson's candidate for the Hanford post was Carleton Shugg, a dynamic vice-president of the Todd Shipyard Corporation. Following his inspection trip to the Commission's field installations in May, 1947, William Webster had recommended his old friend and Annapolis classmate for the Hanford job. Wilson was impressed with Shugg's qualifications, but Shugg had to be convinced he should accept the offer.[10]

There were still no outstanding prospects for the Chicago post, but further delay was impossible in view of the administrative demands generated by plans for new facilities at the Argonne, Berkeley, and Ames laboratories, all of which would be under Chicago's jurisdiction. Simply to hold the office together Walter J. Williams had sent Alfonso Tammaro to Chicago in June. Tammaro, a former Manhattan District officer, had been one of the first persons on the Commission's payroll in 1946, when he became a contracting officer. Late in July Wilson agreed to appoint Tammaro as acting manager at Chicago. Wilson also announced that Tammaro would take over Williams's responsibilities at Chicago on August 31; Franklin would pick up his burdens at Oak Ridge on September 15.[11]

During the first week in August, Wilson also completed two major assignments to his Washington staff. After months of searching for a director of the statutory division of engineering, he decided to appoint Roger S. Warner, Jr., his principal recruiter for the post. During the war Warner had served as an engineering coordinator at the Sandia extension of the Los Alamos laboratory, at the Bikini tests in 1946, and finally on Wilson's headquarters staff in 1947. A second appointment made critical by the

security crises of June and July was that of Admiral John E. Gingrich as director of security and intelligence. Gingrich, a Navy hero in World War II, had served as aide to Secretary James V. Forrestal and as assistant chief of naval operations. The appointment of a naval officer was certain to please Commissioner Strauss, who had a keen interest in security and had in fact suggested Gingrich for the position months earlier. Gingrich was a close personal friend of Forrestal's and also had the support of Admiral Sidney W. Souers, the first director of the Central Intelligence Group, who as a Commission consultant had recommended combining the security and intelligence functions in one office. The Commission hoped that Gingrich would bring the necessary stature and prestige to the position and would be able to make some headway in building a permanent security and intelligence operation.[12]

CLINTON AGAIN

The main purpose of the Berkeley meeting scheduled for mid-August, 1947, was to come to some conclusions about the fundamental shape and direction of the Commission's research and development program. It was obvious that any decisions on that subject would depend upon the patterns which might emerge from the chaos in the Clinton Laboratories at Oak Ridge.

If anything, the situation at Clinton was more confused in August than it had been in May. The announcement of Monsanto's decision to withdraw and Eugene P. Wigner's to return to Princeton left the laboratory with neither a functioning organization nor a leader. With no direction, many of the scientific staff spent their time in discussions deploring the present and speculating on the future. Three months after Monsanto's decision to withdraw, Fisk had still not found a successor. The University of Chicago was still a leading contender; but there was a second possibility in the new Oak Ridge Institute of Nuclear Studies, an association of fourteen Southern universities which hoped to make Oak Ridge a regional research center. The new association seemed especially attractive because its directors included men who had distinguished themselves in the nuclear sciences, such as Wigner, Jesse W. Beams of the University of Virginia, and Frederick Seitz, a University of Pittsburgh physics professor whom Wigner had hoped would succeed him as laboratory director.

Both institutions expressed an interest in the contract late in July, and by early August Fisk and Wilson had Commission approval of the ground rules for negotiation. The contract was to be for three or four years and the fee was not to exceed 6 per cent of the estimated annual operating costs. On August 12, Fisk and Spofford G. English, formerly a Clinton chemist and now on Fisk's staff in Washington, met with William B. Harrell and Warren C. Johnson of the University of Chicago and a group of scientists from the

laboratory. When the meetings ended the next day, there was optimism on both sides that a strong research laboratory could be built under Chicago's management. On August 14, a meeting with William G. Pollard, executive director of the Oak Ridge Institute of Nuclear Studies, led to the conclusion that the new Southern regional association was not yet prepared to assume so great a burden as operation of Clinton involved. But all parties, including Harrell and Johnson, agreed that there should be close cooperation in scientific activities at Oak Ridge between the Commission, the university, and the new institute. Pollard hoped that eventually, perhaps when the proposed four-year contract with the university expired, the institute might be able to take over as operating contractor.[13]

An all-day session in Washington on August 28 confirmed the tentative conclusions of the Oak Ridge meeting. The university should operate the laboratory if a satisfactory contract could be negotiated, and the institute would work closely with the laboratory as a regional center by providing a program for graduate training in the nuclear sciences, taking responsibility for the training school still being operated by the laboratory, and helping the associated universities to develop their own graduate research facilities. The university's board of trustees accepted the broad terms of the proposal on September 2, and the public information officers of the Commission and the university drafted press releases for issuance on the fourteenth to inform the public that the new Commission-university-institute relationship would take effect on November 1. All that remained was negotiating a contract and finding a director for the laboratory.[14]

REACTORS AT CLINTON

The lack of firm leadership was not the only difficulty at Clinton in the summer of 1947. There had still been no clear instructions from Washington to indicate the priority of research projects. The efforts of Wilson and Fisk during the spring to decide the fate of the high-flux and Daniels reactors had been thwarted by the General Advisory Committee's opposition to strengthening Clinton and the Commission's juggling of plans in an effort to keep Monsanto at Oak Ridge. The confusion of late May persisted through the summer. Monsanto, as a caretaker operator, had little interest in the future of Clinton, and the Commission was reluctant to set a new course until it had selected a new contractor.

There was good reason to believe that the high-flux reactor would be a part of any plan the Commission might approve. But until the Commission settled the questions of where it would be built and who would build it, Alvin M. Weinberg and the Clinton scientists had to restrict themselves to the fundamentals of design. By the summer of 1947 it seemed clear that the

reactor would use pressurized water as moderator and coolant. The point at issue during the summer became the design of the fuel elements, especially the amount of uranium 235 to be used and the effect of that specification on designs of the chemical plant that would process the spent fuel elements from the reactor.[15]

Prospects for the Daniels reactor were even less hopeful, but Farrington Daniels and C. Rogers McCullough chose to ignore the unpleasant rumors from Washington. Until Wilson or the Commissioners notified them officially that the project was dead, they would forge ahead as if the start of construction were imminent. As funds dwindled and morale declined, it became even more difficult to maintain the pretense of Commission support. Finally on June 16, Daniels, in the role of consultant, wrote Lilienthal directly. He was facing a crisis with the loss of both Wigner and Monsanto. But there was still real enthusiasm among the engineers at Clinton, he said, and he hoped that the Commission would authorize the procurement of needed materials for the reactor and permit one of the other participating companies to take over the contract. Listing the many advantages he saw in building the reactor, he concluded: "Although further study and delay would, of course, lead to the design of a better pile, we believe that the present design will be satisfactory and safe and that it will provide the best and quickest way of obtaining the information which is needed for the design of other piles and for the development of atomic power in general." [16]

Lilienthal's reply was merely an acknowledgement, but Daniels was hopeful he would now get some action. Charles A. Thomas wrote him privately that he thought the letter was effective. McCullough reported that the Commission's representative at Clinton predicted a decision within several weeks. In the meantime there would be no decision on ordering beryllium oxide bricks for further experiments. McCullough feared that the Commissioners themselves had no ideas on the subject and were leaving the decision to the General Advisory Committee, the members of which, according to McCullough, knew nothing about the project and probably opposed constructing a power reactor immediately.[17]

McCullough's estimate was not far from the truth, but when Daniels met with the Commissioners on July 8, their intentions still were not entirely clear. Wilson did say that the high-flux reactor had first priority and that the Commission could not state when it would authorize design and construction of a power reactor. On the other hand, the Daniels project had not been abandoned. Obviously disappointed, Daniels was nevertheless grateful that the Commission had not terminated the project completely and would permit component development and other basic studies to continue. After the meeting Daniels sent McCullough an enthusiastic telegram. McCullough had been right that an unfavorable report from the General Advisory Committee had been the source of the trouble, but the Commission's attitude had been cordial and positive. The group at Clinton could continue the work it was doing, and

Daniels felt "much relieved." Ralph P. Johnson, who had just joined the Commission as Fisk's deputy, wrote that "Daniels departed moderately happy. I have an uneasy feeling that an evil day has been postponed." [18]

MILITARY REACTORS

The future of Clinton also rested in some degree on the fate of the projects set up by the military services to develop nuclear propulsion systems for aircraft and naval vessels. The Navy officers under Captain Hyman G. Rickover had impressed many at Oak Ridge with their diligence and energy during their year-long study project. But Rickover had now taken his naval officers on an extended tour of other Commission laboratories, and there was as yet no indication that anything more would come of the effort. Admiral Earle W. Mills told Williams that he was willing to keep them working on nuclear propulsion systems on their return if the Commission thought it wise. Williams, impressed by Rickover's industry if not by his diplomacy, urged Mills to do so.[19]

Engineers from Fairchild and other aircraft companies were still attempting at Oak Ridge to understand the implications of nuclear power for aircraft design, in the NEPA project supported by the Army Air Forces. Those at Oak Ridge outside the project were more than ever convinced that NEPA was going nowhere. Until the aircraft engineers understood that there was something more to building a nuclear-powered airplane than devising an airframe compatible with a reactor of "reasonable" specifications, there was little hope for progress. Within the Air Force itself there was enthusiasm for nuclear power. General Curtis E. LeMay told the Commission and the Military Liaison Committee on July 16 that the Air Force believed any future war would have to be fought without benefit of advanced bases. For bombers carrying heavy atomic weapons that meant a combination of long range and high speed which only nuclear power could provide. The first question, however, was whether NEPA was using the right approach. Both Conant and Vannevar Bush had their doubts.

In a meeting of the Joint Research and Development Board's policy council with Conant's committee on atomic energy on July 30, no one questioned the Air Force's argument that it needed nuclear power for long-range bombers, but the goal of completing such a propulsion system in five years seemed unrealistic. Conant, Oppenheimer, and Crawford H. Greenewalt agreed that the Air Force effort would never succeed, despite all the money and pressure put on engineering development, until the basic physics of the reactor were understood. Furthermore, they argued, NEPA should be part of the Commission's reactor development program, and not isolated in a special project at Oak Ridge.[20]

The committee commended the Air Force for its interest in nuclear power for long-range bombers, but recommended prompt termination of the NEPA project at Oak Ridge. In its place the committee urged a coordinated research and development effort directed by the Commission on a high-temperature reactor system. The Commission should take over the project from the Air Force and find a highly qualified aircraft company to develop design criteria for the airframe. Then the Commission could begin to investigate the fundamentals of the reactor system.

The Navy fared better than its sister service in the meeting with Conant's committee. Admiral Mills, saying nothing about Rickover or Clinton, described the contract the Bureau of Ships had awarded to General Electric for paper studies of a ship propulsion system. Groves had helped him get the project started with a small contract in the summer of 1946, before the Commission took over, and the Commission had authorized $30,000 to continue the work, with the stipulation that the number of scientists assigned be cut in half. Conant's committee recommended that the feasibility study be continued and that the Bureau of Ships be permitted to negotiate research and development contracts on a heat transfer system suitable for a naval reactor. The committee thought, however, that the Navy should make sure that any activity beyond the initial paper study was acceptable to the Commission.[21]

Neither the Navy nor the Air Force could take much comfort from the meeting. If Clinton's future depended on these projects, its fate was uncertain indeed.

BOHEMIAN GROVE

After eight months in the hubbub of Washington, the Commissioners could hardly wait to get away for their Western trip. Bacher had already departed for several weeks of observation and conversation at Los Alamos and for a vacation in Colorado. Lilienthal wrote Lawrence, his host, that Congress would adjourn soon and that he expected "the 'atom-secret' scares and alarms, which replaced the flying saucers, will have been replaced by other sensations in a few days." Leaving such distractions behind, he was looking forward to at least a week in San Francisco before the meeting convened on Monday, August 18. Bacher was coming with McCormack from Los Alamos. The other Commissioners were traveling by train. The laboratory directors, who made up the research council—Walter H. Zinn from Argonne, Frank H. Spedding from Ames, Philip M. Morse from Brookhaven, Norris E. Bradbury from Los Alamos, C. Guy Suits from Schenectady, and Wigner representing Clinton—all expected to be on hand in Berkeley on Monday morning.[22]

Four days in the mountains of the California coast range with Law-

rence were all Lilienthal needed to restore his spirits and energy. When he returned to Berkeley on Sunday evening, August 17, to join his fellow Commissioners and the staff, he was looking forward to the meeting with the laboratory directors. Early in the morning he rode with Lawrence in the motorcade which took the party north through the redwood groves to the Bohemian Club camp on the Russian River. Oppenheimer and each of the Commissioners were assigned private rooms and the rest of the group moved into the rustic but pleasant accommodations. Fisk had promised there would be no discussion of administrative matters and he kept his word. With no formal agenda, the group could set aside the distinctions of rank and position to consider as individuals the future course of nuclear research and development.[23]

Initially the points at issue were those the General Advisory Committee had previously raised in May and July, 1947. Oppenheimer, in his usual tactful way, could voice the need for positive Commission leadership in support of basic research in the nuclear sciences, in removing the trammels of security from research activities, and in easing the dissemination of technical data. Fisk, although he accepted Oppenheimer's aims, nonetheless could express the reservations which he and Wilson felt about moving too swiftly. Should the Commission continue to approve research projects and proposals from the national laboratories piecemeal? Would it not be preferable to define the areas of basic research which the Commission would support and then establish a consistent pattern for financing both basic and applied research in the laboratories? On such questions the laboratory directors with their individual perspectives and interests could contribute to the discussions. The Commissioners could enjoy the rare opportunity of listening to the debate free from the usual pressures for decisions.

The immediate subject of the conversations was the Commission's own program, but the wider context must have been evident to those present. Through the spring and summer of 1947, *Science* and the *Bulletin of the Atomic Scientists* had followed step by step the rambling hearings and protracted debate on the National Science Foundation bill. Less than two weeks earlier President Truman had vetoed the compromise measure originally introduced by Senator H. Alexander Smith of New Jersey. Although regretting the veto of a bill designed to give direct support to basic scientific research, the President had reluctantly concluded that the proposal was "a marked departure from sound principles for the administration of public affairs." [24]

From the unhappy history of the Smith bill the group at the Bohemian Grove could draw several conclusions. One, which Fisk no doubt found pertinent, was that defining the Government's role in supporting such activities was neither an easy task nor one which could be taken lightly. If the administrative structure was difficult to design for the traditional scientific disciplines, how much more care would be necessary in establishing proce-

dures for such a new branch of science as atomic energy? On the opposite side, Oppenheimer could argue that the veto of the Smith bill destroyed chances of establishing the National Science Foundation for at least another year. Under these circumstances, it was perhaps more urgent than ever that the Commission take the lead in supporting basic research in the nuclear sciences.

The majestic openness of the California setting and the informality of the participants encouraged a broad discussion of many subjects. By design, there were no formal decisions, although Zinn later informed his staff at Argonne that he thought the Commission would be willing to entertain proposals for certain limited unclassified research. The greatest value of the conference came from the free exchange of ideas and the mutual understanding of problems, whether they were those of the General Advisory Committee, the Commission, the staff, or the laboratory directors. Donald Cooksey, Lawrence's faithful assistant, thought that the refreshingly informal sessions, punctuated by good meals, including heavy breakfasts of ham and bacon, light lunches of salad and cheese, and good, big dinners with plenty of red meat, were "of inestimable value to the country." [25]

FOREIGN DISTRIBUTION OF ISOTOPES

The only note of discord at the Bohemian Grove came on Tuesday morning, August 19, when the Commissioners met privately to debate the long-pending proposal to permit foreign distribution of radioisotopes.[26] Despairing of unanimity, Lilienthal gave Strauss the opportunity to explain in full his opposition to the proposal. Strauss conceded that he was unhappy as a minority of one and that he had attempted to bring his thinking into line with that of the other members of the Commission. But after reviewing all the arguments advanced for foreign distribution he continued to believe that the burden of proof rested upon those who advocated exporting isotopes. Foreign scientists, he said, were not all on the side of the democracies in the international political argument; nor was it possible to buy their good will by authorizing the distribution of radioisotopes abroad. The radioisotopes produced in the Clinton reactor were the equivalent of thousands of years of cyclotron production. By distributing isotopes in large quantities abroad, the Commission would be committing a breach of security comparable to that of publishing the Smyth report. Strauss did not argue that the isotopes would help foreign nations build weapons, but they would be useful in biological and metallurgical research, plutonium chemistry, and other fields which could add to the warmaking potential of other nations.

The majority did not yield to Strauss's arguments. For Waymack the shipment of radioisotopes abroad would be a small part of the Marshall Plan,

which had become a prime instrument of United States foreign policy. Bacher held that radioisotopes were already in use and would be generally available relatively soon. He thought the United States could in the meantime earn a large measure of good will by authorizing foreign distribution and thereby countering the growing sentiment throughout the world that the United States was returning to isolationism. Pike maintained that the conditions imposed on foreign distribution would amply protect the interests of the United States. Lilienthal added to Waymack's justification the argument that foreign distribution would advance scientific knowledge and perhaps even produce effective methods for treating cancer.

Now the informal atmosphere which Lilienthal had tried to encourage in Commission meetings was painfully absent. By a vote of four to one the Commission agreed to forward its recommendation to the State Department. As a concession to Strauss the Commission agreed to include the arguments advanced both for and against the recommendation.

Lilienthal was uneasy about the forcefulness of Strauss's dissent. His insistence upon the right to present his position to the State Department suggested an unwillingness to accept a majority decision. It was hard to imagine how the Commission could continue to operate as a team if a single member were to attempt to reverse the formal decisions of the majority. Strauss himself regretted that he had no alternative but dissent, an option he seldom exercised. Perhaps the President's announcement of the decision in a message to the Fourth International Cancer Research Congress in St. Louis on September 3 would settle the issue once and for all.[27]

A POLICY FOR RESEARCH

From Fisk's perspective the issue of isotopes distribution had long since moved beyond his horizon into the higher realms of Commission concern. Of greater moment in his mind were the implications of the Bohemian Grove meeting for the Commission's policy on basic research. Sentiment was growing in the General Advisory Committee for a broad interpretation of the Commission's responsibilities in supporting basic research, perhaps going even beyond the nuclear sciences to include related disciplines, now that the National Science Foundation bill had failed. Fisk also heard the appeals from the laboratory directors at the California meeting for ever-increasing support of new and exciting research projects. Back in Washington, similar pleas from individual scientists in the universities were piling up on his desk and he was still faced with disposition of the proposal from the Office of Naval Research, which he had sidetracked earlier in the summer.

A physicist himself, Fisk understood that scientific progress depended on support of research, but his sternly disciplined and logical mind would not

WIDE WORLD

LABORATORY DIRECTORS WITH THE GENERAL MANAGER, JANUARY 18, 1947 / In the front row from left to right are Frank H. Spedding of Ames, Iowa, Carroll L. Wilson, and C. Guy Suits of Knolls. Standing from left to right are Ernest O. Lawrence of Berkeley, Philip M. Morse of Brookhaven, Eugene P. Wigner of Clinton, and Walter H. Zinn of Argonne.

THE GENERAL MANAGER MEETS WITH HIS STAFF / Carroll L. Wilson and his principal staff in the headquarters building, Washington, in the summer of 1947. Left to right: Kenneth E. Fields, James B. Fisk, Fletcher C. Waller, Paul W. Ager, G. Lyle Belsley, Carroll L. Wilson, Wilbur E. Kelley, Walter J. Williams, Herbert S. Marks, and Paul M. Green. In the right corner, Richard O. Niehoff and John A. Derry.

U. S. ARMY

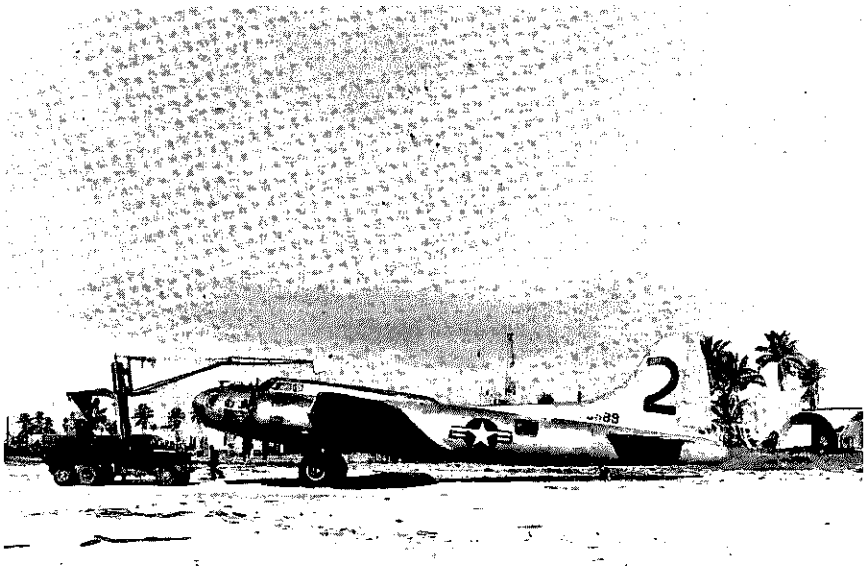
THE GENERAL RETIRES / Army Chief of Staff Dwight D. Eisenhower congratulates Leslie R. Groves on his promotion to Lieutenant General on January 26, 1948, a few days before Groves's retirement.

U. S. ARMY

A NEW CHAIRMAN FOR THE MILITARY LIAISON COMMITTEE / Major General Thomas H. Green, Judge Advocate General, U. S. Army, administers the oath to William Webster (left) in the presence of Secretary of Defense James V. Forrestal (center) on September 22, 1948.

U. S. ARMY

PREPARING FOR *SANDSTONE*, APRIL–MAY, 1948 / One group of the thousands of military and civilian personnel required for construction projects at Eniwetok in early 1948. In the background is one of the three shot towers for the Commission's first weapon test series.



U. S. ARMY

GATHERING DATA FROM *SANDSTONE*, APRIL–MAY, 1948 / A crane operator removes a filter from a B-17 drone aircraft. The B-17 had flown through the radioactive cloud, exposing the filter to pick up test debris for later analysis.

permit him to accept the kind of free-wheeling and haphazard program which would result from simply approving the more appealing projects which happened to reach his desk. The Bohemian Grove meeting had convinced him that he would have to act firmly to forestall the dangers of a slapdash research program; but if he were to avoid the chaos of free competition for the Commission's limited research funds, he would have to devise a formula which others had despaired of finding. It was a matter of defining criteria and proceeding to logical conclusions. Fisk first asked his deputy, Ralph P. Johnson, to help him circumscribe "the boundary of the Commission's proper business." There was no difficulty pinpointing the inner areas for support, such as research on the production of fissionable materials and weapons; but as they moved out to peripheral areas where direct applicability to the Commission's program became ever less evident, how could they draw the line? [28]

The answer emerged slowly in September, 1947, in a new concept which Fisk called "the area of availability." As he had explained it, there were unique materials, facilities, and information which by law were under the Commission's control. In principle, at least, these resources would occasionally be in excess capacity and to the extent that they were excess they could be made available for fundamental research. Thus Fisk proposed to define the boundary of Commission support as the outer limit of the area of availability.

The idea was sufficiently abstruse to require a few examples of its application. The large-scale production of radioisotopes was unique to Commission facilities and had been accomplished with little extra effort or expenditure. Excess research space in the Clinton reactor could appropriately be made available through the Oak Ridge Institute, as could similar research facilities at Argonne to the participating universities. Fisk even thought the Commission might finance the construction of small water-boiler research reactors in various parts of the country, and he thought he could defend the use of the Brookhaven research reactor for private experiments. At the same time private institutions would have to provide the experimenters and any necessary management organization. Since particle accelerators and cosmic ray equipment were not required for Commission work at Brookhaven, private institutions would have to finance the construction and operation of such equipment.

Beyond the area of availability was the limitless domain of subsidy, in which fell the great majority of grants-in-aid, scholarships, fellowships, and the Office of Naval Research program. Fisk had no precise formula for this area. He urged the Commission to select certain sub-areas for support and within them handle proposals in a uniform way. He wanted the Commission to "choose with care the territory it intends to occupy, and to count up the resources it has available to do the cultivation." As Fisk saw it, the production of radioisotopes could be strengthened and expanded. The associated

institutions at Argonne and Clinton could be encouraged to support research to the maximum extent possible. A few small research reactors could be built and the machinery for declassification and publication of technical information improved. The file of pending requests for small grants-in-aid for basic research could be cleaned out, "most of the replies being in the negative." The Navy request would be denied and at Brookhaven and Berkeley support would be cut back to the area of availability.

Fisk's proposals had the merit of being logical and specific enough to serve as a practical guide in selecting research projects for support. They would also, as Johnson remarked, permit the division of research to serve as a responsible guardian of the public purse against the enthusiastic raids of ambitious scientists. But the formula would hardly produce a vigorous and growing research effort.

Fisk's suggestions did not please the General Advisory Committee
112 when it assembled in Washington on October 3. Sharing Oppenheimer's views at the Bohemian Grove, the committee was more than ever convinced the Commission should support research not only in its own facilities but "especially in the universities and other research establishments." Furthermore, the committee now thought the Commission should support research in fields relating to atomic energy and not limit its efforts to basic nuclear science as it had suggested in July. The failure to establish the National Science Foundation, even if only temporary, had left it up to the Commission to step in. The nation's superiority in atomic energy depended upon "the virility of its basic science." Strong support of research would help to alleviate the existing shortage of scientific manpower and would provide the public with some tangible evidence of the peaceful image of atomic energy. The committee told the Commissioners that it had not pressed this matter earlier because it recognized the need to attend to more urgent tasks, but it believed the time for action had come. "In fact we feel further delay will cause damage to science and result in a growing disappointment in the achievements of the Commission." The amount of money needed—ten to thirty million dollars—would not be large; nor would it disrupt existing Commission programs, because most of it would be spent in private institutions. The committee's statement pulled no punches, but it remained to be seen whether Fisk would venture beyond the safety of his logical construct, the area of availability.[29]

BIOLOGY AND MEDICINE

The issues Fisk was trying to resolve embraced all the scientific disciplines, but his own responsibilities extended only to the physical sciences. The wartime laboratories had initiated biomedical research only when it became

apparent that nuclear research and development would involve hazards of unprecedented scale and complexity. Throughout the war biomedical studies had been important but ancillary activities. Under its limited wartime authority the Army could do little more than provide adequate health and safety measures in the laboratories and production plants. Having minor significance in the Manhattan project, biology and medicine never enjoyed the status of the physical sciences.

At least temporarily the Commission accepted the Army's approach to biology and medicine. In establishing the General Advisory Committee the Commission decided to limit membership to physical scientists and engineers, with the understanding that the biomedical sciences would have representation on a separate but nonstatutory advisory group.[30] During the first weeks of 1947 Wilson could do little more than assemble the Army's advisory committee on biology and medicine to review the existing projects and to recommend a budget for the coming fiscal year. The interim committee, consisting of the leaders of biomedical projects in the major laboratories and private institutions, assembled in Washington on January 23 under the direction of Dr. Stafford L. Warren, who as a colonel had directed the Manhattan District program. The committee found the results of wartime research impressive, particularly in pilot studies of the biological effects of radiation, the physical measurement of radiation of various types, and the development of protective measures. But existing projects had scarcely begun to provide the biological data needed to protect workers and the public in peacetime research and technology.

In addition to the existing projects, Warren recommended much more research on radiation effects and the exact toxicity of substances commonly used in atomic energy activities, the mode of entry of such substances into the human body, and the types of biological changes produced. He also saw the need for an intensive study of the hazards in production operations and development of new preventative measures. As a stopgap the Warren committee recommended a budget of $5.9 million in fiscal year 1948 in fifteen Commission laboratories and private institutions. About half this amount should go to Argonne and the University of Rochester. The other national laboratories should each receive roughly $500,000 and each of the other private universities about $100,000.[31]

It was relatively easy for the experts to come up with recommendations but, as Wilson learned in other areas, it was something else again to evaluate the proposals of those who did not have to administer them or fight for appropriations. Fundamentally Wilson's problem was identical to Fisk's: to establish a policy which would enable the Commission to formulate a logical and defensible research program. For assistance Wilson turned in March to Frank B. Jewett, president of the National Academy of Sciences. The result was the appointment of a medical board of review consisting of

seven specialists in biology and medicine under the chairmanship of Dr. Robert F. Loeb.[32] Following a week of meetings in Washington, the board prepared a comprehensive research plan. Paralleling Fisk's approach, the board cited the Commission's unique responsibilities in its own installations. In the area of applied research, which included the biological effects of radiation and all forms of detection, protection, and treatment of employees and the public if exposed, the board urged the Commission to provide liberal support of research in its own installations. Certain unclassified studies bearing on radiation effects should be supported in private institutions. The Commission was also asked to provide substantial training opportunities in recognizing and controlling radiation hazards and providing isotopes at nominal prices for independent biomedical research.[33]

Beyond the central core of applied research, the board saw a need for collaboration with other Government organizations, particularly the U. S. Public Health Service and the armed forces. Here the Commission should offer the use of its equipment and materials, and of its staff as teachers, lecturers, and consultants. Beyond the Federal Government the Commission could offer the universities use of its unmatched equipment and unique conditions for observation in the national laboratories. It could furnish materials to university researchers and declassify and publish research reports. Most important of all were training opportunities which would encourage students to select the biological sciences as a career.

The board's recommendations suggested the need for full-time staff support in the Washington headquarters. In addition to an advisory committee for biology and medicine which would perform its functions on a permanent basis, the board urged the appointment of a medical director. The Commission first agreed to appoint the new advisory committee and turned to Loeb's board for candidates. It took time to balance the membership in terms of specialties and geographic distribution but by the late summer of 1947 the roster was complete.[34] The committee which assembled for its first meeting on September 12 under the direction of Dr. Alan Gregg, director for medical sciences for the Rockefeller Foundation, included seven distinguished physicians and biologists, four of whom had served on the medical board of review. By this time Wilson was completing his plans for a division of biology and medicine and had a list of twenty-five candidates for the position of director. From five candidates recommended by the committee, the Commission selected Dr. Shields Warren, professor of pathology at the Harvard Medical School. Like Gregg, Warren had been a member of the medical board of review and had been chief of the naval medical team which investigated the effects on personnel of the bombing of Hiroshima and Nagasaki. Warren did not want the job but reluctantly agreed to accept until the Commission could find a permanent director. Thus by the end of October, 1947, the Commission had leadership for an effective research effort in the biological sciences.[35]

THE FUTURE OF NUCLEAR POWER

No one could argue that the Commission had taken aggressive action in the first eight months of 1947 to foster basic research in the physical and biological sciences. If the General Advisory Committee found this fact disconcerting, it was deeply troubled by the Commission's failure to take hold in reactor development. The committee's extended discussion with the Commissioners at the meeting of July 19, 1947, convinced Oppenheimer of the need for further exploration of the probable impact of nuclear technology. The Commissioners had seemed unwilling to face the situation, and Oppenheimer had the uneasy feeling that some of the facts underlying the committee's pessimistic prognosis on the future of nuclear power might be inaccurate. Enrico Fermi and Cyril S. Smith had found time during a visit to Los Alamos in August to revise the committee's draft. The principal change was to delete the unqualified prediction that reactors fueled with natural uranium would never be efficient power producers. Fermi and Smith preferred to suggest that such a power reactor was conceivable but that its limitation lay in the inefficient use of nuclear fuel. Although they retained the view that the development of efficient power reactors and the accumulation of significant quantities of nuclear fuel by breeding would require decades of hard work, they advocated language which would acknowledge the ultimate possibility. They also favored a statement pointing up the extreme concentration of energy in a given weight of fuel as a unique advantage of a nuclear power system.[36] They hoped that their revisions would give the statement "a somewhat more optimistic tone."

Although the Fermi-Smith draft, in Oppenheimer's words, did not have the "dismal tone" of the July version, it evoked little enthusiasm among the Commission staff. Edward R. Trapnell, one of the Commission's senior public information officers, conceded the need for such a statement, but he found the committee's phrases too cryptic and too brief. The oblique references to raw materials, he suggested, might set off a world-wide scramble for uranium ore. And if the efficient use of nuclear power proved as remote as the committee contended, how could the Commission explain its concerted efforts to corner foreign ore sources? Would not the statement suggest that the United States, as the world's leading producer of conventional power, was attempting to establish a monopoly for the future? The fleeting reference to breeding also troubled Trapnell. The Government had never released a word on the breeding principle. Trapnell predicted that the reference in the committee's proposed statement would need some further explanation and might provoke headlines reading "Atomic Advisers Promise Power In Ten Years."

Wilson cited Trapnell's arguments in a memorandum urging the Commissioners to take a cautious approach.[37]

The Military Liaison Committee took a strong position favoring release of the report. General Kenneth D. Nichols explained that the report had its origins in a similar statement which Oppenheimer had prepared for the United States delegation to the United Nations Atomic Energy Commission. In Nichols's opinion the report would help to offset some feeling in Europe that the United States was depriving other nations of needed power by not developing nuclear energy for power purposes. The statement might encourage European nations to sell uranium ore to the United States. Nichols also thought the American public should have a realistic picture of the prospects for nuclear power. Waymack was not convinced that the public would understand the report; but others at the meeting, including Bacher, Admiral William S. Parsons, and Groves believed the statement would be effective without compromising security.[38]

When the General Advisory Committee met on October 3, 1947, Bacher told the members that the Commission favored a full statement from which classified information could be later deleted. The problem was that any mention of raw material needs or the principle of breeding would produce questions quickly leading to classified information. Waymack thought the Commission would either have to issue a rather cryptic statement and stick to it or face a major change in classification policy. The discussion was inconclusive and the committee decided to consider the matter again in November.[39]

As adopted by the committee on November 23, 1947, the five-page statement on atomic power described some of the complex economic factors involved in building a nuclear power system. These included the need for high-temperature operation, new materials for components, long fuel cycles, high specific power, and a low net consumption of fissionable materials. Two reactors then under development, presumably the high-flux and the fast-breeder, would probably produce atomic power within two or three years; but neither could conceivably be thought of as an economical producer of power. The outlook would probably be brighter if low-grade ores proved plentiful or if breeding should be possible. Since the engineering difficulties associated with breeding were enormous, the best hope seemed to lie in increasing ore supplies through geological research and prospecting. On the assumption that breeding would not prove practical in the immediate future, atomic power would not compete with conventional fuels in the United States except in high-cost regions unless the cost of uranium concentrates could be brought appreciably below $100 per pound. In any case construction costs would always be higher for plants using nuclear fuel than for those operating on conventional fuels. In summary, the committee did "not see how it would be possible under the most favorable circumstances to have any considerable

portion of the present power supply of the world, replaced by nuclear fuel before the expiration of twenty years." [40]

A COURSE FOR REACTOR DEVELOPMENT

Inevitably the power statement reflected the Commission's own plans for developing nuclear reactors. Still clouded by uncertainties, the subject involved not only technical matters but administrative questions. Should the Commission establish a centralized laboratory? What was the future of Clinton? What role should the Commission have in determining the course of reactor development in the laboratories?

For the moment centralization seemed dead, and the Commission had yet done little to weld the haphazard array of individual laboratory projects into a coordinated effort. Conant had expressed his growing concern at the General Advisory Committee meeting on October 3. He could understand, he said, the Commission's efforts to encourage independent action in the laboratories, but he argued that someone in Washington headquarters would have to stand at the helm, perhaps as deputy director of research. In view of the military interest in nuclear propulsion systems for naval vessels and aircraft, Conant thought the Commission should draft Lawrence to direct work on power reactors. Lawrence could do the job in a hurry and make sure that the fissionable material diverted from bomb production actually was used in power reactor systems. Rabi feared Conant's proposal would exacerbate the already touchy feelings of reactor personnel in the laboratories and would negate the committee's plea for orderly, coordinated development.

Seaborg took a technical view of the question. He could understand Fisk's and George L. Weil's arguments for extensive component development before full-scale power reactors were attempted, but he thought the best way to identify the technical problems of a high-temperature power reactor would be to build one. Farrington Daniels had convinced him that committee opposition to the high-temperature reactor at Clinton had been interpreted as disapproval of the direct approach and as a lack of confidence in industrial participation. Seaborg suggested as a new form of the direct approach that Westinghouse be asked to develop a high-temperature power reactor.

Smith liked Seaborg's idea of bringing industrial engineers into reactor development but he did not believe a company like Westinghouse would do the job on the "quick and dirty" basis which Conant suggested. Oppenheimer had misgivings about industrial participation at this stage. Both he and Fermi believed the scientists had much work to do before the engineers could design a power reactor. On the other hand, Fermi liked the idea of bringing in Lawrence, whose enthusiastic leadership might draw together the dissident

groups in the various laboratories. Again leadership seemed the answer to the Commission's problems.

Fisk and Weil in their cautious way had come to something like the same conclusion. Before the October meeting of the General Advisory Committee, Fisk gave Oppenheimer a copy of his proposal to establish a reactor development committee composed of experts from each of the laboratories. The chairman, a recognized authority on reactors, would evaluate the laboratories' proposals. Although it would reflect the views of the laboratories on technical matters, the committee would be directly responsible to the Commission through the division of research. Thus, Fisk hoped to retain scientific initiative in the laboratories and at the same time provide some centralized control in Washington.[41]

After discussing the Conant and Seaborg proposals, the committee found an obvious solution. Oppenheimer and Rabi suggested almost simultaneously that the committee recommend establishing the reactor development committee with Lawrence as its chairman. The straight-laced style of Manley's minutes could not conceal the reaction: "This was greeted with enthusiasm by many of the members, since it would accomplish the purpose of introducing the virility felt necessary, and would not violently interfere with the orderly development of a well-coordinated reactor program." Conant agreed to drop his "quick and dirty" approach.

In its final form on October 5 the committee's recommendation endorsed Fisk's proposal and nominated Lawrence as chairman.[42] How the new group could be both an operational and an advisory body was not clear, but the committee was confident it could bring order out of chaos. A well-directed program would isolate technical problems and reveal ways in which private industry could participate in reactor development. The new organization would help the Commission to concentrate its efforts on the most important projects. The Commission should immediately authorize construction of the fast-breeder reactor at Argonne. It should not waste its time on projects like the Daniels reactor, which would do nothing more than demonstrate the obvious fact that electrical power could be generated from atomic energy. The committee favored instead materials and component studies which would contribute to the design of ship and aircraft propulsion systems. There should be more effort on a high-temperature power reactor and some study of using natural uranium as fuel. In response to one of Oppenheimer's suggestions, the committee recommended a facility to produce nuclear fuels in the forms needed for the various reactors.

THE REACTOR DEVELOPMENT GROUP

The Commissioners accepted most of the committee's recommendations, but the idea of a new advisory body on reactor development hardly seemed

practical. The idea of giving an *ad-hoc* advisory group operational responsibilities presented administrative difficulties. The committee's recommendation also carried an implication the Commissioners were not willing to accept, namely that the lack of progress in reactor development was the result of defects in the organizational structure. The trouble, they thought, had stemmed rather from their preoccupation with production and weapons. The Commissioners saw the solution in quick action within the existing organization and asked Wilson to assign responsibility within the staff.[43]

There was no question where that responsibility lay. Fisk had claimed it from the beginning, and his idea had sparked the committee's recommendation. His proposal to the Commissioners on October 24 was a compromise. On the one hand he did not abandon the idea of establishing a reactor development committee. He thought it could serve an important function in encouraging communication between the laboratories, and it was even possible that when general consensus existed members of the committee on their own authority could see that decisions were carried out in the individual laboratories. On the other hand, Fisk recognized the need for staff responsibility. Under his revised proposal he would be chairman of the new body and Weil would be executive secretary. The Commissioners showed little enthusiasm for the committee but seemed willing to accept it if Fisk believed it would help.[44]

Fisk lost no time in carrying out the Commission's mandates. He was already exploring with the laboratories the design of a small research reactor suitable for university projects. On November 8 he appointed the members of the new reactor committee and set the date for the first meeting just nine days later. Perhaps to remove any fears among the Commissioners that the new body would have program responsibilities, Fisk chose to call it the reactor development "group" rather than "committee." The membership included those in charge of reactor development in the laboratories: Zinn and Winston M. Manning from Argonne; Harvey Brooks from Schenectady; and Weinberg, Gale Young, and Harold Etherington from Clinton.[45]

When the reactor development group assembled in Washington on November 17, Weil opened by giving a general survey of the Commission's efforts to date. On the recommendation of the General Advisory Committee, the Commission was about to approve the engineering design and construction of Zinn's fast-breeder reactor at the new Argonne laboratory. For more than eighteen months the Argonne group had been conducting the fundamental research necessary to determine the feasibility of a preliminary design which Zinn had completed in January, 1946. Zinn now proposed a reactor composed of thin rods of highly enriched uranium 235 clad in aluminum tubes interspersed with other rods of uranium 238 and surrounded by a large hollow cylinder of uranium 238 in which neutrons from the fission reaction, hopefully, would breed more plutonium than the uranium 235 consumed in the reaction. Zinn had also found a commercial source of sodium-potassium

alloy, which would be used to remove heat from the reactor, and his engineers had built and tested the components of the cooling system. Zinn estimated that the reactor would cost $2.6 million and would require the diversion of 40 kilograms of uranium 235 from the weapon stockpile. He hoped the return on this investment would be a fair demonstration of the possibility of breeding.[46]

Weil could also report some progress on the intermediate-power-breeder reactor which General Electric was studying at Schenectady. North of the city at Sacandaga, General Electric had started construction of experimental facilities which would simulate the operation of the power reactor core just at the point of criticality. Even with the best of luck the "zero power pile" would not be ready for operation before 1948 and construction of the intermediate-power-breeder was far in the future.[47]

Weil had even less reason to be enthusiastic about the situation at
120 Clinton. Still without a new contractor or a director, the laboratory drifted on an aimless course. For technical reasons Wilson and Fisk had killed the Daniels reactor but still had not informed Daniels of the decision in so many words. Overlooking the technical difficulties in the design, Daniels could not believe that the Commission could refuse to sponsor a project which had the support of an impressive segment of American industry. Members of the power pile division at Clinton did not share Daniels's confidence, however, and the future of their group was the prime topic of discussion in the laboratory. Equally uncertain were the prospects for the high-flux reactor. The laboratory's solid accomplishments in establishing the general specifications for the reactor had apparently failed to impress the Commission, which had done nothing to resolve the critical question of the reactor's location. Weil's request for still another review of the project in October, 1947, had brought from Miles C. Leverett an anguished remonstrance. Nothing had changed since Hood Worthington and Smith had visited the laboratory in the spring of 1947; another review would further delay the start of construction for a year. Weil himself did not view the high-flux in such a promising light, and he saw nothing encouraging about the existing projects to develop a civilian power reactor. The best he could say was that the laboratories had begun some of the fundamental studies which would have to be completed before any intelligent design of a power reactor could be started.[48]

It was not surprising that the discussions in the reactor development group turned in other directions. When the group met with the Commissioners and others later on November 17, they heard appeals from Admiral Mills for support of a nuclear-powered submarine and from General Laurence C. Craigie, chief of research and development in the Air Force, for nuclear-powered aircraft. The joint meeting provoked much discussion of nuclear submarines and led the group to conclude that such a project deserved a high priority. Now that Daniels's project was dead, the power pile division at

Clinton would be the obvious group to study the feasibility of a submarine reactor system.

Under the circumstances it seemed difficult for the reactor development group to come to any other conclusion. Certainly the results were comforting to Fisk and Weil, whose greatest concern was that the laboratories would fritter away their meager resources on premature reactor design. Now there was some reason to expect that research activities in the laboratories would help to produce a reactor of practical value.

Fisk told the General Advisory Committee on November 21 that the group's balance sheet of reactor projects gave the Navy effort a high priority. Oppenheimer and other committee members who had visited Oak Ridge on October 17 agreed that this might be a suitable assignment for the power pile group at Clinton. Wary as usual of hasty decisions, Fisk warned that a heavy commitment to one type of reactor might preclude work on other systems of interest to the committee. He expected the reactor development group to examine all the possibilities before the Commission committed itself on any particular project. He was also reluctant to act in the face of rumors that the Air Force was about to make a definite proposal for nuclear propulsion for aircraft. He thought this might require the full-time attention of one scientist who preferably should be a member of the reactor development group.

The General Advisory Committee was not enthusiastic about Fisk's suggestions but saw that they did contain an element of hope. At least the reactor development group was willing to take some initiative. The group would never have the authority which a strong individual like Lawrence might have exercised or which might have resulted from establishment of a central laboratory; but if it could build a reactor program around the Air Force and Navy requirements, that would be a start.

THE FATE OF CLINTON

While the General Advisory Committee considered the Commission's role in supporting basic research and the future of nuclear power, other events were undermining one of the assumptions on which the committee recommendations rested. The group seemed to take for granted that the Commission had settled the future of the Clinton Laboratories by selecting the University of Chicago as the new contractor to replace Monsanto. The public announcements from the Commission and the University on September 25 seemed final enough, but subsequent events began to show the sands were shifting.

For one thing, contract negotiations took time. There were certain fundamental issues which only Fisk or his superiors could decide. What

would be the contractor's responsibility for administering personnel policy, reimbursing costs, and preparing reports? At what point would the Commission step in to fix salary levels, determine personnel standards, or audit the contractor's purchase orders? Harrell for the University and Wilson for the Commission could devise acceptable agreements on these points, but accommodation did not come quickly. Beyond fundamentals was a host of details. How could the Clinton personnel retain Social Security rights as employees of a nonprofit educational institution? How would the contractor's fee be calculated? What patent rights would the contractor retain? By early November, 1947, Wilson and his Oak Ridge staff had agreed on the general provisions of the contract, but the draft was far from a finished product.[49]

By this time Harrell and his associates at Chicago had additional worries. Fisk had approached the University during the summer of 1947 with the idea that it could provide the leadership and talent necessary to make an effective laboratory out of the dispirited scientists at Clinton. Now, within weeks of the time the University was to take over from Monsanto, Harrell had been unable to find a director for the laboratory, much less appoint an administrative staff. Several candidates had refused the offer and one who was interested had been unacceptable to the Clinton scientists. Harrell could do nothing but continue the search. In the meantime, with no signs of rescue in sight, the Clinton scientists sank deeper into the mire of despair. Without a program and without leadership, many scientists set their own course and pace. Unless Chicago could take over soon, there would be nothing left of the laboratory but the ramshackle buildings from World War II.

Privately Lilienthal and the Commissioners were beginning to doubt the wisdom of selecting Chicago for the Clinton assignment. True, Harrell and his associates on the business side of the University seemed capable enough, but there were no signs of widespread support for the enterprise in the University. Lilienthal was growing increasingly uneasy about Robert M. Hutchins's pronouncements on atomic energy. The Chicago chancellor had accepted the Clinton contract on the grounds that it would provide a way for private industry and educational institutions to enter the world of atomic energy, a position which implied distrust of Government control. But beyond the public relations impact of this larger issue, Hutchins seemed to have little interest in Clinton. His estimates of the imminent and profound effect which atomic energy would have on political and economic institutions suggested at best a superficial understanding of the nuclear sciences and technology. While Lilienthal appreciated Hutchins's moral sensitivities about the atomic bomb, he was puzzled by the chancellor's tendency "to build up logical oversimplifications, as a college senior might." Lilienthal, suspecting that the Commission's research program was overbalanced on the academic side, was beginning to respond to the appeals of Daniels and others for participation by American industry. He used the occasion of a speech before the Detroit Economic Club in October to announce the formation of an industrial advisory

panel under the chairmanship of James W. Parker of the Detroit Edison Company. Early in November, during a visit to Knoxville and Oak Ridge, he explored informally with Union Carbide officials the possibility of the company's taking over the Clinton contract to make it a strong industrial laboratory.[50]

Lilienthal's suggestion hardly inspired enthusiasm in Clark E. Center and other Carbide engineers in Oak Ridge. Getting Clinton back on the track was not an attractive assignment, but it did offer a solution to an increasingly dangerous situation. Ever since the Commission had taken over from the Army, Carbide had been snarled in union troubles at Oak Ridge. The main difficulty from Carbide's point of view was that dual management had given the labor unions an opportunity to compete for higher benefits. Although in late 1946 unions affiliated with the Congress of Industrial Organizations had won the bargaining elections in the Carbide-operated K-25 gaseous-diffusion plant, workers in the Clinton Laboratories under Monsanto had chosen to be represented by a union affiliated with the American Federation of Labor. No sooner had Carbide signed a one-year contract with the CIO affiliates on December 9, 1946, than Monsanto signed one granting superior benefits in several respects to the AFL workers in the laboratory. For almost a year Carbide had been under ceaseless fire from the CIO to renegotiate the contract. More than thirty negotiating sessions with the union had produced no agreement. In accordance with the terms of the new Taft-Hartley Labor-Management Relations Act, the CIO on October 9 had formally notified Carbide of its intention to renegotiate any extension of the one-year contract due to expire on December 9, 1947. In November the union had strengthened its hand by winning decisively a bargaining election requested by the AFL union for representation of the workers at K-25.

At the same time, Carbide was feeling pressure from the opposite side as the Commission attempted to formulate a labor policy. Recognizing that a strike in an atomic energy plant could not be tolerated, the Commission was moving cautiously under considerable pressure from the labor unions toward some form of compulsory arbitration of labor disputes. At a meeting with the Commissioners on October 23, George A. Felbeck, a Carbide vice-president, had joined officials representing the Commission's other major contractors in agreeing to accept arbitration, provided it was limited to financial matters, such as contract provisions for wages, holiday pay, and overtime. The Commission itself disliked arbitration because it seemed to suggest Commission interference in traditional labor-management discussions, but the no-strike principle ultimately left no other choice.[51]

Tension increased during the first weeks of December as the Carbide-CIO negotiations dragged on with no sign of settlement. On December 4, the union membership voted its committee strike authority, and the Government began preparations to invoke the emergency provisions of the Taft-Hartley Act. Only a last-minute break in the deadlock on December 8 and a union

agreement to continue negotiations after the contract expired avoided a strike. Not until the new contract was signed on the afternoon of December 11 did the Oak Ridge staff relax the emergency procedures arranged for operation of the gaseous-diffusion plant in the event of a walk-out.

A strike had been avoided but the threat had shaken both the company and the Commission. Williams told a special session of the Joint Committee on December 17 that a sudden shut-down of the gaseous-diffusion plant as the result of a strike might have done permanent damage to production facilities. Senators Hickenlooper and Bricker were concerned enough to press the Commissioners for suggested legislation to bolster the Taft-Hartley Act. Commissioner Pike thought the company and the union had pushed the dispute beyond the deadline in order to test the new labor act and the Commission's determination not to intervene in the quarrel. Strauss and Forrestal did not take such a detached view, although they were not ready to recommend specific legislation. For its part, Carbide had decided that in order to bring labor peace to Oak Ridge, it would be willing to take over the Clinton contract from Monsanto. When Oppenheimer heard this news, he called Rabi and Wigner, neither of whom could assure him of Carbide's abilities to manage an academic research laboratory.[52]

BLACK CHRISTMAS

Within the Commission the fate of Clinton now rested with Wilson. The labor incident had demonstrated the dangers of having two contractors and two unions at Oak Ridge. Carbide's desire to take over Clinton was even more ominous. Would Carbide withdraw if the Commission insisted on bringing Chicago into the laboratory? The university had just received a refusal from the sixth candidate for the directorship. Warren C. Johnson, a Chicago chemistry professor who had been a research director at Clinton during World War II, had agreed to serve as temporary director; but as late as December 5, Franklin complained that the university had not requested a single clearance or sent one member of its permanent administrative staff to Oak Ridge. By the middle of the month Harrell had several of his staff in Oak Ridge and was making arrangements to take over the payroll, insurance, and purchase orders, but there was as yet no permanent director, no laboratory policy or plan. Within a matter of days the extension of the Monsanto contract would expire, and Wilson had no assurance that the new contractor would be as well prepared as the old one to direct the laboratory.[53]

There was little time to think through the issues. At this late hour replacing Chicago with Carbide would shock the laboratory personnel, who had been anticipating a university contractor for months. But Carbide offered an attractive solution in several ways. The firm hand of an experienced industrial contractor might, for example, bring some much-needed discipline

to the laboratory. Beyond the selection of the contractor were other questions which could hardly be posed in the crisis atmosphere of late December. If Carbide took over, what would happen to reactor development at Clinton? What would be the impact on Weinberg's plans for the high-flux reactor? There would be no chance to meet with the reactor development group. The General Advisory Committee had scheduled a special meeting on weapon matters in Chicago on December 29, but that was almost too late for a decision. There was even some doubt the Commission could meet on the subject because Lilienthal had been bedridden with influenza since a speaking engagement in Chicago on December 16, and both Waymack and Pike had gone home for the Christmas holidays.

Wilson and Fisk were in an awkward situation. Men of lesser poise or determination might have panicked under the pressure, but Wilson in his cool analytical way was determined to make the best possible choice under the circumstances. By Monday afternoon, December 22, he was talking hourly with Franklin in Oak Ridge. There were further discussions of the Clinton contract with Williams and his assistant, Richard W. Cook. By Tuesday afternoon Wilson was ready to suggest the Carbide alternative to Lilienthal by telephone. He told Lilienthal that the choice was to stick with Chicago, an ever-less-promising alternative, or to bring Carbide into Clinton. In the latter case Wilson intended to transfer all reactor development work, including the high-flux, to Argonne. The decision would probably please the General Advisory Committee but would devastate the Clinton scientists.

Wednesday, December 24, Wilson devoted almost exclusively to the Clinton question. There were several meetings with Bacher, Fisk, Williams, and McCormack and long-distance calls to Franklin at Oak Ridge and Strauss in New York. At one-fifteen Wilson told Franklin to call Harrell in Chicago and ask him to come to Washington on Saturday, December 27. Early on the twenty-sixth Wilson asked Roy B. Snapp, the Commission's new secretary, to arrange for a Commission meeting at Lilienthal's home in Rockville, Maryland. Strauss had returned from New York to join Bacher in providing a quorum. Wilson explained the background of the negotiations with Chicago and the university's failure to build a management team for the laboratory. Franklin, reflecting Carbide's views, argued that the personnel policies of an industrial and an academic contractor were inherently incompatible and would produce nothing but trouble at Oak Ridge. Fisk reviewed the issue of centralization, the need to replace Monsanto, and the quest for a new contractor. Bacher reported that Oppenheimer and the General Advisory Committee still favored a central laboratory and, failing that, preferred to see reactor development divided between Argonne and Brookhaven rather than between Argonne and Clinton. The conclusion seemed inescapable. Chicago would be asked to withdraw. Monsanto would be asked to continue temporarily until Carbide could arrange to take over at Clinton.

The unpleasant news reached Harrell and his associates officially in the meeting in Wilson's office on Saturday. The Chicagoans were dumbfounded.

They were prepared to discuss the final mechanics of transfer, but under the circumstances there was little to say. Wilson did his best to be gracious in an awkward situation. Now the news was out, Wilson had to act. There were hasty telephone reports to Waymack and Pike, a call to Dayton postponing a scheduled visit to the new Monsanto plant. Fisk was off to Oak Ridge with the unenviable task of breaking the news to Weinberg and his associates. Wilson himself left for St. Louis to persuade Thomas to hang on for a few weeks until Carbide could take charge.[54]

Fisk did his best but the Clinton scientists hardly received him as a Santa Claus. In the laboratory conference rooms his patient but firm explanations brought anger, sarcasm, and disappointment. In the round of Oak Ridge Christmas parties the Commission's director of research felt himself excluded from the warmth and cheer of the holiday occasion. When Wilson arrived on December 30, he found the same bitterness beneath the outward courtesy of the scientists. Whatever their intentions, Wilson and Fisk were betrayers of confidence and destroyers of dreams. Perhaps they never heard the cutting jingle improvised at a New Year's Eve Party, "1947 B.C. (Before Carbide)," in Oak Ridge. To the tune of "Deck the Halls," the group sang raucously: "Pile research is not for us'ums / Leave it for our Argonne cousins /Engineering is for us'ums / We're a bunch of dirty peons. / Fisk considered many factors /Then he stole all our reactors. / Now the New Year's here to greet us / Can the bastards really beat us?" [55]

YEAR-END REFLECTIONS

It was perhaps ironic that the same week the executive secretary of the Federation of American Scientists was drafting a letter of birthday greetings to the Commission with congratulations for "the excellent progress the Commission has made in reorganizing the atomic project on a peacetime basis." Oppenheimer on New Year's Eve was drafting a letter to the President. (Conant had suggested that this might establish a precedent which would give the General Advisory Committee a strong voice in the future.) He wrote of the staggering difficulties the Commission had faced one year earlier. He expressed cautious but genuine confidence that there had been real progress in twelve months, but he could not hide the fact that there had been fumbling and frustration. Lilienthal, still at home weak from his recent illness, spent the evening in a sentimental reverie with his journal. He called it a year of pain but with moments of exhilaration. Both the pain and the exhilaration were the products of a courageous attempt to bring new ideas and techniques to bear on the terrifying issues of the atomic age. Not even Lilienthal thought the Commission had distinguished itself in sharpening the peaceful image of the atom. Hopefully the failures as well as the successes had provided good lessons for the future.[56]

CALL TO ARMS

CHAPTER 5

It was Bastille Day in 1947, a day when free men the world over recalled a classic overthrow of outmoded institutions and old oppressions in western Europe. Secretary of State George C. Marshall, speaking to the Governors' Conference in Salt Lake City on that July afternoon, found the revolutionary theme pertinent to his remarks. Living in revolutionary times, Marshall saw the nation poised at a critical moment in world history, facing a decision which would affect the world for generations. "There is no blinking the fact," he said, "that this country now stands at a turning point in its relations to its traditional friends among the nations of the Old World. Either it must finish the task of assisting these countries . . . or it must reconcile itself to seeing them move in directions which are consistent neither with their own traditions nor with those of this country." The second alternative, in other words, would result in a repudiation of the revolutionary spirit of 1776 and 1789.

In private, according to newsmen, Marshall explained the crisis facing the nation in the plain language of a soldier. Western Europe was on the verge of disintegration, and the Soviet Union stood ready to pick up the pieces. Britain itself might fall. The situation in Greece was so grave, despite President Truman's emergency offer of military and economic assistance in April, that there was little assurance the struggling nation would not slip behind the Iron Curtain.[1]

But could the United States accept the new responsibilities which the postwar crisis was thrusting upon it? Defending the free world would mean a heavy commitment of national will and resources. The nation would have to rebuild its armed forces, and the military services would have to find some way to replace traditional rivalries with new patterns of unified action. Likewise, if the atomic bomb was to have a significant place in the national defense, the Commission would have to resolve some of its differences with the Pentagon. An effective atomic arsenal would require more uranium ore,

new and more efficient plants for producing fissionable material, a rejuvenated weapon laboratory at Los Alamos, mass-production techniques in weapon fabrication, field tests for new weapon designs, and resolution of the old dispute over the custody of weapons in stockpile. These were the tasks the Commission faced during the last six months of 1947 in answering the call to arms.

THE OLD ORDER CHANGES

This was not the first time that the threat of foreign aggression provided the necessary stimulant for reforms in the structure of the Federal Government. To many high in the councils of the Government, World War II had

demonstrated the need for fundamental changes in the defense establishment, including unification of the armed forces, coordinated procurement of essential materials and supplies, establishment of a national intelligence organization, unified direction of military research and development, and creation of new channels for Presidential decision.

Although President Truman had advocated creation of a single defense department late in 1945, Congress still had taken no action on this controversial subject in early 1947. The hearings and floor debates in Congress during the first months of 1947 centered around the authority of the Secretary of Defense and the status of the Air Force, Marines, and naval air arm. The National Security Act, signed by the President on July 27, 1947, reorganized the military departments "to provide for their authoritative coordination and unified direction under civilian control but not to merge them." The Secretary of Defense was given powers of general authority, direction, and control, and presumably would be the only official in the military establishment with Cabinet rank. But with no departmental organization of his own, the Secretary would have the unenviable task of guiding the activities of the sub-Cabinet Departments of the Army, Navy, and Air Force, all of which were part of an ambiguous entity described as the National Military Establishment. The new act provided a statutory basis for the Joint Chiefs of Staff, created the War Council, and moved the Research and Development Board and the Munitions Board into the National Military Establishment. While the joint bodies were advisory to the Secretary of Defense, their composition made it likely that their advice would be the product of negotiations by service representatives.[2]

The sweeping provisions of the National Security Act extended beyond the military services to broader aspects of the national security structure. To provide for better coordination of national security affairs above the department level, the Act created the National Security Resources Board, the Central Intelligence Agency, and the National Security Council. The Board would

advise the President on coordinating all military, industrial, and civilian mobilization. The Agency would advise the Council on intelligence matters related to the national security, and correlate and evaluate intelligence information in the Government. The Council, a major policy advisory group, would include the President, the Secretary of State, the Secretary of Defense, the three service secretaries, the chairman of the resources board, and other heads of Executive departments and agencies as appointed by the President.

It would take President Truman some time to fill the posts created by the new legislation, but in late July there was little doubt who the new appointees would be. Robert P. Patterson's resignation as Secretary of War indicated that James V. Forrestal, once a critic of unification, would become the first Secretary of Defense. Kenneth C. Royall would succeed Patterson as Secretary of the Army, John L. Sullivan would follow Forrestal as Secretary of the Navy, and W. Stuart Symington would be the first Secretary of the Air Force. Since both General Dwight D. Eisenhower and Admiral Chester W. Nimitz would be retiring by the end of 1947 or shortly thereafter, there were good prospects for entirely new military leadership in the critical years ahead. In the summer of 1947 the Soviet threat had been sufficient in a few weeks to spark changes which had been years in the making. World War II was fast becoming history, and the nation's destiny was passing to a new order of leadership.

RELATIONS WITH THE MILITARY

The growing international tensions of which General Marshall spoke had an impact on the thinking of the Commissioners, as renewed interest in producing fissionable materials and weapons in the spring of 1947 indicated. The ominous clouds on the international horizon had postponed the dawn of a new day in which atomic energy would serve the cause of peace rather than the demands of national defense. The Commissioners would have to give much more attention to the military aspects of atomic energy than Lilienthal had expected and would have to spend much more of their time in consultations with civilian and military officials of the defense establishment, mainly the Military Liaison Committee.

Unfortunately for both sides, the Commission had not made a good start in its relations with the committee. The bitter struggle for confirmation and the succession of security crises in the first months of 1947 made it difficult for the Commissioners to concentrate on defense needs and to establish routine working relationships with the committee. Once the two groups started meeting regularly in April, 1947, there was some opportunity to exchange ideas and to develop personal relationships to replace the formal-

ities which usually set the tone in official correspondence.[3] General Lewis H. Brereton, the committee's chairman, knew that General James McCormack was an outstanding officer, and Lilienthal soon discovered that Brereton was a reasonable and effective administrator. For a knowledge of atomic energy development up to that time, few officers could meet the qualifications of General Leslie R. Groves or Admiral William S. Parsons, both members of the committee. Admiral Thorvald A. Solberg, although not directly involved in the Manhattan Project, had long been interested in applying nuclear energy to naval ship propulsion. Admiral Ralph A. Ofstie and Colonel John A. Hinds were both officers of experience and ability.

The long list of varied items on the agenda for the April 30 meeting had indicated the wide range of topics which would be the subject of discussion in succeeding months. In addition to the major policy issues, such as plans for producing fissionable materials and weapons, the two groups faced many administrative matters of lesser import but still of substance. One of these was the policy on access by military personnel to Restricted Data. The committee found it difficult to understand the Commissioners' opposition to broadening access. It seemed that the Commission had the exaggerated idea that its control of atomic energy information was a sort of sacred trust which took precedence over even military requirements. The Commission, for its part, had trouble visualizing the need for clearing thousands of military personnel for access to Restricted Data. Just how many clearances were required was a matter for continuing discussion, although the Commission did agree to accept military clearances, provided the procedures for personnel investigation met Commission standards.

Other areas of the Commission's responsibility had military implications which had received little systematic study during World War II. McCormack reported to the Commission that the armed forces had done little since the war to appraise the techniques and effectiveness of radiological warfare and the defenses against it. He urged that the Commission take the lead in exploring the scientific aspects of radiological warfare and that the Commission raise with the Military Liaison Committee the question of military responsibility for investigating the subject. In October, 1947, the Commission sent the committee the results of a preliminary study conducted at Oak Ridge and requested the military services to participate in the work of a scientific panel on radiological warfare.[4]

Another matter of great concern within the Commission was the long-range detection of nuclear explosions. Like radiological warfare the subject had received some attention in military and scientific circles during and after World War II. But as Commissioner Strauss pointed out in April, 1947, there was no evidence that the military services had set up any system for continuous monitoring of radioactivity in the atmosphere. Such a system would be the best method of detecting an atomic weapon test in another nation. With the Commission's approval, Strauss set out to investigate.

William T. Golden, his administrative assistant and a former naval officer, soon discovered that no monitoring system existed. Although many Government organizations had an interest in the subject, none had primary responsibility. A special committee, organized at the Commission's request by the Central Intelligence Group, confirmed this fact in May, 1947. The committee reported that, although techniques already existed for detecting distant explosions by sonic, seismographic, or air-sampling methods, at least two years would be required to develop an effective network of detection stations.[5]

Strauss and his fellow Commissioners refused to believe that some sort of detection system, however far from perfect, could not be established in a few months. A formal request to the Military Liaison Committee in June and Strauss's personal appeal to Forrestal, Royall, and Eisenhower in September placed the responsibility for long-range detection squarely in the hands of the Air Force. How long it would take to set up an effective monitoring system was still uncertain.[6]

If the Military Liaison Committee was the Commission's contact with the armed forces on the policy level, the Armed Forces Special Weapons Project served the same function on the operational level. Established by Secretaries Patterson and Forrestal under General Groves's command early in 1947, the new organization was to be responsible for all armed forces' participation in developing the military uses of atomic energy. The joint directive clearly anticipated the ultimate unification of the military services, but it was difficult to write a charter for the organization before Congress had acted. In the interim Groves carried on as best he could without a formal charter, for the most part limiting his activities to ordnance work at Sandia with Corps of Engineers officers. As General McCormack well knew, operations at Sandia were far from satisfactory in the first half of 1947, but there seemed little chance for improvement until the service secretaries had clearly defined the functions of the Armed Forces Special Weapons Project.[7]

Early in April Groves had submitted to Eisenhower and Nimitz a draft charter for the special weapons project. Like the joint directive, the charter proposed that the commander have direct access to the Army Chief of Staff and the Chief of Naval Operations, a concession Eisenhower was willing to make. Not acceptable was the proposal that the unit have special command functions. The revised draft which Eisenhower and Nimitz approved on July 8, 1947, limited the commander to staff functions except in the particular areas of ordnance work and technical training of military personnel at Sandia. Since it was now clear that the National Security Act would create a separate department for the Air Force, the charter provided for representation of the Army Air Forces.[8]

The charter was not everything Groves had hoped for, but at least it gave him a toehold on the operational as well as the policy side of the atomic weapon effort. From his place on the Military Liaison Committee he could prod the Commission on producing fissionable materials and weapons. In the

special weapons project he could make sure the military services would have the nuclear weapons they needed in time of crisis.

NEW LIFE AT LOS ALAMOS

Who would have custody of the stockpile was a live issue in the summer of 1947, but a more immediate question was whether there would be a stockpile to control. Certainly no man was more concerned with that question than was Carroll L. Tyler, the new manager of the Commission's vast western empire called Santa Fe Directed Operations. Tyler had faced tough assignments before. During World War II he had helped Vannevar Bush administer contracts for the proximity fuse. The Commission had hired him for his demonstrated ability to manage industrial contractors on a complex technical job involving extraordinary specifications and an incredible time schedule. But Tyler knew from his trip through the western installations in June, 1947, that his wartime job was child's play by comparison. From the decaying ruins of a war project he was expected to build a modern and reliable complex of laboratories and plants for developing and producing nuclear weapons.

The magnitude of his task must have struck him anew as he arrived in Los Alamos on July 16, 1947, to take up his duties. Like thousands before him, Tyler followed the lonely road north of Santa Fe along the Rio Grande, across the one-lane wooden bridge at Otowi, then northwest toward the Indian town of Española, and up the winding canyon road to the ramshackle sentry house, wooden gate, and barbed wire barricade, where military police were still standing guard. Driving west onto the mesa, the new manager followed the dusty road through the tangle of warped plywood hutments, time-scarred Quonset huts, and ugly warehouses with paint peeling off their sides. At the center of town he could see on the right the beginnings of the commercial center just east of the log buildings which had been part of the ranch school before the war. Ahead were two wooden overpasses leading over the high barbed-wire inner fences to the technical area on both sides of the road.

It was hard to believe that these crumbling temporary buildings surrounded by oil drums, cable reels, and mud-caked Army vehicles housed one of the world's famous scientific laboratories. A few hundred yards farther west the road fanned out into the residential area, a conglomeration of ten different types of prefabricated plywood homes, converted barracks apartments, temporary hutments, and trailers. The Army had just completed the first three hundred permanent homes in the western area, but most of the town's 7,000 inhabitants still lived in temporary wartime buildings. There were few paved streets, no sidewalks, and almost no private telephones. One low rambling wooden building served as the town's only school, and church services were still being held in the old post theater until an Army chapel

could be hauled in from Santa Fe. Residents did their daily shopping in the commissary and the post exchange and made other purchases by mail order. It was evident that living conditions in Los Alamos would not help to attract talented scientists to the laboratory.[9]

When Tyler took over from the Army commander on July 17, he had less than four hundred Commission employees to manage the weapon activities at Los Alamos and a half dozen other sites. A year earlier at Los Alamos alone the Army had maintained a work force of more than 5,000 troops and civilians. Many of the former Army jobs were now the responsibility of the Zia Company, which a local construction contractor had organized in 1946. Zia's 3,300 employees did everything from running the schools and the power system to fixing leaking faucets for housewives and purchasing supplies for the laboratory. Administration and research in the laboratory was the responsibility of 1,200 employees of the University of California, under the direction of Norris E. Bradbury. The university also had more than three hundred scientists and technicians at the Sandia Base. For a management job of this magnitude, Tyler's staff was much too small, but he could not even consider reinforcements until additional housing was available.

The one bright spot in the picture in the summer of 1947 was morale among the scientists in the laboratory, if not that among the housewives in the town. Since the April, 1947, meeting with Oppenheimer and the weapon subcommittee, the scientists had found a sense of purpose and were doing important work despite the handicap of inadequate laboratories. The caliber of research impressed Commissioner Bacher during his summer sojourn in Los Alamos. He was especially interested in the theoretical and experimental work on the design of the new weapons which would be tested in the spring of 1948. Long discussions with Marshall G. Holloway and Hans A. Bethe generated hopes that the new weapons would give a much greater explosive yield than the wartime weapons. The new design also promised a relaxation of some of the more troublesome specifications for the existing weapons and hence greater efficiency in the production plants. Edward Teller's descriptions of the laboratory's theoretical work on a thermonuclear weapon also had exciting possibilities.[10]

In the summer of 1947 one could feel new energy, and with it new ideas, surging through the laboratory. A new sense of mission had replaced the spiritless make-work of 1946. The turnover of personnel was slowing down, and Bradbury was giving a new team of relatively junior scientists a chance to show what they could do. The work was challenging. Creating a stockpile of atomic weapons required not only the resumption of many of the activities established during the war, but also substantial new efforts to standardize operations, improve the quality of existing weapon models, and develop new ones.

Only those who had some conception of the intricacy of atomic weapons could appreciate the challenge. The tasks involved were much closer

in scope and complexity to those of developing and building a modern airplane than to those of turning out artillery shells. An atomic bomb approached a small airplane in size, and its flight characteristics on the way to the target were important. Inside its ballistic case it carried an incredible array of precision instruments, electronic gear, exquisitely machined and plated mechanical parts, expertly cast shapes of high explosives, and a core of fissionable material resembling the most ingenious Chinese puzzle. Production and assembly of atomic weapons at Los Alamos would have been a challenge even if there had been well-established processing techniques and assembly lines, but nothing of the sort existed in 1947, or even during the war, for that matter. A small group of exceptionally talented scientists working with a minimum of physical resources had managed to build a few atomic bombs on a laboratory scale almost entirely by empirical methods. Now most of those scientists were gone; they had left behind them no

production lines or printed operating manuals, but only a few assistants, some experienced technicians, some laboratory equipment, and a fragmented technology recorded in thousands of detailed reports.

In every area of the laboratory, the problems were the same in 1947. A few people had seen a specific process or assembly performed during the war, but so few units had been produced, often by cut-and-try methods, that no one could be sure that the processes were really reproducible. For example, the high-explosive lenses had worked in the implosion devices at Alamogordo and Nagasaki in 1945, but just what should the specifications be for lenses in existing models? Could the wartime components be reproduced exactly, even if that were desirable? Would lenses produced at Inyokern by the same process have the same properties as those produced at Los Alamos? Would lenses produced in 1945 behave the same way in 1947 or 1948? Was it possible to improve the quality of lenses in the process of producing additional stocks without delaying the creation of a weapon stockpile or reducing the reliability of the weapon? Or for that matter, were the wartime lenses really reliable, or had the scientists just been lucky? What could be done to improve the components for new weapons under development? During the summer and fall of 1947 the men of X division looked for answers to these questions as Melvin L. Brooks experimented with new casting methods, Leonard E. Hightower improved production techniques, and Arthur W. Campbell broke the desert calm with test firings at Anchor Far Point and Q-5 site.[11]

The pressures were just as great in M division, which was responsible for the nuclear heart of the weapon. In the spring of 1947 the main task had been to clean up the specifications for the standard nuclear cores and to write systematic manuals which technicians and military teams could use in assembling and testing them. During the summer the emphasis turned toward perfecting techniques and increasing production of standard components, developing the new Mark 4 weapon, and studying possible alternatives which

might be used in the devices to be tested in the spring of 1948. Raemer E. Schreiber had charge of testing dozens of critical experiments in a new remotely controlled building, which eliminated the hazards in what had been the deadly game of "tickling the dragon's tail."

CMR division had to handle the steady stream of requests from all parts of the laboratory for chemical processing and analytical services and still maintain the wartime production lines for purification and fabrication of uranium and plutonium metal. Soon after the war General Groves had planned to transfer these production activities to Oak Ridge and Hanford, respectively, but until suitable facilities could be built at the production sites, Los Alamos had to carry the load. In the summer of 1947, the CMR division had to set aside most of its plans for research on process improvement in order to meet the demands for fissionable material for the stockpile and for test activities. Although Bradbury's goal was to make Los Alamos exclusively a research laboratory, a large share of the laboratory's effort through the rest of 1947 went into restarting and maintaining production operations for the components and materials needed for stockpile weapons and those under development.

Bradbury's hope for liberating his staff from production activities rested with Z division, the branch of the laboratory established at Sandia Base on the outskirts of Albuquerque. Los Alamos was to do research and laboratory development of new weapon designs and production techniques; Z division at Sandia was to work out engineering details, establish production lines at various sites, and with assistance from the armed forces set up routine methods for assembling, testing, and maintaining weapons in a ready state. Much of this was a dream even as late as the summer of 1947. Inadequate facilities, a severe shortage of trained personnel, and an uncertain chain of command all made work at Sandia a frustrating experience.

Uncertainties in organization were particularly distressing. There was a distinct advantage in locating engineering and production activities near Kirtland Field and Albuquerque, but separation from the main laboratory at Los Alamos tended to subordinate the status of Z division. Until the autumn of 1947 all administrative actions had to go through Los Alamos, and until regular air service was established between Los Alamos and Albuquerque, Sandia personnel had to invest a full day of travel to attend a short meeting on the Hill. Furthermore, the Sandia operation had grown up gradually out of necessity, without any formal statement of its relationship to Los Alamos. Robert M. Underhill, in charge of business affairs at the University of California, wrote Bradbury in June, 1947, that in his opinion the university never contemplated operations anywhere but at Los Alamos. He considered Sandia a shoestring operation covered neither by Government contract nor by insurance; he wanted the university relieved of any connection with Sandia and the project turned over to the Armed Forces Special Weapons Project.[12]

OPERATIONAL RESPONSIBILITIES

The joint responsibilities of the military and the Commission at Sandia were another source of confusion. True, General Groves now had a charter for his organization, but how this was to be interpreted at the operating level at Sandia was far from clear. In the summer of 1947 Groves had ten officers from a special engineer battalion assigned at Sandia to learn the art of weapon assembly and testing, but just what was the boundary between their work and that of Z division personnel, who were employees of the Commission's contractor at Los Alamos? The Commission had established the principle in December, 1946, that it would assume custody of all atomic weapons and fissionable material, but how did this square with the fact that custody of such materials at Sandia remained with a military officer?

These questions came to a head when Tyler arrived at Los Alamos to take up his new duties. As the Commission's senior representative, he expected to have administrative control of all activities at Los Alamos and Sandia. Since the military would have no authority at Los Alamos after July 16, Tyler's responsibilities there were clear. But it was not so easy to write a directive for Sandia. There was at least a semblance of Commission custody of weapons and weapon parts in the fact that Colonel Gilbert M. Dorland, who had personal responsibility for weapon materials at Sandia, took his orders on this subject directly from Carroll L. Wilson. Dorland's superior in the military chain of command, however, was General Robert M. Montague, commanding general of Sandia, who in turn reported to Groves as head of the Armed Forces Special Weapons Project.[13]

General McCormack and his staff in the division of military application tried to keep the issue in a practical perspective. All that really mattered from their point of view was that reliable atomic weapons be ready when they were needed. With this idea in mind, McCormack proposed a short directive to Tyler requesting him to assume personal responsibility for stockpile items at Sandia. He would make regular inspections and reports to the general manager and control access to stockpile items. General Montague would be responsible for providing storage facilities and their physical security. Tyler would be requested to work out the details with General Montague.

The Commissioners readily accepted McCormack's draft, but the Military Liaison Committee refused to let McCormack slide over the sticky questions of custody. In a meeting on August 13, 1947, Brereton® recommended a directive spelling out in detail the precise division of responsibilities between Tyler and Montague. When Wilson complained that in defining such a division the Commission inevitably would be circumscribing Montague's authority, Brereton suggested that the military and the Commission issue a joint directive. General Groves had a simpler solution: the Commis-

sion and the Secretary of Defense should ask the President to transfer all weapons and weapon parts to the armed forces. In a way, Groves had raised a valid point. Section 6(a) of the Atomic Energy Act provided that the President could direct the Commission to deliver to the armed forces such fissionable material and weapons as he deemed necessary in the interests of national defense. The President could also authorize the armed forces to produce or acquire atomic weapons.

The trouble with Groves's suggestion was that it threatened to raise the old clichés about civilian or military control of atomic energy. Wilson reminded the committee that the President had settled the question of custody in the executive order transferring the atomic energy program from the Manhattan District to the Commission. Brereton, however, seemed to remember that Lilienthal had implied his willingness to transfer custody eventually to the armed forces in the interests of national security. Since neither Lilienthal nor Bacher was at the meeting, that question could not be settled. Groves observed that Tyler could not really assume responsibility for the stockpile unless he assumed command of the troops guarding it.[14]

At this point McCormack's deputy, Navy Captain James S. Russell, tried again to propose a joint directive. Russell said he would be glad to work out a joint order with Groves and send it to Tyler and Montague for their comments. Pike accepted the idea for the Commission and Groves, while making clear his dissatisfaction, agreed to try.

Russell's suggestion proved a good one. He and Groves agreed on a draft the following day, and both Tyler and Montague concurred, with only minor differences of opinion, within a week. The directive itself accurately reflected the complex administrative relationships at Sandia and proved an effective working arrangement. The Commission had compromised by conceding its contention that it should have unilateral and complete authority on matters of weapon custody. Yet for the Military Liaison Committee the directive missed the important point. The military services seemed to be in the dangerous position of not having instant access in times of crisis to the most powerful weapon in the national arsenal.[15]

The Military Liaison Committee could not overlook this danger. On September 4, 1947, Brereton wrote to Secretaries Royall and Sullivan for their support of an effort to gain military custody of the atomic stockpile. The results were not encouraging. Although Secretary Sullivan offered Navy support, there were rumors that Eisenhower wished to avoid raising the issue. One could guess from Eisenhower's previous reactions to the civilian-military control issue, especially during the legislative debate on the McMahon bill in 1946, that he preferred the pragmatic approach to custody advocated by McCormack. His reply to Brereton recognized the Commission's responsibility and the need for ultimate transfer to the armed forces. He suggested an agreement recognizing both points of view.[16]

For the Military Liaison Committee, however, the subject was not one

for negotiation. In a letter to the Commission on November 12, Brereton declared that "in order to insure that all interested agencies of the Armed Forces are prepared at all times to use the available bombs, it is necessary that they have actual custody of the completed weapons." The Commission was asked for its formal opinion.[17]

ACTIVITIES AT SANDIA

If the scientists and military personnel at Sandia were ever aware of these larger issues, they could not think much about them; they had too many immediate concerns. By the summer of 1947 Sandia was just beginning to get back on its feet after the Bikini tests and the departure of many of the
138 wartime staff for civilian jobs. Now there were signs of regular activity and progress. Glenn A. Fowler at last had been able to complete facilities at the remote Salton Sea base, where drop tests of new weapon models would be conducted. The engineering group under Richard A. Bice was making progress on mechanical mock-ups of standard weapon stockpile models so that accurate specifications for procuring components could be written. Similar mock-ups of components for the new Mark 4 weapon helped to determine the precise size, location, and function of each small part.[18]

Learning by doing was the technique Arthur B. Machen used in training the officers of the special engineer battalion in assembling and testing weapons. In addition to its production and training activities Machen's group was developing standardized handling and test equipment. Other groups under O. L. Wright and Alan N. Ayers wrote detailed engineering manuals and subjected proposed weapon components to every conceivable test. In short, Sandia's job was not just to assemble weapons or to train military personnel, but also to create simultaneously with these operations a new technology, including technicians, instruments, tools, and textbooks.

The successive waves of demands on Sandia, first to assemble weapons from existing wartime components, then to procure new components for additional weapons of the same models, then to develop new weapon models, and finally to design weapon devices for the 1948 test series, all but swamped the small staff serving as an extension of the Los Alamos laboratory. Robert W. Henderson, serving as temporary director at Sandia, found it difficult to hire scientists and technicians when the only personnel office for the laboratory was in Los Alamos. Even when he found promising candidates, the long wait for a security clearance imposed an impossible financial burden on those seeking employment. He managed to find some buildings outside the security area where he hoped new employees could work on unclassified projects while they were awaiting clearance. But before he could get the Commission to approve the idea, the military took the facilities for other purposes. A further

obstacle to recruitment was the shortage of suitable housing for civilians at Sandia. Through the autumn of 1947 Henderson continued to complain to Bradbury about the delays in housing construction, while the Corps of Engineers argued with builders about details of contract terms. There was no questioning the fact that it was at best difficult for civilians to control operations in a military installation. Henderson and his associates were completely dependent upon General Montague and his military organization for their day-to-day existence, and there were some who said the scientists were making a hopeless attempt to perform functions rightly belonging to the military. Groves did not help matters by telling his officers at Sandia that Commission fumbling would soon put weapon activities back in the hands of the military, where they belonged.[19]

In these circumstances it was perhaps understandable that the morale of civilians in Z division was low. Some were convinced that Montague gave the military preferential treatment in housing and technical facilities at Sandia. To others the caliber of military personnel assigned to weapon engineering and assembly operations at Sandia suggested that the Army was not much interested in making a success of the venture. On the other side, the civilians seemed unreasonably suspicious and therefore uncooperative to some of the military, especially to the Air Force officers who tended to think of themselves as an innocent third party caught in the crossfire between the civilian scientists and the Army.

Bradbury, a hundred miles north of the troubles at Sandia, could afford a broader perspective. He had been in the weapon business long enough to know that there would always be clashes of this nature and that the momentary animosities did not make effective cooperation over the long term impossible. Bradbury saw some of Sandia's difficulties as the growing pains of a new site, but he recognized the handicaps of Sandia's lack of status and reputation. In June, 1947, he had predicted that Sandia would be subject to continual sniping from both the military and the Commission unless a very senior man with considerable prestige were found to head the organization. Despite his abilities and conscientious efforts, Henderson did not enjoy the complete confidence of either group. Bradbury had wisely suggested that not he, but the several authorities in Washington who would have to accept the Sandia director's decisions, should make the appointment. That, however, was easier said than done in Washington in the summer and fall of 1947. In November, Henderson was still hanging on, doing the best he could to rebuild the nation's nuclear arm.[20]

PLANS FOR SANDSTONE

In the bureaucratic labyrinths of Washington it was easier to avoid some of the direct confrontations with the military which Henderson faced at Sandia.

Certainly there was great potential for conflict in planning for the 1948 weapon tests, which President Truman approved on June 27, 1947. Weapon testing, like development and custody, was an activity of great concern to the military, and it could hardly be successful without military cooperation. Fortunately, however, the Commission was not burdened with an existing organization and its inherent complications in planning for the test. Equally important, it had in General McCormack and his deputy, Captain Russell, two men who knew how to get things done in the military services.

The week following the President's decision, McCormack asked Russell to assemble information for the key decisions on test planning. Russell headed west with his staff for a meeting in Los Alamos on July 9 with Bradbury and John H. Manley. Everyone agreed that the tests would be strictly scientific. Los Alamos would provide technical leadership; the military services, the supplies and logistics; the Commission, the funds and the test weapons. The

Commissioners readily accepted the idea of giving Los Alamos responsibility for technical direction, and by mid-August Bradbury had outlined these responsibilities in some detail. The laboratory would provide the technical director and other aides, prepare the test weapons, provide specifications for the firing areas and towers, and conduct analyses of data collected with the help of the armed forces.[21]

Just as critical in the operation was the role of the armed forces. The job of assembling the task force of almost ten thousand men at a remote Pacific atoll more than four thousand miles from the continental United States had dimensions only the military could contemplate. The operation would require a fleet of ships, harbor facilities, housing, recreational facilities, temporary laboratories, and tons of scientific equipment. With his Pentagon experience Russell had no trouble establishing working relationships with the Joint Chiefs of Staff. He served as the Commission's representative on a planning committee which recommended a special task force under the Joint Chiefs to conduct the tests. By the middle of September, 1947, the committee had rough blueprints for a joint task force and had recommended the appointment of Lieutenant General John E. Hull as task force commander. McCormack was especially pleased with Hull's appointment. With an outstanding reputation in the Army, Hull had served as chief of operations in the War Department and had just been appointed commander of Army forces in the Pacific, a position which would make him especially effective in marshaling military resources for a Pacific test. By this time Russell had also secured the appointment of Darol K. Froman of the Los Alamos laboratory as scientific director.

Late in September the three men joined a party of scientists and military officers to visit possible test sites in the Pacific. There was no question that the site would be somewhere in the Marshall Islands, a chain of lonely atolls in the vast reaches of the central Pacific. The primary concern was to find an island large enough for towers and instrumentation for three

test shots and remote enough from inhabited areas to reduce the hazards from radioactivity. The choice fell on Eniwetok Atoll, three hundred miles from the naval base at Kwajalein. The atoll itself provided an excellent harbor for large ships and was favorably located in terms of prevailing winds and ocean currents. It would be necessary to evacuate one hundred forty islanders from Eniwetok but this appeared feasible.[22]

With the site selected, Russell could concentrate on detailed planning. Appointed test director by the Commission on October 14, he assisted the Joint Chiefs' committee in defining the role of the armed forces in the test. The schedule called for moving the first construction forces to Eniwetok early in November, 1947. Temporary housing for construction workers would be ready before the end of the year. Large portions of the major construction would be completed before the main body of scientists arrived about March 15, 1948, one month before the date for the first shot. The total costs, estimated to be about $20 million, had been allocated between the Commission and the armed forces. General agreement had also been reached on security, communications, radiological safety, meteorology, and supply functions. Before the end of October the Commission had accepted most of these proposals and Russell was ready to start work.[23]

PRODUCTION PLANNING

Whatever the accomplishments of the scientists, engineers, and military officers at Los Alamos, Sandia, and Eniwetok, the strength of the United States nuclear arm depended upon a steady flow of fissionable material from the production plants at Hanford and Oak Ridge. Although Oak Ridge had its share of problems, production operations were not one of them. The trouble-free performance of the gaseous-diffusion plants promised a reliable supply of uranium 235. Plutonium production was another matter. In a meeting with the Military Liaison Committee on July 18, 1947, Carroll Wilson had explained the Commission's plans for replacing the production reactors, which were showing all the signs of old age. Expansion of the graphite moderator blocks in the central region of the reactors was bending the fuel tubes to such an extent that it might soon be impossible to push the uranium slugs through the reactor. Corrosion of the fuel tubes also seemed to be accelerating, and there had already been one instance of a leak which permitted the cooling water to flow into the graphite.

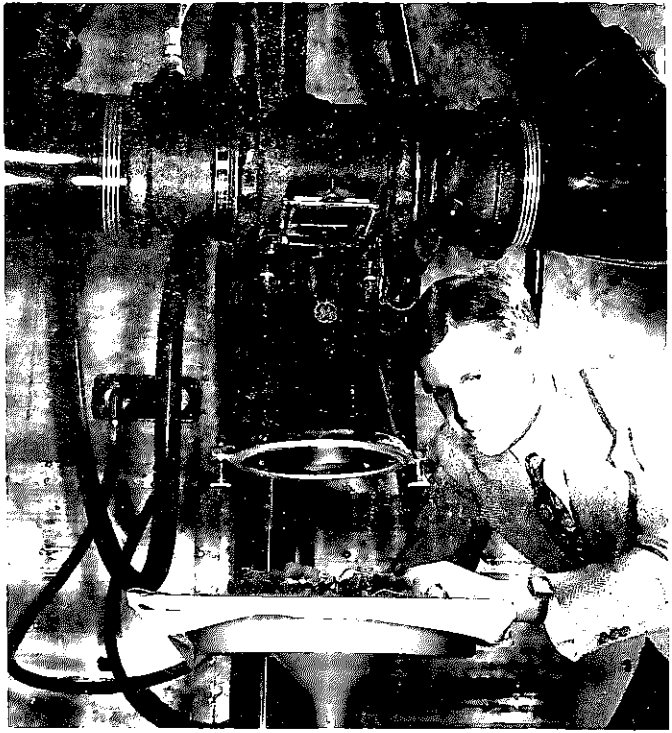
The Commission was absolutely dependent on the Hanford reactors, not only for plutonium, but also for polonium 210, which was used in neutron initiators in weapons. The short half-life of polonium made continuous operation of the reactors imperative. Walter J. Williams had developed with General Electric engineers at Hanford a plan to build two new reactors near

two of the old ones. The replacement reactors could be completed relatively quickly and at modest cost because they would be able to use existing water treatment facilities, each large enough to supply a good-sized city. Williams estimated that one replacement reactor could be completed in eighteen months and a second in twenty-four months. Two completely new reactor complexes, which would take an extra year or more to build, would be started before the replacement units were completed.[24]

In the intervening weeks some doubts about Williams' proposal began to emerge. During a visit to Hanford, Admiral Parsons, a member of the Military Liaison Committee and a veteran of the wartime project, found reason to differ with Williams' assessment of the situation. Contrary to earlier reports, Parsons discovered that the existing reactors were not expected to fail quickly without warning but would rather grind slowly to a halt under the gradual accumulation of maintenance problems. There was even some reason to believe that the existing reactors could be operated indefinitely, in which case there would be no cooling water facilities for the replacement reactors. A violent explosion in one of the old reactors, even if unlikely, might spread so much radioactivity that the replacement unit could not be operated. Parsons was also concerned that in its haste to construct replacement units the Commission was preventing design improvements, including those which would extend the life of the new reactors.[25]

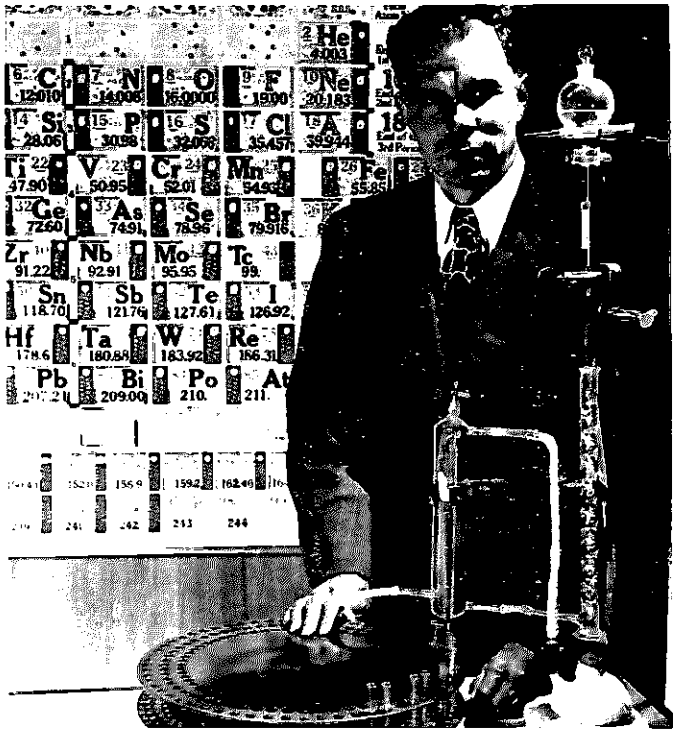
It was difficult to challenge the opinion of an expert like Parsons. The best Lilienthal could do was to suggest that the other members of the Military Liaison Committee accompany the Commissioners on their visit to Hanford after the Bohemian Grove conference. When the train reached Pasco, Washington, on the evening of August 22, Admiral Solberg and two junior officers were awaiting the Commissioners' arrival. The technicalities of reactor design and operation were something Lilienthal could not pretend to understand. He was more interested in finding in the Hanford laboratories examples of nuclear research which would demonstrate to the layman the peaceful promise of atomic energy. Solberg, however, was in his element. He found Williams' briefing on the unsatisfactory conditions at Hanford "a rather sad story" of slow progress, administrative timidity, and security clearance difficulties. Solberg thought General Electric management at Hanford was still weak and he tended to agree with Parsons's reservations about building replacement reactors.[26]

Solberg was even more concerned about the slow progress on Redox. Even under the best circumstances successful development of the process on a production scale involved extraordinary difficulties. By comparison, the bismuth phosphate process used during the war to recover plutonium from the Hanford reactor slugs was a simple matter, depending upon the chemists' time-honored practice of dissolving materials and separating their components by precipitation. In contrast, Redox would use a relatively new technique called solvent extraction, employed up to that time only on a laboratory



BROOKHAVEN NATIONAL LABORATORY

RADIATION BIOLOGY AT BROOKHAVEN, 1948 / Arnold H. Sparrow prepares *Trillium* bulbs for irradiation.

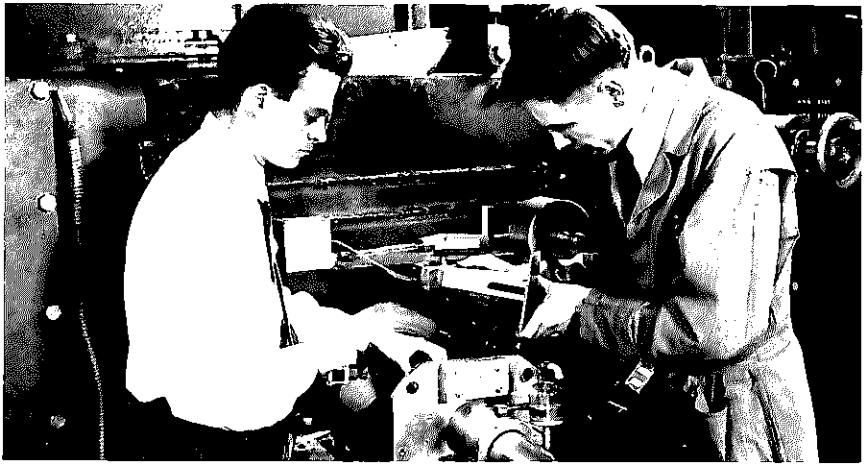


UNITED PRESS INTERNATIONAL

TRANSURANIUM RESEARCH / Glenn T. Seaborg and the elution apparatus used to separate newly created transuranium elements.

LAWRENCE RADIATION LABORATORY

THE 184-INCH CYCLOTRON BEGINS OPERATION / Robert L. Thornton, Ernest O. Lawrence, and Edwin M. McMillan (left to right), reading instruments at 12:15 A.M., November 1, 1946.



LAWRENCE RADIATION LABORATORY

MESON RESEARCH AT BERKELEY / Caesare M. G. Lattes (left) and Eugene Gardner place photoemulsion plates on the target probe of the 184-inch cyclotron in March, 1948, a few days after the first detection of mesons at the University of California Radiation Laboratory.

scale for difficult separations. Solvent extraction operated on the principle that two materials could be separated from each other by mixing them with two solvents which themselves were immiscible and which would each dissolve one of the materials and not the other. Separating the solvents therefore separated the materials. Experiments using packed columns for solvent extraction had proceeded during World War II on a laboratory scale. The columns consisted of small vertical glass tubes containing a bed of coarse solids. Counter-current flow of the solvents through the column containing a solution of materials from the fuel slugs facilitated mixture of the materials and selective extraction of the uranium as well as the plutonium in the irradiated slugs. Wartime research had revealed many difficulties in the process but had led to the conclusion that some organic solvent such as hexone would be most effective in solvent extraction.

There was no lack of activity on Redox in the Commission's laboratories. The remnants of Glenn T. Seaborg's wartime research group at Argonne were remodeling experimental equipment consisting of glass columns 1 inch in diameter. General Electric chemists at Hanford were planning to begin experiments with 3-inch columns, using a nonradioactive solution. The new General Electric laboratories at Schenectady planned to study the basic chemistry of the process, with emphasis on the chemical properties of hexone. Scientists at the Clinton Laboratories hoped to develop a process for extracting uranium 235 from the fuel used in the high-flux reactor. The Standard Oil Development Company was investigating an entirely different approach which would use small tanks fitted with mechanical mixing devices as a substitute for the packed columns. Research on the mixer-settler system suggested the possibility that all the work on packed columns might be abandoned.[27]

The lack of coordination alarmed Solberg. Each of the research groups seemed to be defining the problem in its own way. Neither General Electric nor the Commission seemed to have any general plans or goals; instead the approach seemed to be to let each group work on its own in the hope that something useful would turn up. Solberg found that only Williams had the practical engineering sense which led him to worry about such mundane problems as the specifications for commercially produced hexone and the reliability of pumps to be used in the production facilities. The trip did nothing but confirm Solberg's worst fears about Hanford. The result was a formal request from the Military Liaison Committee that the "diminishing expectation of rapid progress on the development of the Redox process" be the subject of the next joint meeting with the Commission, scheduled for September 24, 1947.[28]

In response to criticisms from Parsons and Solberg, Williams agreed to meet informally with the Military Liaison Committee on September 23 to discuss the difficulties at Hanford before the session with the Commission. Groves quickly took charge of the meeting and began directing his questions to Williams, who did not hesitate to speak up. When Groves asked why the

Commission had allowed Redox work to drift, Williams replied that Redox had drifted under Army direction and that only under Commission leadership had a clear course of action been plotted. Williams' plans to bring experienced engineering and construction contractors to Hanford and his expressions of confidence in the Commission's staff at Hanford did not impress Groves. The General observed that three years, the time Williams thought necessary to build a Redox plant, had been sufficient to complete the entire Manhattan project. Williams stuck to his guns. He claimed that the Redox project was at last off dead center and that the plan to build replacement reactors would guarantee production at Hanford.[29]

Lilienthal, returning from a speaking engagement in Indiana on Tuesday morning, hurried directly to his office from Union Station. A few minutes later in a Commission meeting Williams reported his stormy session with Groves. The briefing might help the Commissioners avoid trouble in the meeting that afternoon with the Military Liaison Committee, but for the moment all they could suggest was that Williams prepare a written report summarizing the encounter.[30]

Having already discussed the technical details with Williams, Groves could address his remarks to the policy issues in the meeting with the Commissioners on September 24. He observed that inefficient production methods developed under wartime pressures and adopted as a makeshift by the Commission suggested the wisdom of reducing weapon requirements to a minimum, at least until Redox and other processes could be devised to make better use of the dwindling stocks of uranium ore. It would be desirable, he said, to have ten times the existing number of weapons in stockpile, but the Commission would have to consider the price it would have to pay in terms of wasted raw materials if the existing plants were used to produce the necessary uranium 235 and plutonium. In Groves's opinion, the most pressing need was to get the Redox plant in operation. Because he had considered Redox ready for engineering development in the summer of 1946, he could not understand Williams's estimate that it would take three years to get the plant in operation. These factors had led him to suggest a special review committee under Warren K. Lewis of MIT to evaluate the Redox projects. More than once during World War II Groves had called for advice from a special Lewis committee in times of crisis.[31]

The Commission wanted to avoid any specific commitments until it had a better understanding of the situation. It would be months before the Commission staff would provide for an independent review of the Redox processes as Groves had suggested. But there was no question of the Commission's determination to increase production of fissionable materials and to find new sources of uranium ore. Since midsummer Wilson had been trying to strengthen the raw materials effort. He had appointed an advisory committee on raw materials to study the prospects for ore procurement and had accepted the committee's recommendation for the position of director of a new head-

quarters division of raw materials. At the same time research on Redox and construction of replacement reactors at Hanford would get top priority. At least on production planning the Commission and its military advisers were now moving in the same direction.[32]

STRENGTHENING PRODUCTION OPERATIONS

The indispensable role of the production plants at Oak Ridge and Hanford in the national defense effort explained the determination of Wilson and Williams to find exceptional men to direct operations at the two production sites. Months of careful recruiting had resulted in the appointment of Carleton Shugg as manager at Hanford and John C. Franklin as manager at Oak Ridge.

Shugg arrived at Hanford on Labor Day, 1947, ready for action. Wilson had told him to accomplish a multiple increase in plutonium production at Hanford within five years. In the wartime shipbuilding industry Shugg had earned the reputation of a hard-hitting expediter. It had never occurred to him that any job was really big enough to take five years, and he was determined to make every day count at Hanford. On the day he arrived, Shugg took the measure of Hanford leadership. On the Commission side, in David F. Shaw and William P. Cornelius, he found eager young men with construction experience who thought General Electric was not giving new construction sufficient priority. Many of the General Electric staff, especially those who had worked for du Pont, were more than competent in technical matters, but Shugg thought too many of them saw their future at Hanford as an idyll of quiet living rather than a challenging endeavor.

The next morning Shugg began the shock treatment. By asking for facts and figures on construction progress, he quickly demonstrated that General Electric was not following activities closely. On Wednesday he demanded immediate overtime work, beginning that very day, on a temporary building for construction design forces. He understood complaints that the demand was arbitrary and unreasonable, but he hoped it would bring home to General Electric that speed was imperative.

What many people at Hanford did not realize was that they were facing a construction project of monumental size. The biggest task would be to build new production reactors to replace the deteriorating wartime models. Equally urgent was the need for the Redox plant, which would rival in size the chemical separation buildings constructed during the war. There were also plans to build at Hanford a plant to purify plutonium as metal and fabricate it into weapon shapes.[33]

The Hanford project, involving as many as five reactors, promised to

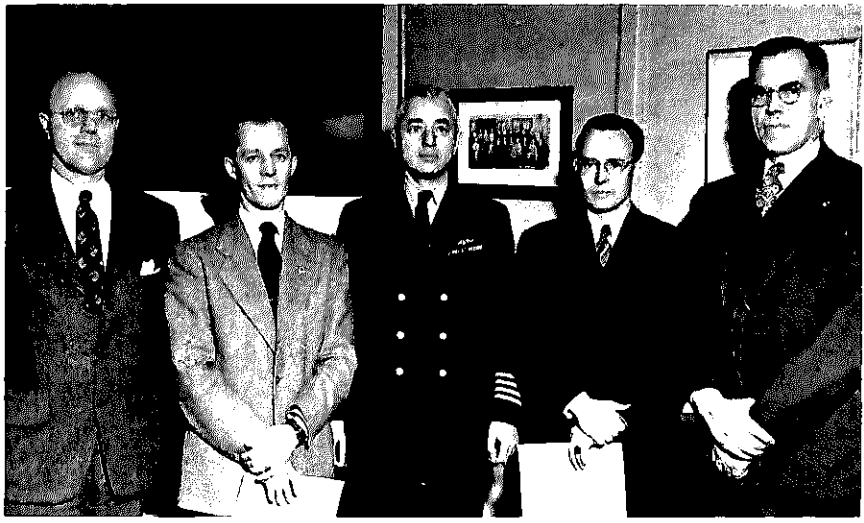
become the largest peacetime construction undertaking of the Federal Government, but the exact dimensions of the job were not yet fixed. The number of reactors to be built would depend upon whether the Commission decided to replace each of the existing reactors or simply to construct new and more efficient units. Construction of the Redox plant would certainly have to await the development of a feasible process. As for the plutonium fabrication facility, General Electric had scarcely begun to consider the design. Whatever the decisions in Washington, Shugg agreed with Williams that he should give first priority to housing, both in Richland for permanent residents and in the area north of the village for construction workers. In Richland the Jones-Atkinson Company had already started constructing 450 precut plywood homes and 500 permanent residences of concrete block. Shugg arranged to haul barracks by barge on the Columbia River from the former naval air station at Pasco, Washington, and from the wartime construction camp at Hanford. By

the end of September there was living space for more than 1,000 workers at the North Richland camp. The number of employees jumped during October from 3,000 to 5,000, an increase held down by the continuing shortage of barracks and mess halls.

In the meantime, General Electric engineers were renovating the existing reactors, performing preventive maintenance, and improving operations. To forestall the effects of corrosion, maintenance teams replaced damaged equipment, including some of the long aluminum tubes in which the fuel elements were placed for irradiation. New types of fuel slugs were designed to withstand the effects of longer irradiation at higher power levels than had been attempted during the war. No one knew how much longer the reactors would continue to operate; but steady progress on renovation in the autumn of 1947 suggested, as the Military Liaison Committee contended, that the reactors would fail gradually, if at all, and not suddenly without warning.

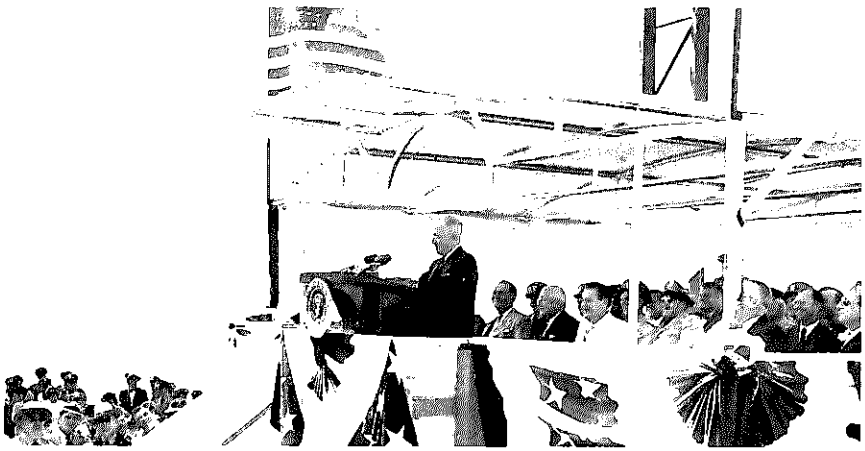
Under the circumstances the Commission found it difficult to select the best plan for reactor construction. Williams had argued it would save both time and money to build replacement reactors near the existing units. But, as the Military Liaison Committee suggested, the replacement reactors without their own water cooling facilities would then have no value unless the original units failed. They would also be vulnerable to an operating accident or enemy air attack. When the Commission discussed the issue in Washington early in October, Williams persisted in his belief that the replacement reactors were necessary. In his estimation the overriding requirement to have at least one production reactor in operation at all times to provide short-lived polonium 210 for weapon initiators demanded construction of the replacement units. The Commission's decision was tentatively to build three replacement units and eventually two new production reactors, with the understanding that initially construction would begin on only one replacement reactor and one completely new facility to be known as "H." [34]

The pressures at Hanford left Shugg little time for the Redox project

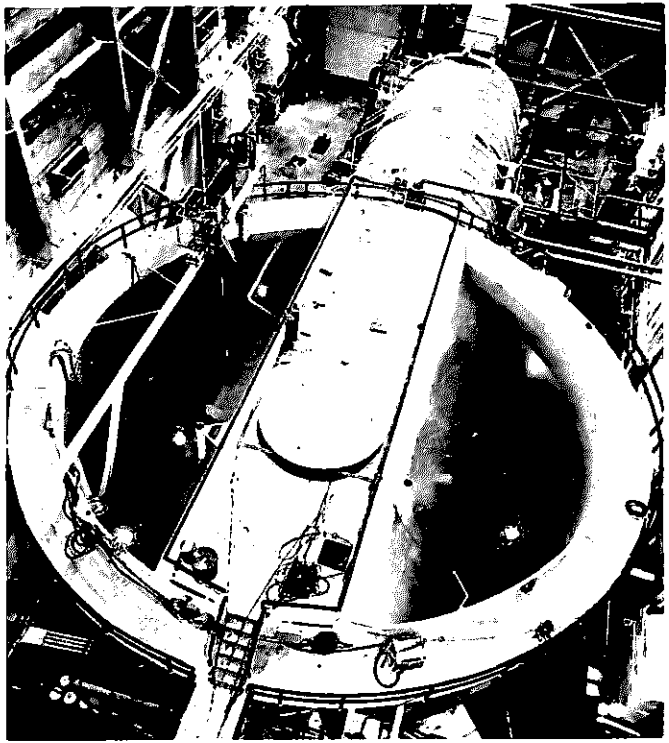


KNOLLS ATOMIC POWER LABORATORY

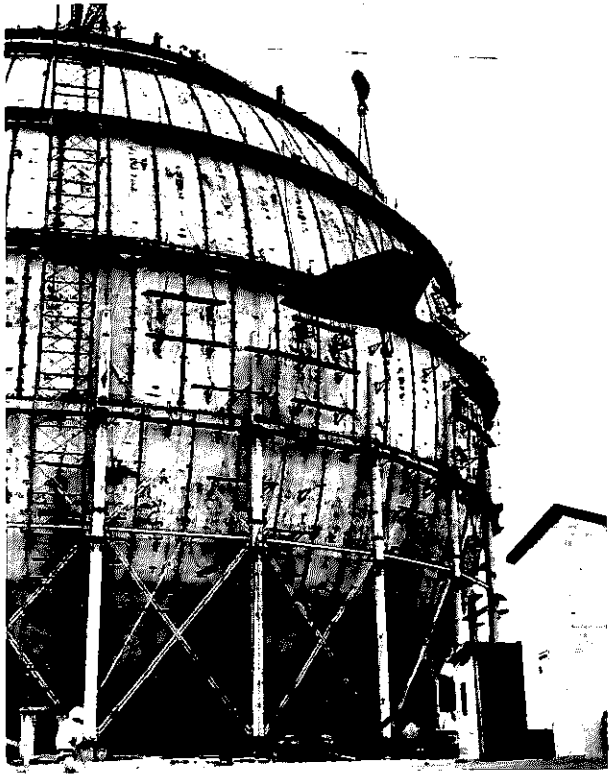
PLANNING THE DEVELOPMENT OF NUCLEAR-POWERED SHIPS / Captain Rickover with General Electric and Government officials in Schenectady, summer, 1946. Left to right: C. Guy Suits, John J. Rigley, Hyman G. Rickover, Leonard E. Johnston, and Harry A. Winne.



KEEL LAYING FOR THE WORLD'S FIRST NUCLEAR SUBMARINE / President Truman speaks at ceremonies at Groton, Connecticut, on June 14, 1952. Gordon Dean is in the first row on the far right.



SUBMARINE THERMAL REACTOR, MARK I, IDAHO / The land-based prototype as it appeared in 1954. The reactor is located within the portion of the submarine hull surrounded by water.



GENERAL ELECTRIC COMPANY

SUBMARINE INTERMEDIATE REACTOR, MARK A, WEST MILTON, NEW YORK / The huge sphere which would contain the prototype reactor nears completion early in 1953.

in the fall of 1947. Certainly there was little evidence that the various laboratories studying solvent extraction methods would concentrate on a practical Redox process without some firm leadership. Yet the Commission showed little enthusiasm for a high-powered committee which Groves had suggested to review the project or for assigning administrative responsibility to one Commission official, as Admiral Solberg advocated. For the remainder of 1947 Redox research at Argonne, Clinton, Schenectady, and Hanford followed independent courses. If anything, the Commission moved away from, rather than toward, consolidation of effort. The Standard Oil Development Company began experiments with mixer-settlers in solvent extraction, and the Kellex Corporation agreed to build both a small-scale pilot plant and the main plant, as well as train operating personnel. It was not yet clear how Kellex could accomplish its assignment until the fundamental process had been defined.[35]

By comparison Franklin faced a somewhat easier task at Oak Ridge. The gaseous-diffusion plants K-25 and K-27, completed at the end of the war, continued to perform with unexpected efficiency. Before the end of 1947 Carbide and Carbon began centralizing at Oak Ridge equipment for manufacturing the barrier tubes through which the uranium hexafluoride gas diffused in the isotope separation process. The only dark spot on the Oak Ridge production scene was continuing labor unrest, which reached a climax in December, 1947, in the threat of a strike during contract negotiations. Following the Commission's sudden decision to transfer the operating contract for the Clinton Laboratories to Carbide, Franklin had more problems than he could handle at the laboratory, but he could take comfort in the ever-increasing production at K-25.[36]

RAW MATERIALS

Ultimately the production chain led back to the source of raw materials. This was the domain of John K. Gustafson, the distinguished mining engineer and executive who became the first director of raw materials in the fall of 1947. Once he had obtained an emergency security clearance and reviewed the records of the raw material effort in Wilbur E. Kelley's New York office, Gustafson knew he had a challenging task. It shocked him to discover that the nation's huge investment in atomic energy, now approaching $5 billion, rested on the production of uranium ore from one mine deep in the Belgian Congo and another small source in the sub-Arctic regions of Canada. The richer veins of the Shinkolobwe mine were already exhausted. To keep operations going at lower levels, the operators had to pump out as much as thirty thousand gallons of water per day. The Canadian mine near Great Bear Lake was at best a small source and was subject to the handicaps of seasonal operation.

Gustafson knew he could not do much to increase foreign ore receipts immediately. Congo procurement fell in the province of the Combined Development Trust, established during World War II to allocate production between the United States, the United Kingdom, and Canada. In September, 1947, Wilson found occasion during a visit to the United States by Belgian officials for an informal discussion of the Commission's ore needs on the one hand and Belgian interest in peacetime nuclear technology on the other. Until the Commissioners and the State Department could resolve some of the uncertainties in the delicate relationships with the British as well as the Belgians, Gustafson could not hope to increase Congo receipts. In the spring of 1947 there had been some interest in extracting uranium as a byproduct from gold mining operations in South Africa. Mining engineers sent to South Africa reported to the Commission that uranium ore extraction was technically feasible. Again diplomatic considerations required a cautious approach
148 and the State Department had recommended no direct overtures until General Jan Christian Smuts returned home from his visit to London for Princess Elizabeth's wedding in November, 1947.[37]

Even on the domestic scene Gustafson found arguments for caution. General Groves told Gustafson it had been his policy to exploit foreign sources and thereby conserve what little domestic ore might exist in the United States. During World War II the Manhattan District had obtained relatively small quantities of uranium concentrates produced in vanadium mills on the Colorado Plateau, but these operations had ended with the war effort. Gustafson was not even certain the Commission could grant contracts for domestic exploration and procurement. He could read the strong language of Section 5b(5) of the Atomic Energy Act as Congressional intent that only Government agencies such as the Geological Survey and the Bureau of Mines should produce such highly strategic materials.

More persuasive than these admonitions was Gustafson's conviction that domestic ore production was imperative. He saw no other way to maintain the flow of uranium through the gaseous-diffusion plants at Oak Ridge and the Hanford reactors. Neither was there much hope for domestic source development by Government agencies alone. Because there were no proven uranium ore reserves in the United States, exploration would be the first task. To supplement exploratory work by the Bureau of Mines, Gustafson and his assistants laid plans for public announcement of incentives for exploration and production. At best it would be several years before the incentives would affect deliveries to the Commission's production facilities.

In the meantime Gustafson's staff set about providing the mills necessary to process ore mined on the Colorado Plateau. The Commission purchased an excess mill at Monticello, Utah, from the War Assets Administration and a vanadium plant at Durango, Colorado, from the United States Vanadium Corporation. Steps were also taken to reactivate the Colorado mills at Naturita, Uravan, and Rifle. To assure successful extraction of uranium

from the low-grade ores of the plateau, Gustafson negotiated a contract with the Dow Chemical Company to supplement research already in progress at the Massachusetts Institute of Technology and the Battelle Memorial Institute in Columbus, Ohio. Gustafson hoped that announcement of incentives in the spring of 1948 would start the flow of domestic ore to the Commission's processing mills.[38] The production chain still had some weak links, but with some patience and work Williams and Gustafson expected to meet reasonable requirements for weapon production.

TROUBLE IN EUROPE

As President Truman entered the House Chamber on November 17, 1947, the ugly steel girders overhead could not have escaped his notice. Installed during World War II to support the sagging roof and skylight, the huge beams traversing the chamber were designed to hold the structure in place until the return of peace made reconstruction possible. Now more than two years after the end of the war, the beams still scarred the architecture of the chamber as a nagging reminder that the pursuit of peace so far had been a failure.

In opening this special session of Congress, the President used some plain and sober words to describe the events which had postponed the advent of world peace and national prosperity. In the spring of 1947 he had called for emergency measures to bolster Greece and Turkey against communist subversion. He admitted that the massive transfusion of money and resources had not restored the two allies to health, but it had at least prevented their death from the communist infection. The President's opening words sounded the alarm: "the future of the free nations of Europe hangs in the balance. The future of our own economy is in jeopardy." Still struggling to reestablish economic and political stability after the ravages of the war, western Europe faced another winter of cold and hunger, a prospect which swelled the ranks of communist rioters. For France, Austria, and Italy, the President needed $597 million to keep the three nations alive until spring. The burden on the United States would be heavy. Despite increased farm and industrial production, severe shortages in food, fuel, and housing threatened a bleak winter even for Americans. The growing demand for scarce commodities had pushed fuel prices up 13 per cent, clothing up 19 per cent, and retail food up 40 per cent in one year. New requirements for European recovery in Truman's estimation called for controls over prices and wages as well as rationing of consumer goods.[39]

Equally alarming in the week before Thanksgiving, 1947, was the hostility which punctuated debate in the United Nations. The hardening position of the Soviet Union destroyed hopes for agreement on such important issues as the international control of atomic energy and threatened the

very existence of the organization itself. In a speech before the Woodrow Wilson Foundation in New York on November 10, Bernard M. Baruch pleaded for a new effort to save the United Nations. The next morning General Eisenhower, the Army Chief of Staff, made a similar appeal in his testimony before the President's Air Policy Commission in Washington. The commission, appointed during the summer under the chairmanship of Thomas K. Finletter, had already completed two months of intensive hearings, which gave representatives of the aircraft industry, the commercial airlines, and transportation associations an opportunity to describe the stagnation and decay which afflicted civilian aviation in the United States.[40]

Eisenhower's testimony on Armistice Day marked the beginning of two weeks of hearings on military aviation. The highlight of the testimony came on the day of the President's special message to Congress. General Carl A. Spaatz, the Air Force Chief of Staff, declared that until the United Nations became an effective agency of world peace, the United States had no choice but to maintain adequate defense against aggression. To Spaatz "the barest minimum necessary for our security" was an Air Force of 70 combat groups reinforced by 22 separate and specialized squadrons. The 70-group force would require almost 7,000 ready aircraft with more than 8,000 in reserve, about 400,000 military personnel, and 150,000 civilians. With its 1948 appropriations the Air Force could not hope to maintain more than 55 combat groups and might have to cut back to 40 if Congress accepted the Administration's 1949 budget.

General Spaatz's remarks were of special interest to John A. McCone, a West Coast industrialist, whose companies had built ships and aircraft during World War II. As a member of the Finletter commission, McCone concentrated on the military aspects of aviation. At the Air Force's request the Atomic Energy Commission had authorized Admiral Parsons to brief McCone on the Commission's activities. Thus Finletter's group was assured the latest information on nuclear weapons even though the subject could not be discussed in public hearings.[41]

How much the military services could rely on nuclear weapons in an emergency was still far from certain. Much to the dissatisfaction of the military, the Commission still retained complete custody of every atomic weapon. Not until November 14, 1947, did Lilienthal receive from General Brereton a formal recommendation from the Military Liaison Committee that "all weapons now in stockpile and completed weapons and parts thereof, when ready for stockpiling, be delivered to the Armed Forces at the earliest practicable date." Lilienthal's immediate reaction was that Commission custody rested on an executive order and that the issue involved policy decisions by the President and not by the Commission or the Secretary of Defense. Wilson raised the more practical question of whether it was technically feasible to transfer the stockpile to the military. This was something General McCormack would have to study.[42]

Admiral Solberg raised the subject of custody the following week in a meeting with the Commission. Lilienthal was not prepared to debate the issue, but he was willing to discuss it informally. The argument, he said, seemed to be that the military could not rely on nuclear weapons unless military personnel had had experience in handling, storing, and maintaining them. Lilienthal chose to find this contention perplexing in view of the difficulties the armed services had experienced in obtaining weapon information from the Manhattan District immediately after World War II. Because Groves was not present Lilienthal was perhaps indulging in a facetious remark, but he did succeed in conveying to the military officers a lack of enthusiasm for the proposal.

The Commission had its own complaints about existing relationships with the military at Sandia. Strauss had just told the Commission that the Eighth Air Force and the Armed Forces Special Weapons Project in a few days would conduct a training maneuver involving atomic weapons. Only by chance had Strauss learned of the plans; there had been no opportunity to designate Commission observers. Lilienthal was willing to accept the explanation that the failure to notify the Commission was an oversight, but he let Solberg know that the Commission expected closer liaison in the future.[43]

The Commission was in no hurry to reach a decision on custody and had no intention of acting before the staff had studied the subject thoroughly. As often happened on weapon matters, the request for a study moved down the chain of command from the Commission through McCormack and Tyler to Bradbury at Los Alamos. Bradbury never hesitated to speak plainly. He reminded Tyler that the weapons in the stockpile were still more laboratory devices than production models. Assembly and testing still required scientists with laboratory instruments more than technicians with check lists. The existing models had been developed during the war and were marginal in engineering design. The new Mark 4 weapon, which was intended to be a production model, would remain a question mark until the forthcoming test at Eniwetok was completed. Bradbury doubted the armed forces had the kind of talent required to maintain the stockpile in a ready state, and he disagreed with the argument that preparedness required actual custody. Adequate training with dummy components was one thing, custody of active material something else. Bradbury also found disturbing the laboratory's unstable relations with the Armed Forces Special Weapons Project. He distrusted the obsession with secrecy that pervaded the project, and he bridled at the assumption that the Commission was merely a service and procurement organization for an operation the military intended to control.[44]

Perhaps one reason for the Commission's unhurried approach to the custody question was the possibility that General Groves might soon be replaced either as a member of the Military Liaison Committee or as commander of the special weapons project. His reassignment would remove from the scene one of the most forceful advocates of military custody. Lilienthal

learned on December 1 that Secretary Royall had been discussing Groves's future with General Eisenhower. There was some thought in the Pentagon of replacing him as a member of the Military Liaison Committee. Lilienthal suggested that Groves might better be relieved of the special weapons command. In any event, the future of the special weapons project seemed uncertain. Early in January, 1948, Charles F. Brown of Forrestal's staff recommended abolishing both the Commission's division of military application and the Armed Forces Special Weapons Project, their functions to be transferred to a more powerful Military Liaison Committee and to the individual services.[45]

On January 16, 1948, Vannevar Bush, James B. Conant, and Oppenheimer spent four hours discussing the situation with Forrestal and Royall. Oppenheimer later wrote Lilienthal that he had a strong impression that Forrestal would take some action. Lilienthal knew it would be a delicate matter to relieve a man of Groves's stature and ability from activities in which he had played a dominant role, but Lilienthal was convinced that some kind of a change would be desirable. While waiting for Forrestal to act, the Commission learned on February 2 that General Groves planned to retire from the Army on February 29 to enter private business.[46]

Whether Groves's departure would actually make it easier to settle the question of custody remained to be seen. Anything the Commission and the military services might do further to unite their efforts in building a stockpile of nuclear weapons would be welcome. Certainly international developments had enhanced the value of a nuclear arsenal. After the collapse of the London foreign ministers' conference in December, 1947, the Truman Administration had prepared for trouble in Europe. Congress passed an interim foreign aid bill to assist Austria, France, and Italy. The President early in January requested a staggering total of $8.6 billion to finance European recovery for fifteen months. Reports were coming from Berlin that the Soviet Union intended to force the Allies from the city. Finletter's Air Policy Commission released a hard-hitting report supporting the Air Force's seventy-combat-group plan on the assumption that the United States should be prepared for a full-scale air attack by the Soviet Union, presumably with nuclear weapons, by January, 1953. A theoretical monopoly of the atomic bomb could not much longer serve as the rationale for miserly defense budgets providing military forces structured on World War II technology.[47]

The Commission had succeeded in large measure in putting its own house in order since the summer of 1947. New efforts to procure uranium ore and improvements in the chain of production plants would assure a larger supply of fissionable materials in the years ahead. Los Alamos and Sandia had taken on new life, and new weapon designs were ready for testing in the Pacific. New leadership in the Armed Forces Special Weapons Project and the Military Liaison Committee might strengthen ties with the military

services. Now if the Commission could settle the troublesome question of weapon custody and if the weapon tests scheduled for early 1948 proved successful, the United States might soon have an impressive arsenal of nuclear weapons. With the armed services, the Commission was responding to the President's call to arms.

NUCLEAR ARSENAL

CHAPTER 6

By February, 1948, both the Commission and the military services had good reason to believe that the nation could have a significant stockpile of atomic weapons within a matter of months. The growing threat of communist aggression in Europe and the Middle East suggested that the nuclear arsenal would come none too soon. The accomplishments of 1947, however, had not removed all the uncertainties still lurking on the horizon. No one could be sure that the spring tests at Eniwetok would fulfill the hopes of the Los Alamos scientists. Even if the tests proved successful, it would be difficult to translate the technical achievements into usable weapons unless the military establishment could unite its own forces and strengthen its ties with the Commission. New leadership in the Military Liaison Committee and the Armed Forces Special Weapons Project would help. Perhaps it would then be possible to settle the question of custody, to formulate new requirements after the Pacific tests, and to accelerate the production of fissionable materials and weapons. These concerns would preoccupy the Commission until the summer of 1949.

CHANGE IN COMMAND

The worsening international situation in the first week of 1948 gave the Military Liaison Committee cause for anxiety over the question of custody. As yet there had been no reply to the committee's letter of November 12, 1947, recommending transfer of the weapon stockpile to the military as soon as practicable. At the committee's regular meeting with the Commission on February 4, 1948, Pike said the Commission staff had prepared a technical study which the General Advisory Committee would consider during the

coming weekend. He did not add that the same meeting would bring Robert Oppenheimer and James B. Conant to Washington and facilitate discussions with Vannevar Bush, and possibly with James V. Forrestal, concerning better relations between the Commission and the armed forces.[1]

Wilson and his staff had their study of custody ready when the General Advisory Committee convened in Washington on Friday, February 6. The report listed the military's arguments for transfer as the staff understood them. Fundamental was the contention that all weapons, including atomic bombs, should be available to the armed forces for instant use. The divided responsibility between the Commission and the military in the existing organization at Sandia invited confusion in an emergency. Furthermore, the ability to transfer military personnel anywhere on short notice promised greater flexibility in operation than the Commission could attain. Whatever the validity of these claims, Wilson and his staff found certain technical difficulties in immediate transfer of the stockpile. Their report followed closely the arguments Norris E. Bradbury had advanced in his letter to Carroll L. Tyler in November. Wilson concluded that the Commission should for the present retain custody of weapons and weapon parts but should reconsider the question sometime early in 1949. Both Isidor I. Rabi and Conant supported Wilson's study, and the committee voted unanimously to include a statement on custody in its report to the Commission. Just how and when these views would reach the Military Liaison Committee was something for the Commission to decide.[2]

Over the weekend the Commissioners first learned of the candidates the Department of Defense was considering as a civilian replacement for General Lewis H. Brereton as chairman of the Military Liaison Committee. Strauss was pleased to hear the name of Donald F. Carpenter, a vice-president of the Remington Arms Company, whom he had induced to serve on the Commission's Industrial Advisory Group. The second candidate was William Webster, a New England utilities executive and friend of Carroll Wilson.

Carpenter came to Washington that same week for a meeting of the industry group, and Bush over lunch at the Cosmos Club sounded him out about accepting the chairmanship of the Military Liaison Committee. Carpenter, who had been hypersensitive to the "merchants of death" label since he had joined the du Pont organization as a young man, expressed little enthusiasm. On Saturday evening, when the Commissioners joined the General Advisory Committee and the industry group for dinner at the Carleton Hotel, Carpenter's candidacy seemed to be common knowledge and more than one of the dinner guests urged him to accept. Strauss was particularly interested in Carpenter. By taking over as chairman of the Military Liaison Committee and as Forrestal's deputy on atomic energy matters, Carpenter could end the crippling hostilities between the Commission and the military and at long last weld the two organizations into an effective team for building the nuclear stockpile which each day was becoming more critical to national security.

Carpenter would need time to make up his mind, but Strauss thought he was more than half convinced.

There had already been talk of a successor to Groves as head of the Armed Forces Special Weapons Project. General Kenneth D. Nichols seemed the logical choice, but Strauss urged Forrestal to delay any decision on Nichols to avoid presenting Carpenter with a *fait accompli*.[3]

The prospects of reorganization of atomic energy activities in the military establishment revived Commission consideration of the custody issue. Wilson told the Commissioners on February 18 that the General Advisory Committee had agreed that there were objections on technical grounds to transferring the stockpile to the military services, but he hastened to add that policy considerations were probably more important. In other words, despite the transfer provision of the Atomic Energy Act giving the President control of atomic weapons, Wilson, like Lilienthal, still clung to the conviction that the future of civilian control of the atomic energy program somehow hung on the matter of civilian custody of the stockpile.

General James McCormack, always looking at the practical side, was uneasy about drawing too sharp a distinction between the technical competence of the scientists and the military assembly teams at Sandia. In the interest of harmony he suggested the Commission forego the temptation to embarrass General Groves over deficiencies in the new weapon storage sites then under construction. The Commissioners decided they should concentrate on the policy issues of transfer while McCormack and his staff would do all they could to advance the time when transfer of custody would be technically feasible.[4]

Later that afternoon, when the Commissioners met with the Military Liaison Committee, McCormack went out of his way to describe the progress in this direction at Sandia since Paul J. Larsen had taken over as permanent director. The best way to develop technical competence in military personnel was to assign more military men to Sandia. Admiral William S. Parsons agreed. He appreciated the dangers of permitting technicians to check the reliability of weapon components without any understanding of their operation, but he thought it was time to dispel the belief that only an Einstein could assemble or test an atomic weapon. He recalled the exceptional capabilities of many naval technicians during World War II. However the custody issue was resolved, Parsons saw a system of joint inspection by military and civilian personnel as the best guarantee of weapon reliability.[5]

Meanwhile Forrestal was trying to induce Carpenter to accept the liaison chairmanship. In a telephone conversation on February 17, Carpenter told Forrestal he could not be away from his job at Remington Arms for more than six months. This limitation did not seem to diminish the Secretary's interest in Carpenter's services. William Webster, the other leading candidate for the job, would not be able to begin work for at least that long. Perhaps the two of them could serve successive terms. The following week Forrestal

brought additional pressure on Carpenter by calling Crawford H. Greenewalt, the president of du Pont. Greenewalt did not see how Carpenter could accomplish anything in six months, particularly in view of the problems he would face in bringing harmony to Commission-military relations. Forrestal admitted the assignment was tough, but he insisted Carpenter's services were imperative. The main difficulty, Forrestal thought, was the Commission form of organization provided by the Atomic Energy Act. He had long believed that an effective atomic energy program required the leadership of one man of exceptional ability. Perhaps eventually it would be possible to amend the Act, but in the meantime he needed to establish in one man of Carpenter's caliber the responsibilities which would assure steady progress in building a nuclear weapon stockpile.[6]

Forrestal's remarks made clear that he intended the reorganization of the Military Liaison Committee to be a first step in unification of the armed forces. A civilian chairman of the committee would quell interservice rivalry and incidentally might ease the Commission's concern about "civilian control" of the atomic energy program. At a meeting with the three service secretaries on February 25, Forrestal explained the new charter for the committee. It would consist of a civilian chairman, presumably Carpenter, and two members appointed by each of the service secretaries with Forrestal's concurrence. Forrestal said he expected the Military Liaison Committee to function generally on the level of the Joint Chiefs of Staff and the Research and Development Board, by exercising broad powers over all atomic energy activities of the National Military Establishment.[7]

Forrestal still had to convince Carpenter to take the job. As often happened, the final argument was an appeal to patriotism. The last week in February Forrestal sent Colonel John H. Hinds, a member of the Military Liaison Committee, to Wilmington, Delaware, where he met Carpenter secretly and related to him confidential information about the alarming military situation in Germany and eastern Europe. The newspapers were full of reports of a government crisis in Czechoslovakia and by the end of the week it was clear that Klement Gottwald had destroyed the last vestiges of democracy and established a communist dictatorship.[8] The implication of Hinds's message was that Carpenter could help his country by strengthening the nation's nuclear arm. Relenting, he agreed to go to Washington the following weekend. If he could assure himself that he had the support of the service secretaries and the Atomic Energy Commissioners, he would take the job.

On Friday evening, March 5, Carpenter waited in Secretary Kenneth C. Royall's office in the Pentagon as Forrestal, W. Stuart Symington, and John L. Sullivan arrived; Lilienthal and General Nichols, who was to be Groves's successor as head of the Armed Forces Special Weapons Project, joined the group. The dinner conversation ranged over a variety of subjects, including the President's civil rights program, but this provided only momentary diversion from the tension created by the news from Europe. In a cable

from Berlin, General Lucius D. Clay reported "a subtle change in Soviet attitude, which I cannot define," but which gave him the feeling that war might come with dramatic suddenness. The reorganization of the Military Liaison Committee and the Armed Forces Special Weapons Project was coming none too soon. Constructive cooperation would have to replace the suspicions and recriminations which had crippled relations between the Commissioners and the Military Liaison Committee. The scientists and the military technicians at Sandia would have to come closer together to create a reliable weapon stockpile and to see that nuclear weapons were ready for instant use anywhere in the world. The discussion convinced Carpenter that he had a job to do. He would return to Washington by April 1 to take up his new assignment.[9]

It had been just a year since President Truman had sounded the alarm to avert communist aggression in the Middle East. As the Soviet Union consolidated its position in eastern Europe and threatened to extend its influence westward, Truman had called upon Congress for successively larger appropriations to rebuild western Europe and strengthen the nation's military defenses. Arthur H. Vandenberg, the Republican champion of the bipartisan foreign policy, had brought the Senate to its feet on March 1, when he supported the European Recovery Program as an undisguised counteroffensive against the march of communism. On March 11 the news of Jan Masaryk's alleged suicide brought home to Americans the tragic finality of events in Czechoslovakia. The same day Secretary Forrestal announced that he would meet with the Joint Chiefs of Staff over the weekend at Key West, Florida, to find ways of accomplishing the unification of the armed forces contemplated by the National Security Act of 1947.

That morning Truman called Lilienthal, Royall, and Nichols to his office without telling them in advance what he had in mind. The President was grim and emphatic. He had before him the papers for Nichols's appointment as head of the Armed Forces Special Weapons Project. He knew that Nichols and Lilienthal had differing philosophies on custody of nuclear weapons, but he would not tolerate the kind of squabbling that had prevailed in 1947. The two men would have to learn to work together. Both assured the President they were on the same team. Truman was already preparing a special message to Congress requesting legislation to establish universal military training. He expected the armed services and the Commission to respond to the emergency.[10]

PARTNERS IN ARMS?

For Lilienthal the key point in the President's remarks on March 11 had been his stress on civilian control of atomic energy. Nichols, however, left the

White House with the impression that Truman was above all interested in close cooperation between the Commission and the military. In Nichols's mind this meant just one thing: transfer of the nuclear stockpile to military custody. Others in the Pentagon shared Nichols's determination as the March crisis grew more tense. The three service secretaries joined forces after the Key West conference to ask Forrestal formally to take the question to the President. The Joint Chiefs of Staff added their support a week later. The Commission, however, was in no mood to press the issue. Strauss and Bacher told Forrestal on March 18 that transfer still presented many technical difficulties; they thought it was mainly a policy issue which the President would have to decide. In the meantime, the Commission would try to speed up the training of military assembly teams.[11]

However reassuring the Commissioners tried to sound, the growing crisis in Europe undermined their efforts to keep the discussion of custody on the policy level. A sharp exchange between General Clay and the Soviet representative on March 20 marked the end of the Allied Control Council. On March 31 Soviet authorities ordered inspection of all military trains moving from West Germany to Berlin. Nichols told a special meeting of the Military Liaison Committee with the Commission on April 1 that the situation in Berlin might well lead to war. He had already discussed with McCormack plans to speed up the movement of nuclear weapons to the new storage sites, where they would be less susceptible to destruction by a single enemy air attack or by sabotage. He was reviewing emergency procedures for transferring weapons and suggested recalling civilians who had been on weapon assembly teams during World War II.

Strauss warned Forrestal against permitting all of the weapon assembly teams to go to Eniwetok for the forthcoming *Sandstone* weapon test series. Strauss feared that a sneak attack on the small Navy task force in the Eniwetok lagoon might cripple or even destroy the nation's capability of assembling its nuclear weapons. Although Strauss's fears proved to be groundless, they showed the tension gripping those present. For a few minutes there was even talk of postponing the *Sandstone* tests to preserve the meager weapon stockpile and bringing the assembly teams back to the United States, where they would be ready for an emergency in Europe. Nichols was inclined to go ahead with the first test, but he thought it might be necessary to cancel the second and third shots if the European situation deteriorated further.[12]

The most critical task was to check the emergency transfer procedures at Sandia. After the Military Liaison Committee left, Wilson arrived for a regular Commission meeting. A few minutes' informal discussion convinced Wilson that he and McCormack should leave at once for Albuquerque and Los Alamos. Canceling a speaking engagement in Vermont, Wilson boarded an Army plane with McCormack the following morning. The first order of business at Sandia on April 4 was to find ways to speed up the joint inspection of equipment for the armed forces. Tyler, Larsen, and Bradbury

were all helpful, and General Robert M. Montague agreed to press for completion of assembly facilities at appropriate air fields. Wilson spent the rest of the week with Montague on plans for the actual delivery of nuclear weapons to the armed forces in an emergency.

Wilson returned to Washington on April 12 fully convinced that there would be "absolutely no delay" in an emergency transfer. He told Carpenter, who was now on the job in Washington, that the Armed Forces Special Weapons Project had given him excellent cooperation and there was virtually perfect coordination between the two organizations. Much of the improvement in relations he attributed to General Nichols. The question of custody was another matter, but Wilson believed he had solved any remaining difficulties in emergency transfer.[13]

Carpenter had spent his first weeks in office trying to reorganize the Military Liaison Committee. He wished first of all to make certain that the organization would be a vehicle for unifying the efforts of the armed forces on atomic energy affairs, and that meant it had to have some authority worth unifying. In addition to making sure that competent officers were assigned, he insisted that each of the members have full authority to speak for his own service. Carpenter had no intention of letting the committee continue to function as a debating society for protagonists of the services. As another step toward unification he insisted that each member of the committee be fully responsible for one phase of the atomic energy program in the National Military Establishment, without regard to service distinctions. Initially the services found it difficult to accept either of these reforms, but Carpenter expected that in time he would be able to convince them that they could trust each other and work together.

Carpenter's interest in reorganization went far beyond the need to put his own house in order. There was also the important question of how the Military Liaison Committee would operate within the National Military Establishment. In the midst of an international crisis, the armed services were still struggling with the reorganization necessary to accomplish unification under the Secretary of Defense. Carpenter saw that the effectiveness of the committee would in large measure determine its role in the new establishment. Symington, with Generals Carl A. Spaatz and Hoyt S. Vandenberg, told Carpenter on April 10 that they thought the Armed Forces Special Weapons Project should report for operational purposes to the Chief of Staff of the Air Force. The best defense against this proposal would be a strong Military Liaison Committee setting policy for a rejuvenated organizaton at Sandia under Nichols's direction.[14]

Carpenter explained some of these considerations when he met with Lilienthal and Wilson on the day the general manager returned from Los Alamos. Another aspect of a more efficient Military Liaison Committee was better relations with the Commission. This Carpenter hoped to accomplish, first, by serving personally as a conciliator between the military and the

Commission and, second, by making clear to both sides their common objectives in developing the nation's nuclear arm. Carpenter was not certain that existing channels were providing the Commissioners and general manager with a true picture of field activities. He proposed to establish a review committee of outstanding scientists and engineers, acceptable to both sides, who would visit the laboratories and draft a set of long-range objectives toward which both the Commission and the military could work as a team. To head the panel Carpenter was calling on Oppenheimer, who already had extensive experience in preparing reports of this nature.

Carpenter's tact at the April 12 meeting was a model of the conciliatory approach he intended to bring to relations with the Commission. He told Lilienthal that the custody issue had a high priority in the Pentagon. He did not think the Commission could postpone a decision indefinitely. He listened patiently as Wilson waxed enthusiastic about the improved situation at Sandia and reiterated the Commission's reluctance to transfer the weapon stockpile to the military until the technical difficulties had been resolved. Carpenter seemed to appreciate the Commission's position even if he did not agree with it, and he suggested the Commissioners join the Military Liaison Committee in a trip to Sandia for a firsthand look at the problems of transfer. All agreed that any proposal to the President should be made jointly. Lilienthal was pleased that for once a meeting with the military had ended on a note of harmony, if not agreement. He told Forrestal on the telephone about Wilson's enthusiastic report from Sandia and assured the secretary that Carpenter had been an excellent choice as head of the Military Liaison Committee. When Carpenter reported to Forrestal, he mentioned his suggestion of a meeting at Sandia as a possible avenue for resolving the custody dispute. Forrestal liked the idea. Perhaps when the *Sandstone* test series was completed, a decision on custody would at last be possible.[15]

SANDSTONE

On March 16, 1948, four United States naval vessels dropped their destroyer escort in the central Pacific and slipped into the quiet emerald waters surrounded by Eniwetok Atoll. Once inside the ring of coral reefs three of the ships proceeded to the island of Eniwetok and dropped anchor off its western shore. The command ship U.S.S. *Mt. McKinley*, its masts bristling with antenna arrays, carried General John E. Hull, the commander of Joint Task Force 7, who surveyed the harbor dotted with cargo ships and boats. Ashore, temporary supply buildings, tent camps, and mess halls obscured the remaining buildings of the World War II base; the airfield, refurbished and enlarged, buzzed with small aircraft and C-54 cargo planes from Kwajalein.

Lying at anchor near the *Mt. McKinley* was a converted seaplane tender, the U.S.S. *Curtiss*, which the Navy had equipped with special facilities

for storing and assembling the components of nuclear weapons. The *Curtiss* also served as headquarters for Captain James S. Russell, the test director, and Darol K. Froman, the scientific director of Operation *Sandstone.* The third ship in the task force was the escort carrier *Bairoko,* which Russell had commanded before he left sea duty to join the Commission as McCormack's deputy. The *Bairoko* housed the scientists in charge of radiological safety for the tests and provided a base for helicopter operations. The fourth ship in the convoy, the seaplane tender *Albemarle,* had continued northward across the lagoon with one destroyer and had dropped anchor off the island of Engebi near the northern end of the island chain. The *Albemarle* had been hastily refitted at Norfolk early in 1948 to provide laboratories for the Los Alamos scientists who would collect and analyze the mass of data produced in the test shots. In February the *Albemarle* had joined the *Curtiss* at Terminal Island, near San Pedro, California, where the weapon components and other test
162 equipment had been loaded before the ships proceeded to Hawaii and Eniwetok.[16]

From the deck of the *Albermarle* the scientists could see the 200-foot steel tower rising above the island, now denuded of vegetation and bulldozed into a flat table a few feet above the sea. An inspection of Engebi revealed the impressive achievements of the Army engineers, Navy teams, and private contractor forces in completing the elaborate test facilities in little more than ten weeks. The zero tower rising above an asphalt apron 600 feet in diameter was nearly ready to receive the test device. Little more than a half mile away was a sturdy, reinforced concrete building which would house the electronic equipment for measurement of phenomena from the test detonation. Similar concrete structures at various distances from the tower were ready for installation of equipment to measure blast and radiation. Between the tower, instrument buildings, and the central control post, men of the special engineer battalion were laying miles of submarine cable. Five miles southeast along the coral rim of the atoll stood a second zero tower and a much shorter Navy radar tower which had been modified to house photographic equipment. Still farther south on the northwestern tip of the island of Runit was another set of towers which had been prepared for the third shot in the test series. Ten miles farther south were Parry Island, where the main control center for the test was located, and the main island of Eniwetok.

Within a few days Hull had inspected all the facilities on the several islands. Froman cabled McCormack in Washington that the General seemed completely satisfied with construction progress at Eniwetok. He was especially pleased with the work of the Army engineers under Brigadier General David A. D. Ogden. Poor communications had hampered operations to some extent, but most of the work was on schedule. Unloading of test instruments and equipment began soon after the task force anchored, and technicians began setting up the elaborate arrays of test instruments, recorders, and interconnecting cables. Froman thought morale was high within the test group despite

the unnerving effects of a submarine alert the second night in port and disturbing news reports from Berlin.[17]

As the April 15 target date for the first shot approached, there was a last-minute flurry in Washington about public announcement of the event. The military services opposed any announcement until the entire test series was completed, and General Hull agreed that delaying announcement would make his task easier. The Commissioners, however, were convinced that news of the detonation would quickly leak through observers returning from the first shot or would be detected in some fashion by Soviet vessels skirting the outer perimeter of the Marshall Islands. At the last minute Carpenter worked out an agreement which provided for public announcement only after a delay sufficient to thwart Soviet attempts to pick up airborne samples of the radioactive cloud.[18]

By this time Froman had completed all but the last-minute checks of the test sequence. The assembly team aboard the *Curtiss* completed a dummy weapon, which was placed on a trailer and lowered overside into a tank landing craft. Once ashore, the trailer was hauled to the zero tower, where the dummy weapon was hoisted to the cab at the top and the firing circuits were attached. To test the firing circuits and to align the cameras, a bank of photoflash lamps was installed on the tower. The firing sequence proceeded smoothly and Froman felt certain they were ready for the real thing.

On the afternoon of April 14 the firing party went ashore on Engebi for the final check. The task force had already moved south across the lagoon to the control point at Parry Island. Checking hourly by radio with Russell and Froman at Parry, the firing party tested the circuits on the zero tower and instrument stations through the night. In the early morning hours of April 15 they left the island for the last time and sped away across the lagoon by aircraft rescue boat to the Parry control point. By this time General Hull had a final weather report and had determined that all personnel were out of the danger area. At minus one hour Alvin C. Graves manually gave the timing signal for starting the blast measurement equipment. Soon the first of eight B-17 drone aircraft began to take off from Eniwetok. Equipped with special filters the planes would circle the zero tower at various altitudes to pick up radioactive samples as they passed through the cloud. Fifteen minutes before zero Captain Russell obtained permission from General Hull to fire, and Graves started the sequence timer. At minus two minutes came the familiar command to adjust protective goggles or turn away from the zero point. At the ten-second signal the flood lights at the base of the zero tower went out, leaving only the red light at the top of the tower to be engulfed by the huge ball of fire which illuminated the entire atoll and was visible as far away as Kwajalein.

Within four minutes helicopters were in the air, heading for Engebi. Jumping from the helicopters on the southeastern tip of the island, technicians in protective clothing started a winch that reeled in a cable of samples

from near the zero tower. By this time a landing craft had set off for Engebi from Eniwetok to operate by remote control a military tank on the island. The tank, stripped of excessive armor and equipped with a special scoop, was designed to collect samples of surface earth from various parts of the test island. Meanwhile the drone planes, all except one which had crashed just before the detonation, were being landed at Eniwetok by the mother planes still in the air. Crews used long booms to lift the air filter units from the radioactive planes. Samples divided in two lots were placed aboard waiting C-54 aircraft for the long flight to Albuquerque. Because many of the most significant fission products in the samples were short-lived radioisotopes, speed was critical. By using relays of planes in pony-express fashion, the Air Force was able to deliver the samples to the radiochemists at Los Alamos less than thirty hours after the detonation. Within a few days radioactivity on Engebi declined enough to permit the scientific group to recover the test
164 equipment and begin the modifications and improvements for the second shot scheduled within two weeks at Aoman. The test group followed the same general procedures for the second and third shots, on May 1 and 15. Once the test information was air-borne for Los Alamos, it took the scientists only a few days to remove their instruments; within a week the military support forces were closing down the Eniwetok site.

For the relatively few people who knew what the scientists were attempting at *Sandstone*, the very fact that the test devices detonated was clear evidence of a stunning success. From the cryptic reports the rest of the world could gather only that the United States had detonated at least two test weapons and was satisfied with the results. A brief press release on April 19 announced the first detonation but gave no details. Hull, Russell, and Froman held a press conference in Hawaii on May 18, but they permitted the reporters to quote them only from carefully prepared written statements.[19] Even at Los Alamos detailed results were slow in coming. It would take weeks, if not months, to analyze the data collected. All the preliminary evidence, however, pointed toward success. The yield of the first test, for example, was equivalent to 37,000 tons of TNT, compared with about 20,000 tons for the Nagasaki weapon.

Not only did the tests seem to verify the new design principles developed by the Los Alamos scientists, but they also suggested promising courses of development for the future. In this sense McCormack saw *Sandstone* as the beginning, not the end of weapon development. The tests had opened a new realm of possibilities for nuclear weapons, and McCormack understood even before he saw the data from Los Alamos that full realization of that new potential would place unprecedented demands on financial and manpower resources. *Sandstone* also had important implications beyond mere technological developments. Under the able and efficient administration of Hull, Russell, and Froman, *Sandstone* had established a new standard for cooperation between the military services themselves, as well as between the

military and the scientists. At a time of international crisis a solid demonstration of the benefits of unity was an accomplishment of no little importance.

AN ACCOUTERMENT OF POWER

At eight o'clock on Monday morning, May 24, 1948, an Air Force C-54 lifted off the runway at Washington National Airport for a nonstop flight to Kirtland Field at Albuquerque, New Mexico. Aboard were Carpenter, with his newly constituted Military Liaison Committee, McCormack, and all the Commissioners except Lilienthal. Their mission was the long-planned conference on weapon custody.

Shortly after lunch the plane arrived at Kirtland. Whisked off to a classroom at nearby Sandia Base, the visitors heard a briefing on weapon storage facilities and visited one of the temporary storage igloos at Kirtland. On Tuesday morning they studied current bomb design and observed weapon assembly operations by military personnel. In the afternoon they saw how technicians were trained in inspecting, testing, and maintaining weapon components, activities which had come to be described by the general term "surveillance." On Wednesday morning the group flew to Santa Fe and proceeded by automobile to Los Alamos, where Bradbury and his senior staff were waiting.[20]

Bradbury had carefully prepared his remarks in an effort to avoid the emotional issues of civilian-military control. He concentrated on the practical need for speedy weapon development and reliable emergency transfer procedures. He began by saying that the nuclear weapon was far more sophisticated than conventional ordnance in terms of complexity, materials, and techniques. This had been true since 1943 but it was especially important at that moment. The *Sandstone* tests had rendered virtually every component of the existing stockpile weapons obsolete. Bradbury ticked off a long list of the modifications necessary to translate the results of *Sandstone* into hardware. The implications for custody were obvious. If the military services had custody of the stockpile, the Los Alamos laboratory could not simply send out replacement components. In many instances the entire weapon would have to be returned to Sandia for modification. In this sense transfer of the stockpile to the military would be only temporary.

Bradbury thought it was equally important to understand that responsibility for surveillance had to go with custody and that surveillance was an important aspect of weapon improvement. The complex technical activities of surveillance not only assured weapon reliability but also revealed the need or opportunity for modification. It seemed unlikely that even the best military personnel could master the developmental aspects of surveillance. If development needs suggested continued Commission custody, the requirements for

emergency transfer did not, in Bradbury's thinking, support the arguments for military custody. Availability and reliability of weapons in time of crisis depended not on whether the men wore uniforms, but rather on effective procedures that could be worked out in advance.

The group heard the other side the following day at Sandia. Nichols, now a major general as commander of the Armed Forces Special Weapons Project, reiterated what he saw as the two "basic military principles" supporting military custody. The first was that in time of emergency each weapon considered a factor in a tactical plan must be in the control of a single military command. The second was that the device became a reliable weapon only when it had been disassembled, repaired, assembled, and handled by the men who would use it in battle. The military services had recognized these principles in 1946 in the decision to organize and train assembly teams and in the decision a year later to organize the special weapons project. The Military
166 Liaison Committee, the Joint Chiefs of Staff, and the service secretaries had more recently recognized these principles in their advocacy of military custody of the nuclear stockpile.

Now that new storage sites were nearing completion at locations remote from Los Alamos, continued Commission custody seemed to Nichols even less realistic. The storage sites had been planned and constructed under military supervision. They were operated and protected by military personnel. Routine surveillance could and should be the function of the military. This would not, in Nichols' opinion, exclude the Commission from performing destructive tests and surveillance necessary for continual development of better components. For major modifications the Commission would refabricate components or provide replacements, but the military would perform minor modifications and repairs of weapons in storage. In short, Nichols rejected Bradbury's arguments for continued Commission custody and took an unalterable position favoring military custody of the stockpile.[21]

General Montague, the special weapons commander at Sandia, followed Nichols with a summary of Sandia activities which, he suggested, showed that in a practical sense the military teams were already performing all the essential functions of surveillance and custody. General Brereton, speaking as an Air Force representative, closed the presentation with the argument that strategic planning, including "prompt and large-scale use of these weapons," could be assured not by cooperation alone but only by "direct and exclusive control by the military forces." In Brereton's mind the March crisis in Berlin had made that fact clear.

Carpenter thought he had the basis for an agreement. Nichols and Montague had demonstrated that the military were capable of performing the accountability, protection, inspection, repair, and training functions of custody. He could meet Bradbury's point about the developmental aspects of surveillance simply by giving scientific teams access to the weapons in stockpile. In Carpenter's words, the technical and operational problems in-

volved in transfer of custody were capable of solution. But the Commissioners did not share Carpenter's confidence. Strauss argued that the unsatisfactory condition of the new storage sites led him to doubt the military's ability on technical grounds. The larger issue, which the Commission still saw as civilian or military custody, was something only the President could decide. Carpenter readily agreed, but he continued to hope that the Commission and the National Military Establishment could go to the President with one recommendation for transfer. He followed this approach the following week after his return to Washington. He told Nichols to prepare a definitive recommendation along these lines, and he sent the Commission a summary of the Sandia meeting in a form which would conveniently permit them to assent to a joint recommendation.[22]

Carpenter's intentions were good but his method backfired. The Commissioners saw the draft minutes of the Sandia meeting as an effort to force them into a decision. An informal but pointed objection caused the Military Liaison Committee to withdraw the document as the official minutes of a joint meeting. Before acting, the Commissioners wanted to see a letter on its way from Bradbury citing specific examples of technical difficulties involved in military custody. There would also be an opportunity for the General Advisory Committee to review the decision at its regular meeting in Washington later the same week. Through its secretary, John H. Manley, who worked with Bradbury at Los Alamos, the committee could be expected to get full exposure to Bradbury's arguments.[23]

Actually the General Advisory Committee was not as firm as the Commissioners might have wished. In a session with Bacher on June 4, Oppenheimer began by ruling that the committee could take no formal position on whether custody should be transferred to the military but could only evaluate the technical difficulties of military custody or the hazards of emergency transfer. The conversation showed that the committee's general sentiment favored continued Commission custody; but when the committee came to what it considered its area of competence, the majority seemed to believe that it would be possible in time for the military to perform surveillance operations. True, Nichols had underestimated the technical complexities of transfer, but this did not mean they could not be resolved in time. As a compromise the committee suggested transferring a part of the stockpile, an idea of practical merit but not one likely to be acceptable to either side in a debate involving principles.[24]

The showdown came on June 18 when the Commissioners met in special session with the Military Liaison Committee. The document on the table was the memorandum Nichols had drafted for Carpenter. It summarized discussions at Sandia and the arguments for military custody. It concluded with a request that the Commissioners join the Secretary of Defense in recommending that custody be transferred to the military at the earliest practicable date. The tone of the memorandum was urgent and insistent. The

Berlin crisis was heating up again. The previous week Soviet troops had blocked all rail traffic between West Germany and Berlin for two days and had closed the Elbe River highway bridge for repair. In such a moment of crisis it seemed hazardous to leave the nation's most important weapon in the hands of civilians with no military experience. The day before the joint meeting Forrestal had met with the War Council at the Pentagon to discuss governmental reorganization necessary for waging atomic warfare. The council agreed that the custody question had to be settled first, that the Commission was "engaging in dilatory tactics," and that pressure was needed. Carpenter's inclination was to be less aggressive in demeanor but his experiences of the previous few weeks could not help but color his presentation.[25]

Lilienthal made it clear from the beginning that the Commission was not prepared to negotiate. With Carpenter's memorandum in hand, the Commissioners the previous day had decided they could not join Forrestal in a joint recommendation. Lilienthal discussed the policy question, and Bacher reviewed the technical difficulties of transfer. For almost two hours Carpenter sparred for an opening but there was none. The meeting was correct and business-like, but no agreement was possible. After the meeting Strauss called Forrestal and urged him to discuss the issue with the Commissioners before going to the President.[26]

Fortunately, disagreement did not lead to a break in communications. In exchanging informal views with Carpenter, Lilienthal was ready to accept Forrestal's invitation to discuss the subject, but he was in no mood for compromise. Already committed to civilian custody of the stockpile, Lilienthal saw recent events as confirming that conviction. He recalled a conversation a few weeks earlier with James E. Webb, director of the Bureau of the Budget. Webb in great agitation had told him that Forrestal seemed to be unable to control the Joint Chiefs in his attempts to unify the armed services. The day after the meeting with the Military Liaison Committee, Lilienthal and the Commissioners went to the Pentagon for a briefing on *Sandstone*. Lilienthal found it dull listening to reports he had heard several times before. What bothered him most was the enthusiasm Froman and Bradbury showed over the prospects for developing bigger and better weapons. This kind of attitude Lilienthal would have expected from a strategic bombing general, but he thought someone in the room might have expressed at least token regret over the necessity to develop weapons for indiscriminate mass destruction.[27]

The meeting with Forrestal and Carpenter on Wednesday noon, June 23, covered much of the ground of the previous week. Forrestal expressed his concern that the armed services be prepared to respond quickly to an international crisis. Lilienthal explained that tests had shown it would take no more than thirty minutes to get a message from the President to Sandia. Neither Royall nor John J. McCloy, who joined the group late, seemed to be aware of these emergency procedures. As Lilienthal described the very real dangers he saw in transferring custody to the military, he got the impression

that Forrestal had never heard these countervailing arguments. When Forrestal raised the possibility of transferring weapons to bases in England, Lilienthal admitted the Commission could not maintain custody under such circumstances. The two leaders agreed on a meeting with the entire Commission just one week later.

The next day Soviet forces in Berlin severed the last link of ground communication between the city and West Germany as the last freight trains ground to a halt. Cutting off food and milk supplies, Soviet authorities ordered termination of most electric power transmission to the Western sector. The Allies' response was to step up the airlift which was already supplying the military garrisons in what seemed at first a token effort to supply needs of the entire population. Truman made it clear on June 28 that the United States was going to stay in Berlin. But further Soviet pressure might lead to war, and with few troops available to strengthen American forces in Europe, the President chose the obvious alternative of sending a group of B-29's to Germany and one to England.[28]

Forrestal's meeting with the Commissioners on June 30 produced nothing new in the custody argument except Royall's concern over the need to establish policy for the use of nuclear weapons. Lilienthal saw this as an attempt to treat the bomb as just another weapon, to use the argument over technical custody to confuse what he considered to be the fundamental question of military or civilian control. Before the group adjourned for lunch with General Eisenhower, Forrestal and Lilienthal agreed that each would prepare an independent statement setting forth his position for presentation to the President.[29]

Lilienthal was encouraged. He had succeeded in his efforts to bring the issue to Truman in a form which would give the President complete freedom of action. Earlier that morning Lilienthal had learned from Clark M. Clifford that Truman was determined to continue civilian custody. In the following days Lilienthal kept his hand close to the White House pulse. Carpenter had gone off to the Berkeley laboratory with Oppenheimer for the first meeting of the long-range objectives committee. Perhaps Carpenter took some comfort in Ernest O. Lawrence's vigorous support of military custody, but such sentiments in California hardly offset those Lilienthal was hearing in Washington. Webb, still grumbling over Forrestal's failure to bring the military services into line, told Lilienthal he was opposed to military custody and that Secretary of State George C. Marshall agreed with him. Webb offered to discuss the subject with Truman and to seek a delay on the decision. Lilienthal thought it would be best to have the meeting and let the President make the decision in a strong, well-reasoned letter to Forrestal. In effect, Lilienthal had been able to choose what for him was the most advantageous time for the meeting.[30]

Lilienthal was confident as he entered the President's office on July 21 with his fellow Commissioners. Deliberately he selected his seat in a strategic position before the President and maneuvered Forrestal into speaking first.

Instead of speaking himself, Forrestal turned to Carpenter, who with little experience in the high policy circles of Government, was attending his first Presidential meeting. Obviously nervous, Carpenter chose to read Forrestal's long memorandum to the President. As Truman squirmed in his chair, Lilienthal sensed Carpenter's tactical error. He made the most of it by opening his remarks in an informal conversational manner. He gave the President the Commission's paper on the technical aspects of transfer and concentrated on the policy issue of civilian control, which he knew would strike a responsive cord in the President.[31]

If there had been any doubt about the President's decision, the meeting on July 21 dispelled it. Two days later in a Cabinet meeting Truman told Forrestal he had decided against transfer and would issue a public statement. Truman said it would be possible to review the decision after the fall elections. The decision itself was disappointing enough; but Forrestal found it hard to accept the public announcement that he had been overruled, particularly when Truman chose to issue it in connection with the release of the Commission's fourth semiannual report to the Congress. Lilienthal saw the President's own hand in the words: "I regard the continued control of all aspects of the atomic energy program, including research, development, and the custody of atomic weapons as the proper functions of the civil authorities." Carpenter took the release to Forrestal's office. The Secretary was annoyed. Truman had not even given him the courtesy of an advance copy, and a formal letter from the President did not arrive until two weeks later. Carpenter tried to calm his chief. The important thing now, he said, was to see that the military services took every step to expedite the emergency transfer of weapons. Before the day was out, Carpenter had drafted instructions for the Secretary's signature.[32]

The President's decision had clarified the respective roles of the Commission and the military establishment, but it had not resolved important questions in Forrestal's mind. At lunch on July 28 he told Marshall, Royall, and General Omar N. Bradley of the difficulties he faced in carrying out his responsibilities without knowing whether the United States would use the atomic bomb in war. When Bradley said that the Joint Chiefs were studying the question, Forrestal suggested the need for two studies, one assuming that the bomb would be used and the other that it would not.

A second matter troubling Forrestal was the role of the armed services in atomic warfare now that the bomb was more clearly than ever before an accouterment of power. He had suggested to the three service secretaries on July 19 that their disagreement boiled down to the use of the atomic bomb. Navy Secretary Sullivan was willing to concede to the Air Force the responsibility for strategic warfare, but he did not think the Navy should give up the right to use nuclear weapons on certain targets. Forrestal had proposed a compromise under which the Air Force would have "dominant interest" in the use of the bomb while the Navy would be limited to strategic bombing

under Air Force direction and to sorties on purely naval targets. In a memorandum to Sullivan two days later, Secretary Symington made clear that such a compromise would not be acceptable to the Air Force. Symington held that strategic air operations were the primary responsibility of the Air Force and that any naval air operations involving nuclear weapons should be under Air Force direction. This contention, Symington observed, removed any justification for Navy development of special equipment or organization.[33]

The burden of reconciliation as usual fell on Forrestal. General Bradley assured him on July 28 that the Joint Chiefs of Staff were developing policy on the use of nuclear weapons. The same day, after a conversation with General Vandenberg, Forrestal decided to recall General Spaatz and Admiral John H. Towers to active duty to review the issues in terms of recommendations from the Key West conference in March. Until Spaatz and Towers could complete their study, the issue could not be resolved. In the meantime, Carpenter wanted to avoid any commitment on the organization and responsibilities of the Armed Forces Special Weapons Project. He thought he detected in Pentagon discussions the efforts of the Air Force to place the special project "under them for operational command." He urged Forrestal to resist requests for reorganization until the roles of the Air Force and the Navy had been defined. The issues in that debate were finally drawn on August 9, when Navy Secretary Sullivan sent his formal reply to Symington's memorandum. Within two weeks Forrestal had the Spaatz-Towers report and was prepared to settle the question in a meeting with the Joint Chiefs of Staff at Newport, Rhode Island, on the weekend of August 20.[34]

The future of the special weapons project was at the center of the Newport debate. Carpenter revealed that he was considering various reorganization schemes, including the idea of abandoning the special organization altogether and letting each of the services assume responsibility for atomic energy activities. But, as Carpenter had told Forrestal, the future of the special project depended upon the outcome of the Air Force-Navy argument. As the discussion turned to the Symington-Sullivan memorandums, General Vandenberg sounded the note of compromise. Appearing far more flexible than Symington, Vandenberg claimed that the Air Force wanted an independent hand in the special project only until the Navy had developed specific capabilities for nuclear warfare. The outcome was a compromise. As an interim measure, General Nichols would report to the Air Force Chief of Staff in carrying out emergency war plans. The future of the special project and the Military Liaison Committee would await the completion of studies Carpenter had started. Each service would have exclusive responsibility for planning its primary missions, but in executing any mission the services could count on all available resources.[35]

Forrestal thus erected the fragile compromise that avoided one of the obstacles to the unification of the armed services. In the year since the

National Security Act had become law, Forrestal's hopes for unification had been far from realized, but he had inspired some major achievements in the face of profound changes at home and abroad. In that time the atomic bomb had emerged as the key to the nation's defense. An agreement, however tenuous, had been reached on nuclear roles and missions. Still, the future was fraught with danger and uncertainty. In the closing weeks of his six-month term, Carpenter pursued his organizational studies. Still not satisfied, he even explored the possibilities of amending the Atomic Energy Act to give the military services direct representation on the Commission. Commissioner Strauss thought the idea interesting, but it was hard to imagine how the issue could be raised without stirring the emotional fires of civilian-military control. At least for the moment it was reasonable to expect that in an emergency the Commission could transfer its weapons to the military services for prompt delivery on enemy targets.[36]

CONSOLIDATING OPERATIONS

High policy decisions in the Pentagon and Commission headquarters might well determine the shape and size of the nation's nuclear arm, but its fundamental strength depended upon the success of Wilson, Walter J. Williams, McCormack, and John K. Gustafson in building the nuclear stockpile. Living in a world of facts and figures, they struggled with requirements, costs, schedules, and estimates. Success lay not in magical shortcuts or clever theories but in careful planning and efficient performance.

As always, good production planning began with sound requirements, something hard to come by during the chaotic transitions of 1947. An exchange of correspondence with the military establishment in the fall of 1947 had resulted in a tentative schedule for bomb production for each of the five years beginning in 1948. Against this the Commission had matched its production resources. The result was a plan, which President Truman approved in April, 1948, to continue the production of fissionable materials at essentially the level authorized for 1947. Events in early 1948 suggested the need for higher requirements, but until results were available from the *Sandstone* tests, there would be no sound basis for planning. In effect, the directive authorized the Commission to produce all the fissionable material it could with existing facilities until the Joint Chiefs of Staff could formulate new and higher requirements.[37]

After studying Williams' production plans in March, 1948, Gustafson felt confident that available sources of raw materials would be sufficient for both production and research needs in the immediate future. Part of his optimism stemmed from a recent British agreement to allocate to the United

States all uranium concentrates available in 1948 and 1949 through the Combined Development Agency, as the tripartite procurement group was now called. This source alone would provide about 2,000 tons of uranium concentrates annually through 1950. There was, however, an inherent weakness in the American position. All of this material would come from the Shinkolobwe mine in the Belgian Congo, and continued procurement after 1950 would depend upon successful negotiations with the Belgians. The mine itself was vulnerable to sabotage and in any event would be exhausted by the end of 1952.[38]

More accessible sources were small by comparison. The Canadian deposit would not bring more than 150 tons per year. The only domestic ore immediately available was on the Colorado Plateau. In the spring of 1948 only a dribble of concentrates was coming from that source as a byproduct of the vanadium mills. Even after all the existing mills were acquired and renovated, the area probably would not produce more than 300 tons of concentrates annually. Although all ore bodies then positively located on the plateau would produce little more than 1,000 tons, inferred reserves were six times as much, and potential reserves in phosphate and shale deposits were many times that figure. Cost, not quantity was the issue. Gustafson estimated that the low uranium content and the high development costs for domestic ores would force the price of concentrates from American sources up to $20.00 per pound or higher, compared with $3.40 for Shinkolobwe material delivered in the United States. In a sense, the amount of uranium produced depended on how much the Commission was willing to pay for it.

By the end of March, 1948, Gustafson had formulated a domestic procurement plan with the help of his raw materials advisory committee. Underlying the plan was the assumption that new reserves could best be developed by competitive private industry under the stimulus of profits. This meant incentives in the form of a $10,000 bonus for the discovery of significant deposits and a guaranteed minimum price of $3.50 per pound of concentrate in high-grade ore, to be offered for ten years. Actually the incentives were to be more of psychological than practical value. Few, if any, domestic deposits were likely to qualify for the bonus. The guaranteed minimum price for high-grade ore was far below expected costs, but it could not be higher without jeopardizing the price the Commission was paying for Belgian Congo material. In any case, the incentives and the price schedule established for lower-grade ores of the Colorado Plateau made clear to the American mining industry that there was a domestic market for uranium. The Commission would help by getting all existing mills on the plateau back in operation and by financing an extensive search for additional ore by exploratory drilling. This plan, costing about $5 million per year, would increase concentrate production on the plateau from 100 to 300 tons per year without disrupting the economy of the area. In the meantime, Gustafson intended for

security reasons not to disclose the Commission's interest in phosphates and shales until further research indicated that uranium extraction was feasible.[39]

The most promising foreign ore sources were in the Belgian Congo and the Union of South Africa. Wilson's assurances of technical assistance to Belgium during a visit by two Belgian officials in the summer of 1948 paved the way for successful negotiation in December for an additional 5,000 tons of uranium concentrates from Shinkolobwe. Interest in South Africa came from the fact that by 1953 that nation would be the largest potential foreign source, but diplomatic overtures were necessarily deliberate and unhurried. Having to deal with the United Kingdom as a member of the Combined Development Agency and with South Africa as a member of the British Commonwealth complicated Wilson's task of arranging discussions. In fact, there were other reasons for not moving too quickly. The confused political situation in South Africa suggested caution, and the relatively high price the Commission would have to pay for South African material threatened the United States bargaining position with the Belgians. Not until the summer of 1949 did Wilson complete arrangements for negotiations with the South Africans, to begin in November.[40]

The only other uranium source of any consequence was to be found in the waste tanks and chemical processing plants at Hanford. The Commission had given work on Redox a high priority in the summer of 1947, but the project languished for lack of firm leadership. Finally in June, 1948, Roger S. Warner, the director of engineering, put a review committee to work, and a new plan for Redox was ready before the end of the summer. The first decision was to abandon the idea of using packed columns in the solvent extraction process for the mixer-settler system which the Standard Oil Development Company had been investigating. Secondly, the independent efforts of the Kellex Corporation, Standard Oil, Argonne National Laboratory, and the Blaw-Knox Construction Company were all to be united under General Electric's control. With a clear purpose and some organization, Warner hoped that the first of three plants could be completed at Hanford in two years at a cost of $43 million. During the same period Kellex would try to develop a process to recover the uranium in the Hanford waste tanks.[41]

In the months before the *Sandstone* tests verified the design of new weapon types, plans for increased production wisely centered around Hanford. Unless Los Alamos could find a more efficient weapon than the Hiroshima model for uranium 235, the Hanford reactors would continue to be the principal source of fissionable material for weapons. The most obvious way to increase plutonium production was to restart B reactor, which had been shut down in 1946 to assure some production capability should the other two reactors fail. In March, 1948, Wilson reported his conclusion that neither of the reactors was likely to fail suddenly and that they would continue to operate for at least three years. With this assurance, the Commission in April

authorized restarting B reactor, thus placing three reactors in operation by the summer of 1948.

Meanwhile, construction had started on the new DR and H reactors at Hanford. In March, 1948, when the reactor development group visited Hanford to discuss possible design improvements in the new units, there were more than ten thousand construction workers on the job. The main building for DR was already going up, and site clearing had started at H. In seven months Carleton Shugg had transformed Hanford into a beehive of activity, an accomplishment which suggested a bigger role for his talents. In August, 1948, Wilson called Shugg to Washington to serve as deputy general manager, and Frederick C. Schlemmer, the TVA engineer who had gone to Hanford as a consultant with Williams in the summer of 1947, took over at Hanford.[42]

Nowhere did the anticipation and achievements of *Sandstone* have greater effect than in weapon activities at Sandia. By the spring of 1948 Sandia had all but accomplished the transition from a makeshift branch of Los Alamos to a full-fledged laboratory in its own right. Regular routines and procedures were replacing the bickering and confusion of 1947. To some extent the new patterns simply demonstrated that the scientists and military personnel were learning how to work together, but new leadership was helping to speed the process. In Paul J. Larsen, the new director, the laboratory had a man of reputation and experience in applied research and development. In Colonel William M. Canterbury the Armed Forces Special Weapons Project had a knowledgeable officer who knew how to get along with people. To unite the efforts of the two groups, Larsen and Canterbury had established a research and development board, which would meet regularly to study assignments and plan activities. McCormack and his staff in Washington were at first uneasy about the lack of definition of the board's power and authority, but it soon proved an effective device for weaving together the scientific and military units into a single team. Equally important was the influence of George P. Kraker, who gave Tyler and the Commission for the first time an effective representative at Sandia. Kraker's job was to see that Sandia activities meshed smoothly with other parts of the Commission's production complex; and that meant, according to McCormack, even closer coordination with military personnel.[43]

Sandstone helped to pull Sandia together, not only by sweeping away the remnants of existing rancor, but also by giving the laboratory new goals which required a united effort. In May, 1948, even before the third *Sandstone* shot had been fired, orders from Bradbury completely revamped production schedules. So clearly had *Sandstone* verified the design of the new Mark 4 weapon that first priority would now go to production of components for the new model, even at the expense of completing current stockpile items. Fabrication of standard nuclear cores stopped immediately so that all fissionable

material would henceforth go into new models. The day of tailor-made weapons was fading fast; with Mark 4 would come mass production of components and assembly-line techniques.[44]

The new technology which *Sandstone* made possible turned the Commission's sights from building on the past to striking out into the future. An increase of Sandia employment from 320 to 700 in seven months rendered the temporary buildings at Sandia Base obsolete. In August, 1948, the Commission approved the purchase of additional land for permanent buildings estimated to cost $15 million. Los Alamos was feeling similar pressures. With the old technical buildings crumbling beneath them, Bradbury and his associates had no choice but to look for a new laboratory site off the crowded Los Alamos mesa. By the summer of 1948 plans were well developed to build the new laboratory on South Mesa, with a high bridge over the canyon to connect the laboratory with the town. The proposal itself was ambitious enough, calling for $107 million for construction over a five-year period. There was a momentary drop in morale when the Commission, with the support of the General Advisory Committee, limited new construction to immediate needs, but it appeared certain that Los Alamos had a promising future.[45]

Just exactly what lay ahead Bradbury outlined for Tyler in September, 1948. There was still much to be done in analyzing the data from *Sandstone* and finding ways to use that information in new weapon models. *Sandstone* had already kindled interest in several new types of weapons and had raised hopes for a smaller, lighter weapon of standard design. Bradbury hoped that a series of studies already started would fix the general specifications of the new Mark 5 weapon within a year. In this way the talents of Los Alamos could be joined with those of the aircraft industry in designing a new bomber around its nuclear payload as an integrated weapon system. Once Los Alamos had determined the weight and size of the new weapon more than two years of research and development would be needed to ready the TX-5 for a test at Eniwetok early in 1951. The designation "TX," as McCormack liked to point out, meant "test" *and* "experimental"; both letters were necessary to indicate the kind of technological leap the new weapon would require.[46]

Bradbury was also planning other research with less direct application to immediate weapon requirements. He proposed research with the fast-neutron reactor "Clementine," basic studies of important weapon materials such as plutonium and tritium, construction with the help of John von Neumann of an electronic computer for theoretical studies, continued theoretical research on various approaches to a thermonuclear weapon, and further investigation of weapon design. Basic research in nuclear physics, chemistry, and biology would complete the transformation of Los Alamos from a task force of scientists with a narrowly defined mission into an applied physics laboratory.

To the extent Bradbury accomplished this transformation at Los Alamos, the task at Sandia became more clearly industrial. The University of California had never been happy with the extension of its Los Alamos con-

tract to cover Sandia, and the increasingly industrial nature of the Sandia operation prompted the university to inform the Commission in December, 1948, that it wanted to withdraw from Sandia management within six months. The university's position was understandable, but it would not be easy to find a new contractor. Any other academic institution would have the same reservations as California's about the Sandia assignment. There were rumors that the existing Sandia staff might form its own corporation to operate the laboratory, but this would not bring new strength and experience to the organization. The best hope seemed an industrial contractor in the electrical, automotive, or aircraft industries. Wilson and Warner at once thought of the Bell Telephone Laboratories and consulted James B. Fisk, the former director of research who had close ties with the Bell organization. Oliver H. Buckley, president of Bell Laboratories and a member of the General Advisory Committee, thought the assignment would overload the laboratory with military research, but he agreed to let Mervin J. Kelly, his executive vice-president, study the situation at Sandia and Los Alamos.[47]

Kelly, a thoroughly professional and experienced engineer, knew what to look for at Los Alamos and Sandia. He observed operations, studied personnel records, and talked with the leaders. Not wishing to involve himself in formal written reports, he insisted on discussing his findings directly with the Commissioners. His report on May 6, 1949, did more than confirm Wilson's arguments for an industrial contractor; it also gave the Commissioners an impressive independent appraisal of the two organizations. Kelly had nothing but praise for Los Alamos. It was the finest Government laboratory in the nation. The staff was excellent, and the salaries and working atmosphere would draw the best young men in the country. The laboratory was well organized and efficiently administered, a solid tribute to Bradbury, Tyler, and McCormack. At Sandia Kelly found less to extol. The laboratory had improved tremendously since early 1947, especially under Larsen's direction. Most of the staff were eager, hard-working young men, but much of their output Kelly found amateurish and lacking the professional touch of a first-rate production organization. Kelly thought a good industrial contractor could bring Sandia up to Los Alamos's standards in twelve months.

In his presentation Kelly was careful to avoid any discussion of possible contractors, but his excellent performance did nothing but increase the Commission's determination to bring the Bell Laboratories or one of the other Bell subsidiaries to Sandia. A pending antitrust suit made the American Telephone and Telegraph Company more than reluctant to undertake a contract which seemed likely to draw on the resources of the whole Bell system, but assurances from the Attorney General and a personal request from President Truman removed the company's reservations. On July 11, 1949, the Commission announced that it was negotiating a contract with the Western Electric Company, an AT&T subsidiary, thus opening a new chapter in weapon activity at Sandia.

THE BATTLE REJOINED

All these efforts to consolidate and strengthen the Commission's production complex added up to substantial progress by the end of 1948. Arthur V. Peterson of the production division told the Commissioners on January 19, 1949, that inventories of feed materials, fissionable materials, and special products were well ahead of schedule despite several unforeseen breakdowns at Hanford and Oak Ridge. Only the previous week Wilson had discussed with the Commissioners a draft letter to the President authorizing fissionable material production for calendar year 1949. The letter would inform the President that the Commission was in the process of converting production to
178 the new weapon models tested at *Sandstone;* the Commission would now be able to produce more weapons than had been required in the schedule which the Joint Chiefs of Staff had prepared late in 1947.[48]

There was, however, no room for complacency. The draft letter to the President evoked from the Military Liaison Committee formal notice that "the currently established military requirement for scheduled bomb production should be substantially increased and extended." The military had not yet been able to translate *Sandstone* results into firm requirements. In the meantime, the committee suggested the most profitable ways of modernizing the weapon stockpile and the approximate numbers of weapons of each type which should make up the stockpile on each target date of the existing schedule.[49]

The letter from the Military Liaison Committee illustrated the enormous importance which the armed forces now attached to atomic weapons. Forrestal, long a proponent of a strong nuclear arm, had returned from his last trip to western Europe more than ever convinced that the atomic bomb was the key to the defense of that part of the free world. He agreed with Winston Churchill that it would be dangerous to underestimate the military value of nuclear weapons. In the face of President Truman's severe limitations on defense spending, Forrestal saw the atomic bomb as a way of maximizing the nation's defenses with limited resources.[50]

If nuclear weapons were to have such a prominent defense role, they would have to be available in relatively large numbers and in practical sizes and weights, a possibility that had seemed remote before the *Sandstone* tests. General Nichols was one who did not accept the existing limits of weapon technology. He was willing to consider defense plans involving an ultimate stockpile of thousands, not just hundreds of weapons. In William Webster, who had succeeded Carpenter as chairman of the Military Liaison Committee and as Forrestal's assistant for atomic energy, Nichols found a new ally. Aware of the economic advantages of mass production, Webster did not let

the size of the Commission's existing production facilities limit the range of his thinking. As for reducing weapon size and weight, the results of *Sandstone* had encouraged the military planners. The absence of new weapon requirements in Webster's letter to the Commission reflected anything but indecision and lack of enthusiasm in the armed services.[51]

However little the Commissioners may have known of this background, they had already sensed the demand for increased production of fissionable materials. Williams had explored the possibility of duplicating the Hanford and Oak Ridge plants at other sites for better security against military attack or sabotage. Hanford was especially vulnerable to air attack from the Soviet Union, but the cost and time required to build plants at a new site seemed prohibitive in the absence of definite military requirements. It seemed more reasonable, as Bacher suggested, to increase plutonium production by making changes in the operation of the existing Hanford reactors or even by enlarging the batches of irradiated slugs dissolved in the chemical processing plants at Hanford. Gustafson and Williams felt certain that they would have enough feed materials to operate four reactors at Hanford at the higher production levels.

As for the Oak Ridge plant, the relatively remote possibility of enemy attack or plant failure made duplication at another site unnecessary, but an addition to the existing plant had been a live possibility since 1947. A plant addition at Oak Ridge, particularly one using a new type of compressor, an improved barrier, and a simplified cascade design, would make possible the extraction of more uranium 235 from a given amount of raw material. Furthermore, these improvements would provide the additional capacity at much less than the equivalent cost of the original plant, even at existing prices, and would reduce the unit cost of uranium 235 produced. Before the end of 1948 Williams had Carbide and the Maxon Construction Company at work on engineering designs. Thus, when the Commissioners approved construction of the K-29 addition on March 9, 1949, Williams could predict that the new unit would be in production by the middle of 1951.[52]

All these topics were the subject of discussion when the Commission met with the Joint Committee on Atomic Energy on March 10, 1949. Under the leadership of Brien McMahon, the new chairman in the Eighty-first Congress, the committee was taking an unprecedented interest in the Commission's production plans. Some saw in McMahon's energetic leadership an effort to create in the eyes of the American people an image of himself as "Mr. Atom." Faced with reelection in 1950, McMahon was appearing whenever possible as a speaker on atomic energy and had recently created a stir by suggesting that the United States reveal the number of nuclear weapons in its stockpile as a way of deterring the Soviet Union from reckless action in Europe. McMahon's motivation, however, was more than just political. The world situation profoundly disturbed him, and he was determined to see that the Congress, through the Joint Committee, held high the atomic shield—even

if the Commission failed to do so. In short, McMahon hoped to make the Joint Committee an instrument of national policy.[53]

Aiding McMahon in this effort was William L. Borden, the committee's new executive director. Borden was an intelligent young man with some of the talents and intellectual ability which had made James R. Newman so valuable to McMahon in the legislative battle for the Atomic Energy Act in 1946. Like Newman, Borden was a graduate of the Yale Law School and had proved himself capable of independent thinking and articulate writing. Ever since he had seen a German V-2 missile streak past his B-24 bomber while returning to England from a raid in November, 1944, Borden had been obsessed with the frightening dangers modern technology posed for American security in the postwar world. His book, *There Will Be No Time,* written while he was still in law school, stridently proclaimed the need for a revolution in strategy which recognized that cities, industry, and land armies would be obsolete in the lightning atomic warfare of the future. Borden argued that national defense should have precedence over all internal problems; a united armed force should be ready for instant retaliation with atomic weapons against sneak attack. The choice, he had said in 1946, was between a strong America and no America.[54]

Some of the intensity of Borden's dedication to national defense showed through in his discussion with the Commissioners. He was particularly concerned about plans for the new production reactors at Hanford and about progress on Redox. Wilson assured him that the Commission was studying the best way to use the new DR reactor, which was now almost complete. There was little chance the reactor would be used as a replacement for D, which was now operating well, but graphite expansion in F was reaching dangerous proportions. Perhaps it would be necessary to tie the F waterworks to DR. If F continued to operate, Wilson said it would still be possible to build another waterworks near DR, which would place five reactors in operation (including H, to be completed in the summer of 1949).

Wilson was candid in saying that technical difficulties were continuing to prolong development of the Redox process. He explained the decision in the summer of 1948 to switch all development of the solvent extraction process to the mixer-settler system when it appeared that the packed columns would have to be 50 or 60 feet high. By November engineers had revised the column height to 35 feet, and a review committee had decided that either packed columns or mixer-settlers would work. To assure a correct choice, the Commission had asked the du Pont Company to have some of its best engineers review the entire Redox project. Their recommendations would be in by April 1, 1949. The hearing went pleasantly enough, but there was no disguising the fact that McMahon and Borden would continue to press for greater production.

It was also likely that renewed pressures would come from the military. McMahon had stated his intention to raise the same sorts of questions

with the service secretaries. Perhaps he was only waiting for a new Secretary of Defense to replace Forrestal. Lilienthal was already uneasy. He distrusted "what is sonorously called 'the requirements of the Joint Chiefs of Staff,' " as if there were something sacred about their pronouncements. The joint letter for the President authorizing 1949 production was ready for signature, including the added phrase that the Joint Chiefs did not consider current production adequate even if the number of weapons produced exceeded the 1947 schedule. Lilienthal reminded the Military Liaison Committee on April 8, 1949, that any substantial increase in weapon requirements might push production above authorized levels. Such an increase would require Presidential approval, and Lilienthal did not see how he could make such a recommendation without having some knowledge of the war plans on which it was based.[55]

Lilienthal's anxiety must have stemmed in part from Forrestal's resignation as Secretary of Defense. His spirit broken by the heavy weight of his duties, Forrestal was then in the Bethesda Naval Hospital in a state of deep depression. The Commission's first meeting with Louis A. Johnson, the new Secretary of Defense, did not help to allay these concerns. Lilienthal found in the new secretary a callous self-confidence bordering on the flippant. It was bad enough that Johnson seemed more interested in contract awards than policy issues; the Secretary's supreme confidence in the Joint Chiefs and the sanctity of their opinions—inviolate even to Presidential criticism—was downright unbearable. The next day, when he and Johnson presented the joint letter to the President at the White House, Lilienthal found momentary assurance in Johnson's statement of admiration for the Commission's accomplishments and his promise of cooperation, but new signs of trouble soon appeared. General Nichols had renewed his campaign for military control of the atomic energy enterprise, and a forthcoming Joint Committee hearing with the Joint Chiefs in mid-May seemed likely to generate new military requirements for nuclear weapons.

Higher requirements in themselves did not bother Lilienthal; the Commission would do its best to meet any goal based on sound planning and Presidential approval. What he feared was an arbitrary demand from the Joint Chiefs in a form the President could not effectively challenge. The result, he told Truman on May 11, might be a new threat to civilian control. Truman's sharp response to that warning was reassuring, but Lilienthal was determined to keep up his guard. So sensitive had the issue become that the Commissioners spent several sessions in May discussing the need to replace military officers on General McCormack's staff with civilians, a significant action in view of the Commissioners' high regard for McCormack and Russell.[56]

To some extent Lilienthal was using the requirements issue to sound the old alarm against military control. He knew as well as anyone that Wilson's staff worked with the military in developing requirements and that

these were based in large part on the capacity of the Commission's production plants. Certain elements of the procedure, however, did cause friction even at the staff level. Although the Commission never questioned the right of the Military Liaison Committee to any atomic energy information, the great amount of detail requested in some cases aroused the suspicion that the military officers were trying to second-guess the Commission's staff. Furthermore, Webster and Nichols made no effort to disguise the fact that they were building requirement figures on the Commission's capacity to produce. In the spring of 1949 the Military Liaison Committee scheduled visits to the major production sites with the avowed purpose of determining the maximum production of existing facilities and the relative advantages of arbitrary, multiple expansions of existing capacities. In Oak Ridge on May 19, Webster and Nichols took this approach in discussing with George T. Felbeck and other Carbide officials the economic advantages of building still another
182 gaseous-diffusion plant, to be called K-31, at the Oak Ridge site. Webster used the information gathered in the field for preparing the new requirements which he sent to the Commission on May 26, 1949.[57]

Webster thought his approach eminently practical and saw no reason to apologize for it. To Lilienthal, it embodied all that he had found objectionable in negotiations with the military. Webster was ordering atomic weapons like mess kits or rifles. Just how the new requirements would fit into larger strategic and political considerations was to be of no concern to the Commission.

Even worse, Webster's methods suggested to Lilienthal and others an arbitrary approach, not based on military planning but on rule-of-thumb estimates to be dignified as formal recommendations by the Joint Chiefs. Unfortunately for both sides, the Commission was excluded from an understanding of the complexities which Webster and his associates faced in drawing up requirements. The capacity of the Commission's production facilities was only one factor. Far more difficult to estimate was the requirement for nuclear weapons, depending as it did on such complicated variables as Air Force targeting plans, options in weapon size, and improvements in weapon design still evolving from the results of the *Sandstone* tests.[58]

Only the most extraordinary circumstances forestalled a prompt reaction from the Commission. The day Webster's letter arrived, the Commissioners were attending the first of a series of hearings before the Joint Committee, stemming from Senator Bourke B. Hickenlooper's charges of "incredible mismanagement." Not until June 23 did the Commissioners find time to consider a reply. Wilson explained on Friday, June 24, that he could meet the requirements approved by the President in April with four reactors (B, D, F, and H), but that the May 26 request would require a waterworks for DR and a new gaseous-diffusion plant at a cost of at least $230 million. Lilienthal was quick to remark that such an expansion would certainly require Presidential approval, and he thought it important to avoid any step "that might narrow

the area of exercise of judgment by the President." He had already discussed that danger with Frank Pace, the new director of the Bureau of the Budget; on the Commissioners' instruction, Wilson arranged a meeting with Webster in Pace's office on Monday afternoon.[59]

The military demand for a "substantial" increase in production put the determination of production goals in a new context. As long as requirements stayed within the capacity of existing or planned facilities, the Commission could negotiate with the military establishment to determine the final recommendation to the President. But the May 26 request, going beyond existing construction plans and authorization, left no basis for decision. McMahon made this dilemma clear in a letter to Secretary Johnson on July 14. In the past, military requirements had "merely reflected an estimate of what the Atomic Energy Commission was capable of producing with existing or planned facilities—and did not reflect an independent judgment as to what we need in the event of war." That independent judgment, McMahon and Borden argued, should stem from the proposition that strategic bombing with atomic weapons was "the keystone of our military policy and a foundation pillar of our foreign policy as well." In this sense McMahon and Borden believed the nation could never have enough atomic bombs and could well afford a "substantial" increase in production.[60]

Lilienthal worried about translating that word "substantial" into specific requirements. If, as McMahon suggested, the decision involved fundamental national policy, some device was necessary to collect all the pertinent factors for the President's consideration. The solution emerged from Wilson's discussions with Webster and Pace. On July 26, Truman signed a letter to Admiral Sidney W. Souers, executive secretary of the National Security Council, directing him to undertake a complete review of plans for producing fissionable materials and atomic weapons. To assist Souers in his study, the President was establishing a special committee consisting of the Secretaries of State and Defense and the Chairman of the Atomic Energy Commission. The President's directive made clear that all members of the committee were to have access to all pertinent information, regardless of sensitivity. This provision assured Lilienthal that the Joint Chiefs' requirements would be subject to discussion and criticism.[61]

To Lilienthal's mind the Presidential directive was a new victory for civilian control of atomic energy. Amid the tribulations of the Hickenlooper investigations and the debate over technical cooperation with the British in July, 1949, the Commission's accomplishments in meeting its military responsibilities were comforting. Not only had the Commission apparently increased production faster than the military could develop firm requirements; it was now forcing the military to base its requirements on sound planning consistent with national policy.

There were also a few hopeful signs on the international scene in July, 1949. The Berlin airlift had broken the Soviet blockade and a new govern-

ment in West Germany was in the making. The United States Senate had ratified the North Atlantic Treaty, establishing a new partnership for the defense of western Europe. Secretary of State Dean G. Acheson, returning from a foreign ministers' conference in Paris, had declared that "the position of the West had greatly grown in strength, and that the position of the Soviet Union in regard to the struggle for the soul of Europe has changed from the offensive to the defensive." [62] The Administration, as well as the Commission, had done much since Secretary Marshall's Bastille Day appeal in 1947 to extend American defenses against aggression to western Europe and the Middle East. The nation now had an arsenal of nuclear weapons. Behind its atomic shield the nation seemed secure, at least until the Soviet Union could break America's monopoly of the atomic bomb.

ATOMIC POWER QUANDARY AND QUAGMIRE

CHAPTER 7

The decision in late December, 1947, to centralize reactor development at Argonne had shocked and dismayed Oak Ridge. Alvin M. Weinberg, the thirty-two-year-old director of the physics division at the Tennessee laboratory, bitterly stigmatized relocating the high-flux and the Navy reactor projects—both of which he thought ready for engineering—as an act which would delay reactor development for two years.[1] At Argonne Walter H. Zinn viewed his enlarged assignment with no enthusiasm. His laboratory was engaged in moving from several locations in Chicago to the new site southwest of the city. Here he hoped to build in the near future his experimental fast-breeder reactor. C. Guy Suits and Kenneth H. Kingdon at Schenectady impatiently watched the construction of the General Electric Research Laboratory and the adjacent Knolls Atomic Power Laboratory. Their intermediate-power-breeder reactor was a challenging and ambitious project, but at least it could proceed undisturbed by the move toward centralization.

Whether at Oak Ridge, Argonne, or Schenectady, reactor engineers and physicists faced a host of unknowns. They lacked vital data on nuclear constants and on the behavior of metals and coolants under prolonged radiation. They had to develop components such as pumps, control mechanisms, and shielding. During the stress of war they had found it necessary to take calculated risks on safety, a course not acceptable for a technology which was to become part of the civilian economy. The obstacles in developing reactors were real, but so was the sense that their conquest would be exhilarating. For those at Oak Ridge the worst blow was that they had been barred from adventure.

LOCATION OF THE HIGH-FLUX

The key to the centralization plan was the decision to locate the high-flux reactor at Argonne. During January, 1948, Zinn studied the feasibility report which Weinberg's group had prepared on the Clinton high-flux reactor. He thought Argonne was too near Chicago for an experimental reactor operating at 30,000 kilowatts. Furthermore, Clinton had planned an integrated complex consisting of the reactor and a chemical processing plant. Zinn was even more certain that the Chicago area was a poor location for handling highly radioactive fuel.[2] Having wrestled with questions of reactor safety since 1942, Zinn was himself an expert on the subject. But he did not have to depend upon his own views. The design and location of the high-flux would be the concern of the Commission's reactor safeguard committee.

That committee had already considered two reactors. At Schenectady in early November, 1947, Kingdon's group had reviewed the design of the intermediate-breeder, a 30,000-kilowatt, sodium-cooled reactor. Design and development were still preliminary, but Suits and Kingdon were anxious to select a site so that further work could meet the requirements of an actual location. Obviously the nearer to Schenectady, the easier for General Electric personnel to use the reactor; otherwise the company's role might be reduced to operating the reactor rather than performing research. The result, the committee was persuaded, would be disastrous to the leadership of the United States in atomic energy. Recognizing that any recommendation had to be tentative until further work had been completed, the safeguard group had concluded unenthusiastically that a location near Schenectady might be acceptable. The committee next had visited Argonne, where in late January, 1948, it had found the laboratory acceptable for the 1,000-kilowatt reactor and its chemical processing facility, provided that the amount of plutonium and fission products generated in the reactor were limited. In considering both reactors, the committee studied not only the chance of accidents, but also the risk of sabotage.[3]

The safeguard committee gathered at Oak Ridge on February 8, 1948, to consider the high-flux reactor. The experienced and talented group served under the leadership of Edward Teller who, among his other activities during the Manhattan days, had studied the possibility of accidental criticality in the uranium separation plants. Now at the Institute for Nuclear Studies at Chicago, Teller was an engaging and energetic chairman. Few people had a better understanding of the complexities of reactor development than John A. Wheeler, a physicist at the Palmer Physical Laboratory at Princeton. Wheeler had published with Niels Bohr in September, 1939, a significant paper on the mechanism of nuclear fission and had served as a member of the engineering

council at Chicago which had guided the work on the production piles at Hanford. Joseph W. Kennedy, chairman of the department of chemistry at Washington University at St. Louis, brought to the group a brilliant grasp of chemistry and experience at Los Alamos; to these he added a vigorous sense of humor. Chemical engineering was the speciality of Manson Benedict from Hydrocarbon Research, Incorporated. Colonel Benjamin G. Holzman, chief of the geophysical sciences branch of the Air Force, provided experience based on several years as a meteorologist. Oldest of the group was Abel Wolman of Johns Hopkins University, whose field was public health and sanitary engineering. Energetic and articulate, he was familiar with Commission activities through his service on other committees which had studied safety problems. It was a strong body and well versed in those various fields which Oppenheimer genially described as "general deviltry" when he and the General Advisory Committee recommended establishing the group.[4]

For two days the full committee, except for Wheeler, heard Weinberg, Miles C. Leverett, John R. Huffman, and other members of the laboratory present plans and drawings for the construction and operation of the high-flux reactor. Listening closely were Zinn and Eugene P. Wigner. Wigner's interest stemmed from his part in selecting water as the coolant and moderator, and in designing the fuel elements. The fissionable material was to be an aluminum-uranium alloy rolled into sheets which were to be clad with aluminum. In the slang of the designers, the alloy was the meat, the cladding the bread, and the combination the sandwich. Eighteen sandwiches were to be brazed to aluminum side plates and together would comprise an assembly. Each sandwich was about .06 inch thick and separated from its neighbor by a distance of .117 inch, through which the water coolant and moderator passed. It was important to minimize buckling which might block the flow of cooling water and lead to overheating. Wigner had thought of curving the fuel plates to give the assembly greater strength. The reactor core was to be surrounded by beryllium, which would reflect neutrons and conserve them for experiments. To everyone it was clear that Clinton had designed a sophisticated reactor, able to provide large quantities of thermal and fast neutrons for testing reactor materials, furnishing the nuclear and engineering data indispensable to the development of advanced reactors, and yet sufficiently flexible for performing biological experiments. Its chemical facilities would supply information on the complicated problems of processing used fuel. Moreover, the laboratory was constructing a full-scale reactor mock-up to test the mechanical reliability of high-flux components and under Wigner's leadership had considered safety aspects of the design. In January, 1947, the staff had reported to him that reactors could operate at Y-12 with no greater risks than those often associated with more conventional industries.[5]

The risks worried Teller and his colleagues; patently the high-flux reactor and the chemical processing plant had not been designed with Ar-

gonne in mind. Any accident releasing the fission products built up in the fuel elements could be hazardous to the 4 million people of the nation's second largest urban center. What Zinn had suspected was confirmed. Perhaps recognizing the impact of its report, the committee pointed out that so far it had considered each reactor individually. Possibly a different approach was needed, one dealing with the entire reactor effort, including chemical processing and radioactive waste disposal.[6]

The General Advisory Committee considered the safeguards report when it assembled in Washington on April 23, 1948. Zinn and Wolman were also present to give their opinions. Wolman outlined the safety arguments which the advisory committee accepted reluctantly. Isidor I. Rabi recognized the importance of the safety factors, but was dissatisfied with the lack of precise data. He thought there ought to be a formula into which values representing various aspects of safety could be inserted. Wolman was doubtful. In his opinion the unknowns were too many and the hazards too great. Zinn saw the real danger as the scattering of radioactive fission products built up in the fuel elements during reactor operation. These products could only escape through a failure of the fuel cladding, perhaps by rupture from a sudden shock, perhaps by melting from a rise in temperature. The most likely cause of an increase in temperature was an interruption in the coolant flow. Even if the reactor were shut down, fission products during their decay gave off heat. Without the circulating coolant to remove the decay heat, the cladding could melt. But in terms of safeguard criteria, Zinn thought a heavy-water, natural-uranium research reactor of 5,000 kilowatts, or a high-flux reactor of 1,600 kilowatts, would be safe for a laboratory. As matters now stood, the high-flux reactor could not be built at any Commission laboratory. Zinn warned that he needed a decision for the high-flux; otherwise the interest of designers would fade. He left no doubt that he favored a proving ground; eventually one would be needed to test more advanced and higher powered reactors. He saw the testing station as a Commission enterprise not identified with any one laboratory.

The advisory committee did not like separating the high-flux from the central laboratory. To Cyril S. Smith the two facilities were inseparable. To Oppenheimer progress in reactor development depended upon building the high-flux at Argonne, a possibility he would not exclude until additional design had been completed. Smith and Enrico Fermi agreed: perhaps the answer lay in some emergency arrangement for flooding the reactor. Rabi and Glenn T. Seaborg saw no reason why the reactor could not be located at Argonne, leaving the chemical processing facilities for a remote site. Fermi, Hood Worthington, and Smith as members of the subcommittee on reactors drew up the sense of the discussion: to prevent delay in reactor development, the Commission should try redesigning the high-flux for Argonne and begin the search for a proving ground.[7]

MILITARY PRESSURES

January, 1948, had little more than begun when Vannevar Bush, vacationing in Hobe Sound, Florida, received a letter from General Carl A. Spaatz, Chief of Staff of the Air Force. As he opened the envelope the chairman of the Research and Development Board must have had some idea of what Spaatz wanted. During the summer James B. Conant's committee on atomic energy of the Research and Development Board had criticized the NEPA effort to propel aircraft by atomic energy, and had advised a new approach which would place the Commission in charge of a unified program. Spaatz had not liked the recommendation and he hoped to enlist Bush in an effort to reverse it. Perhaps he could compensate for Conant's cool scientific approach; perhaps he could stress to Conant the importance of coupling the engineering resources of the aircraft industry to the research abilities of the Commission.[8] To one as familiar with the Washington scene as Bush, there was no need to mention that Conant was a member of the influential General Advisory Committee as well as the chairman of the Research and Development Board's committee.

No such difficulties appeared to hamper Navy development of a nuclear-powered submarine. Conant's committee had recommended that the Navy Bureau of Ships consult with the Commission about organizing the project. Before reporting his plans to the Commission on January 20, 1948, Admiral Earle W. Mills, chief of the bureau, and Captain Hyman G. Rickover had discussed with General Electric officials the possibility of a broad development effort, one part of which would be to demonstrate the feasibility of an intermediate reactor for submarine propulsion. They also had indications that Westinghouse was interested in reactor work at Argonne.

Mills's recommendations to the Commission focused on speed in obtaining a naval propulsion plant. Research would be necessary but engineering was more important. To hasten development Mills proposed that his bureau act as the Commission's agent in organizing and supervising the project. The group of Navy officers assigned this responsibility would have a dual status in both the Commission and the bureau.

On development plans for the naval plant, Mills urged greater effort on feasibility studies at both Oak Ridge and Schenectady. He called for more research on shielding, structural materials, fuel assemblies, and heat-transfer and power-generation systems. An integral part of his plan was a rigorous educational and training course for personnel from the Navy and industry. Thus qualified engineers and technicians would be available when an industrial organization was ready to start detailed design of the submarine reactor. Mills contemplated actual construction of only one experimental

reactor, but selection of the design would have to await the outcome of preliminary studies.[9]

The General Advisory Committee considered both the Air Force and Navy projects on February 6, 1948. Never enthusiastic over aircraft nuclear propulsion, the advisory committee agreed that the Commission should make no decisions on NEPA before a study had been completed. Response to a Navy reactor was more favorable. Smith, for example, thought that a Navy project offered a concrete goal which would stimulate reactor development, but Mills's proposals on organization drew fire. Hartley S. Rowe saw in the Bureau of Ships's plans for administration an uncomfortable resemblance to those impeding NEPA. Conant added to the general feeling of skepticism by pointing out that the committee on atomic energy, which had met the preceding day, had concluded that Mills was pushing too fast. The view found ready acceptance in the advisory committee. Still, Seaborg was sympathetic to
190 Mills's eagerness to bring in an industrial organization. Westinghouse, in Seaborg's opinion, would add the needed touch of industry to reactor development, provided its participation would not interfere with a central laboratory.[10]

Commission action did not differ greatly from the recommendations of the advisory committee. On February 18, 1948, the Commission agreed to a study of NEPA, and Carroll L. Wilson, after some weeks of negotiation, persuaded Walter G. Whitman, head of the department of chemical engineering at MIT, to direct a study to be called the Lexington project. The Whitman group was to provide a report in the fall. The Commissioners delayed action on the Navy project, mainly because the Bureau of Ships and the Commission staff needed time to formulate plans for cooperation.[11]

In the Bureau of Ships, Captain Rickover completed plans for the studies and research necessary for a nuclear submarine. He described the Navy reactor effort as largely one of studies by engineers: two or three at Knolls working on liquid-metal-cooled reactors and about twenty at Oak Ridge investigating high-pressure, water-cooled systems. These men designing reactor components had uncovered large areas in which information was lacking. Even worse, many of these fields were not under investigation. To meet these deficiencies, Rickover proposed preliminary engineering on liquid-metal, water-cooled, and gas-cooled reactors by General Electric, Westinghouse, and perhaps a third company. But studies were not enough, and Rickover went on to compile a formidable list of tasks, of which corrosion analyses, engineering designs, shielding development, and neutron measurements were only a few.[12]

Mills and Rickover were determined men who understood what they wanted and knew how to make their views heard. Mills was one of a number of persons asked to address the annual symposium on underseas warfare meeting in Washington on April 2, 1948. It was an audience of influential scientists, many of whom were outside the Government. An eloquent extempo-

raneous speaker, thoroughly familiar with his subject and deeply convinced of the Navy's cause, Mills depended upon an outline, notes, and a speech written earlier by Rickover. As Commissioner Strauss completed his introduction, Mills stepped forward. After asserting the military importance of the nuclear submarine, Mills moved on to what had been done. Not much, was his blunt verdict. Oak Ridge and Knolls were doing paper work. Contrary to public opinion, perhaps less than 1 per cent of the design of a nuclear propulsion plant had been completed. For this state of affairs he blamed the Commission. If the effort were given high priority, and if the Commission and the Bureau of Ships could decide how to handle the project, the nation could have a nuclear submarine in the mid-1950's. But the Commission had to move. The main obstacles lay in engineering, and industry could solve these quickly.[13] Mills sat down and a sorely tried but imperturbable and composed Lewis Strauss returned to the lectern. He glanced back at Mills: "I never thought an old friend would do that to me."

Mills's presentation had been dramatic, but it did not spur the Commission as much as he had hoped. On April 22, 1948, the Commissioners agreed that Zinn should be encouraged to make the Navy project one of his first assignments. As part of the reactor development effort at Argonne, Zinn would assign separate teams to investigate systems using water, gas, and liquid metal as the heat-transfer medium. The most promising design would receive further study as part of the laboratory's effort on power reactors, with the ultimate aim of building an experimental ship propulsion plant. The Bureau of Ships could help by loaning personnel to Argonne and by taking on some engineering work. Eventually the Commission and the bureau would have to devise procedures for administering a contract with the company that would design and construct the experimental plant. Embodied within the cautious phrasing of the Commission's position was the Delphic promise that the Navy effort would be prosecuted "with the high priority commensurate with the importance of the project." [14]

On May 4, 1948, a Navy delegation including Rear Admiral Thorvald A. Solberg and Rickover went to Argonne to explore working relations between the laboratory and the Navy. Zinn said he expected the Navy group from Oak Ridge to arrive in August, and assured his visitors that he understood the high priority of the assignment. Quickly the Navy officers raised their key issue: the participation of industry. Since the Commission had authorized General Electric at Schenectady to perform some work on a liquid-metal-cooled Navy reactor, the officers thought that the company should be given the task of independently designing a reactor and propulsion plant. Zinn did not object, but he pointed out that it was a decision only the Commission could make. As for Westinghouse, that company already had a contract with the Bureau of Ships to study ordinary water as a coolant and was negotiating with Zinn to provide technical personnel and services for reactor work at Argonne. Arguing that at this point no reactor type could be

ruled out, Solberg and Rickover brought up the gas-cooled system. Zinn agreed that the Bureau of Ships should study the final report on the helium-cooled Daniels reactor and arrange for any necessary work on blowers, valves, and heat exchangers.[15]

Mills approached Lilienthal on May 12 to ask that General Electric undertake the design of a complete liquid-metal-cooled reactor and propulsion system. In the program council General James McCormack thought that adding a high-priority reactor project at Knolls after centralizing reactor development at Argonne would be rubbing salt into the wounds of Oak Ridge. A competitive project at Knolls might also give Argonne trouble in recruiting personnel. George L. Weil, chief of the Commission's reactor branch, recognized the manpower shortage. He doubted that General Electric could carry both the intermediate-power-breeder and a Navy project. If the choice were his, he would drop the breeder and concentrate on the submarine reactor.[16]

Along with Argonne and the Commission, General Electric was feeling the Navy pressure. For over two hours on May 14, Wilson and his staff talked with Harry A. Winne and Suits. Despite the Navy's insistence, they wanted to continue with the intermediate breeder. If they were directed to take on a Navy project on the grounds of national security, they would comply; but this decision would sacrifice the intermediate breeder since they did not have the manpower or facilities for both. Besides, the intermediate reactor was to be a flexible test facility, a capability they would lose in a reactor restricted to the dimensions of a submarine hull. Winne and Suits had a further argument: technology from the intermediate breeder could be applied to a Navy reactor, but a Navy project would add nothing to the knowledge of breeding. Then too, shifting the focus at Knolls from industrial applications to military purposes would inevitably entail a loss in morale. As Winne and Suits viewed the situation, the best plan was for another company—say, Westinghouse—to take on a Navy project. General Electric would cooperate fully.[17]

James B. Fisk presented the case to the General Advisory Committee on June 4, 1948. Cyril Smith continued to favor a Navy reactor as a good incentive for reactor development, but Conant, Rabi, and Worthington were not so sure. Adding to the workload at Knolls they believed might retard reactor development even more. Conant saw Navy influence on General Electric, and from the NEPA example, he doubted whether military pressure was the best way to spur reactor development. In any event, the committee was not convinced of the military need for a submarine reactor although, observed Oppenheimer, the Navy had presented the arguments often enough.[18]

Mills and Rickover had no intention of quitting. On June 16, 1948, they joined a group of Naval officers in a meeting with Bacher, Waymack, and Pike at Commission headquarters. After his colleagues had set forth the advantages of a nuclear propulsion system for urgent military missions, Mills reviewed the recommendations of the Chief of Naval Operations, the Secretary of the Navy, the Research and Development Board, and the Military

Liaison Committee. All had urged a high priority for a nuclear-powered submarine. It was possible to have such a vessel by the mid-1950's, when guided missiles carrying atomic warheads would be available. Together the submarine and missile could give the nation a major defensive weapon. To Bacher's and Wilson's doubts that General Electric could carry both an intermediate-breeder reactor and a Navy project, Mills expressed optimism gained from a recent trip to Schenectady. Because in many characteristics—neutron flux, power density, and control—the two reactors would be similar, General Electric would not have to increase its efforts greatly. Mills was satisfied with the work at Argonne, but bringing in General Electric would make possible a better choice among the possible approaches to nuclear submarine propulsion.[19]

The Commission was unmoved. On July 28, 1948, Wilson wrote Mills that the Commission could not justify a second full-scale project. Mills expressed his disappointment in a reply to Lilienthal on August 2. He saw no hope that the Commission's approach would give the nation an operational nuclear submarine "in that minimum time which a project of such importance to the national defense warrants." In an appeal to Secretary of the Navy John L. Sullivan, Mills claimed that the Commission's action conflicted with the recommendations of several boards and committees for strong industrial participation. To balance the Commission's theoretical approach to reactor development and to supplement the work at Argonne, Mills wanted to give certain tasks to industry. He would still have to depend, however, on the Commission for technical information and for access to test facilities. "It is hoped that the recent designation of Captain H. G. Rickover, USN, as liaison officer with the AEC will lead to this cooperation." [20]

Captain Rickover was not an unknown quantity. With a gift for trenchant observations on any subject, Rickover had won a reputation in the Bureau of Ships and in the Commission as a man who got results. Mills also did not relax. Through the Navy hierarchy he moved again to bring pressure upon the Commission. The battle was not over.[21]

CENTRALIZATION—COLLAPSE

Assigning the high-flux and Navy projects to Argonne did not mean that all reactor work stopped at Oak Ridge. Until personnel and equipment could be moved to Argonne, work would continue even if the luster were gone. In early 1948 Stuart McLain came to Oak Ridge from Wayne University in Detroit, where he had been a professor of chemical engineering. He found the situation confused. Leverett, head of the technical division, had resigned to be replaced by Merlin D. Peterson. Both McLain and Peterson were chemical engineers, but in dividing up responsibilities McLain took over reactor work.

He found morale poor. The uncertain future of the high-flux and the laboratory under a new contractor left the group listless. At nine o'clock one March morning McLain met with his staff. In two hours they compiled a list of jobs that needed to be done, so many that McLain discovered that his shortage was of men rather than projects.

One subject of great interest was the metallurgy of zirconium, which appeared to be highly resistant to corrosion. Earlier that metal had been ruled out for reactor use because of the high probability of capturing thermal neutrons, but now the picture was changing. Stimulated by an inquiry from Albert R. Kaufmann of MIT, Herbert Pomerance at Oak Ridge in 1947 had examined zirconium more closely. The results of his work were fascinating. It appeared that hafnium—present to a few per cent in commercially pure zirconium—was the culprit. Remove the hafnium and zirconium no longer possessed the same appetite for thermal neutrons. From a metal of limited promise for thermal reactors, zirconium became one of great potential. Weinberg hailed the work of Pomerance as "probably . . . the most useful discovery of the last two years in any AEC laboratory." Admittedly the task of removing hafnium from zirconium was difficult, for the two elements were chemically similar.[22]

McLain saw a more immediate challenge in fabricating beryllium as a reflector for the high-flux. While the metal had good nuclear characteristics, it was brittle and hard to shape. He also decided to resume work on the mechanical mock-up of the reactor. This would shed light on several unknowns, particularly on the hydraulic system. The way in which his group settled to work convinced him that it was best by far to forget politics and devote full time to the job at hand. He called this philosophy the engineering approach.

Not everyone had the same outlook. Some people at Oak Ridge refused to accept the loss of reactor work and began a campaign to overturn the decision. Their strategy was to propose for their laboratory a low-power version of the high-flux reactor. Such a project might receive Commission approval because it would not need elaborate water-cooling systems or expensive and complicated chemical and metallurgical facilities. Weinberg was enthusiastic over the possibilities. Once the laboratory got a new reactor, the shackles of centralization would be broken. Weinberg saw a future for Oak Ridge in reactors because of the history of Berkeley, where one accelerator had led to others. The first step was the most important. To his delight, Weinberg discovered that Zinn did not interpret centralization as giving him the power to veto the reactor plans of other laboratories.[23]

With increased confidence Weinberg began to move. His plan for Oak Ridge he related to Zinn at the April, 1948, information meeting at Brookhaven, one of a series of gatherings at which scientists from the several laboratories met to give papers and hold discussions. Weinberg proposed that

Oak Ridge and Argonne each construct a research reactor, with the high-flux located in some remote area. On May 20, 1948, he offered Zinn another idea. Although the high-flux could probably be redesigned so as to meet the safety standards for either laboratory, Weinberg thought the reactor was too big and powerful for Zinn's research needs. Even if a redesigned high-flux could be built at Argonne, Zinn would still want a low-power research reactor. It might make more sense, Weinberg wrote, to build the high-flux at Oak Ridge and a research reactor at Argonne. While the Tennessee laboratory would concentrate on solid state physics, the Illinois laboratory would stress reactor design, and both groups would work together.[24]

In Wilson's office on May 29, 1948, Weinberg, C. Nelson Rucker, and several others from Oak Ridge presented their case. Rucker wanted to construct a low-power version of the high-flux reactor for research and isotope production. For economy he proposed to build the reactor in one of the Y-12 buildings, even if this location meant separating the facility from the radioactive chemistry work at the X-10 site. Wilson and John C. Franklin objected that expediency and minor economy were hardly good grounds for planning a strong laboratory. Weinberg founded his arguments on the need of Oak Ridge for neutrons. A large part of the laboratory research was already limited by the low neutron flux from the old X-10 reactor. If Oak Ridge were to be strong in research and the center of isotope production—as the Commission had promised—a new research reactor was necessary. Wilson and Fisk must have listened uneasily as Weinberg used the Commission's pledge for a strong Oak Ridge as an attack on centralization. However, Zinn was responsible for reactor development and would have to be consulted. On June 9, 1948, Fisk wrote Zinn to ask whether there was a reactor design suitable for Oak Ridge. If so, could the reactor be built without interfering with other reactor projects? Fisk also suggested that Zinn and Weinberg work together on the research reactor requirements of both laboratories.[25]

At Argonne on June 14 and 15, Weinberg and Zinn dealt with Fisk's questions fairly easily. They agreed on a modified high-flux reactor for each laboratory. Although both reactors would be based upon the high-flux design, they would operate at power levels to be determined by the reactor safeguard committee. Weinberg and Zinn did not think that building these units would penalize reactor development. Constructing the two reactors would provide valuable experience for the high-flux itself. Furthermore, close cooperation between Oak Ridge and Argonne would yield dividends by bringing more people into reactor development. Unlike Zinn, Weinberg had to justify a reactor at Oak Ridge. From discussion with Zinn and Fermi he decided to rest his case on the laboratory's responsibility for producing radioisotopes.[26]

Rucker listened with interest to Weinberg's report on his Argonne trip. Because the Commission and Carbide were in the midst of selecting an architect-engineer to plan the new laboratory facilities, Rucker thought the

time was ripe to press for a decision. He suggested on June 18 that Fisk meet with representatives of Argonne and Oak Ridge for further talks.[27]

The two laboratories were redesigning the high-flux to meet the criteria set by the safeguard committee. One hazard was that a reactor core might melt down if the flow of cooling water were interrupted. Since the core was to be submerged in a tank of water, the designers had to determine whether natural convection would be sufficient to remove the heat before meltdown. Zinn ran several tests in which an electrically heated fuel element in a tank of water was carried to temperatures above those expected during reactor operation. The results were favorable. Of particular importance to Zinn was the fact that Teller witnessed one of the tests. Teller was also serving as a consultant on a redesigned high-flux which, operating at 10,000 kilowatts rather than 30,000 kilowatts, might be suitable for Argonne. As an additional safety factor, Argonne was thinking of housing the reactor in a structure which would contain vapor and gases. A major difficulty was preserving the integrity of the containment while providing access for personnel and equipment.[28]

At Hanford in June, the Teller committee tried to frame the problem of reactor siting in mathematical terms. Simply stated, the higher the power level the greater the area over which control was needed. Ideally a reactor location should meet three criteria: complete Commission control over the immediate area; a population of less than 10,000 in the surrounding country; and no installations vital to the nation's defense in the region.[29]

The formula caused Zinn to pause. He had promised Weinberg a reply to Fisk on a reactor for Oak Ridge, but the reactor safeguard committee once again had forced a review of the Commission's reactor plans. On July 23, 1948, Zinn wrote a long letter to Fisk. There were three projects to consider: the high-flux and the research reactors for the two laboratories. Zinn dealt with the high-flux first. Since no Commission installation met the safeguard criteria, Zinn was inclined to strip away the pretense that the effort was going ahead. If the work were stopped, there would be no need to uproot Oak Ridge people and move them to Argonne. He would carry on with reactor development as best he could, using experimental data from research and production reactors. Of course, if the Commission decided to acquire a reactor proving ground, Argonne would be glad to work on the high-flux. Zinn stressed that he did not consider it his role to pass on the reactor plans of other laboratories. In his opinion, a good design for a reactor suitable for Oak Ridge did exist, but only the Commission could decide whether to construct it. Turning to Argonne, Zinn was not certain what power level and reactor type would be acceptable to the safeguard committee. Admitting the impact of safety factors on reactor planning, Zinn did not think the concern unreasonable. Realistically he observed: "I am inclined to the opinion that for a nation with the land space of ours and with the financial resources of ours, adopting a very conservative attitude on safety is not an unnecessary luxury." [30]

The attempt to centralize reactor development at Argonne had collapsed. One reason was the irrepressible spirit of the scientists at Oak Ridge. Fisk's announcement of the decision during the Christmas holidays of 1947 had been devastating, but a mere declaration of policy could not suddenly halt research that already had momentum. Indicative of the resurgent spirit of the laboratory was the exuberance with which Weinberg was proposing one reactor after another. Moreover, Zinn had weakened centralization further when he insisted upon limiting his authority to activities at Argonne. He did not intend to settle policy questions which were Washington's responsibility. This he made clear on July 23, 1948, in returning to Fisk a sheaf of questions which only Washington could decide. Centralization might have made sense in terms of coordinating research activities; but if it meant that one laboratory was to pass on the proposals of another, then the idea had failed.

ORGANIZATION AND THE NAVY

If the hopes for centralization were now dead, Wilson and Fisk would have to devise some new principle of organization for reactor development. Long before Zinn sent his letter from Chicago, Wilson had been pondering changes in the Commission's organization. He had never regarded the administrative structure as rigid, and he had encouraged comments from such close associates as Fisk and McCormack. Reactor development in particular had never lacked for criticism. At the General Advisory Committee meeting on February 8, 1948, Oppenheimer had spoken of the tension between reality and desire. The continued lack of progress on reactors had only deepened that feeling. On June 5, Oppenheimer had delivered to the Commissioners a stinging indictment of the agency's structure, particularly of reactor development. On this subject Oppenheimer had summed up the attitude of his committee: "We despair of progress in the reactor program." Harsh as these words were, the committee was only adding the force of its prestige and impatience to changes already being planned.[31]

Some of the changes Wilson was considering had come from the Navy's efforts to organize development of a submarine propulsion plant. One of the principal concerns for Mills and Rickover had been the creation of a structure that would give industry a larger role than was possible under the 1948 centralization plan.

In this conviction the Navy officers had support from the Commission's own industrial advisory group, a small number of industry and utility executives who had taken the temporary assignment of surveying the Commission's activities for commercial opportunities. After observing activities at Argonne, Isaac Harter, chairman of the board of Babcock and Wilcox Tube Company, had expressed his concern over the lack of balance between

physicists and engineers in the Illinois laboratory. Unless Zinn brought engineers into the submarine project early, Harter feared that the physicists might overlook the best design for the reactor.[32]

Donald F. Carpenter, also at one time a member of the industrial advisory group, had similar worries. Now serving as chairman of the Military Liaison Committee, Carpenter visited Argonne in August, 1948, along with members of a special committee he had appointed to examine the long-range objectives of the atomic energy program. Like Harter, Carpenter feared that the lack of engineering experience at Argonne would delay the Navy project. Zinn seemed to understand the difficulties of the assignment, but he was wary of bringing private industry into the early design work. Carpenter did not agree that an industrial contractor would necessarily assign mediocre engineers to the project, and he left the discussion with the disconcerting impression that Zinn was not aware of the high priority the Navy had assigned to the Argonne project.[33]

Fully convinced that Argonne needed more engineering perspective, Carpenter was not prepared to let the matter rest until Wilson and Fisk reorganized the Commission's reactor development program. Back in Washington Mills and Rickover cited a lack of Commission interest in the Navy project as the real source of trouble. At Mills's suggestion Carpenter proposed a meeting with Wilson and his staff. The purpose was to convince Wilson that the Commission and the Navy should jointly select one or more companies to start development of the reactor with the understanding that a contract for building the propulsion plant would follow. Mills and Rickover recommended a contract with General Electric, but they also wanted to consider Westinghouse.[34]

Wilson was reluctant to accept the Navy proposals at the meeting on August 25. The general manager and his staff were then deeply involved in the throes of reorganization. These plans included the establishment of a division of reactor development with responsibility for Argonne and reactor work at other Commission laboratories. Wilson hoped soon to appoint a director of the new division, and he wished to delay a decision on the Navy project in the meantime.

A more fundamental objection to the Navy proposal was Wilson's dissatisfaction with General Electric's performance at Hanford. Furthermore, Wilson had received from General Electric a letter stating that the company did not want the Navy project. Wilson's statement contradicted the Navy's understanding of the company's position. Rickover read a statement from Winne that "within the limits of available manpower and facilities the General Electric Company is willing and anxious to design and build a reactor suitable for use in a naval vessel."

When Fisk objected to putting so much reactor effort into naval propulsion, Mills and Rickover pointed to the danger of allowing the experience and knowledge of General Electric to evaporate. The company, they

claimed, was willing to accept the assignment, and Zinn agreed that more than one approach was healthy. When the discussion turned to Argonne, Rickover stated that Westinghouse had authorized him to say that the company was anxious to design and build a Navy reactor.[35]

Obviously the Navy had to clarify General Electric's position. On September 3 Winne and his staff explained to Rickover in Schenectady their plan to complete the intermediate-power-breeder as the first shore-based prototype for the submarine. The company would then construct a second reactor on land or on a ship. If the second were on land, still a third would be needed for shipboard tests.

The open-ended nature of the proposal troubled Rickover. He also saw possible significance in a recent opinion of Carpenter's long-range objectives panel which cast doubt on the prospects of breeding, particularly at intermediate neutron energies. Perhaps the company's strong interest in the Navy project was an attempt to buttress the sagging fortunes of the power breeder. Rickover also realized that intermediate reactors would require more fissionable materials than those using slow neutrons. Thus for a given amount of fissionable material, the Navy could operate fewer submarines powered with intermediate reactors. For all these reasons, Rickover warned Mills not to become too deeply committed to the General Electric proposal. The best course would be to fight for a larger role for the company in the project. Once that struggle was won, the Commission and the bureau could decide where the company should place its efforts.[36]

WILSON DRAFTS A PROGRAM

All these discussions in the spring and summer of 1948 had made Wilson acutely aware of the need for some clear directions in reactor development, and he gave this subject his personal attention. It was not easy to weave into a coherent pattern the strands from Argonne, Oak Ridge, and Knolls, together with those held by the Navy and the Air Force. Wilson decided to confine his analysis to the next two or three years; to predict further was impossible. On production reactors, he called for a major effort for improved development and design. Because General Electric was already so heavily committed, he thought another organization should be assigned to the task.

Wilson found exploration of nuclear power heavily biased toward breeding. Although the growing supply of uranium was making this less important, Wilson thought that Zinn's fast reactor and the Knolls intermediate project were too far along to be canceled. Yet, if Zinn's reactor could not be built at Argonne, the project became less attractive. He concluded that General Electric should push the Knolls reactor vigorously and, if the company could do so without interfering with this project, take on the design and

construction of an intermediate reactor for the Navy. Power reactors fueled with natural uranium Wilson saw as a neglected field, but certainly worthy of study. Production of isotopes was important to many parts of the Commission's program, but analysis was needed to determine whether this purpose justified building a special reactor, or whether existing facilities were adequate. Little was required on the Air Force–NEPA effort except materials studies; certainly design and construction of an aircraft reactor were premature. The Navy effort at Argonne, Wilson thought, was ready for help from Westinghouse on engineering design.

The final reactor in Wilson's survey was the high-flux. Testing materials and proving the technology of controls, coolants, and other reactor components would be the two main uses of the high-flux which, since it was to advance reactor technology, Wilson called the "reactor's reactor." Fundamentally he questioned both purposes. The Argonne and Knolls reactors could be
200 adapted to testing components. Furthermore, the high-flux would not meet all the requirements for testing materials. The reactor itself was of experimental design. Even with top priority, it would be at least two years before operation could begin and even longer before results from testing materials would become available. Wilson thought that possibly a Hanford reactor might be modified to provide the neutron fluxes needed for testing materials. He concluded that there was no reason to rush into acquiring perhaps 400,000 acres for a remote proving ground.

Wilson also wanted to investigate the need for an isolated chemical separation plant to process used reactor fuels. He saw a vigorous reactor program as dependent upon a variety of research and development efforts in several locations, all coordinated in a definite program. Wilson sent his summary to the program council on September 20, 1948, in preparation for later talks with Zinn.

On the same day Bacher directed a memorandum on reactor development to his fellow Commissioners. He admitted that progress had been disappointing and slow; the reasons he found were at least partly technical. Effects of radiation, corrosion, and high temperatures upon materials, to name but a few difficulties, had proved far more serious than expected. In addition, he believed that preoccupation with producing fissionable material and weapons had preempted talent which might otherwise have been used to attack reactor problems. Bacher saw progress in the two new production reactors at Hanford which incorporated several technical advances. The Los Alamos fast reactor was providing important information for this type, and the Brookhaven research reactor was nearing completion. Nonetheless, the need for a reactor development program was pressing. The main parts of this effort he saw as the high-flux, the submarine reactor, the Zinn fast breeder, and the Knolls intermediate breeder. Unlike Wilson, Bacher deemed the high-flux reactor urgent and, because of the restrictions established by the reactor safeguard committee, felt that a proving ground was imperative. Above all Bacher wanted to avoid protracted discussions.[87]

Wilson asked Zinn on September 28 to come to Washington. The two men spent much of Saturday, October 2, discussing reactors. On October 5 Wilson lunched with Bacher. That afternoon Wilson spent in the recesses of the Cosmos Club on Lafayette Square where, in the rooms once known to Dolley Madison, he recast his reactor program. Many of his ideas of September 20 remained, but the influence of others was evident. On materials testing, the possibility of using Hanford reactors was to be studied, but the high-flux reactor—now designated the materials testing reactor—was advanced to the status of a major project. From the higher standing of the high-flux, it followed naturally that the remote proving ground gained importance. Specifications, plans, and surveys were to begin at once on a schedule permitting the Commission to exercise a choice by February 1, 1949.[38]

For further advice Wilson met in New York on October 11, 1948, with Whitman of the Lexington project; Oliver E. Buckley, president of the Bell Telephone Laboratory and a new member of the General Advisory Committee; Crawford H. Greenewalt, president of du Pont; Charles A. Thomas of the Monsanto Chemical Company; and Eger V. Murphree, president of Standard Oil Development Company.

Wilson wanted candidates for the position of director of reactor development, and opinions on his program. Greenewalt sent his impressions to Wilson a few days later. He thought that chemical problems were far more important than Wilson had indicated; such at least had been the du Pont experience during the Manhattan days. Nor did Greenewalt believe there were enough competent physicists and engineers available to man so many reactor projects. Zinn, for example, would be saddled with three reactors. Zinn was undeniably competent, but he might be spreading himself so thin that none of his projects would go well.[39]

Wilson had done nothing to relieve the uncertainty at Oak Ridge. Disturbed by the lack of information from Washington, Franklin finally wrote Wilson on October 14 to request that he or someone from Oak Ridge be present during the final discussions. He wanted to understand the basis for the decisions, and he obviously felt that the laboratory was receiving shabby treatment. Nearly a year had elapsed since the Commission had stripped Oak Ridge of the high-flux reactor. Still the Commission had not decided whether to build the reactor, where to put it, or who would undertake the task.[40]

A QUESTION OF SAFEGUARDS

Wilson's efforts to chart a course for reactor development would help the laboratories judge the feasibility of their own plans; but Argonne, Oak Ridge, and Schenectady could not move much beyond the planning stage until the Commission somehow settled on criteria for determining where the proposed reactors might be safely operated. Experience had shown that these

questions were highly technical and very complex. If there were to be answers, they were mostly likely to come from Teller and the reactor safeguard committee, which would meet in the fall of 1948.

Zinn's first concern was reactor power levels at Argonne. He wanted to know what the committee would accept for a fully moderated thermal reactor and for a research reactor based on the high-flux design but with additional safety features. Would the safeguard group object to a high-flux research reactor operating at 2,500 kilowatts? Zinn suggested the committee focus on reactor operations at Argonne, for he did not intend to build a chemical processing plant at his laboratory.[41]

The Oak Ridge group hoped the committee would consider a 3,000-kilowatt, high-flux research reactor which could be modified to reach the original design power of 30,000 kilowatts. As Weinberg pointed out, the committee had never been asked to evaluate reactors at Oak Ridge. Bacher
202 and Fisk asked Weinberg to prepare data for the September meeting of the Teller committee and to assemble information on costs, schedule, and engineering requirements for the Commission and the General Advisory Committee. While all of this was encouraging, Weil could not promise that the committee would take the time for a formal answer.[42]

Schenectady was pressing for approval of a nearby site for the intermediate-breeder reactor. According to Kingdon, preliminary grading at the site should soon begin if the reactor were to go into operation in late 1950. In November, 1947, the reactor safeguard committee had flown over possible sites near Schenectady. The one Suits liked was about twenty miles north of the city, near the village of West Milton. For an independent opinion Wilson had turned to Carleton Shugg, manager of the Commission's Hanford office. Shugg's comprehensive site study, completed on July 30, 1948, had confirmed the advantages of West Milton. Winne asked for authorization on September 7 to acquire the site and begin construction.[43]

Kingdon, with help on theoretical problems from Harvey Brooks, had prepared an impressive report on the intermediate reactor. The critical assembly, located at Sacandaga near Schenectady, was functioning well and providing what both men hoped would be all the nuclear data required, not only for the specific intermediate reactor under design, but also for others of the same general type. Experimental work was under way on two types of fuel, and the laboratory, while slightly behind schedule in exploring the qualities of the sodium coolant, was encountering no real difficulty. The only somber reports came from Hanford, where radiation tests were casting some doubts on the possibility of breeding at the neutron energies planned for the intermediate reactor.[44]

The reactor safeguard committee was also to consider Zinn's suggestion that the Commission acquire a remote proving ground. One of the most promising possibilities was uncovered by Carl H. Giroux, a special assistant to the Chief of Engineers of the Army who had served as consultant to the

safeguard group. Giroux in June, 1948, suggested the Fort Peck area in northeastern Montana. Population density was low, the land was generally poor for farming or grazing, water was abundant, and electric power was available from the Fort Peck dam. Zinn guessed that perhaps five reactors might be built on the proving ground over the next ten years. Perhaps an area of about 100 square miles would be needed for a number of reactors which might total 500 megawatts. Water and power supplies he found difficult to estimate; some reactors might require comparatively little cooling water and some might even produce power. The only danger Zinn saw was that the Commission, by assuming large numbers of reactors and no improvements in the handling and disposal of chemical wastes, might draw up requirements so rigid that no place in the United States could satisfy them.[45]

On September 8, 9, and 10, 1948, the reactor safeguard committee studied documents, heard briefings, and discussed the thorny problems of reactor safety. Perhaps the easiest of the subjects was the testing ground. Acknowledging that nearness of population centers had conditioned their earlier considerations of reactor projects, the committee over Teller's signature formally recorded itself "most enthusiastically in favor" of a large and remote proving ground.[46]

Not so easy were the questions which Zinn had asked. After four hours of deliberation, Teller presented a statement which, he remarked, was not what the committee wished to say, but what it was forced to say. In the light of existing knowledge, the committee was not likely to recommend a reactor power level at Argonne greater than 1,000 kilowatts. In dismay, Huffman searched for ideas that might have permitted a higher power level. The committee could only suggest better automatic and foolproof safety devices, but these would have to be demonstrated. To Huffman this response amounted to suggesting construction of a 1,000-kilowatt reactor to demonstrate the devices before building at Argonne a 1,000-kilowatt reactor with the devices. The only grounds the committee could see for increasing the power level would be a directive from the Commission stating that the international situation required more risks. The committee, explained Teller, was uneasy over hazards within 12 miles of a reactor operating at 1,000 kilowatts, and afraid of potential danger within 24 miles of a 4,000-kilowatt reactor. Although the committee would not take the responsibility for recommending a higher power level, they believed that a 1,000-kilowatt reactor—perhaps more than one—could be built at Argonne. Only the preceding April, Zinn had told the General Advisory Committee that, based on his interpretation of the safeguard criteria, a heavy-water-moderated, natural-uranium research reactor of 5,000 kilowatts or a high-flux reactor of 1,600 kilowatts would be safe for Argonne.[47] Now he faced restrictions which left him less leeway.

Because the agenda was full, the committee refused to consider the question of building the high-flux at Oak Ridge, but Weinberg now proposed two sites in the Cumberlands some 20 miles from the gaseous-diffusion plants.

How, he asked, would the committee compare a 2,000- to 4,000-kilowatt research reactor at the laboratory with a 30,000-kilowatt reactor at one of the Cumberland locations? Teller replied, speaking only for himself, that the larger reactor 20 miles from the laboratory would be more likely to receive approval.[48]

General Electric's West Milton site raised two questions for the Teller committee: one on general zoning regulations for reactors operating at considerable power levels, and another on applying these standards to West Milton. In the abstract, the committee decided that two concentric zones should surround each reactor site. The zone nearest the reactor would be a controlled area—one in which an accident could cause acute danger. While the radius of the controlled zone could be determined by a formula based on power operating level, such was not the case for the second zone. Designated the "hazard area," this zone was determined by the type of reactor and by meteorology, hydrology, and seismology. Within this zone the danger from an accident was considered small; thus population and industry would not be excluded. Applying these criteria to West Milton, the committee recognized that Schenectady, Albany, and Troy would be at the outer edge of the hazard zone. More development work on the reactor would be necessary before the committee could give its final judgment, but the West Milton site looked acceptable.[49]

STRUGGLING TOWARD DECISIONS

The reactor safeguard committee had been helpful on technical matters, but the policy decisions would still be difficult. The reservations the Commissioners expressed on September 10 in approving the West Milton site illustrated some of the problems. General Electric's proposal was clear enough and seemed to meet the technical criteria which Teller's committee had established. Assurance of safe and effective operation, however, seemed to involve other matters. Waymack suggested the need for frequent safety reviews, and Bacher urged the Commission to ask General Electric for a formal statement that the company had approved the site. Lilienthal was so concerned that he insisted upon discussing the company's views directly with Winne and Suits. On September 21, Lilienthal warned Winne that approval of the site was not a commitment to build the reactor. Bacher expressed his concern that operating restrictions imposed by the location at West Milton might limit the value of the project. Strauss added his view that the Commission would not let financial commitments override considerations of safety. General Electric could hardly interpret the Commission's action as a blanket approval of the proposal.[50]

The committee's recommendation of a remote proving ground raised

new questions about the high-flux. Weil suspected that engineers would be more likely than physicists to use the reactor at a remote site. This thought suggested the possibility of redesigning the reactor to make it more useful for testing materials, and dropping some of the proposed facilities for basic research. Informal conversations convinced Weil that others shared his reservations. Only after a long meeting with twenty-six other reactor experts in early October did Weil decide that the basic design was adequate.[51]

Weinberg himself had introduced a new uncertainty by proposing to build a 15,000-kilowatt model of the high-flux in the nearby Cumberland mountains of Tennessee. On October 11, Weinberg told Shugg, now in Washington as deputy general manager, that building the high-flux at a remote site would result in still another Commission laboratory and place still greater demands on the limited supply of skilled manpower. The meeting did nothing to raise Weinberg's hopes. It seemed to him that Washington meddling had plagued the high-flux from the start. Now he heard rumors that Zinn was losing interest in the project, which supported almost a hundred scientists and technicians at Oak Ridge. The next day Weinberg wrote Zinn to suggest that the two laboratories carry the high-flux as a joint venture, with as little intervention as possible from Washington.[52]

The decision, when it came, offered Weinberg some consolation. True, the high-flux would be built at a remote testing station, but the project would be a joint effort of Argonne and Oak Ridge. Weinberg's group at Oak Ridge would be responsible for the design; Argonne would take over engineering and construction. Franklin was disappointed when he received the news from Wilson by telephone on October 29. Oak Ridge had lost the high-flux and would have only a secondary role in its development. He feared a loss of morale and the departure of most of the Oak Ridge physicists engaged in basic research. Only after a few days' reflection could he appreciate the fact that, after all, the high-flux would now be built and that Oak Ridge would have a part in it.[53]

Zinn and Weinberg promptly set up a three-man steering committee under McLain to direct the joint project. The selection of McLain was Zinn's decision, for Wilson and Weil knew little about him. Reporting to McLain were Marvin M. Mann of Oak Ridge and Huffman of Argonne. Both were thoroughly familiar with the high-flux and were to serve as project leaders at their respective laboratories. Mann's speciality was gathering nuclear data through critical assemblies, while Huffman's concern was design, materials testing, and procurement. McLain, Mann, and Huffman had the immediate responsibility; Zinn and Weinberg would resolve any differences. The organization was ready but, as Zinn warned Shugg, effective work could not begin until a site was chosen.[54]

The Commission was moving toward selecting the reactor proving ground. Ralph P. Johnson had outlined site requirements for the program council on September 17, 1948. First among the reactors Johnson listed the

high-flux, followed by reactors for isotope production, Navy propulsion, and breeding, and finally and far into the future, for aircraft propulsion. The council estimated requirements for water, electric power, and fuel processing facilities. During the fall of 1948 the division of engineering under Roger S. Warner studied a score of sites. Of these the most promising seemed to be Fort Peck, Montana. Secretary of the Interior Julius A. Krug, a friend of Lilienthal's from TVA days, saw no objection to Fort Peck, provided the reservoir and Willow Creek would not be contaminated. Admiral John E. Gingrich of the division of security found Fort Peck reasonably secure from air and ground attack. The reactor safeguard committee found Fort Peck the best choice, but warned that no site on any main river system was desirable unless provision were made for containment or disposal of radioactive wastes.

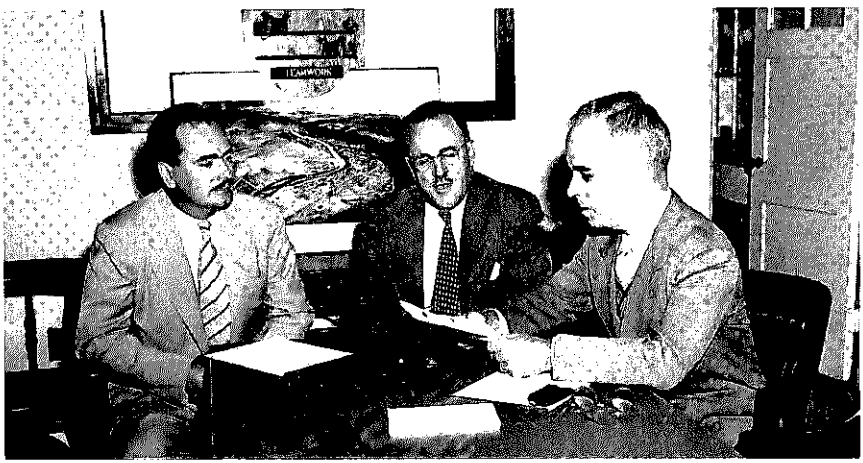
Impatient of delay, Shugg was ready to accept Fort Peck even though
206 Zinn was still dissatisfied and was looking for a location closer to Los Alamos. The main thing in Shugg's mind was to get started on construction. Despite his efforts, the Commission failed to act before the end of 1948. By that time Warner had been able to draw on other Government agencies for ideas, and the U. S. Geological Survey had found several advantages in a location near Pocatello, Idaho. Now, as Shugg feared, there would be further delays. In the meantime, development work was picking up on the fast-breeder, the high-flux, and the submarine reactor, all of which were destined for the testing station. The Commission had taken some forward steps in deciding which reactors it would build, but the failure to select the remote site posed a continuing threat to steady progress in reactor development.[55]

A REACTOR FOR THE NAVY

As Rickover was probing the role of General Electric in the Navy effort during the late summer of 1948, Harold Etherington completed a preliminary study of a water-cooled reactor. Most of the data he had gathered as director of the power pile division at Oak Ridge. He had focused the effort on a submarine reactor which could be constructed by using conventional industrial techniques as much as possible. Analyzing calculations and test results from several sources, Etherington and his group concluded that a water-cooled thermal submarine reactor was feasible, provided they could master problems of control, corrosion, fuel element fabrication, shielding, and the breakdown of water under irradiation. Except perhaps for the design of reactor controls, the selection of metals for reactor components promised the greatest challenge. Metals for structural parts would have to absorb few neutrons, resist corrosion, and maintain integrity under irradiation. The same desirable qualities were needed in fuel cladding. For both uses, beryllium and

WIDE WORLD

SEEKING AGREEMENT ON ANGLO-AMERICAN COOPERATION / David E. Lilienthal meets with Secretary of Defense Louis A. Johnson (center) and Secretary of State Dean G. Acheson (right) on July 27, 1949, before a hearing with the Joint Committee on Atomic Energy.



ROBLEY L. JOHNSON

COMMISSION OFFICIALS AT HANFORD, SEPTEMBER, 1949 / Deputy General Manager Carleton Shugg (right) discusses production matters with Hanford Manager Frederick C. Schlemmer (center) and Deputy Manager David F. Shaw.

WIDE WORLD

PRESIDENT TRUMAN GREETS PRIME MINISTER ATTLEE, DECEMBER 4, 1950 / Attlee arrives in Washington to discuss the atomic bomb and Korea.

UNITED PRESS INTERNATIONAL

OLD FRIENDS, JANUARY 5, 1952 / Truman and Churchill at the Washington National Airport. The British leader had come to discuss several aspects of Anglo-American relations, among them atomic energy. Foreign Secretary Anthony Eden stands on the steps.

zirconium were the leading candidates. On the basis of available data, beryllium seemed to possess the best nuclear properties while zirconium appeared more resistant to corrosion. As yet Etherington had no grounds for selecting one over the other.[56] Moreover the study was admittedly preliminary, and Argonne was still considering other coolants.

The Westinghouse Electric Corporation was the logical choice as the industrial contractor to develop a pressurized-water submarine reactor. The company had long been interested in entering the nuclear energy field. In June, 1948, Westinghouse had signed a contract with the Bureau of Ships for Project Wizard, a heat-transfer study based on water. Project Wizard was somewhat similar to General Electric's Project Genie, a study of sodium as a heat-transfer medium. Rickover and Mills had thought of bringing in a third company—perhaps Allis Chalmers—to work on a high-pressure gas-cooled reactor, but Wilson was hardly prepared to go so far. In his thinking, Westinghouse development of a water-cooled reactor was the main effort for the Navy.[57]

Zinn had long understood that after Argonne had designed a water-cooled reactor, an industrial contractor would take on detailed engineering, construction, and operation. But Zinn saw Navy pressure and the Westinghouse-General Electric rivalry as forcing the pace of development. He wanted to be certain that Westinghouse did not weaken the growing competence of Etherington's Navy group. Furthermore, Zinn wrote Shugg on November 8, "There is some justification for the opinion that the reactor program has in the past lacked sufficient firmness and concreteness of purpose." Zinn thought Argonne had gone far toward remedying this situation, and he did not want to see the gains jeopardized.[58]

Not until December 10 did Charles H. Weaver of Westinghouse sign a letter contract committing the company to construct a thermal submarine reactor propulsion plant, designated as Mark I. Westinghouse had already surveyed the Pittsburgh area for a suitable plant site and had selected the Bettis airport, some 8 miles from East Pittsburgh.[59] The company understood that the first Navy reactor would be a land prototype built somewhere on the Western plains.

While Westinghouse, the Navy, and the Commission had reached agreement, General Electric's role was still uncertain. During the fall of 1948, Kingdon and Suits had proposed to continue work on the intermediate breeder and to add the construction and testing of a full-scale mock-up of a submarine power plant. Experience from both projects would help the company in building a full-scale reactor system which, for greater flexibility, would be placed on a surface ship. Both Shugg and Rickover questioned the proposal and wondered if it were motivated in part by a desire for more laboratory facilities. In Schenectady on December 9 Rickover convinced General Electric to postpone the decision on whether to build the land- or ship-based unit. In the meantime, the company would prepare cost estimates

and schedules for both an intermediate reactor and a thermal-neutron plant for submarine propulsion.[60]

To a certain extent Shugg's actions were properly those of a director of reactor development. Blunt, plain-spoken, decisive, and energetic, Shugg possessed qualities needed for the task. Wilson considered the arrangement temporary, but he was finding it easier to get Commission approval for the reactor program than to recruit a director to carry it out.

A DIRECTOR AND A PROGRAM

Wilson presented his reactor proposals to the Commission on October 19, 1948. He had built his plan around four projects: the materials testing
208 reactor, as the high-flux was now known; the Zinn fast-breeder; the intermediate breeder at Schenectady; and the Navy-Argonne submarine propulsion reactor. Three of these would be constructed at the remote proving ground. Wilson noted that General Electric's cost estimates for the intermediate breeder were increasing and included some facilities which he and McCormack thought unnecessary. Furthermore, Navy interest in a General Electric project could add to the Commission's capital outlay. Bacher favored resisting the Navy pressure and holding General Electric to the intermediate reactor. On the aircraft propulsion reactor, Wilson promised to make recommendations based on the September report of the Lexington group. Oak Ridge, however, could carry on some experimental work.[61]

The General Advisory Committee considered Wilson's plan in late October, 1948. At Oppenheimer's suggestion, the members divided the subject into categories: aircraft reactors, the testing ground, and the over-all program. Conant and Oppenheimer thought a joint Commission–Air Force organization was decidedly premature. They were still not convinced that a nuclear-propelled aircraft was important. In the fifteen years of expensive development forecast by the Lexington report, many factors such as new metals or more powerful chemical fuels might lessen the urgency of nuclear propulsion. In view of the high cost in manpower, fissionable material, and money, the committee agreed with the Lexington group that the decision should be a matter of national policy. On Navy reactors Buckley spoke the mind of the committee in observing that one project was enough for the present. Wilson's remarks on a testing ground evoked no enthusiasm.

All of the committee felt that the Teller group had exaggerated the consequences of a reactor accident and perhaps without adequate justification had retarded reactor development. Fermi warned against separating reactor operation from development. He recalled that such a division had almost led to failure during start-up of the Hanford reactors in 1944. Perhaps, however, organizing the testing station as a branch of a reactor development laboratory

could lessen the evils he foresaw. To Oppenheimer and the rest of the committee, Fermi's idea seemed sound: obviously Argonne should be closely linked to the testing station.[62]

The committee accepted the Commission's program, but without enthusiasm. For Fermi reactor development had lost its savor. The exciting and zestful days when a small group of men could plan, design, and operate a reactor to perform their own experiments were passing, and in their stead were mounting numbers of regulations unleavened by any measure of vigor. It was not strange that he should feel this way. He, like most members of the General Advisory Committee, could recall the excitement of years when vision and daring had brought so much. Against this past he saw the Commission's program marked by caution, hesitancy, and weakness.

The advisory committee had helped Wilson to clarify his ideas. Before seeking a final approval from the Commissioners, he decided to add a study of a homogeneous reactor. For months Weinberg had been pressing hard for exploration of a homogeneous system, in which the fuel would be fissionable material carried in a circulating slurry. This approach avoided the high cost of fabricating fuel elements and offered the possibility of continuous chemical processing of the fuel. The main difficulty would probably lie in finding some material for the reactor vessel and piping that would withstand the highly corrosive fuel slurry. Another potential problem was bubbling, which might occur if the fissionable material concentrated unevenly in the slurry and caused hot spots. Still, the potential benefits of the homogeneous system seemed to outweigh the disadvantages. Furthermore, including the reactor would give Oak Ridge an interesting new project.[63]

The Commission approved Wilson's reactor plan on November 10, 1948, but not without some qualifications. Bacher advised Wilson to make sure that the laboratories understood the difference between the four reactor projects and other studies. He was thinking especially of the Navy study at Schenectady and the aircraft work at Oak Ridge. The Commission would provide reasonable support for these efforts, but they could not be permitted to interfere with the four-reactor plan.[64]

Wilson was having difficulty finding a director of reactor development. He enlisted the aid of others but the uniform failure of his efforts was depressing. To Murphree, Wilson wrote on December 17: "Personally, I have found it very discouraging that there seemed to be so few people with the necessary qualifications and the pioneering urge among the many industrial people with whom I have discussed this matter and whom I have considered." The solution was nearer at hand than Wilson realized. Lawrence R. Hafstad was growing weary of his position as executive secretary to the Research and Development Board.[65] Wilson, McCormack, Fisk, and Johnson knew of Hafstad's restlessness and of his qualifications as a physicist and as director of research at the Applied Physics Laboratory of Johns Hopkins University. Their persuasions had been unsuccessful until Admiral Mills learned of the

matter. To Mills, Hafstad had two important qualifications. He had been an able executive secretary and, perhaps even more important in the Admiral's view, believed in the need for a nuclear submarine. Hafstad, convinced of the importance of the position, accepted Wilson's offer of January 12, 1949. It was virtually Mills's last effort to advance Navy reactors. In ill health, he was forced to resign in March, 1949.

SELECTING THE IDAHO SITE

Hafstad's first assignment from Lilienthal was to examine the plans for a testing station. To help in the final choice between the Idaho and Montana sites, Warner had brought in a Detroit engineering firm, Smith, Hinchman and Grylls. After comparing such factors as isolation, drainage, climate, and population, the Detroit firm early in February, 1949, issued an opinion favoring Pocatello. A formal report, containing more data, would follow but the first evaluation would enable the Commission to act.

If the Commission could acquire the Navy reservation near Pocatello, active site work for the materials testing reactor could begin within the year. On February 14, the program council recommended that the Commission acquire the Navy land. Teller's committee had already studied the topographic, seismic, and meteorological reports of the Idaho area and concluded formally, on February 17, that Pocatello was acceptable. The following day the Commission approved the location. Strauss, with his Navy connections, felt confident that the chief of the Bureau of Ordnance, under whose jurisdiction the Navy was operating its Pocatello site, would prove reasonable. The only jarring note, and that in a minor key, was that Senator Brien McMahon, the new chairman of the Joint Committee, had learned only recently of plans for the site. The Commission, mainly through the explanations of Bacher and Shugg, was successful in smoothing McMahon's sensibilities in an executive session on March 14.

Shugg as always was anxious to move ahead. The testing station, he pointed out to the program council, was the Commission's first major field enterprise, and he wanted careful planning. Hafstad, who was well satisfied with Warner's work on the site selection, asked him to handle organization and planning. Warner's main obstacles were the Navy, which was reluctant to release the land, and the Montana Congressional delegation, which deplored the Commission's choice of the Idaho site. In an effort to settle the issue, the Commission issued a press release on the Pocatello site on March 1 and announced on April 4 that Leonard E. Johnston, then manager of the Commission's Schenectady office, would be the new manager at Idaho. Montana, however, was not ready to give up.

In response to the Montana complaints, the Joint Committee held open hearings on April 14 and May 10 to question the Commission and Smith, Hinchman and Grylls. After bringing out the fact that until the survey the Montana site had been the favored choice, Senator James E. Murray introduced affidavits to show that the company's representatives had been in the town of Glasgow, near Fort Peck, for but a single snowy day in January when a visit to the site was impossible. Embarrassing as the situation was, however, the selection of Pocatello was never seriously threatened. In May, 1949, the Commission selected a contractor to drill a test well for fresh water at the Naval Proving Ground near Arco, Idaho. Within a week the Idaho Falls newspaper jubilantly announced that Johnston would soon establish his headquarters in the town's best hotel. Now all the Commission had to do was acquire 400,000 acres of Idaho desert, about half of which was still held by the Navy.[66]

IMPLICATIONS OF THE LEXINGTON REPORT

One subject Hafstad could not long avoid was the aircraft reactor. Wilson had asked William Webster of the Military Liaison Committee on December 8, 1948, for military justification of a billion-dollar, fifteen-year effort to produce the first nuclear-powered aircraft. Aircraft nuclear propulsion, and particularly the NEPA effort at Oak Ridge, had been a subject capable of rousing strong emotions. In the summer of 1948, Carpenter, then chairman of the Military Liaison Committee, had reported that NEPA personnel had damaged their own cause by appearing critical of the efforts of others, assertive and argumentative in defense of their own. Oppenheimer and Conant had delivered a stinging rebuke to the Air Force and NEPA at a December meeting of the committee on atomic energy of the Research and Development Board. Turner A. Sims, vice-president and general manager of NEPA, had described the rationale of the project: "No matter how large our stockpile of atomic bombs may be, this stockpile would become the tragic Maginot line of forlorn hope, if the bombs remained undelivered over the targets where they would damage the enemy's war-making capacity to the utmost." Such a contingency could arise, Sims declared, if American overseas bases were lost.

William L. Borden, executive director of the Joint Committee staff, had read the Lexington report with interest. In his view, unless a formal commitment were made to go ahead with a nuclear aircraft, very little would be done. What, he asked Hafstad on March 24, 1949, was involved in implementing the Lexington recommendations? What if NEPA were given an overriding priority? Hafstad called for perspective. The Commission was

doing research and development for the project while waiting for a reply on the military justification. A crash program, Hafstad believed, would shorten the time to nuclear flight only a little, and would disrupt the rest of the reactor effort. A carefully balanced program, he thought, could supply for the next few years the required information for an aircraft reactor.[67]

ARGONNE AND WESTINGHOUSE

On December 16, 1948—six days after Westinghouse accepted the assignment to work with Argonne on the submarine thermal reactor—Zinn met with industry and research representatives to discuss fabricating fuel elements. The two best metals for cladding were beryllium and zirconium. The chief difficulty with beryllium was getting a sound billet. The major cause of cracks in extruded billets seemed to come from impurities in the ingots; perhaps careful quality control was the answer. Zinn saw zirconium as possibly superior in metallurgical and mechanical qualities, but its nuclear properties were still not well known. For both metals, high purity was essential.

The question of cladding material was still open on February 17, 1949, when Etherington laid out a work schedule for the project. Because Argonne's assignment called for studies of liquid-metal-cooled, gas-cooled, and water-cooled reactors, Etherington had decided to carry out a three-phase effort for each type. The first phase would be a survey to reveal critical areas for research. In the second phase these areas would be examined in some detail to determine the extent of the work needed. From this analysis Etherington thought it would be possible to choose one reactor. The final phase would be a detailed report from which an engineering company could make working drawings and build a land-based prototype. It was not necessary that all phases for each reactor begin and end simultaneously, but as Etherington saw the schedule, a preliminary choice should be possible during September, 1949.[68]

Etherington and the power pile division had completed a preliminary study of a water-cooled reactor in September, 1948, and similar but less elaborate reports followed on other possibilities: helium-cooled, beryllium-moderated; sodium-cooled thermal; and bismuth-alloy-cooled. The trend toward water-cooled reactors was evident from the Westinghouse work on heat-transfer characteristics of water and a list of assignments Etherington recommended on May 12, 1949, for the company. He included corrosion tests of beryllium and zirconium, as well as other materials, at the temperatures, water velocities, and heat fluxes expected in the naval reactor. Control rod and systems development, pump testing, and reactor mock-ups to check thermal stress in fuel elements and cores, were some of the other areas which Argonne should prepare to turn over to Westinghouse.[69]

SHIFTING GOALS AT SCHENECTADY

While Argonne and Westinghouse were developing the Navy propulsion system using thermal (or slow) neutrons, and Argonne was also working on the fast breeder, General Electric at Schenectady was concentrating on a reactor using neutrons in a carefully selected intermediate energy range. The approach had certain attractions. Unlike the thermal reactor, the intermediate type promised to breed more fuel than it consumed, an advantage of no mean importance because of the shortage of uranium. Further, the core would be larger than the fast reactor's, a feature which would make easier the removal of heat for use in producing power. As Brooks had explained at a colloquium in March, 1948, preliminary data—all that were available—showed that neutrons of slightly higher velocity than thermal avoided capture by plutonium; this process, since it did not cause fission, did not directly produce energy.

Experiments at Schenectady, however, did not demonstrate the expected breeding advantages at relatively low neutron energies. A group under W. Rudolph Kanne had irradiated special foils of plutonium in the Hanford reactors. Both the irradiation and the chemical and nuclear analysis of the foils took months of exacting work, and preliminary results were not encouraging. Thoma M. Snyder and another group of General Electric scientists had exposed foils to neutrons within the critical assembly for the intermediate reactor at Sacandaga. These results too were disheartening.[70]

During the irradiation experiments, General Electric was also developing pumps and fuel elements and investigating the characteristics of sodium as a heat-transfer medium. Henry Hurwitz, Jr., was directing research on a fuel element in which a ring of uranium was set in a wafer of beryllium, a series of rings and wafers making up the active part of the fuel. The idea was interesting because it used beryllium both as a moderator and as a structural element. Another team, under Kenneth A. Kesselring, was exploring an approach in which uranium was placed in small pin-like tubes. These pins were spun at high temperatures above the melting point of uranium so that the metal would be evenly distributed over the inside wall of the pin.

As General Electric's search for an advantageous neutron energy moved toward the higher end of the energy spectrum, the reactor's value for power generation declined. This fact left the Commission with the question of whether the necessary research on fuel element and component development was worth the effort. After studying the feasibility report which General Electric submitted in early 1949, Weil raised two questions for Hafstad. Should the company slow down its design and construction work on the breeder until the data were conclusive? If, as appeared likely, breeding was not feasible, how important was the project? [71]

Kingdon saw several reasons to continue development of the intermediate reactor. It could be useful in exploring breeder possibilities for much larger reactors, testing fuel elements, generating electricity for a utility system, and providing engineering data for a Navy propulsion reactor. By May, 1949, Zinn and Weinberg completed their analysis of the General Electric report. To Weinberg the difficulties the intermediate-breeder reactor had encountered strengthened his confidence in the homogeneous reactor, which Oak Ridge was then developing. Zinn took a different view. Observing that the Commission's efforts had so far accomplished little, he concluded: "Temporizing on decisions because not all of the corners have been swept out, because our program doesn't stand on the highest imaginable hill of endeavor, may at the moment not be the sensible thing to do." He thought the Commission should authorize the reactor.[72]

PROGRESS ON THE MATERIALS TESTING REACTOR

Although the Schenectady project was in trouble, the materials testing reactor under the leadership of McLain and the steering committee appeared under control. There were technical difficulties, but these were part of any reactor project. The most critical matter was the beryllium metal for the reflector. At Oak Ridge, Peterson, scanning the reports of his technical division, found that the breakage rate of extruded beryllium shapes was unacceptably high. The continued failure to find a solution was ominous. Broken surfaces, whether from machining or from hidden defects, would increase the rate of corrosion. Corrosion products could block the flow of cooling water through a few passages and cause a dangerous increase in temperature.

On November 1 and 2, 1948, at New York and Boston, personnel from Oak Ridge, the Commission's New York office, and MIT explored the matter of quality control and coordination. As improved measures were put into effect, and as Kaufmann at MIT continued to experiment with extrusion techniques, Oak Ridge restudied the reactor design. Changing the dimensions of the basic beryllium units composing the reflector might at least ease fabrication difficulties. But to solve them McLain's steering committee turned to James L. Gregg, professor of metallurgical engineering at Cornell. On February 18, 1949, in Hafstad's office Gregg discussed strategy with McLain and others who were struggling with the problem. According to Mann's schedule, if the materials testing reactor were to become fully operational in early summer of 1951, extrusion of beryllium had to begin by mid-September, 1949.

The two major problems were casting sound ingots and extruding them into billets. Kaufmann noted improved efficiencies in the Commission-owned beryllium metal casting facilities at the Beryllium Corporation plant at Reading, Pennsylvania. For better extrusions Gregg suggested using a 2,750-

ton press in a war surplus magnesium plant at Adrian, Michigan. Some agreed with Weinberg that less powerful presses would be adequate, but Kaufmann, who had wrestled with the problem for some time, sided with Gregg. The more powerful press might be needed to meet the construction schedules, particularly if development work indicated the need for high pressures. By mid-May, 1949, Mann was able to report that initial results at Adrian seemed encouraging. Of growing interest was the fact that improvements in powdered and pressed beryllium metallurgy might offer another production method [73] in which great flexibility of shapes might be possible.

Although the technical difficulties seemed to be yielding, the confusion in Washington was continuing. In early January, 1949, Bacher returned from a visit to Chicago and reported that Zinn was worried about selecting a contractor for the reactor. Oak Ridge was inclined toward a choice which Bacher felt was not strong; in his view only General Electric or du Pont possessed the necessary capability. General Electric, however, was already heavily engaged in Commission work. To Shugg's inquiry, Greenewalt of du Pont on January 7, 1949, would only promise that Granville M. Read, the company's chief engineer, would review the plans. Read sent men to Oak Ridge to interview Huffman and McLain and to inspect the mock-up. After studying Read's report, Greenewalt telephoned Shugg on February 28 that Read's cost estimate was far too low. The following day Wilson and Shugg went to Wilmington where Greenewalt told them the reactor would cost more than it was worth and probably was not reliable enough for continuous operation as a testing facility. The Commissioners listened sympathetically to Wilson, Shugg, and Hafstad on April 7. Even admitting, as Bacher believed, that du Pont was looking for more maturity and dependability than could reasonably be expected in an experimental reactor, the company's conclusions could not be disregarded.[74]

Hafstad had already suggested to Zinn a meeting of leading reactor personnel at Argonne to discuss feasibility and costs. To Zinn a better place was Oak Ridge, where the mock-up could be used to illustrate the size and scale of some of the parts. In preparation McLain gathered the various cost estimates, including those of du Pont and one made by his steering committee. The difference was striking. The du Pont estimate was $51.6 million, compared with the $18.1 million estimate of the steering committee. Zinn opened the two-day Oak Ridge meeting on April 25, 1949, by outlining the intention to build simply and add facilities as needed. Weinberg covered the nagging question of the dimensional stability of the fuel assemblies. Two days of talk and a successful demonstration of the mock-up satisfied nearly everybody that more experimentation was not worth while; the next step was to build the reactor.[75]

One who remained unconvinced of the need for the materials testing reactor was Charles W. J. Wende of the General Electric operation at Hanford. Wende did not believe the reactor would be finished in time to help

the Navy project at Argonne, the Zinn fast breeder, or the intermediate reactor at Schenectady. The urgency of the materials testing reactor he saw as the result of Oak Ridge zeal. He believed the Hanford capabilities were being overlooked because of the Commission's policy of assigning research and development work to the national laboratories. The Commission would do well, Wende wrote Hafstad, to use Hanford research facilities and talent and to postpone the materials testing reactor until a hard-bitten survey could clearly show the need for the project.[76]

While Wende had doubts, Oak Ridge had none. From the view of the laboratory personnel, the meeting had been an outstanding success. The mock-up had worked perfectly, demonstrating not only the control and hydraulic systems, but also the important fact that Oak Ridge had overcome the confusion and uncertainty of earlier years. The Commission had also promised the laboratory a nuclear reactor of modern design, a commitment not yet fulfilled. Casting up these reasons, along with the potential savings in money and personnel, Rucker and Weinberg decided to reopen once again the question of building the reactor at Oak Ridge. Weinberg felt diffident since he was working with Zinn as a partner on the project. Yet Weinberg thought that if the savings in money and time were real, Zinn would accept the proposal. Over the signature of George T. Felbeck, vice-president of Carbide, Oak Ridge sent its arguments to Wilson on May 19, 1949.[77]

SUMMER APPRAISAL

By the summer of 1949, Hafstad was fully aware of the problems facing him. The delay on the reactor testing station bordered on the comic; the difficulties facing the intermediate breeder and the materials testing reactors were troublesome. Perhaps of all the projects, the one proceeding most smoothly was Zinn's fast reactor, which had now received the more formal designation of experimental breeder reactor. Despite the pressures upon him, Zinn had been able to maintain close contact with his reactor team. On January 25, 1949, the Commission had approved a contract with the Austin Company of Cleveland for detailed design of the reactor. Technical progress was also keeping pace with administrative decisions. Leonard J. Koch had devised a core test unit to subject fuel rods to heated liquid sodium. Results from hundreds of hours of testing showed that the coolant at high temperatures did not cause distortion of the fuel rods. The core test unit, simulating as it did a part of the proposed actual reactor core, was also proving useful in testing the motors and gears of the mechanism needed for sharp acceleration and deceleration of the control rods. Detailed work on fuel elements, on the sodium-potassium coolant, and on the control mechanisms was progressing, if

not with the speed that Zinn and others hoped, at least without revealing difficulties so serious as to jeopardize the project.[78]

The General Advisory Committee began its three-day meeting on June 2 with a large contingent from General Electric present to consider the intermediate-power-breeder reactor. After Suits had described the extent of the company effort, Kingdon covered the design features, with stress on the flexibility of the core arrangement. Brooks and Snyder reported on the latest results of breeding measurements. Although the quality of the data had improved, prospects were still poor for breeding at the originally selected neutron energies. Hans A. Bethe, advising General Electric on the project, remarked that he was inclined to favor going to higher energies, although additional fissionable material would be required. It was not an easy matter to decide. If the schedule for the intermediate breeder were to be maintained, a decision had to be made before complete data were available. Winne argued for proceeding. The reactor would yield experience on engineering and control and would demonstrate to the public safe operation. Furthermore, from the intermediate reactor it would be possible to proceed to a submarine project.

Having heard the General Electric delegation, the committee talked with Hafstad and Rickover. Hafstad turned first to the Schenectady reactor. Foremost in his analysis was the fact that General Electric had a strong group working on the project. If breeding should prove impractical, then to maintain the momentum, changing the goal to Navy propulsion might be justifiable. At the moment, however, the reactor program seemed responsive to the national interest. The Zinn fast breeder and the intermediate reactor were exploring the possibilities of civilian power. Argonne and Westinghouse were meeting military requirements for the Navy through the submarine project, and the experimental facilities of the materials testing reactor would help the Air Force. The weakest of the projects, thought Hafstad, was the materials testing reactor, which had suffered one blow after another, first from the du Pont cost estimates, then from the Wende letter, and finally from the Felbeck proposal to move the reactor to Oak Ridge. Of these the most serious was reconsideration of the Oak Ridge location. Hafstad believed the proposal would reopen the question of the need for the reactor proving ground and require going back over the dreary course with the reactor safeguard committee.

Fermi disagreed with Hafstad's analysis. To him the urgent need for a strong, flexible test facility to develop reactors made the project the most important of the lot. Cyril Smith, accepting Fermi's reasoning, added only that the Schenectady reactor ranked next in importance because it brought to bear the talents of a strong engineering group. Although the committee members understood Rickover's explanation of the Navy's need for submarine propulsion, they were not convinced that two Navy projects were necessary.

For a time the committee discussed whether one reactor might meet several needs. Hafstad maintained that keeping the momentum of those working on the projects was a valid defense of the four-reactor program.

Although Oppenheimer agreed that the reactor program could not suffer many more changes, the results of the meeting must have disappointed Hafstad. Oppenheimer recommended that the Commission proceed with the Schenectady reactor and leave to General Electric the decision of whether to emphasize power or breeding, so long as the necessary fissionable material were available. The Argonne-Westinghouse Navy reactor received committee approval but with the admonition that the Commission should try to prevent the development of another laboratory similar to Knolls. Despite Hafstad's warning, the committee urged the Commission to explore the possibility of an Oak Ridge site for the materials testing reactor. For one moment Oppenheimer proposed to broaden the issue. If the materials testing reactor could be
218 built at Oak Ridge, if the intermediate reactor could be constructed at West Milton, then perhaps Zinn should place the fast breeder at Argonne. Hafstad had warned Oppenheimer that procrastination by the Navy in making the Pocatello site available might delay the fast breeder.[79]

A few days after the General Advisory Committee adjourned, Hafstad reviewed the results with Shugg. Although Hafstad was willing to consider postponing a decision on the materials testing reactor for a year, Shugg thought the Commission should consider the matter. Hafstad met with the Commissioners on June 13 and 14, 1949, and described the Wende, Felbeck, and advisory committee proposals. Wende's suggestion of greater utilization of Hanford's testing capability was useful, but hardly the answer to the long-range problem. Felbeck's Oak Ridge proposal probably overestimated the savings in time and money, and Hafstad doubted whether the site would be suitable for the reactor without relaxation of the safeguard criteria. Nonetheless, he could not disregard the advisory committee's recommendations.[80]

By the time Hafstad met with the Commission, Henry D. Smyth, the Princeton physics professor and veteran of the Manhattan project, had replaced Bacher as the Commission's scientific member. Smyth then decided to attend the General Advisory Committee meeting scheduled for July 14–15, 1949, at Berkeley, California. The main reason, Smyth wrote John H. Manley on July 12, was to present the Commission's decision that the acquisition of the Idaho reactor testing station should continue and that the Zinn reactor should be built there. He opposed construction of the materials testing reactor at Oak Ridge.[81]

At Berkeley Smyth explained that the previous committee meeting had raised questions about the committee's enthusiasm for the reactor program and particularly for the materials testing reactor. The committee admitted some reservations but hoped that no evidence of anxiety had found its way into any of the committee reports. The uncertainty had arisen over the

growing expense of the reactor program, the rate of progress, and genuine doubts about the military justification for the Navy and Air Force reactors. Some concern also stemmed from the shift from the centralized laboratory principle to the idea of an isolated test station. Nonetheless, the committee could point to its approval of the four reactors and a reactor testing station.[82]

By the summer of 1949 the reactor program was finally taking shape. Rickover was impatiently prodding Etherington's Navy reactor division at Argonne to make greater use of Westinghouse facilities and to recruit additional experienced reactor designers. Etherington had concluded that by far the greatest amount of the work in his division would be on water-cooled reactors, although a little effort would be given to a gas-cooled reactor study to support helium heat-transfer work by the Allis-Chalmers Manufacturing Company. It was now fairly certain that the Navy reactor, the Zinn fast breeder, and the materials testing reactor would be built at the reactor testing station. Huffman had been worried that bubbles in the lava beds might affect foundation work, but a visit to the Idaho site reassured him. He had noticed with interest that although Arco, the nearest town, was small, it was on the main road into the best fishing country. With growing assurance, once the materials testing reactor had a firm location, McLain's steering committee had made another cost study and found that $21.5 million was their best judgment—less than half the du Pont estimate. At Oak Ridge, Weinberg was preparing a proposal for a small liquid-fueled homogeneous reactor which would generate 20 kilowatts of electric power. As for the Schenectady reactor, the Commission had authorized resumption of site work near West Milton. Wilson's request for a military evaluation of the NEPA–Air Force project was as yet unanswered. Toward the end of August, Hafstad's reactor program looked in reasonably good condition.[83]

PRIORITIES

To Hafstad the Soviet detonation of August, 1949, meant many things, among them the place of his four reactor projects in an atomic energy program which would be increasingly geared to national defense. He expressed disappointment to Rickover over the progress at Argonne on the Navy reactor, a project which now above all had to be pushed vigorously. Hafstad wondered whether the Argonne Navy project should be shifted to Westinghouse, although he realized that the strength of the company in this area was as yet untried. As he understood it, Argonne ranked the experimental breeder first in its efforts, followed by the CP-5 research reactor, the materials testing reactor, and finally the Navy reactor. Rickover urged giving the Navy work at Argonne the first priority, strengthening Westinghouse in technical personnel,

and establishing a long-range Navy reactor project at Schenectady which would rank immediately after the intermediate breeder.[84]

Zinn gave his opinion on October 13. First priority went to the submarine reactor; although Zinn had seen no careful analysis and heard no qualified military expert on the subject, he assumed nuclear propulsion would be vital to the Navy if a war were to break out in the next five or ten years. Second place went to the materials testing reactor. Even if it could not be completed in time to benefit the Navy project, it could be useful in providing data for the aircraft reactor, as well as materials for weapons. The experimental breeder ranked third in Zinn's list. This reactor still seemed to be the best and quickest means of measuring breeding possibilities at fast-neutron energies and of obtaining experience with liquid-metal coolants. The intermediate breeder was in last place. The breeding possibilities were not good, and although they could be improved by going to higher neutron energies, to do so was to approach the range which the fast breeder would explore. The fact that sodium was the coolant rather than sodium-potassium did not make a great difference. If however, the intermediate breeder effort were shifted to submarine propulsion, the Schenectady project would share first priority with the submarine thermal reactor.[85]

220

Hafstad agreed that military projects had to be stressed. On the other hand, with the staff at Zinn's disposal, Hafstad believed that the materials testing reactor should not fall too far behind. Military requirements, if not military reactors, accounted for the priority of tasks given to General Electric. Winne had asked on August 22 for permission to increase the effort on the submarine intermediate reactor, but not until November 9 did he receive a formal reply. Until the Commission had fixed the scope of an expanded atomic energy program, General Electric should first assist Hanford, then work on the intermediate breeder, and third, study the intermediate Navy reactor.[86]

The influence of the Soviet detonation, in its broadest perspective, was the subject Eugene P. Wigner chose for a speech at the Oak Ridge information meeting of October 24–26. Few were better qualified to deal with such a broad subject. Wigner had headed the Oak Ridge laboratory during the difficult days of early 1947, he had influenced the design of the materials testing reactor, and he had been a major consultant on reactors. Yet, as Weinberg said in his introduction, Wigner was far enough away from the program to be above the details. Wigner came soon to the main question. Why had the hopes of reactor development, so high in 1944, been denied? He suggested that weapons had received the higher priority; yet this was not the whole story. More important, he thought, was the fact that the Americans no longer had German competition. Reactors had also become expensive. More money meant more time spent in justifying decisions, in elaborate precautions to be certain that the expense was wise, and in overdesign to protect the funds invested. These were the expenses of experimentation. Finally, Wigner saw

that reactor development had suffered from failure to attract the undivided attention of first-rate scientists. Of all factors the most important seemed to him to be the lack of competition. The Soviet detonation, whatever else it had done, had at least brought back rivalry. Now there was a race and a spur. "We will stop glorifying our past," said Wigner.[87]