THE JOURNAL OF THE SOCIETY FOR HISTORIANS OF AMERICAN FOREIGN RELATIONS
DIPLOMATIC HISTORY

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"A Very Pleasant Way to Die": Radiation Effects and the Decision to Use the Atomic Bomb against Japan*

In the days following the American nuclear attack on Hiroshima, Dr. Michihiko Hachiya noticed strange symptoms among his patients. Some of the survivors who had made their way to the Hiroshima Communications Hospital complained of vomiting, diarrhea, loss of appetite, and general malaise in addition to their more visible wounds. Hachiya, who had himself been injured in the bombing, was at first too overwhelmed to devote much time to exploring these symptoms. Then on August 17, eleven days after the bombing, a new mystery confronted the doctor. Many of his patients developed petechiae—small hemorrhages under the skin that appear as a pattern of dots—and started to lose their hair. Suddenly the death rate in his hospital, which had been declining since the initial wave of casualties, began to increase again. In some cases, patients, who had received only minor injuries in the bombing and appeared to be well on their way to recovery, died shortly after displaying these new symptoms, often with signs of massive internal hemorrhaging. A blood analysis revealed that those suffering from these strange symptoms displayed a markedly low count of white blood cells. On August 26, after interviewing his patients and conferring with fellow physicians, Hachiya posted a "Notice Regarding Radiation Sickness" at the Communications Hospital, one of the first attempts to scientifically assess the effect of nuclear radiation on the Japanese victims of the atomic bombs.[1]

Even before Dr. Hachiya posted his findings, reports of "the uncanny effects which the atomic bomb produces on the human body" surfaced in the press—

*This article grew out of research presented at the June 2008 conference of the Society for Historians of American Foreign Relations (SHAFR) in Columbus, OH, and the March 2009 "Symposium on Nuclear Histories in Japan and Korea" at the Tokyo Institute of Technology. I would like to thank my all fellow panelists for their feedback and comments. Alex Wellerstein was particularly helpful in pointing me toward documents at the Nuclear Testing Archive in Nevada that proved to be crucial to illuminating the pre-Hiroshima understanding of radiation effects in the United States. I have also benefited from exchanges on this subject with Barton J. Bernstein, Michael R. Gordin, Gregg Herken, Robert S. Norris, M. Susan Lindee, Masakatsu Yamazaki, Shiho Nakazawa, Jacob Darwin Hamblin, and Campbell Craig, as well as the comments of two anonymous reviewers for *Diplomatic History*.

1. Michihiko Hachiya, *Hiroshima Diary: The Journal of a Japanese Physician, August 6–September 30, 1945* (Chapel Hill, NC, 1955), 21, 36–37, 90–91, 96–97, 125. Also see Yukuo Sasamoto, "Investigations of the Effects of the Atomic Bomb," in *A Social History of Science and Technology in Contemporary Japan, Volume I: The Occupation Period, 1945–1952*, ed. Shigeru Nakayama (Melbourne, Australia, 2001), 73–107.

Diplomatic History, Vol. 36, No. 3 (June 2012). Published by Wiley Periodicals, Inc., 350 Main Street, Malden, MA 02148, USA and 9600 Garsington Road, Oxford OX4 2DQ, UK.

first in Japan and then in the United States.[2] An August 23 article by Associated Press (AP) science editor Howard W. Blakeslee asserted that "[t]he Japanese who were reported today by Tokyo radio to have died mysteriously a few days after the atomic bomb blast probably were victims of a phenomenon which is well known in the great radiation laboratories of America." In addition to lending credence to Japanese claims that radiation had produced lingering and sometimes fatal injury, Blakeslee suggested that American scientists had known of these effects prior to Hiroshima; he specifically cited prewar studies conducted with the cyclotron at the Radiation Laboratory (or "Rad Lab") at the University of California.[3] Though Blakeslee did not mention it in the article, the man behind the Berkeley cyclotron, physicist Ernest O. Lawrence, had been an important player in the wartime development of the atomic bomb and had served on the major scientific panel that recommended its use against Japan in 1945.

General Leslie R. Groves, military head of the wartime atomic bomb project, was privately alarmed by the press attention given to radiation effects. On the morning of August 25, Groves placed a call to Lt. Col. Charles E. Rea, a surgeon and head of the base hospital at the Oak Ridge, Tennessee, facility that separated the uranium used in the Hiroshima bomb. Despite his formal connection to the project, Rea had no expertise in the field of radiation or its effects on the human body. Nevertheless, Groves sought from him confirmation that the reports of delayed deaths due to radiation were simply "a good dose of propaganda." Groves candidly admitted that his concern was not with those potentially afflicted, but rather with the political impact of the stories. "We are not bothered a bit," he said of the reports of radiation sickness, "excepting for—what they are trying to do is create sympathy [for the Japanese]." Groves was particularly worried about Blakeslee's AP story. "This," he confided before reading aloud Blakeslee's assertion that radiation effects were well known in American laboratories prior to Hiroshima, "is what hurts us."[4]

Dr. Rea obligingly told Groves what he clearly wanted to hear, repeatedly affirming that the delayed deaths were likely the result of "just good old thermal burns" and that Japanese claims to the contrary were "hookum" and "propaganda." Rea dismissed reports of reduced white and red blood cell counts among those exposed to the bomb, suggesting that these findings were the result of "a very poorly-controlled experiment." The two men made light of reports of nausea and loss of appetite among the victims. "From what I've heard of how much food they get in Japan," Groves remarked, "I don't think they'd lose their appetite, do you?" Like Groves, Rea's greatest concern appeared to be that

2. *New York Times*, August 23, 1945, 1.

3. *Los Angeles Times*, August 23, 1945, 4.

4. "Memorandum of Telephone Conversation between General Groves and Lt. Col. Rea, Oak Ridge Hospital, 9:00 a.m., 25 August 1945," Correspondence ("Top Secret") of the Manhattan Engineer District, 1942–46, microfilm publication M1109, file 5G, National Archives, Washington D.C. (hereafter Groves "Top Secret").

stories of delayed deaths due to radiation caused by the A-bomb might arouse public sympathy for the Japanese. To quash these stories, Rea advised the general that "you had better get the anti-propagandists out." Groves confided that he had already made efforts to that effect and suggested that "the only other thing is to get the AP science editor on the straight track, but I don't know how to do that."[5]

Though Groves sometimes appeared buffoonish, the general who had helped guide the Manhattan Project to a successful conclusion was not a stupid man.[6] He understood that Rea's reassurances would not be sufficient to contain the emerging story of delayed radiation effects among Japanese victims of the bomb. In addition to mounting a vigorous public relations campaign, Groves had already ordered the dispatch of radiological survey teams to Hiroshima and Nagasaki in order to gather information on the bomb's after effects.[7] Groves repeatedly cabled the team, led by his second in command General Thomas F. Farrell, for any information that might be of use in combating "Japanese horror stories" about radiation that were "getting big play in the American press."[8] A front-page story in the *New York Times* in early September reporting that Allied prisoners of war at Nagasaki were among those killed by radiation only added to the urgency.[9]

The findings of the American survey teams at Hiroshima and Nagasaki were mixed. On the one hand, they successfully combated sensational claims that residual radioactivity had rendered the affected cities totally uninhabitable, perhaps for as long as seventy years. They confirmed, however, that the initial burst of radiation from the bomb's explosion had produced the kind of delayed and lingering symptoms observed by Dr. Hachiya and his colleagues.[10] By the time Groves testified before a Senate committee in November 1945, he could no longer plausibly deny that the bomb's radiation effects had lingering and fatal consequences. Instead, he tried a new tactic. While greatly downplaying the number of radiation casualties, he also insisted there was nothing particularly

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5. Ibid. See also the follow-up conversation later that morning, "Memorandum of Telephone Conversation between General Groves and Lt. Col. Rea, Oak Ridge Hospital, 10:50 a.m., 25 August 1945," Groves "Top Secret," file 5G.

6. The definitive work on Groves is Robert S. Norris, *Racing for the Bomb: General Leslie R. Groves, the Manhattan Project's Indispensable Man* (South Royalton, VT, 2002).

7. Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942–1946* (Berkeley, CA, 1987), 110.

8. Col. Consodine to Major Jack Derry, "Cable to Gen. Farrell," September 5, 1945, Tinian Files, Box 17, RG 77, entry #3, National Archives II, College Park, Maryland (hereafter Tinian files). See also Groves to Kirkpatrick and Farrell, September 5, 1945, Tinian files, box 19; Washington Liaison Office to Commanding Office Clear Area, September 20, 1945, Tinian files, box 17.

9. *New York Times*, September 10, 1945, 1.

10. See Farrell's statement in the *New York Times* on September 13, 1945. Also see Shields Warren et al., "Atomic Bombs, Hiroshima and Nagasaki, Article I, Medical Effects," December 15, 1945, DOE/NV Nuclear Testing Archive, Las Vegas, Nevada (hereafter NTA). The holdings of the NTA (which are not grouped by box or folder) can be searched via the Department of Energy's OpenNet system, https://www.osti.gov/opennet/index.jsp.

horrible about such deaths. "[A]s I understand it from the doctors," Groves told the committee, "it is a very pleasant way to die."[11]

RADIATION EFFECTS: SIGNIFICANCE, CONTEXT, AND DEFINITIONS

Groves's post-Hiroshima statements, which ranged from the comic to the macabre, were part of an evolving campaign by American officials to downplay or deny the fatal and lingering radiation effects inflicted by nuclear weapons. While he showed no concern for the victims in Hiroshima and Nagasaki, Groves seemed to fear that if the bomb were proved to have indiscriminate, lethal, and invisible effects that persisted long after its use, then it might easily be grouped with chemical and biological weapons as an inhumane form of warfare. Such a categorization would not only undercut the ability of the United States to test or to make use of nuclear weapons in any future war, but also might lead to criticism of those who had designed, built, and authorized the use of the atomic bomb against Japan. Indeed, despite the best efforts of Groves and his successors, radiation effects ultimately became central to the widespread understanding of nuclear weapons as uniquely terrible and have likely contributed to the formation of a nuclear "taboo" that has helped check their use since 1945. Domestic concerns about radiation effects starting in the 1950s spurred efforts to ban above-ground nuclear testing as well as lawsuits by "downwinders" exposed as a result of tests on U.S. soil. Internationally, the 1954 *Lucky Dragon* incident, in which the crew of a Japanese fishing trawler was exposed to dangerous levels of fallout from a U.S. H-bomb test on Bikini atoll, strained relations with Japan and led to increased antinuclear activism at a crucial moment in the Cold War.[12]

In light of their human, environmental, political, and diplomatic significance, the radiation effects created by nuclear weapons are an important and underresearched historical topic. While these effects have received substantial attention from scientists, physicians, and some historians of science, diplomatic historians have seldom attempted to link this body of knowledge to more traditional questions relating to the use of the atomic bomb and the Cold War nuclear arms race. Very little has been published, for example, on what American scientists, soldiers, and high-level leaders knew about radiation effects *prior* to Hiroshima. Did those who made the crucial decisions about the use of the bomb against Japanese cities and civilians in August 1945 understand that it would have lingering effects in some ways analogous to chemical or biological weapons?

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11. U.S. Congress, Senate, Special Committee on Atomic Energy, 79th Congress, 1945–1946, *Hearings* (Washington, DC, 1946), 37.

12. Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons Since 1945* (New York, 2007), 113; Howard Ball, *Justice Downwind: America's Atomic Testing Program in the 1950s* (New York, 1986); Ralph E. Lapp, *The Voyage of the Lucky Dragon* (New York, 1958).

This question is relevant not only to the scientific and technical history of the Manhattan Project, but also to the way in which we weigh the morality of the atomic bombings of Japan. As Groves's panicked reaction illustrated, a weapon that continues to silently and invisibly kill long after hostilities are over raised disturbing moral questions even in the context of a near total conflict such as World War II. Understanding what American leaders and scientists knew about radiation effects at the dawn of the atomic age is also relevant to a variety of questions relating to the Cold War arms race, particularly with respect to nuclear testing and war planning in the 1940s and 1950s.

The only sustained published work that examines pre-Hiroshima knowledge of radiation effects among American scientists and leaders is a 1987 official history of radiation safety during the Manhattan Project produced by Barton C. Hacker at the behest of the Department of Energy and Reynolds Electrical & Engineering Co., the private company responsible for running the Nevada nuclear test site. Hacker's study, however, is limited by its narrowly prescribed focus on domestic safety issues, which blocked him from engaging in any depth with the larger diplomatic, political, military, and moral issues raised by the bomb and its radiation effects.[13] Scholarly defenders of President Harry S. Truman's decision have often claimed that these effects were simply not understood prior to use, thus exculpating American leaders from the charge that they knowingly used a weapon that caused lingering illness and death long after the bombing. Historian Michael Kort, for example, asserted in a recently published survey that "the full impact of its destructive power, especially the extent to which radiation would kill long after the explosion, was not fully understood."[14] This is, of course, true in a literal fashion. Even today, the long-term effects of radiation on the human body are not "fully understood." The relevant question is not whether American leaders or scientists had a perfect grasp of the bomb's radiation effects, but rather what level of knowledge they *did* have prior to Hiroshima. Though several authors, including Robert S. Norris, Robert J. Lifton and Greg Mitchell, Monica Braw, and Paul Boyer, have examined the post facto attempts by the U.S. government to downplay radiation casualties, none has wrestled with the documentary evidence that would illuminate pre-Hiroshima knowledge of these effects.[15] Barton J. Bernstein remains the only

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13. Hacker, *The Dragon's Tail*. Also see Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York 1999); Jonathan D. Moreno, *Undue Risk: Secret State Experiments on Humans* (New York, 2001); Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (Chicago, 1990), 43–63; Stafford L. Warren, "The Role of Radiology in the Development of the Atomic Bomb," in *Radiology in World War II*, ed. Kenneth D. A. Allen Washington DC, 1966), 831–92.

14. Michael Kort, *The Columbia Guide to Hiroshima and the Bomb* (New York, 2008), xv.

15. Robert J. Lifton and Greg Mitchell, *Hiroshima in America: Fifty Years of Denial* (New York, 1995), 40–55; Paul Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age* (New York, 1985), 187–88, 308; Peter Wyden, *Day One: Hiroshima and After* (New York, 1984), 18–19, 280–81, 325; Norris, *Racing for the Bomb*, 440; Yukuo Sasamoto, "Reporting on the Atomic Bomb and the Press Code," in *A Social History of Science and*

A-bomb scholar to have seriously explored this issue, and his published writings on the subject amount to no more than about a handful of pages.[16]

This article makes use of military, governmental, and scientific documents to trace the American understanding of radiation effects prior to Hiroshima and weigh what impact that knowledge had on the decision to use the atomic bomb. The picture that emerges is complex and at times troubling. On the one hand, Truman's defenders are correct in their assertion that the president and many of his key advisers, including Secretary of State James F. Byrnes and Secretary of War Henry L. Stimson, knew almost nothing about the bomb's radiation effects at the time they were making decisions about its use in 1945. This ignorance is puzzling, however, given that at as early as 1940, radiation was not only understood as an important byproduct of nuclear fission, but also as one that might have more immediate promise as a killing agent than an atomic bomb. While the pre-Hiroshima understanding of radiation was far from perfect, human and animal studies conducted by scientists and physicians attached to the Manhattan Project during the war generated a great deal of information about the biological effects of nuclear radiation. But while wartime studies greatly advanced knowledge of radiation effects, this knowledge was compartmentalized and marginalized in the American decision-making process with respect to the atomic bomb.

The disconnect between scientific knowledge and policymaking with respect to the bomb is significant for a number of reasons. Most broadly, it illustrates how organizational routines, combined with the pressure of time and the desire on the part of the Manhattan Project's managers (particularly Groves) to limit and control the spread of information, influenced the way in which the decisions about the bomb were made at the highest levels. While most of the relevant policymakers in the Roosevelt and Truman administrations understood the atomic bomb to be a special and unique weapon, the routines, procedures, and language embedded in the decision-making process sometimes worked subtly and perhaps even unconsciously to "conventionalize" the weapon.[17] This, in turn, raises an intriguing counterfactual question: if Truman, Stimson, and Byrnes had grasped the basic significance of radiation effects (even at a layman's level with the knowledge then available), might it have affected their decisions about its potential use? Would a high-level discussion of radiation effects have

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Technology in Contemporary Japan, 437–469; Monica Braw, *The Atomic Bomb Suppressed: American Censorship in Occupied Japan, 1945–1949* (Armonk, NY, 1991). Also see Michael R. Gordin, *Five Days in August: How World War II Became a Nuclear War* (Princeton, NJ, 2007), 40, 52–54; Andrew J. Rotter, *Hiroshima: The World's Bomb* (New York, 2008), 122–24.

16. Barton J. Bernstein, "Doing Nuclear History: Treating Scholarship Fairly and Interpreting Pre-Hiroshima Thinking about 'Radioactive Poisoning'," *Society of Historians of American Foreign Relations, Newsletter* 26, no. 3 (September 1996): 17–36.

17. For contrasting views on whether policymakers saw the bomb as an "ordinary" weapon prior to Hiroshima, see Gordin, *Five Days in August*, 40; Sean L. Malloy, *Atomic Tragedy: Henry L. Stimson and the Decision to Use the Bomb Against Japan* (Ithaca, NY, 2008), 49–50, 67–70, 199 n. 2. The evidence presented in this article suggests that the "special" versus "normal" dichotomy was perhaps overdrawn by both authors.

pushed the bomb into a different category, akin to chemical and biological weapons, and complicated or derailed consideration of its use against Japanese cities and civilians? While such a question is impossible to answer definitively, the evidence suggests that a better understanding of radiation effects at high level might have at the very least influenced the discussion over *how* the bomb was used in spring-summer 1945. Even if this knowledge had not been integrated into planning for the use of the bomb against Japan, it might have at the very least aided Japanese efforts to help the victims in the aftermath of the war. An honest discussion of the issue at the highest levels of the U.S. government also might have led to a sharpened debate over postwar nuclear testing and its risks both at home and abroad.

Before proceeding, a handful of definitions are in order. The ionizing radiation produced by an atomic bomb can be grouped into two main categories.[18] *Initial radiation* is that produced by the fission process and its immediate aftermath within the first minute after detonation. The most deadly forms of initial radiation are neutrons and gamma rays, both of which can travel significant distances and penetrate human skin to cause internal injury. *Residual radiation* is that which persists in the environment after the first minute following detonation. The most well-known danger to humans posed by residual radiation comes in the form of fallout: a mixture of radioactive debris and isotopes sucked up into the air by the initial blast, sometimes traveling great distances before falling back to earth.[19] Short-term symptoms of radiation sickness include those Dr. Hachiya observed in his patients at Hiroshima: nausea, vomiting, malaise, diarrhea, epilation (loss of hair), fever, and hemorrhaging. Even a relatively low level of radiation can cause changes in the blood and blood-forming organs, particularly the bone marrow. Those who do survive an initial exposure remain at risk for a variety of long-term ailments, including an increased chance of developing cataracts, leukemia, and a number of types of cancerous tumors. Children exposed to ionizing radiation while in the womb run an increased risk of mental retardation and microcephaly. Finally, exposure to radiation can produce genetic effects that extend to future generations.[20] The rest of this article will examine

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18. An excellent source on the radiation effects produced by nuclear weapons, and one that I drew on extensively in preparing this article, is Samuel Glasstone and Philip J. Dolan eds., *The Effects of Nuclear Weapons*, 3rd ed. (Washington, DC, 1977).

19. The term "fallout" is actually an anachronism for the pre-Hiroshima period. Though there was discussion of this issue prior to the first atomic test in the New Mexico desert in July 1945, the term fallout (or fall-out) dates to the 1946 Crossroads tests at Bikini atoll. See Jonathan M. Weisgall, *Operation Crossroads: The Atomic Tests at Bikini Atoll* (Annapolis, MD, 1994), 4.

20. There is an extensive scientific and medical literature on the biological effects of radiation on the bomb's victims in Hiroshima and Nagasaki. See particularly, William J. Schull, *Effects of Atomic Radiation: A Half-Century of Studies from Hiroshima and Nagasaki* (New York, 1995); Eisei Ishikawa and David L. Swain, trans., *Hiroshima and Nagasaki: The Physical, Medical, and Social Effects of the Atomic Bombings* (New York, 1981). M. Susan Lindee, *Suffering Made Real: American Science and the Survivors at Hiroshima* (Chicago, 1994) addresses the complex social, political, and diplomatic context of the postwar radiation studies in Japan.

the extent to which American scientists and leaders were aware of these effects prior to Hiroshima and how that knowledge influenced the decision to use the atomic bomb.

EARLY THINKING ABOUT RADIATION EFFECTS IN BRITAIN AND THE UNITED STATES

In March 1940, Otto Frisch and Rudolf Peierls, refugees from Hitler's *Reich* who had found a home in England at the University of Birmingham, calculated that the amount of uranium 235 needed to produce a critical mass (and hence an explosive chain reaction) might be as little as one kilogram. But even as they raised the prospect of a "super-bomb" that would be "practically irresistible," Frisch and Peierls also warned the British government that such a weapon would also produce "very powerful and dangerous radiations" that posed both short-term and long-term dangers.[21] They correctly predicted that the bulk of the radiation would be emitted in the immediate aftermath of the explosion. But they also suggested that residual radioactivity posed unique challenges, including the strong possibility that "[s]ome of this radioactivity will be carried along with the wind and will spread the contamination; several miles downwind this may kill people." Anticipating one of the most terrifying features of radiation, they warned that those not killed immediately might suffer "delayed effects and hence near the edges of the danger zone people would have no warning until it were too late."[22]

Frisch and Peierls suggested that to cope with the radiological aftermath of a nuclear attack would require specialized equipment, including radiation detectors and sealed, lead-lined vehicles, as well as experts who could judge what constituted a safe level of exposure.[23] Conceding that "[t]his safety limit is not at present known with sufficient accuracy," the two émigré scientists warned that "further biological research for this purpose is urgently required." Ultimately, they concluded it would be impossible to use an atomic bomb without lingering fatalities due to radiation. Specifically citing "the spread of radioactive substances with the wind," Frisch and Peierls warned that "the bomb could probably not be used without killing large numbers of civilians, and this may make it unsuitable as a weapon for use by this country [Great Britain]."[24] The Frisch-Peierls memoranda prompted Prime Minister Winston Churchill's government to form a high-level advisory panel, code named the MAUD Committee, to study the possibility of building a bomb during the war. The committee's

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21. Otto Frisch and Rudolf Peierls, "Memorandum on the Properties of a Radioactive Super-bomb," March 19, 1940, in Robert Serber, *The Los Alamos Primer: The First Lectures on How to Build an Atomic Bomb*, ed. Richard Rhodes (Berkeley, CA, 1992), 81.

22. Ibid., 80, 82–83.

23. Frisch and Peierls, "On the Construction of a 'Super-bomb' Based on a Nuclear Chain Reaction in Uranium," in Serber, *The Los Alamos Primer*, 88.

24. Frisch and Peierls "Memorandum on the Properties of a Radioactive 'Super-bomb,'" 81–82

top-secret reports, issued in July 1941, also acknowledged the dangers posed by radiation effects, which would be "delayed and cumulative" and threatened to "make places near to where the bomb the bomb exploded dangerous to human life for a long period."[25]

Across the Atlantic, radiation effects intrigued the small circle of scientists attached to the nascent American nuclear program. A committee of the National Academy of Sciences (NAS) headed by physicist Arthur H. Compton concluded in May 1941 that the most effective use of nuclear fission would be to produce "violently radioactive materials to be used as missiles destructive to life in virtue of their ionizing radiations."[26] Even when a follow-up report in November 1941 (also authored by Compton) joined the MAUD Committee in endorsing the possibility of an atomic bomb, radiation effects remained an important consideration. "It is possible," the report concluded, "that the destructive effects on life caused by the intense radioactivity of the products of the explosion may be as important as those of the explosion itself."[27] Three days after Pearl Harbor, a subcommittee of the NAS led by physicists Eugene Wigner and Henry DeWolf Smyth reported on both radioactive poisons and a proposal by Leo Szilard for a "neutron ship" (an airplane or ship carrying a partially shielded nuclear reactor that could direct neutron radiation at the enemy). They concluded that radioactive poisons had greater potential as a weapon, but that both methods merited further study.[28]

Though the Anglo-American interest in radiation effects remained mostly theoretical in 1940–41, by the end of 1942 they were the subject of a growing body of laboratory and real-world research. The initial impetus for wartime

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25. MAUD Committee report reprinted in Margaret Gowing, *Britain and Atomic Energy, 1939–1945* (New York, 1964), 395, 407.

26. Arthur Compton, "Report of the National Academy of Sciences Committee on Atomic Fission," May 17, 1941, Bush-Conant File Relating to the Development of the Atomic Bomb, 1940–45, Records of the Office of Scientific Research and Development, Record Group (RG) 227, microfilm publication M1392, file 1, National Archives, Washington, DC (hereafter cited as Bush-Conant).

27. Compton, "Report to the President of the National Academy of Sciences by the Academy Committee on Uranium," November 6, 1941, Bush-Conant, file 1. Soviet scientists also acknowledged the potentially significant radiation effects of the bomb in this period: Campbell Craig and Sergey Radchenko, *The Atomic Bomb and the Origins of the Cold War* (New Haven, CT, 2008), 40–41.

28. Eugene. P. Wigner and Henry D. Smyth, "Radioactive Poison," December 10, 1941, NTA; Smyth, *Atomic Energy for Military Purposes: The Official Report on the Development of the under the Auspices of the United States Government, 1940–1945* (Princeton, NJ, 1945), 65. The scholarship on the American World War II radiological warfare program remains relatively slim. See Barton J. Bernstein, "Oppenheimer and the Radioactive Poison Plan," *Technology Review* (May/June 1985): 14–17; Bernstein, "Radiological Warfare: The Path Not Taken," *Bulletin of the Atomic Scientists* 41, no. 7 (August 1985): 44–49; James Hershberg, *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age* (Stanford, CA, 1993), 201; Richard Rhodes, *The Making of the Atomic Bomb* (New York, 1985), 510–12; Jacob Darwin Hamblin, "A Global Contamination Zone: Early Cold War Planning for Environmental Warfare," in *Environmental Histories of the Cold War*, ed. John McNeill, ed. (Cambridge, England, 2010), 85–114.

studies of radiation effects flowed from efforts at the Metallurgical Laboratory at the University of Chicago to construct a nuclear reactor (or "atomic pile"). The pioneer pile at Chicago, which went critical on December 2, 1942, and the more sophisticated reactors that were later constructed at the Manhattan Project's Oak Ridge, Tennessee, and Hanford, Washington, facilities, posed numerous hazards. The greatest immediate danger stemmed from the intensely radioactive byproducts of the fission reaction. Met Lab director Arthur H. Compton had chaired the 1941 NAS committees that had reported on nuclear fission and was acutely aware of the radiological dangers posed by the pile and its byproducts. In August 1942, he appointed Robert S. Stone, a radiologist at the San Francisco medical school of the University of California, to head the Health Division of the Met Lab.[29]

In protecting Met Lab workers and the surrounding public against the biological effects of radiation, Stone's team could build on international efforts that dated back to the early twentieth century and included extensive studies on the health effects of both X-rays and radium.[30] During the 1930s, pioneering work involving cyclotrons and their byproducts for medical purposes at the Massachusetts Institute of Technology, the Berkeley Rad Lab, and the University of Rochester further expanded knowledge of the biological effects of radiation. Stone and his colleague Joseph Hamilton (who worked closely with the Health Division during the war) had conducted human trials using neutron radiation from the Rad Lab's cyclotron as a medical treatment in 1939–41.[31] But while the Health Division could call on a useful background of prewar radiation studies, the daily operations of the Manhattan Project posed new safety challenges for which there were no easy answers. In response, Stone and his team conducted an ambitious research program that sought to document, predict, and eventually treat the biological effects of ionizing radiation.

The Health Division experiments most directly relevant to understanding and predicting the effects of an atomic bomb involved exposing humans and animals to external radiation in the form of gamma rays, x-rays, and neutrons. The goal, as formulated by Stone, was to determine the "[e]ffects of overexposure" (both long term and short term) as well as to attempt to determine

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29. Hacker, *The Dragon's Tail*, 29–31.

30. On early thinking about radiation, see Stephen R. Weart's intriguing but sometimes idiosyncratic *Nuclear Fear: A History of Images* (Cambridge, MA, 1988). For more on pre–World War II studies of radiation and its effects, see Lawrence Badash, *Radioactivity in America: Growth and Decay of a Science* (Baltimore, 1979); J. Samuel Walker, *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley, CA, 2000), 1–28; Ronald L. Kathren and Paul L. Ziemer, "Introduction: The First Fifty Years of Radiation Protection—A Brief Sketch," in *Health Physics: A Backward Glance: Thirteen Original Papers on the History of Radiation Protection*, ed. Ronald L. Kathren and Paul L. Ziemer (New York, 1980), 1–3; Caufield, *Multiple Exposures*, 3–42; Claudia Clark, *Radium Girls: Women and Industrial Health Reform, 1910–1935* (Chapel Hill, NC, 1997); Matthew Lavine, "A Cultural History of Radiation and Radioactivity in the United States, 1896–1945," Ph.D. diss., University of Wisconsin-Madison, 2008.

31. Gregg Herken, *Brotherhood of the Bomb: Robert Oppenheimer, Ernest Lawrence, and Edward Teller* (New York, 2002), 17–18; Welsome, *The Plutonium Files*, 26–27.

"safe" or "tolerance" doses and perhaps discover "[a]ids to recovery."[32] In addition to experiments on a veritable menagerie of animals, Manhattan Project scientists also engaged in a series of human trials during World War II. The most infamous of these involved the injection of a plutonium solution into unknowing human test subjects in order to determine the rate at which it was excreted from the body.[33] But years before the plutonium injection experiments began in April 1945, Health Division scientists were overseeing the exposure of human test subjects to significant doses of external radiation in order to determine its biological effects.[34] The Health Division was also able to gather data on radiation effects by studying employees of the Manhattan Project who had been exposed in the course of their work. "It must be remembered," Stone urged, "that the whole clinical study of the [Manhattan Project] personnel is one vast experiment. Never before has so large a collection of individuals been exposed to so much irradiation."[35]

Though the primary aim was to ensure the safety of Manhattan Project employees, the Health Division's data allowed for at least a tentative forecast of radiation effects on victims on an atomic bomb. Wartime studies on humans showed that the symptoms of radiation sickness and the resulting changes in blood cell counts appeared at anywhere from 20 to 100 Roentgens (r).[36] Animal studies also showed strong links between radiation exposure and changes to the reproductive organs as well as the onset of fatal "hemorrhagic disease."[37] Health Division research also conclusively demonstrated that even nonfatal exposure could lead to the growth of malignant tumors.[38] And though the exact link between radiation exposure and leukemia remained a subject of debate, it was a matter of concern to both the Chicago Health Division and the Manhattan

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32. Robert. S. Stone et al., "Health Division Program," May 10, 1943, NTA.

33. Welsome, *The Plutonium Files*; Moreno, *Undue Risk*, 119–56; Advisory Committee on Human Radiation Experiments (hereafter ACHRE), *The Human Radiation Experiments: Final Report of the President's Advisory Committee* (New York, 1996), 139–71.

34. Stone et al., "Health Division Program," May 10, 1943, 6, NTA. For additional mention of human trials with external radiation see, Stone et al., "Report for the month ending December 25, 1943", 9–10; Stone et al., "Report for the month ending May 31, 1944," 29; Stone et al. "Report for the month ending May 31, 1944," p. 25; Stone et al., "Report of Health Division for Month of April 1945," April 26, 1945, p. 5 all from NTA.

35. Stone et al., "Health Division Program," May 10, 1943, 1–2, NTA.

36. Louis H. Hempelmann to Chadwick, "Recent Experiments Dealing with Biological Effects of Radiation," June 5, 1944, NTA.

37. A. H. Dowdy, J. W. Howland, et al., "Summary Medical Research Program, 1943–1946," n.d. [circa 1947], NTA. On damage to reproductive organs in animal subjects, see Stone et al., "Report for the Month Ending October 23, 1943"; Stone et al., "Supplement Monthly Health Report for the Month Ending December 25, 1943"; Hempelmann to Chadwick, "Recent Experiments Dealing with Biological Effects of Radiation," June 5, 1944; Stone et al., Health Division, "Report for Month Ending October 31, 1944," 48; Stone to Compton, "Research Activities of Health Division," March 24, 1945, all from NTA.

38. On tumors in animal subjects, also see Stone et al., "Report for the Month Ending January 22, 1944"; Stone et al., Health Division, "Report for the Month Ending May 31, 1944"; Stone et al., "Report for Month Ending October 31, 1944," all in NTA.

Project's Medical Section.[39] While much work remained to be done (particularly on long-term genetic effects), most of the serious radiation injuries that Japanese doctors encountered in the aftermath of the atomic bombings had been demonstrated and documented by Manhattan Project scientists well prior to Hiroshima.

RADIOLOGICAL WARFARE: SCIENTIFIC, POLITICAL, AND MORAL IMPLICATIONS

From the beginning, there was substantial overlap between health and safety research for the Manhattan Project and preparations for radiological warfare.[40] Since radiological warfare would involve using the products of a nuclear reactor, most of the research necessary to evaluate its offensive potential flowed naturally from the studies already being conducted by the Health Division. It was a short jump from determining the "tolerance dose" of radiation to calculating that which would be necessary to kill or incapacitate when used as a weapon. The same instruments and procedures used to protect workers at Chicago, Oak Ridge, or Hanford could also be used to defend against the use of fission products by the enemy or prepare friendly forces to enter an area contaminated by radiation. "The data required in case of offensive or defensive radio-active warfare," Stone concluded, "could be calculated very easily from our findings."[41]

In June 1943, presidential science adviser James Conant asked University of Rochester radiologist Stafford Warren to undertake a series of additional tests aimed at determining the feasibility of using radiation as a weapon. Warren and his staff at Rochester procured a small sample of radioactive sodium that they mixed into a variety of sprays and powders. They then conducted field tests that included spraying and dusting these radioactive mixtures over open ground and inside buildings (including a parking garage) around the university campus.[42] The results led Warren to conclude that should fission products be available in sufficient quantities, they could be utilized as "an effective military weapon." They also led him to forecast some of the psychological effects of radiation. Though the test sample was formulated to pose no health risks, Warren reported that, "[t]he knowledge that active material is contaminating the shoes, clothing, is being blown about by the wind with the ever-possible hazard of inhalation gave the group a feeling of constant uneasiness."[43] Warren offered no moral

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39. Stafford L. Warren to The District Engineer, Manhattan District, Oak Ridge, Tenn., February 7, 1945; Stone et al., "Report of Health Division for Month of April 1945," April 26, 1945, both from NTA.

40. See, for example, Stone et al., "Health Division Program," May 10, 1943, NTA.

41. Stone to A. H. Compton, "Research Activities of Health Division," March 24, 1945, NTA.

42. ACHRE, *The Human Radiation Experiments*, 7–8.

43. Stafford L. Warren to James B. Conant, "Radiation as a War Weapon," July 27, 1943, Bush-Conant, file 157. For details on these experiments, see Harold C. Hodge and William F. Bale, "Practical Tests of the Application of Highly Radioactive Sprays and Dusts to Level Ground and to Buildings," August 6, 1943, Bush-Conant, file 157.

judgment on radiation as a weapon, but his report was one of several in 1943 that highlighted the troubling features associated with this type of warfare.

Although the 1941 NAS studies had expressed some enthusiasm for radiological warfare, the high-level scientists and administrators who studied the question in 1943–44 were reluctant to recommend its use by the United States. Displaying an early sensitivity to the issue of radiation, Manhattan Project head Leslie R. Groves disclaimed any desire for offensive use of such weapons. Writing to Conant in May 1943 to request a formal study of radiological warfare, Groves made a point of stressing that, "I do not believe that the United States would initiate offensive use."[44] In asking Arthur Compton and Harold C. Urey to join the ensuing committee, Conant seemed reluctant to even mention the possibility. This reluctance extended to the committee's August 1943 final report, which largely stressed defensive measures.[45] In summarizing the committee's finding for presidential science advisor Vannevar Bush, Groves enunciated what amounted to a tacit no-first-use policy: "*if* military authorities feel that the United States should be ready to use radioactive weapons in case the enemy started it first, studies on the subject should be started immediately."[46]

Why were Groves, Conant, Compton, and Urey so reluctant to consider radiological warfare? A major reason appears to have been the belief that it would be akin to chemical warfare. The poison gas analogy first appeared in the 1941 NAS reports and the correspondence surrounding the formation of the Conant committee in May 1943 referred repeatedly to "radioactive poisons."[47] The committee's report drew an implicit comparison between radiological and chemical weapons, suggesting that, "[i]f the Germans were to use this form of warfare, it would be self-evident that ordinary gas warfare would be used in retaliation."[48] Arthur. V. Peterson, an army engineer who had helped oversee the construction of the Chicago pile, was even more direct, drawing an elaborate eleven-point comparison between "Chemical Agents and Radio-Active Materials."[49] The first use of chemical and biological weapons was prohibited by the 1925 Geneva Protocol. Though the United States had not ratified the protocol, Roosevelt repeatedly affirmed that the United States would not be the first to

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44. Groves to Conant, May 12, 1943, Bush-Conant, file 157.

45. Conant to Harold C. Urey, May 17, 1943; "Report of Subcommittee of the S-1 Committee on the use of radioactive material as a military weapons," August 6, 1943; Arthur H. Compton to Vannevar Bush, August 20, 1943, all in Bush-Conant, file 157.

46. Groves, "Use of Radioactive Material as a Military Weapon," November 10, 1943, NTA, emphasis in original. For the accompanying cover letter, see Groves to Bush, November 11, 1943, Bush-Conant, file 157.

47. Groves, "Policy Meeting," May 5, 1943, Groves "Top Secret," file 23. Also see Tannenwald, *The Nuclear Taboo*, 95–96; Rotter, *Hiroshima*, 122, 175.

48. "Report of Subcommittee of the S-1 Committee on the Use of Radioactive Material as a Military Weapons," August 6, 1943, Bush-Conant, file 157.

49. Arthur V. Peterson, "Appendix IV: Military Use of Radio-Active Materials and Organization for Defense," n.d. [circa June 14, 1943], Bush-Conant, file 157.

use such weapons during World War II.[50] Perhaps because of these factors, the Manhattan Project's administrators apparently never even raised the issue of radiological warfare with the president. In an early example of the compartmentalization of discussions about radiation effects, there is no evidence that either Roosevelt or Secretary of War Stimson were ever informed of the research into radiological warfare.[51] The final report of Conant's committee effectively ended discussion of the offensive use of radiological warfare in World War II, though quiet preparations to defend against German use of such weapons continued though the June 1944 Normandy invasion.[52]

The American exploration of radiological warfare revealed pre-Hiroshima qualms about radiation, including implicit and explicit comparisons to chemical warfare, at the same time it produced new data on radiation effects. In light of these facts, the paradox posed at the start of this article looms even larger. How could Groves and others attached to the Manhattan Project appear to be genuinely surprised by the radiation effects of the atomic bombs used against Hiroshima and Nagasaki? Why were high-level decision makers in the Roosevelt and Truman administrations not warned that the radiation unleashed by the bomb would have lingering effects similar to that of chemical warfare? At least a partial answer to these questions can be found in developments at the Los Alamos laboratory under the direction of J. Robert Oppenheimer.

RADIATION ECLIPSED: THINKING ABOUT THE BOMB AT LOS ALAMOS

The American nuclear effort in 1939–42 was relatively open ended and exploratory in character. In contrast, work at Los Alamos from spring 1943 onward was characterized by a single-minded quest to build a working atomic weapon. Under Oppenheimer, the issues that received time and resources were those directly related to designing and fabricating a bomb. Radiation effects did not fall into that category and thus received little attention prior to the eve of the first test of a plutonium bomb in July 1945. This is not to imply that Los Alamos scientists were entirely ignorant of such effects. The series of lectures given by physicist Robert Serber to new arrivals to the laboratory in April 1943 acknowledged that the bomb would produce dangerous neutron radiation.[53] But while Los Alamos physicist Victor Weisskopf later asserted that there were "constant discussion about the nature of the damage caused by fire and radiation sickness,"

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50. John Ellis van Courtland Moon, "United States Chemical Warfare Policy in World War II: A Captive of Coalition Policy?" *Journal of Military History* 60, no. 3 (July 1996): 497–99.

51. Bernstein, "Radiological Warfare: The Path Not Taken," 46.

52. For more on defense against possible German use of radiological warfare, see Norris, *Racing for the Bomb*, 297–98.

53. Serber, *Los Alamos Primer*, 34.

the available documentary evidence does not support this claim.[54] Rather, the vast majority of data generated on the bomb's potential effects at Los Alamos was concerned with blast, omitting or minimizing the effects of either fire or radiation. As Hymer Friedell, who worked in the Manhattan District's Medical Section, remarked on the wartime climate surrounding the birth of the bomb, "The idea was to explode the damned thing. . . . We weren't terribly concerned with the radiation."[55]

The most obvious explanation for the lack of interest in radiation effects at Los Alamos was that the immense pressure to complete the theoretical and engineering work necessary "to explode the damn thing" precluded giving much thought to the bomb's potential after effects.[56] But in addition to the general pressure of wartime work, several more specific institutional and organizational factors also played a role in deflecting concerns about radiation effects at Los Alamos. At the Chicago Met Lab, the challenge of housing the world's first nuclear reactor at a university in the center of a large American city necessitated a major effort to understand, predict, and treat radiation effects. The environment at Los Alamos was quite different. The isolated New Mexico laboratory did have a small Health Group of its own under the direction of Louis H. Hemplemann, a medical doctor who had worked with Stone at the Rad Lab in Berkeley prior to the war. But during its first year of operation, Hemplemann's group was a relatively insignificant presence and conducted little or no research.[57] Given the small quantities of enriched uranium and plutonium then available, radiation was not initially a major concern for workers on the mesa. Moreover, as Hacker noted in his study of wartime radiation safety, as late as World War II most physical scientists still "tended to believe that biological damage from radiation could somehow be fully reversed."[58] Physicians and health physicists took a more serious view of the long-term effects of even small doses of radiation, as exemplified by the efforts of Stone's Health Division. But physical scientists dominated the team at Los Alamos and this undoubtedly contributed to the relative lack of interest in radiation effects.

The arrival of significant amounts of plutonium starting in February 1944, followed by an accident in August in which Los Alamos chemist Donald F. Mastick accidentally ingested an unknown amount of the material, did raise some specific concerns about radiation safety at Los Alamos. But even as Oppenheimer and Hemplemann lobbied for expanded research on the health effects of

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54. Victor Weisskopf, *The Joy of Insight: Passions of a Physicist* (New York, 1991), 127–28, 137. Also see, Kenneth D. Nichols, *The Road to Trinity: A Personal Account of How America's Nuclear Policies Were Made* (New York, 1987), 184, 223.

55. Hacker, *The Dragon's Tail*, 84–85.

56. On time pressure at Los Alamos, see Charles Thorpe, "Against Time: Scheduling, Momentum, and Moral Order at Wartime Los Alamos," *Journal of Historical Sociology* 17, no. 1 (March 2004): 32.

57. Louis. H. Hempelmann, "History of the Health Group (A-6), March 1943–November 1945)," April 6, 1946, NTA.

58. Hacker, *The Dragon's Tail*, 66.

plutonium, ultimately including human tracer experiments, most of the actual research work was done elsewhere. Groves, meanwhile, insisted on a policy of compartmentalization that strictly limited communication between scientists working at the many various Manhattan Project facilities scattered around the country. While usually justified by security concerns, Groves later admitted that compartmentalization was also driven by a desire to exercise control over project scientists and to ensure that they would "stick to their knitting."[59] The practical result of this policy was that the scientists and engineers working on the bomb at Los Alamos knew little or nothing about the extensive findings on the biological effects of radiation generated by Health Division studies at Chicago, Oak Ridge, and Hanford. Health physicists at those sites, in turn, had scant knowledge of the weapon being designed and built at Los Alamos.

At a more abstract level, organizational routines at Los Alamos also worked to systematically downplay radiation effects. While the vast bulk of the work at Los Alamos was focused of the practical challenge of building the bomb, there were some efforts to predict its effects. Virtually all these pre-Hiroshima predictions focused on blast damage. In her 2004 study *Whole World on Fire*, scholar Lynn Eden analyzed how American planners during the Cold War systematically failed to account for the very extensive fire damage produced by nuclear weapons. Eden's explanation is that these planners were operating under the influence of organizational frameworks and routines originally developed during World War II by the Army Air Forces (AAF). The AAF's wartime planning focused heavily on predicting, producing, and categorizing blast damage and these routines continued to dominate planning well into the nuclear age, despite the fact that the fire effects produced by nuclear weapons were both extensive and predictable.[60] An analysis of wartime Los Alamos indicates that a similar set of organizational routines led the scientists, soldiers, and engineers working there to focus on blast at the expense of both fire damage and radiation effects.

The emphasis on predicting blast can be traced back to the early days of the American nuclear effort. In December 1941, physical chemist George B. Kistiakowsky was tasked with preparing a study predicting "The Destructive Action of Uranium Bombs." At the outset, Kistiakowsky, who would later help oversee the plutonium implosion project at Los Alamos, inserted a caveat that came to characterize wartime thinking about the bomb: "Considered will be only the explosive action, since the lethal action of the radioactive materials formed by fission has no counterpart in ordinary bombs."[61] Kistiakowsky was not ignorant of the bomb's radiation effects; he simply chose not to focus on them. The logic behind this choice was simple: throughout the war, planners could call upon a

59. Leslie R. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (New York, 1962), 140; Charles Thorpe, *Oppenheimer: The Tragic Intellect* (Chicago, 2006), 99–100, 102.

60. Lynn Eden, *Whole World on Fire: Organizations, Knowledge, & Nuclear Weapons Devastation* (Ithaca, NY, 2004).

61. George. B. Kistakowsky, "The Destructive Action of Uranium Bombs," December 26, 1941, Bush-Conant, file 2.

rich and growing body of both real-world and experimental data on blast effects. In predicting the blast effects of an atomic bomb, Kistiakowsky and those who followed him could also employ a vocabulary and set of categories (usually expressed as "damage codes" that rated blast on its effects against certain types of buildings) that were widely understood by planners in the War Department and operational commanders in the field.[62]

No similar body of knowledge or shared vocabulary existed with respect to radiation effects at the outset of the Manhattan Project. The Health Division's biological research, had it been combined with the work of the physicists at Los Alamos, would have allowed for at least a rough forecast of the bomb's radiation effects prior to Hiroshima. This research, however, remained largely compartmentalized within a handful of bodies concerned with either safety or radiological warfare. Nor could those involved in radiation research call upon a widely shared vocabulary to communicate the practical implications of their findings. The prediction that an atomic bomb would produce "Class A" blast damage within a given radius would instantly be understood by high level military planners and easily explained even to those not versed in the nomenclature by reference to factories gutted and homes destroyed. Similar predictions about radiation were complicated by the lack of a simple, widely shared way of measuring and expressing its effects on human beings. This was not for lack of effort on the part of Health Division researchers, who during the war created new dosage measurements that later became widely accepted standards. But predicting radiation dosages and their accompanying biological effects was (and remains) an undeniably complicated endeavor, particularly when compared to more conventional blast effects.[63]

Individual actors also played a part in suppressing concerns about radiation at Los Alamos. Laboratory director J. Robert Oppenheimer was not only the single most influential individual on the mesa, but also an important conduit for information and advice at higher levels in Washington. Had he expressed interest or concern about the bomb's radiation effects, he could have both directed resources toward studying the subject at Los Alamos and alerted Groves, Bush, Conant, or Stimson to their potential importance. But other than urging human trials to measure the excretion rate of plutonium in March 1945, Oppenheimer expressed no such interest or concern. Indeed, even *after* Hiroshima and Nagasaki, he was apparently reluctant to send a medical team to study the

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62. Eden, *Whole World on Fire*, 4–5.

63. Hacker, *The Dragon's Tail*, 41–42; Lindee, *Suffering Made Real*, 197–206. Most wartime estimates of the bomb's effects ignored radiation altogether. Even the exceptions to this rule confirmed the primacy of the blast framework. In late 1944, physicist William Penney mentioned both fire and radiation effects in general terms, noting that "the possibility of eliminating a large fraction of the Fire Forces of a Japanese town by getting the firemen into the radioactive contaminated area to fight fires is attractive and realistic." This brief (and favorable) mention of possible radiation and fire effects, however, was buried in the concluding paragraphs of a seven-page memorandum filled with calculations aimed at maximizing the bomb's blast effects. William G. Penney, "The Height of Burst of the Gadget," December 13, 1944, NTA.

biological effects of radiation on the victims.[64] Though he later earned the reputation as a tragic figure haunted by the atomic fire that he had helped to unleash, nothing on the pre-Hiroshima record suggests that Oppenheimer was uncomfortable with mass killing in general or the lingering effects of radioactivity in particular.[65] On the specific issue of radiation, Oppenheimer was aware of the discussions of radiological warfare in 1943. His judgment at that time, that offensive use should not be considered "unless we can poison food sufficient to kill a half a million men," reflected a cold-blooded calculus devoid of moral or legal concerns over this particular form of mass killing.[66]

The individual and organizational factors that worked to deflect attention from radiation effects at Los Alamos had consequences that went far beyond the isolated mesa that housed the laboratory. From spring 1943 onward, Los Alamos was the focal point of the American nuclear effort. Important work continued for the duration of the war at other Manhattan Project facilities around the country (and later at the forward base on the island of Tinian in the Pacific where the bomb was assembled for delivery).[67] But as the project moved from theory to reality, all roads converged at Los Alamos. Reflecting the priorities and discourse of the desert laboratory, the handful of men who acted as a gateway between the scientists and high-level decision makers in Washington downplayed or ignored radiation effects in reports to the president and his nuclear advisers.[68]

PLANNING FOR COMBAT USE, APRIL-JUNE 1945

As work at Los Alamos neared fruition in spring-summer 1945, there were two opportunities to integrate the growing body of knowledge about radiation effects into decision making about the bomb. The first arose in April-May as a result of the operational planning for its combat use conducted by the Target Committee, a group composed of representatives from the Manhattan Project and the AAF. As indicated by its name, the committee's primary charge was to recommend targets for the bomb, though in the process its members also

64. Lindee, *Suffering Made Real*, 22.

65. Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York, 2005), 287; Thorpe, *Oppenheimer*, 129, 154, 156; Herken, *Brotherhood of the Bomb*, 364, n. 79; Sean L. Malloy, "'The Rules of Civilized Warfare': Scientists, Soldiers, Civilians, and American Nuclear Targeting, 1940–1945," *Journal of Strategic Studies* 30, no. 3 (June 2007): 489–90.

66. J. Robert Oppenheimer to Enrico Fermi, May 25, 1943, Papers of J. Robert Oppenheimer, box 33, Library of Congress, Washington, DC.

67. On Tinian, see Gordin, *Five Days in August*.

68. Conant, "Findings of Trip to L.A. July 4, 1944," Bush-Conant, file 3; Conant, "Report on Visit to Los Alamos," August 17, 1944, Bush-Conant, file 86; Conant, "Report on Visit to Los Alamos—October 18, 1944," Bush-Conant, file 3; Groves to George C. Marshall, "Atomic Fission Bombs—Present Status and Expected Progress," August 7, 1944, Groves "Top Secret," file 25M; Groves to Marshall, "Atomic Fission Bombs," December 30, 1944, U.S. Department of State, *Papers Relating to the Foreign Relations of the United State, Conferences at Malta and Yalta, 1945* (Washington DC, 1955), 383–84. All of these high level reports stress blast effect; none mention radiation.

discussed a variety of other factors affecting combat use. The composition of the Target Committee virtually ensured that radiation would play little or no role in its discussion of the bomb. The AAF representatives naturally inclined toward an understanding of the bomb as an unusually large blast weapon. The Los Alamos scientists attached to the committee—John von Neumann, William Penney, and Bright Wilson—apparently shared this assumption. Reflecting the dominant organizational frame at Los Alamos and in the AAF, both the specific target criteria and the procedures for delivery discussed by the Target Committee centered on taking advantage of the bomb's blast effects. Its members quickly narrowed their focus to locating "a large urban area" that was "capable of being damaged effectively by a blast."[69]

Radiation effects did briefly intrude on the Target Committee's discussions when the group assembled for a meeting at Los Alamos on May 10–11. Apparently in response to questions over the safety of the aircrews delivering the weapon, Oppenheimer presented a memorandum offering a "brief summary of the radiological effects to be expected from the special bomb." The initial radiation, he suggested, would "be injurious within a radius of a mile and lethal within a radius of about six-tenths of a mile." Oppenheimer was less exact in his predictions with respect to residual radiation, noting that "[t]he actual physical distribution of the radioactive products is not known to us, since it depends in detail on meteorological conditions." Should there be rainfall at the time of delivery, or if the superheated air created by the blast should interact with existing humidity to generate precipitation (as some Los Alamos scientists suggested it might), then "it may be expected that most of the active material will be brought down by the rain in the vicinity of the target area." In such circumstances, residual radiation might be quite intense in localized areas.[70]

Oppenheimer's May 10 memorandum demonstrated awareness, at least in broad terms, of the dangers posed by both immediate and residual radiation. But the memo, and the reaction to it, is also illustrative of the degree to which these dangers were minimized or ignored in planning for use of the bomb. With respect to the bomb's radiation effects, the Los Alamos director's only recommendations related to safety for American air crews and occupation troops. To protect the crew, the plane delivering the bomb should be no less than two-and-one miles away at the time of detonation. Oppenheimer doubted that there would be substantial residual radiation, but he suggested that "[m]onitoring will be necessary if this area is to be entered within some weeks of the primary detonation" to ensure the safety of any occupying troops.[71] Significantly absent from the memorandum was any discussion of, or concern over, the effects of

69. Jack Derry, "Summary of Target Committee Meetings on 10 and 11 May 1945," May 12, 1945, Groves "Top Secret," file 5D.

70. Oppenheimer, "Memorandum for Brigadier General Thomas Farrell," May 11, 1945, Groves "Top Secret," file 5G.

71. Ibid.

radiation on the Japanese victims of the bomb. There was also no mention of the fact that even absent residual radiation, the effects of the initial radiation would continue to kill, injure, and shorten the life span of those exposed to it long after the explosion. Unlike the 1943 discussions of radiological warfare, there was neither an implicit nor explicit suggestion during the Target Committee's deliberations that the use of a weapon with long-term radiological effects might strain ethical or legal boundaries.

There are likely several overlapping explanations for the lack of concern over radiation effects during the preparations for combat use. Perhaps most importantly, neither Oppenheimer nor any of the scientific representatives on the Target Committee had any background or experience in the biological effects of radiation. As physical scientists, they likely shared the traditional understanding of radiation damage as something that tended to be immediate and reversible. The work done by the Met Lab's Health Division during the war had provided substantial evidence to overturn this assumption. But the narrow composition of the Target Committee, combined with the compartmentalization of information within the Manhattan Project, meant that those considering the use of the bomb in April-May 1945 likely did not fully grasp the extent to which radiation would have delayed and irreversible effects on those exposed to it. Moreover, unlike the 1943 discussions of radiological warfare, the Target Committee's focus on blast allowed them to avoid dwelling on any potential troubling issues raised by radiation. As physicist Norman Ramsey later summarized it, "the people who made the decision to drop the bomb made it on the assumption that all casualties would be standard explosions casualties . . . Any person with radiation damage would have been killed with a brick first."[72] This assumption was not only wrong but also *predictably wrong*, even prior to Hiroshima. However, the absence of relevant experts on radiation effects among the key decision makers left the blast framework unchallenged during the decisions about use in spring-summer 1945.

If radiation effects received only cursory attention at the level of the Target Committee, they played an ever smaller role in the higher-level decision making about the bomb. The most extensive and wide-ranging discussions about the bomb prior to Hiroshima took place in the meetings of the Interim Committee in May 1945. Though the Interim Committee—which was chaired by Secretary of War Stimson and included Bush, Conant, and soon-to-be Secretary of State James F. Byrnes among others—was nominally tasked with preparing for the postwar handling of atomic energy, its deliberations spilled over to include a number of issues related to the wartime use of the bomb. While outlining the effects of the bomb at a lengthy meeting of the Interim Committee on May 31, Oppenheimer suggested that the "neutron effect of the explosion would be dangerous to life for a radius of at least two-thirds of a mile."[73] The Los Alamos

72. Rotter, *Hiroshima*, 123.

73. Gordon Arneson, "Notes of the Interim Committee Meeting," May 31, 1945, Harrison Bundy Files Relating to the Development of the Atomic Bomb, 1942–46, Records of the Office

director apparently failed to mention the gamma rays that would be produced as part of the bomb's initial radiation (which were known to kill and injure at a longer range than neutron radiation) or the possibility of fallout or other forms of residual radiation. Nor is there any evidence that the Interim Committee's members were told that even the bomb's initial radiation could have lingering and delayed effects on the survivors, including leukemia and cancerous tumors. This one passing mention in the midst of the lengthy May 31 meeting constituted the only acknowledgement of the bomb's radiation effects during the life of the Interim Committee.

As was the case at both wartime Los Alamos and among the members of the Target Committee, the lack of relevant experts with respect to radiation and the almost universal acceptance of blast damage as the interpretative framework for understanding the bomb likely combined to help suppress concerns about radiation at the level of the Interim Committee. Moreover, the Interim Committee's responsibility for postwar planning and the sheer range of issues discussed at these meetings, including national and international policy related to nuclear energy, prevented a sharp focus on *any* of the various questions related to wartime use of the weapon. Lawrence, for example, seemed preoccupied at the climactic May 31 meeting with securing federal funding for postwar domestic research into atomic power.[74] Finally, it is possible that high-level scientists and administrators feared that invoking the specter of lingering death and illness as a result of the bomb's radiation effects might raise concerns among civilian policymakers just as the $2 billion Manhattan Project was about to bear fruit. There is no evidence to suggest a coordinated conspiracy to withhold information from high-level decision makers in the Truman administration. But the earlier reluctance of Bush and Conant to even discuss radiological warfare with President Roosevelt suggests awareness on their part that radiation might be a sensitive issue.

When Stimson reported the Interim Committee's recommendations to Truman on June 6, 1945, he made no mention of radiation. Nor did the June 16 final report of the Scientific Panel—which recommended immediate combat use of the bomb even as it acknowledged division among scientists over the wisdom of such a course—raise the issue. [75] Thus, while some concerns about radiation did creep into lower-level planning for use of the bomb, high-level officials, including Truman, Stimson, and Byrnes, were very poorly informed on this issue prior to Hiroshima. What information they did have was often narrow and misleading. Meanwhile the Manhattan Project scientists and physicians who knew the most about radiation and its potential effects played no role in the decisions about the combat use of the atomic bomb.

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of the Chief of Engineers, RG 77, microfilm publication M1108, file 100, National Archives, Washington, DC (hereafter cited as Harrison-Bundy).

74. Arneson, "Notes of the Interim Committee Meeting," May 31, 1945.

75. Scientific Advisory Panel, "Recommendations on the Immediate Use of Nuclear Weapons," June 16, 1945, Harrison-Bundy, file 76.

TRINITY, POTSDAM, AND TACTICAL USE OF THE BOMB, JULY–AUGUST 1945

The final opportunity to integrate an understanding of radiation effects into the decision to use the bomb against Japan arose around the time of the so-called Trinity test: a proof firing of the plutonium implosion bomb in the New Mexico desert in July 1945. Given the organizational focus on blast that dominated thinking about the bomb at Los Alamos, it is unsurprising that initial thinking about the test focused on measuring blast effects. In October 1944, George Kistiakowsky outlined for Oppenheimer the types of measurements that should be incorporated into the test. "It is hardly necessary," Kistiakowsky wrote, "to discuss the reasons for measuring the air blast, since the present plans for the use of the gadget over enemy territory consider blast as the effective damaging agent." The initial radiation produced by the bomb was a distant third in priority (after blast and ground shock) and measurement of residual radiation ranked even lower.[76]

Shortly prior to the Trinity test, two physicists in the Theoretical Division at Los Alamos challenged the complacency regarding radiation and the upcoming test. Joseph O. Hirschfelder was one of the few on the mesa to show significant interest in radiation effects prior to Hiroshima. In April 1945, he circulated a memorandum to Oppenheimer and others suggesting that the bomb might be deliberately employed in such a way as to generate a large amount of radioactive debris such that "radiation effects might cause considerable damage in addition to the blast damage ordinarily considered."[77] Predictably, given the apparent lack of interest in the subject at Los Alamos, Hirschfelder's proposal seems to have elicited neither enthusiasm nor condemnation. Blast effects, not radiation, remained the driving concern in the design and planning for use of the bomb, and there is no record of any response whatsoever to his proposal. However, in mid-June, he raised the issue again in a different context, this in conjunction with fellow theoretical physicist John L. Magee. In their June 16 memorandum, Hirschfelder and Magee warned that under certain weather conditions radioactive dust and debris from the test might pose a serious risk to surrounding communities.[78] This was a warning about what would later be described as fallout, though at the time no such term existed for this predictable but poorly researched aspect of nuclear weapons. Those in charge of safety for the test, however, were largely dismissive. In an analysis prepared by the Los Alamos Health Group, Hemplemann and his assistants assured their superiors that

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76. Kistiakowsky to Oppenheimer, October 13, 1944, NTA.

77. Joseph. O. Hirschfelder to Oppenheimer, April 25, 1945, NTA. For predictions that the bomb might, under certain conditions, produce rain, see Hirschfelder and J. M. Hubbard to Oppenheimer, April 23, 1945, NTA.

78. Hirschfelder and J. Magee to K. Bainbridge, "Danger from Active Material Falling from Cloud Desirability of Bonding Soil Near Zero with Concrete and Oil," June 16, 1945, NTA.

"there is little likelihood of serious damage to individuals in neighboring towns unless the contamination in 2–3 times that which is described."[79]

High-level political pressure also inadvertently worked to compromise radiation safety. What little radiological safety planning preceded the test focused largely on assuring favorable meteorological conditions. Advisable precautions included awaiting a time of favorable winds (blowing the fallout away from populated areas) and dry weather (to prevent the threat of rain bringing down large concentrations of active material in any one location). Truman and his advisers, however, wanted to have the bomb successfully tested at the outset of the diplomatic meeting at Potsdam at which the new president would negotiate directly with Joseph Stalin for the first time. This pressure led to the test taking place on July 16, several days before the optimal meteorological window and at a time when thunderstorms risked bringing down concentrated fallout near the test site. Safety measures were confined to dispatching monitors to track the posttest debris cloud. Even this limited measure appears to have been driven more by bureaucratic concerns over potential lawsuits (particularly by ranchers whose cattle might be affected) than by genuine worry over public health and safety.[80]

The Trinity test was illustrative of the generally low priority given to radiation effects by the scientists, soldiers, and engineers at Los Alamos. If Groves and Oppenheimer were largely dismissive of radiological safety during a test on American soil, they could hardly have been expected to express concerns about the bomb's radiation effects on the Japanese. The handling of the Trinity test was characteristic of the entire approach at Los Alamos, which aimed at speedy development of a weapon whose effects were primarily understood to be those of a large blast bomb. When Groves reported the results of the Trinity test to Secretary of War Stimson, who was with Truman at the Potsdam conference outside Berlin, he dealt at length with the "tremendous blast effects" produced by the bomb. Groves made no mention of the initial radiation produced by the explosion and generally sought to downplay the danger posed by fallout, though he acknowledged that "concentrations of highly radioactive materials resulted from the fission" and that these materials were deposited "over a wide area."[81]

The reports from New Mexico had a dramatic effect on Truman and his advisers at Potsdam. There is no indication, however, that they focused on or even understood the implications of the radiation effects as briefly described by Groves.[82] As an inexperienced president attending his first international

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79. Hemplemann and James F. Nolan to Bainbridge, June 22, 1945, NTA.

80. Hacker, *The Dragon's Tail*, 90–92; Hoddeson et al., *Critical Assembly*, 364–65; Norris, *Racing for the Bomb*, 399–402.

81. Groves, "Memorandum for the Secretary of War," July 18, 1945, Groves "Top Secret," file 4.

82. Truman Diary, 25 July 1945, in *Documentary History of the Truman Administration*, vol. 1, *The Decision to Drop the Atomic Bomb on Japan*, ed. Dennis K. Merrill (Bethesda, MD, 1995), 156.

conference, Truman was confronted with a host of major issues related to both ending the ongoing war with Japan and shaping the postwar order in Europe and Asia. In these trying circumstances, it is not surprising that he latched onto the bomb as a diplomatic and military tool without inquiring too closely into the details of its operation. Having never received a briefing on radiation, the president had no reason to raise questions about its possible lingering effects. Neither Stimson, Byrnes, nor any of the other civilian members of Truman's staff at Potsdam had any understanding of the subject beyond the very limited discussion that had taken place during the May 31 Interim Committee meeting.

Though knowledge gleaned from the Trinity test played no role in high-level decision making, it did have some impact on lower-level planning. The blast measurements confirmed previous predictions made at Los Alamos that the most effective use of the weapon would be an air burst that spread the bomb's blast effects over a wide area containing soft targets such as wood frame houses (e.g., Japanese urban areas). Post–Trinity test, Oppenheimer estimated that the optimal height of detonation would be 1,850 feet above the surrounding terrain, a figure that was "appropriate for the maximum demolition of light structures." He went on to predict that exploding the bomb at this height would also reduce the chance of "radioactive contamination" reaching the ground.[83] Contrary to postwar claims by Groves and a handful of historians, there is no evidence that concerns about limiting radiation exposure played any role in setting the blast height.[84] While the data gathered at the Trinity test indicated that the optimal detonation height for maximizing blast effects of light structures would also have the effect of reducing the bomb's residual radiation effects on the ground, this was a fortuitous coincidence. Oppenheimer later conceded as much, admitting in September 1945 that "if we had to contaminate to increase the blast, I don't know what we would have done, but we were not confronted with that issue."[85]

The data on radiation gathered from the Trinity test also factored into a revealing discussion about the tactical use of the bomb as a battlefield weapon against enemy troops and fortifications. The issue was briefly raised at the final meeting of the Target Committee in late May. Given that there were few remaining untouched cities in Japan that would provide for "efficient use" of the

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83. Oppenheimer, "Memorandum for General T. F. Farrell and Captain W. S. Parsons," July 23, 1945, reproduced in John Coster-Mullen, *Atom Bombs: The Top Secret Inside Story of Little Boy and Fat Man* (self-published, 2003), 203.

84. For postwar claims that the detonation height was set with the goal of reducing or eliminating radiation effects, see Grove, *Now It Can Be Told*, 286, 352; Stanley Goldberg, "Note on Barton Bernstein's 'Seizing the Contested Terrain of Early Nuclear History,'" *Society of Historians of American Foreign Relations Newsletter* 24 (September 1993): 5–7. For a discussion the primacy of blast in setting detonation height see Lillian Hoddeson et al., *Critical Assembly: A Technical History of Los Alamos During the Oppenheimer Years* (Cambridge, England, 1993), 183–84, 260–61; Bernstein, "Doing Nuclear History," 17–36; Malloy, "'The Rules of Civilized Warfare,'" 486–88; Norris, *Racing for the Bomb*, 385; Gordin, *Five Days in August*, 46; Bird and Sherwin, *American Prometheus*, 314.

85. *Los Angeles Times*, September 12, 1945, 4.

weapon, the committee suggested it was worth exploring tactical use once those cities had been destroyed. Using the bomb in this manner, particularly if it came in conjunction with an invasion of Japan, raised questions about radiation safety for U.S. troops. Nine days after the Trinity test, Stafford Warren, head of the Manhattan Project's Medical Section, sent a memorandum to Groves discussing "The Use of the Gadget as a Tactical Weapon" based on data gathered in the aftermath of the test. Warren suggested that the bomb *might* be safely used in such a way, but only if certain conditions were met. To prevent fallout from affecting friendly troops, there would have to be "a strong, steady wind essentially perpendicular to the line and in the direction of the assault." Ideally this would be accompanied by rain that would "wash the active material into the natural drainage" in an area away from the line of advance. Finally, the advancing troops should be sheltered in armored vehicles stationed roughly ten miles away from the point of detonation. They could then pass quickly "through the right and left margins of the devastated area." Even then, troops should be issued masks to protect against dust inhalation, and the assault should be preceded by monitoring vehicles to ensure that the area was safe. The document concluded with a simplified table outlining the biological risks to human beings associated with various doses of radiation.[86]

Warren's post–Trinity test memo to Groves is illustrative of how the wartime health and safety research on radiation effects might have better informed decisions about the bomb. Though Warren was generally less conservative when it came to radiation risks than Stone and those in the Met Lab's Health Division, he was quite clear in his July 25 memorandum that even relatively low-level exposure to lingering radiation could produce significant biological changes. No similar warning was ever presented to the Interim Committee or to individual policymakers, such as Stimson, Byrnes, and Truman, who made the final decision about the use of the bomb against Japan. Warren's memo on tactical use, less than two weeks before Hiroshima, was a rare exception to the policy of compartmentalization that kept the work of health and safety experts on radiation effects well removed from the decision making about the use of the bomb. Even then, Groves chose to significantly dilute Warren's warnings when passing this information up the chain of command. In a July 30 memorandum to Army Chief of Staff General George C. Marshall, Groves stripped away virtually all of Warren's caveats and precautions (as well as his estimates of safe and unsafe dosages for occupying troops). "No damaging effects are anticipated on the ground from radioactive materials," Groves asserted, going on to suggest that "we think we could move troops through the area immediately preferably by motor *but on foot if desired*."[87] Discussions of tactical use continued to percolate

86. Stafford Warren to Groves, "The Use of the Gadget as a Tactical Weapon Based on Observations Made During Test II," July 25, 1945, NTA.

87. Groves to George C. Marshall, July 30, 1945, Groves "Top Secret," file 4. Emphasis added.

in the background until the end of the war, with Marshall apparently expressing some interest in the idea.[88]

Groves's cavalier endorsement of sending unshielded U.S. troops on foot through the immediate aftermath of a nuclear blast is one of most shocking aspects of this entire story. It seems improbable that the military head of the Manhattan Project, one of the few individuals who had direct access to all aspects of the work on the bomb, failed to understand the plainly stated concerns raised by the head of his own Medical Section only days earlier. But while he had ample motive to downplay or cover up radiation effects on Japanese victims *after* Hiroshima, it is harder to explain why he might risk his career by knowingly offering false assurances to his superiors that radiation posed no significant danger to American troops. It seems most likely that a combination of ambition, wishful thinking, and a form of "self-compartmentalization" were responsible for Groves's bizarre and irresponsible recommendations with respect to tactical use and radiation effects prior to Hiroshima.

Groves was, in theory, not subject to the compartmentalization that segregated the health and safety research on radiation effects from the decisions related to the design and use of the bomb. In practice, however, he appears to have shared the single-minded focus of the Los Alamos group on overcoming the practical obstacles to a working weapon, particularly as the bomb grew closer to a reality in 1944–45. Though he had access to the vast research generated during the war on radiation and its biological effects, there is no evidence that he paid much in the way of attention to its findings. Grove likely suffered from a kind of self-imposed compartmentalization that led him to disregard or delegate matters not directly related to the task of producing and using the atomic bomb, including the issue of radiation effects. To the extent that he was aware of the dangers posed by radiation effects, Groves clearly found them troubling at some level, as evidenced by his handling of the radiological warfare issue in 1943. As a tireless booster of the bomb, he undoubtedly had no desire to focus on or draw attention to aspects of the project that might raise troubling questions about its use. His misleading statement on radiation hazards to Marshall in July 1945 thus likely reflected a genuine disinterest and lack of knowledge in the subject combined with a reflexive desire to avoid raising issues that might trouble those above him.

"APPARENTLY ALL THINGS ARE RELATIVE": POST-HIROSHIMA DISCUSSION OF RADIATION EFFECTS

In the aftermath of Hiroshima and Nagasaki, radiation effects briefly became front-page news in the United States. On August 8, a sensational article in the

88. Barton J. Bernstein, "Eclipsed by Hiroshima and Nagasaki: Early Thinking About Tactical Nuclear Weapons," *International Security* 15, no. 4 (Spring 1991): 149–173.

Hearst press by Harold Jacobson, a scientist who had briefly worked on the bomb project at Oak Ridge and Columbia University, asserted that the residual radiation in Hiroshima "will not be dissipated for approximately seventy years."[89] Jacobson greatly overstated the bomb's residual effects while omitting any mention of the immediate exposure that accounted for the vast majority of the bomb's radiation casualties. Nevertheless, the article alarmed Groves, who phoned Oppenheimer in hopes of rebutting the charges. The Los Alamos director assured Groves that Jacobson's assertions were "of course lunacy" and lent his name to a public statement denying that residual radioactivity posed any significant hazard in Hiroshima.[90] Jacobson, meanwhile, was questioned by the FBI and under apparent duress issued a statement "clarifying" his initial claims.[91] The larger issue, however, was not so easily dismissed. Within weeks, a fresh batch of stories direct from the ruins of Hiroshima and Nagasaki painted a more realistic but no less tragic picture of lingering sickness and death caused by the bomb's radiation effects.

Behind the scenes, some of the doctors and scientists attached to the Manhattan Project also raised concerns about radiation effects in the aftermath of Hiroshima. Given what they had learned during their wartime research, members of the Met Lab's Health Division were particularly sensitive to reports of radiation sickness in Japan. On August 9, Stone wrote a letter to Hymer Friedell in the MED's Medical Section at the behest of concerned scientists at Oak Ridge and Chicago. Though he professed no personal unease, on behalf of these unnamed individuals Stone wrote to ask, "were the Japanese warned that radiation hazards would remain after the explosion had passed away?" Without such warnings, he suggested, "we might be considered guilty of unnecessary destruction of life," particularly if neutral relief workers were to be unknowingly exposed to residual radiation during their rescue efforts. Stone closed the letter with a jab at Oppenheimer for his role in what appeared to be a cover-up with respect to radiation effects. "I could hardly believe my eyes," Stone wrote, "when I saw a news release said to be quoting Oppenheimer, and giving the impression that there is no radioactive hazard. Apparently all things are relative."[92]

Some two weeks later, following fresh reports of radiation sickness in Japan, George Kistiakowsky, acting at the behest of fellow scientists at Los Alamos, sent Groves a teletext expressing concerns about "Japanese broadcasts claiming murderous delayed radioactive effects at Hiroshima."[93] Meanwhile, two Health Division scientists at Oak Ridge, Paul Henshaw and Robert R. Coveyou, wrote a memorandum in response to a news story about radiation sickness published in

89. *San Francisco Examiner*, August 8, 1945, 1.

90. Gordin, *Five Days in August*, 54.

91. *New York Times*, August 9, 1945, 8; *Los Angeles Times*, August 9, 1945, 3; Lifton and Mitchell, *Hiroshima in America*, 40–42.

92. Stone to Hymer. L. Friedell, August 9, 1945, NTA.

93. Wyden, *Day One*, 18; Leslie R. Groves Diary, August 25, 1945, Papers of Leslie R. Groves, box 3, RG 200, National Archives II, College Park, Maryland.

the Knoxville *News-Sentinel*. Though they lacked access to both the victims of the bomb and specific details of how it had been employed, on the basis of pre-Hiroshima data on radiation effects Henshaw and Coveyou concluded that "*it seems highly plausible that a great many persons were subjected to lethal and sub-lethal doses of radiation, in areas where direct blast effects were possibly non-lethal*." In direct contrast to the official line offered by Groves and the War Department, they suggested that "current Japanese reports of the effect of the explosion are, in the main, trustworthy."[94] The fact that Henshaw and Coveyou were able to independently confirm the radiation effects of the bomb in Japan using only pre-Hiroshima data gathered by the Health Division is another indication of the extent to which such effects were, in fact, roughly predictable prior to the use of the bomb.

In the short term, Groves and his allies were largely successful in suppressing public discussion of radiation effects. General Douglas MacArthur's occupation authority exercised strict control over the Japanese press, censoring articles that might raise questions about the bomb. Even the publication of scientific and medical reports on the bomb's effects was prohibited.[95] Controlling the story in the United States was a more subtle proposition. Though the War Department did censor some early American reports that made mention of radiation, Groves preferred to deal with the issue by selectively employing Manhattan Project scientists to rebut the most sensational public charges. As Robert J. Lifton and Greg Mitchell note in their study *Hiroshima in America*, the Jacobson article turned out to be a boon for Groves in this respect.[96] Jacobson's claim that Hiroshima would be uninhabitable for up to seventy years was quickly and easily disproved. It also focused public attention on the narrow issue of residual radiation. While there remains dispute over the effects of residual radiation in Hiroshima and Nagasaki on survivors and rescue workers, the overwhelming majority of radiation casualties were due to the release of neutrons and gamma rays within the first minute after detonation (even though in many cases the effects did not manifest themselves until much later).[97] By responding narrowly to the issue of residual radiation, Groves deflected attention away from the well-documented fact that even low-level exposure to the bomb's initial radiation could have lingering biological effects.

Oppenheimer proved to be a valuable and willing ally in Groves's post-Hiroshima efforts to downplay the bomb's radiation effects. While the Los Alamos director's dismissal of the dangers posed by residual radiation at

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94. Paul Henshaw and Robert. R. Coveyou to H. J. Curtis and K. Z. Morgan, "Death From Radiation Burns," August 24, 1945, NTA. Emphasis in original.

95. Braw, *The Atomic Bomb Suppressed*; Lindee, *Suffering Made Real*, 48–51; Ishikawa and Swain, trans., *Hiroshima and Nagasaki*, 14.

96. Lifton and Mitchell, *Hiroshima in America*, 42.

97. For contrasting views on the significance of residual radiation see Schull, *The Effects of Atomic Radiation*, 120 and Ishikawa and Swain, trans., *Hiroshima and Nagasaki*, 149–150. For more on this dispute, see Lindee, *Suffering Made Real*, 19, 28, 199–200.

Hiroshima may, perhaps, have been correct in a narrow sense, in omitting any mention of the delayed effects of immediate radiation, he implied that tales of lingering death and sickness amongst the ruins were nothing more than propaganda. On September 9, 1945, Oppenheimer appeared alongside Groves at a tour of the Trinity test site in order to show a select group of American reporters that there was nothing to fear from the bomb's radiation effects. The tour, during which Oppenheimer repeated his previous assurances that residual radiation posed no threat to those who entered the bombed cities, was a dramatic success. United Press correspondent Charles B. Degges declared that the assembled reporters departed the test site "convinced that they would not die within a few weeks or that their hair and teeth would not fall out as Jap propaganda would have the world believe."[98] Even Howard Blakeslee, whose story implying American foreknowledge of radiation effects had led an alarmed Groves to wonder how "to get the AP science editor on the straight track," left the Trinity test site convinced. Blakeslee reported that the tour "show[ed] first hand that the facts do not bear out Japanese propaganda" and invoked Oppenheimer to assure his readers that the bomb produced "no indirect chemical warfare due to poisoning the earth with radioactive elements, and no horrors other than the familiar ones due to any great explosion."[99]

CONCLUSION: LESSONS AND ALTERNATIVES

This survey of pre-Hiroshima knowledge of radiation effects in the United States makes it clear that most of the immediate and long-term biological effects of radiation on victims of the bomb were predictable at the time of the A-bomb decision, even if still imperfectly understood. Much of the research that made such predications possible was generated by men and women directly employed by the Manhattan Project during the course of the war. It is also clear that this knowledge played little or no role in the decision to use the atomic bomb. The policy of compartmentalization combined with the single-minded drive at Los Alamos to build a working bomb and the primacy of the blast damage model meant that few even inside the Manhattan Project were aware of, or interested in, the emerging body of knowledge on radiation effects generated during the war. The scientists and physicians tasked with researching those effects knew little or nothing about the efforts to build and deliver the atomic bomb and played no role in the decisions about its wartime use. The high-level American leaders who made the final decisions about the bomb, including President Truman, Secretary of State Byrnes, and Secretary of War Stimson, were never informed that the weapon would continue to sicken and kill its victims long after use.

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98. *Los Angeles Times*, September 12, 1945, 4; Gordin, *Five Days in August*, 54.

99. *Washington Post*, September 12, 1945, 1; "Memorandum of Telephone Conversation between General Groves and Lt. Col. Rea, Oak Ridge Hospital, 9:00 a.m., 25 August 1945," Groves "Top Secret."

If Truman and his closest advisers *had* been briefed on what was then known about radiation and its biological effects, might they have handled the bomb differently? In light of the tremendous investment in time and resources poured into the Manhattan Project and the bloody, ongoing war in the Pacific, it is hard to imagine Truman foregoing use of the bomb. But if American leaders had had even a rough understanding of radiation effects, that knowledge might well have affected decisions about *how* the bomb was used. The debates inside the Truman administration in spring-summer 1945 centered not on whether to use the bomb, but rather on more subtle questions such as the choice of targets, the possibility of an explicit warning or demonstration, and the pursuit of various diplomatic options (most notably a guarantee of the postwar status of the Japanese Emperor) prior to use. Even without an understanding of the lingering and indiscriminate effects of radiation, several important American decision makers expressed qualms about combat use of the bomb against Japanese cities and civilians. Army Chief of Staff Marshall, for example, lobbied Secretary of War Stimson on May 29, 1945, for use of the bomb against a strictly military target in order to avoid civilian casualties.[100] Stimson also expressed concerns about the targeting of Japanese civilians on several occasions. As late as July 25, Truman recorded in his diary that "I have told the Sec. Of War, Mr. Stimson to use [the atomic bomb] so that military objective and soldiers and sailors are the target and not women and children. . . . The target will be a purely military one."[101]

Ultimately, the press of events, the precedent set by conventional firebombing, and the accretion of previous decisions relating to the design and use of the bomb overrode ethical qualms about the mass killing of Japanese civilians among American policymakers. Whether knowledge of the bomb's radiation lingering radiation effects would have been enough to jolt Truman and his advisers into revisiting the issues of targeting, warning, or the possibility of a noncombat demonstration is impossible to answer definitively. But the wary response of Bush, Conant, Groves, and others toward the possible offensive use of radiological weapons in 1943 (including explicit comparisons to chemical warfare) combined with Groves's anxiety upon hearing reports of radiation effects after Hiroshima, suggests that they suspected their superiors might be troubled by a weapon that continued to kill, injure, and contaminate long after its use. At the very least, a presentation of the findings on radiation effects by the Manhattan Project's own scientists rendered in layman's terms would have allowed Truman to make a more informed decision about the bomb.

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100. John J. McCloy, "Memorandum of Conversation with General Marshall May 29, 1945, 11:45 AM," "Safe File," box 12, "S-1."; Formerly Top Secret Correspondence of Secretary of War Stimson, RG 107, National Archives II, College Park, Maryland.

101. Truman Diary, July 25, 1945, Merrill, *The Decision to Drop the Atomic Bomb on Japan*, 156. For more on the concerns over targeting Japanese civilians, see Malloy, *Atomic Tragedy*, 106–09, 118–19, 134–38.

Even after Hiroshima and Nagasaki, information gathered by the Health Division during the war might have allowed Japanese physicians to better cope with the mysterious "atomic bomb disease" that continued to kill long after the surrender. An examination of the Cold War implications of the failure to integrate radiation effects research into the design, testing, and use of nuclear weapons is beyond the scope of this essay. A cursory glance at the history of U.S. domestic and international nuclear testing, however, suggests that the caviler attitude exhibited by Groves and Oppenheimer toward radiation effects during World War II was far from exceptional during the Cold War period. This study confirms Eden's conclusion in *Whole World on Fire* that the primacy of the blast effects model in U.S. nuclear war planning and the continuing failure to adequately assess both radiation and fire effects almost certainly contributed to the unchecked growth of a U.S. Cold War nuclear arsenal that was massively larger than required by any rational calculation of military or national security requirements. For all of the outstanding technical successes of the Manhattan Project, the policy of wartime compartmentalization and postwar denial with respect to radiation effects ultimately served neither American leaders, the American people, nor the many victims of the bomb.