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0521441323 - Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945 - Lillian Hoddeson, Paul W. Henriksen, Roger A. Meade and Catherine Westfall

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This volume treats the technical research that led to the first atomic bombs. The authors explore how the “critical assembly” of scientists, engineers, and military personnel at Los Alamos collaborated during World War II, blending their traditions to create a new approach to large-scale research. The research was characterized by strong mission orientation, multidisciplinary teamwork, expansion of the scientists’ traditional methodology with engineering techniques, and a trial-and-error methodology responding to wartime deadlines.

The book opens with an introduction laying out major themes. After a synopsis of the prehistory of the bomb project, from the discovery of nuclear fission to the start of the Manhattan Engineer District, and an overview of the early materials program, the book examines the establishment of the Los Alamos Laboratory, the implosion and gun assembly programs, nuclear physics research, chemistry and metallurgy, explosives, uranium and plutonium development, confirmation of spontaneous fission in pile-produced plutonium, the thermonuclear bomb, critical assemblies, the Trinity test, and delivery of the combat weapons. Readers interested in the development of the atomic bomb will find many previously unrevealed details in this volume while those interested in the more general history of science will find this volume a crucial resource for understanding the underpinnings of contemporary science and technology.

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Critical Assembly

A Technical History of Los Alamos during the Oppenheimer Years, 1943–1945

LILLIAN HODDESON
PAUL W. HENRIKSEN
ROGER A. MEADE
CATHERINE WESTFALL

with contributions from

GORDON BAYM, RICHARD HEWLETT, ALISON KERR,
ROBERT PENNEMAN, LESLIE REDMAN, and ROBERT SEIDEL



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Preface

The story of the Los Alamos project to build the first atomic bombs has been told often. Why then another history of Project Y, as it was known during World War II? Three features distinguish this account: it is a history of the technical developments; it is based on the full complement of documents, both classified and unclassified, of wartime Los Alamos; and it explores for the first time the methodology by which researchers at Los Alamos succeeded in their wartime mission.

Unlike earlier histories of Los Alamos, this book treats in detail the research and development that led to the implosion and gun weapons; the research in nuclear physics, chemistry, and metallurgy that enabled scientists to design these weapons; and the conception of the thermonuclear bomb, the “Super.” Although fascinating in its own right, this story has particular interest because of its impact on subsequent developments. Although many books examine the implications of Los Alamos for the development of a nuclear weapons culture, this is the first to study its role in the rise of the methodology of “big science” as carried out in large national laboratories.

Our primary aim is to recount this technical history, but we have not ignored the social context entirely. Although we largely leave for other historians the problem of analyzing the social community at Los Alamos in wartime – for example, the role of women, of foreign scientists, and of military personnel – we do provide an abbreviated account of the establishment and early years of the unique community that grew around the Los Alamos Laboratory.

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The principal reason that the technical history of Los Alamos has not yet been written is that even today, after half a century, much of the original documentation remains classified. With cooperation from the Los Alamos Laboratory, we received authorization to examine all the relevant documentation. The book then underwent a classification review that resulted in the removal from this edition of all textual material judged sensitive by the Department of Energy and all references to classified documents. (For this reason, a number of quotations appear without attribution.) However, the authorities removed little information. Thus, except for a small number of technical facts, this account represents the complete story. In every instance the deleted information was strictly technical; in no way has the Los Alamos Laboratory or the Department of Energy attempted to shape our interpretations. This is not, therefore, a “company history”; throughout the research and writing, we enjoyed intellectual freedom.

Previous histories of wartime Los Alamos fall into three categories: semischolarly or popular histories that deal only in passing with the technical and scientific issues;¹ volumes of participant recollections;² and official government-commissioned histories.³ The books in the first two categories had to side-step most of the technical history because the authors, including those who participated in Project Y, did not have access to the full set of technical documents or a comprehensive overview of the project. They had to rely heavily on memory, which inevitably becomes biased by the distortions of time, feelings, and changing values and images.

Of the official histories, only the volume by David Hawkins is centered on Los Alamos. The laboratory authorized Hawkins, a philosopher and mathematician who held an administrative position on its wartime staff, to prepare in 1946–47 a technical history of Project Y. In his heroic effort, Hawkins provided a unique work that has served as a vital source of information as well as a springboard for the present volume, which, however, goes beyond Hawkins. Unlike his report, this treatment is referenced. Whereas Hawkins was primarily interested in setting down *what* transpired, we have tried also to explain how the developments were shaped by individuals and how they related to earlier efforts. For example, we consider how prior explosives research in England or at the Explosives Research Laboratory in Bruceton, Pennsylvania, created the context for the designing of explosive lenses. Hawkins approached his task analytically, summarizing the work done by each wartime division of the laboratory; we have tried to tell an integrated story. Finally,

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because we are writing more than four decades after the completion of Project Y, we have had the considerable benefit of historical perspective in our analysis and interpretation.

In its entirety, the book presents a coherent, essentially chronological, account of the wartime technical developments at Los Alamos. The volume begins with an introductory chapter that brings into focus the major themes of the book: the new approach to research that made it possible to build the atomic weapons during World War II, the new style of organization, and the role of the military in the scientific developments at Los Alamos. The methodology used by the “critical assembly” of scientists, government officials, military personnel, and engineers who built the first atomic bombs during World War II is illustrated throughout and recapitulated in the final chapter. The second chapter – which readers familiar with the prehistory of Los Alamos can pass over – provides background details, from the discovery of nuclear fission to the start of the Manhattan Engineer District. Chapter 3 describes the early materials program, and Chapter 4 covers the establishment of the Los Alamos Laboratory and the research carried out there in its first months. The following chapters can be read either sequentially or in separate units: Implosion is covered in Chapters 4, 5, 8, 9, and 14–16. Gun assembly is treated in Chapters 4, 5, 7, and 13. Uranium development at Los Alamos is described in Chapters 11 and 13; plutonium in Chapters 11, 14, and 16; and polonium in Chapters 7, 13, 15, and 16. The confirmation of spontaneous fission in pile-produced plutonium is discussed in Chapter 12. The Super is dealt with in Chapters 4, 10, and 17. Nuclear physics is treated in Chapters 4, 5, 10, and 17. Critical assembly is reviewed in Chapter 10 and Chapter 17. Trinity is discussed in Chapter 18; and Delivery in Chapter 19. The institution and community are treated in Chapters 4, 6, and the epilogue.

This volume grew out of the concern of L. M. Simmons and David Sharp of the Theoretical Division, during the mid-1970s, that valuable historical insights were in danger of being lost and that persons who lived through the wartime events might never be interviewed about their important contributions. In a short proposal written in October 1975, Simmons and Sharp suggested that the laboratory establish both an archives and a history project. In March 1977, as a first step in this direction, Simmons hired Lillian Hoddeson, a physicist and historian of modern science, to work as a consultant to the Theoretical Division on a “pilot” history project. T-Division held a particularly valuable collection of reports and notes by Hans Bethe, Richard Feynman, Edward

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Teller, Robert Serber, Emil Konopinski, and other wartime members of the division. Because the documents were disorganized – many papers were not even signed by their authors (and required handwriting identification) – Simmons and Sharp worried that if they were shipped to Washington, they would never be seen again. To extract their historical content would require a dedicated effort possible only at Los Alamos.

In the course of the pilot project during the late 1970s, Hoddeson organized the division's wartime documents, conducted a number of oral history interviews (with Bethe, Nicholas Metropolis, Feynman, Serber, and several others), and in a series of memoranda advised the laboratory about its current archival needs. During this time, archivist Alison Kerr joined the history project. Together, Hoddeson and Kerr coauthored proposals to establish an archives and set up a laboratorywide history project.

These proposals came to the attention of Gilbert Ortiz, leader of the laboratory's Communications and Records Management (CRM) Division. Ortiz had independently realized the need for permanent laboratory archives. With Ortiz's enthusiastic sponsorship, the archives were established in 1981 within CRM Division. Nancy Zachariasen became the first Los Alamos archivist; Kerr helped Zachariasen build up the archives. The effort was nontrivial because at this time mounds of documents were scattered in many locations about the laboratory and in need of organization if they were to be accessible for a history effort. Before long, Ortiz began "toying with the idea . . . of a project to write the history of the Lab."⁴ Hoddeson and Kerr drew up a working plan for such an effort and Ortiz and Kerr subsequently appointed an advisory committee for the project, which met first in August 1983. By fall 1983, the laboratory had agreed to support the project and an official request for proposal was sent out to seven historians working in the area of the twentieth-century history of science. A three-year contract was signed in 1984 with History Associates Incorporated, a Washington-based company, whose proposal was prepared by Hoddeson in collaboration with Richard Hewlett, former Department of Energy historian, and Philip Cantelon, the company's president. When the contract with History Associates lapsed, CRM Division elected to continue the project on its own.

Starting the project in July 1984, Hoddeson selected as junior historians Catherine Westfall and Paul Henriksen, who at that time were both advanced graduate students in the history of science. Duties were divided. Hoddeson took responsibility for implosion; Westfall for pre-

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history, chemistry, metallurgy, and nuclear physics; and Henriksen for Trinity, Delivery, the institution, and the town of Los Alamos. Three consultants helped with the project: Gordon Baym, professor of physics at the University of Illinois; Robert Penneman, a former Los Alamos chemist; and Robert Seidel, a historian of science, who soon afterward became director of the laboratory's Bradbury Science Museum. In addition to providing scientific expertise, Baym contributed substantially to interviews and the writing and editing, particularly of chapters dealing with implosion and nuclear theory. Penneman contributed to and reviewed sections on chemistry and metallurgy. Seidel worked on the early history of the laboratory, particularly its relation to the University of California. On Kerr's departure from Los Alamos in summer 1985, Roger Meade, who had been hired earlier by Los Alamos to work with Kerr as the laboratory's second archivist, assumed all archival responsibilities of the laboratory as well as Kerr's commitment to the history project. Meade took responsibility for writing the history of the gun program. In September 1986, Leslie Redman, a nuclear scientist who for some years had been responsible for security classification for the laboratory, joined the history project as a technical expert; in addition to his primary contributions concerning high explosives and chemistry, he edited many of the chapters. In the final stages of the preparation of the manuscript, Redman contributed hundreds of hours of his time to checking references and technical details. When the classified manuscript was almost completed, Kerr returned to work as a consultant, editing sections and offering critical suggestions for revision of the manuscript.

Although most of the research was based on documents in the archives, the team benefited from a large number of oral history interviews conducted with individuals who had participated firsthand in Project Y. Unfortunately, as in all histories of modern events, the later the start, the fewer the number of central participants who could be interviewed. These interviews were typically carried out in the Los Alamos Records Center, whose secure environment allowed free discussion of material and enabled interviewers to key their questions to specific documents made available to the interviewees both before and during interview sessions. This mode of interviewing helped to refresh and sharpen the memories of the interviewees, and it sometimes led the historians to documents that might otherwise have been overlooked.

A great number of individuals and institutions contributed to the present manuscript, and it is a pleasure to express our appreciation to them here. We sadly regret that we cannot possibly list in the brief

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Preface

space of this preface all those who contributed in various ways to the project, but we are deeply grateful to them all. We thank the Los Alamos National Laboratory for its generous support of this project. We are particularly indebted to Simmons and Sharp for their pioneering efforts on behalf of the archives and history project; to Kerr and Ortiz for their pivotal roles in setting up both the archives and history project; and to Rosemary Harris for guiding the establishment of these efforts through the administration of the laboratory. We are also grateful to the members (past and present) of the Advisory Committee - Harold Agnew, Robert Bacher, Richard Baker, Hans Bethe, Norris Bradbury, Berlyn Brixner, Charles Critchfield, Darol Froman, Louis Hempelmann, L. D. P. King, Robert Krohn, John Manley, Carson Mark, Nicholas Metropolis, Max Roy, Raemer Schreiber, Richard Taschek, and Robert Wilson - for their help in formulating the history project, and for invaluable aid in developing its contents. Special thanks go to all members of the CRM Division office, particularly Adelia Stewart, for superb administrative support, and Judy Rose Archuleta, who was always able to solve problems imaginatively. At the archives, we are indebted to Mollie Rodriguez for her tireless and cheerful archival and administrative services; she always did her best to track down even the most obscure and difficult-to-find documents. For secretarial support during the hectic last months of preparation of this manuscript, we thank Marsha Perez, who graciously spent more time than we could expect on expediting its completion. For general support in the Records Center we thank Tony Rivera and his staff, who not only provided a very hospitable atmosphere but were always willing to help. We also wish to thank Phyllis Hoffman, as well as Eva Roybal, Betty Cummings, Ann Carlyle, and Ileana Buican for painstakingly transcribing interviews. We are very grateful to Dan Baca and his staff in the Los Alamos National Laboratory Report Library for hours of help in providing technical documents. The library staff also generously assisted in uncovering wartime technical reports and other reference materials. We thank Eugene Sandoval and his staff for their efforts and advice on declassification.

We are especially grateful to the many former Los Alamos scientists who often traveled long distances in poor weather to contribute hours and days to help us with interviews and critical readings of the manuscript. For special help with technical material and for reading early drafts, we thank Robert Bacher, Hans Bethe, Kenneth Bainbridge, Charles Critchfield, George Farwell, Al Florin, Peter Galison, Ronald Rabie, Silvan Schweber, Emilio Segrè, Roger Steuwer, Spencer Weart,

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and Robert Wilson. The efforts of Hedy Dunn and others at the Los Alamos Historical Museum in providing material on the Los Alamos community are greatly appreciated. Gary Westfall kindly helped during the final months of the project by reviewing sections on experimental nuclear physics. We also thank Richard Hewlett for working with us to create the general working plan of the project and for commenting on several early chapter drafts. The staff of History Associates helped to arrange the contract for the history project and to administer the project between 1984 and 1987; we thank them also for helping to locate numerous documents in Washington, D.C. We are particularly grateful for the heroic efforts of Dan Lewart and Tonya Lillie who enabled us to produce this book in T_EX on schedule. We would also like to acknowledge the Command Post of Chanute Air Force Base in Rantoul, Illinois, for hosting Hoddeson's work on the history project during various periods between 1986 and 1990. Finally, we thank Johndale Solem for suggesting the title, *Critical Assembly*, which so well describes the wartime scientific community at Los Alamos, the technical work, the bomb assembly itself, and the story that has played such a crucial role in the modern world.

Lillian Hoddeson
Paul Henriksen
Roger A. Meade
Catherine Westfall