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Resource Letter MP-4: The Manhattan Project and related nuclear research

B. Cameron Reed

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B. Cameron Reed[a)]
Department of Physics (Emeritus), Alma College, Alma, Michigan 48801

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This fourth Resource Letter on the Manhattan Project comprises over 140 new sources to complement the 390 listed in the first three on this topic. Books, review papers, and journal articles are cited for the categories of general works; specific topics within the Manhattan Project; technical and historical works; biographies and autobiographies; international wartime programs, allied intelligence, and the use of the bombs; postwar developments; and educational materials. A separate section lists videos and websites.

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I. INTRODUCTION

Since the publication of the first Resource Letter on this topic in 2005, awareness of nuclear issues has waxed and waned. Perhaps the biggest change since then has been the increasing awareness of climate change and the role nuclear power will have to play as we transition away from fossil fuels. Tempering this are, as always, concerns with possible accidents, dual-use technologies, the politics of waste disposal, and developments surrounding nuclear weapons. North Korea continues to enhance both its weapons and delivery systems (Ref. 120); enrichment activities continue in Iran; "established" nuclear powers are undertaking expensive, long-term expansions and upgrades of their arsenals (Ref. 123); arms control agreements are being allowed to expire; and sabre-rattling associated with Russia's brutal invasion of Ukraine has the world potentially closer to a nuclear exchange than at any time since the height of the Cold War in the 1980s; the world faces many nuclear issues and choices (Ref. 36). Progress on nuclear arms limitations and approaches to disarmament seems to be moving backwards.

In combination with Resource Letters MP-1,[1] M-2,[2] and MP-3,[3] the sources listed here bring the total to over 500. Those listed here include some that should have been included in these earlier Resource Letters, but many are recent; interest in the science, personalities, and legacy of the Manhattan Project continue apace. As with the previous installments in this series, I have had to draw the line somewhere as to what topics, particularly of the "postwar" type, to exclude or touch upon only minimally for sake of completeness. For example, the Chernobyl and Fukushima disasters are not strictly Manhattan issues, and histories of postwar weapons systems and tests could be the subject of their own extensive bibliographies, although I do include some sources along these lines likely to be of wide interest. Also, I largely eschew sources whose focus is more towards historical/sociological interpretations of nuclear issues, although this too is a gray area.

The organization of this Resource Letter follows that of Refs. 1–3; within each section, books are listed first, followed by journal and magazine articles; where appropriate, sources are cross-referenced to the earlier installments in this series. Section III lists video and websites. The web addresses given here were correct as of the time of publications but of course can be volatile.

II. BOOKS AND JOURNAL ARTICLES

A. General works; synoptic overviews

1. "Resource Letter MP-1: The Manhattan Project and related nuclear research," B. C. Reed, Am. J. Phys. **73**(9), 805–811 (2005). This and Refs. 2 and 3 list a total of nearly 400 sources of information on the Manhattan Project and related nuclear research. (E, I, A)
2. "Resource Letter MP-2: The Manhattan Project and related nuclear research," B. C. Reed, Am. J. Phys. **79**(2), 151–163 (2011). Sequel paper to Ref. 1. (E, I, A)
3. "Resource Letter MP-3: The Manhattan Project and related nuclear research," B. C. Reed, Am. J. Phys. **84**(10), 734–745 (2016). Sequel paper to Refs. 1 and 2. (E, I, A)
4. **The History and Science of the Manhattan Project**, B. C. Reed (Springer, Berlin, 2019). This revised edition of Ref. 3 of MP-3 includes a new chapter on the German

wartime nuclear program, a new section on the feed materials program of the Manhattan Project, an extensive index, and a number of corrections and clarifications. (I)

5. **Manhattan Project: The Story of the Century**, B. C. Reed (Springer, Berlin, 2020). A popular version of Ref. 4. Recommended for readers seeking a non-mathematical but technically credible coverage of the Project. (E)
6. **The Manhattan Project: A Very Brief Introduction to the Physics of Nuclear Weapons**, B. C. Reed (Morgan and Claypool, San Rafael, CA, as part of IoP Concise Physics, 2017). This book is a companion volume to Ref. 4 of MP-3 and presents a brief coverage of the physics underlying nuclear weapons at a level suitable for undergraduate students. See also Ref. 28 of MP-2, which is now in a fourth edition. (I)
7. **The Neutron's Long Shadow: Legacies of Nuclear Explosives Production in the Manhattan Project**, M. Miller (Schiffer Publishing, Atglen, PA, 2017). This beautifully produced book comprises dozens of high-quality black and white photographs of Manhattan Project facilities, including some in their present-day conditions. The photographs are expertly composed and powerfully convey a sense of the scale, complexity, and functionality of installations such as reactors and enrichment plants. Accompanying text describes how each facility operated. (E)
8. **Inward Bound: Of Matter and Forces in the Physical World**, A. Pais (Oxford U.P., Oxford, 1986). This is a superb history of the development of atomic, nuclear, and particle physics from 1895 onwards. Pais explores developments and the personalities associated with them in detail, giving numerous references to original literature. For readers with advanced understanding of the technicalities involved. (A)
9. **One World or None**, D. Masters and K. Way (eds.) (Latimer House, London, 1947). This slim book is a collection of essays originally published in the United States in 1946 as a report to the public on the dangers and opportunities of the new atomic age; the edition listed here is a British reprint. Authors include Arthur Compton, Philip Morrison, Robert Oppenheimer, Hans Bethe, Leo Szilard, Albert Einstein, and General Henry Arnold. While some of the essays are now dated, this volume is still worth reading to get a sense of how many of the individuals intimately involved with the Manhattan Project perceived the implications of their work, particularly in the area of international control of atomic energy. (E)

B. Specific topics within the Manhattan Project

10. **Thorium Research in the Manhattan Project Era**, K. F. Sorensen (University of Tennessee, Knoxville, 2014). Research into using thorium to breed fissile U-233 in reactors as a potential backup to plutonium-239 was begun by Glenn Seaborg in 1940. This effort was hobbled by difficulties in producing suitable fuel and contamination by highly radioactive uranium-232 and so was eventually abandoned. This University of Tennessee Master's thesis by a student of nuclear engineering relates this little-known aspect of the Manhattan Project. The thesis is freely available at http://trace.tennessee.edu/utk_gradthes/2758/. (I)
11. **The Apocalypse Factory: Plutonium and the Making of the Atomic Age**, S. Olson (W. W. Norton, New York, 2020). If plutonium had not been suitable as a nuclear explosive, there would have been no Trinity or Nagasaki bombs or Hanford Engineer Works; the entire nuclear arms race would have been different. Olson, an experienced science writer, gives a fast-paced and readable history of Hanford, beginning with the discovery and isolation of plutonium and then moving on to the establishment of the Manhattan Project, the selection of the Hanford site, wartime operations, and finally the Cold War and the site's legacy of waste and health concerns. (E)
12. **Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters**, K. Brown (Oxford U. P., Oxford, 2013). This book is a comparative history of life in two "atomic cities," one in America (Richland) and one in Russia (Ozersk), which were built to house workers at the two countries' plutonium production plants, Hanford in Washington state and Maiak in the southern Urals. For professional families, particularly in Hanford, life was good, with secure, well-paying jobs, safe communities, and good schools. This came at the cost, however, of the constant presence of security forces, discriminatory hiring practices, segregated housing, environmental damage, medical monitoring, unethical radiation experiments, illnesses and birth defects allegedly caused by radioactivity, dangerous jobs for lower-level workers, accident cover-ups, and legacies of waste; some of the parallels between the two locations are striking. (E)
13. **Polonium in the Playhouse: The Manhattan Project's Secret Chemistry Work in Dayton, Ohio**, L. C. Thomas (Trillium, Columbus, OH, 2017). In 1943, the Monsanto Chemical Company established a polonium extraction and purification operation in Dayton, Ohio, under the direction of Charles Allen Thomas, the author's grandfather. The Dayton project was in some ways more secret than Los Alamos; not declassified until 1983, it has remained largely under the radar of Manhattan Project scholars. Two methods of acquiring polonium were developed: Extracting it from lead-oxide ore residues from Canadian radium and uranium-mining operations, and, more productively, from slugs of bismuth which underwent neutron irradiation in the Project's reactors at Oak Ridge and Hanford. Ultimately, Dayton provided the polonium used in the neutron initiators used to trigger the Trinity, Hiroshima, and Nagasaki bombs. This very readable, well-illustrated book relates the stories of the Dayton project and Charles Thomas' career. See also Ref. 20. (I)
14. **Images of America: The Manhattan Project at Hanford Site**, E. Toomey (Arcadia, Charleston, SC, 2015). This book is in the same series as MP-3, Refs. 13 and 14, and features photos of life and work at Hanford, other Pacific Northwest wartime facilities such as Boeing's Seattle plant, the Grand Coulee dam, airfields, and among native tribes. The emphasis is on Hanford, with images documenting the scale of construction and operations and aspects of day-to-day life in trying conditions. Many of the photos were taken by Robley Johnson, who supervised DuPont's photography crew at the site. (E)
15. **Tinian and the Bomb: Project Alberta and Operation Centerboard**, D. A. Farrell (Micronesian Publications, Tinian Island, 2018). This well-illustrated and

meticulously referenced book tells the story of how operations for the Army Air Force's 509th Composite Group, which conducted the Hiroshima and Nagasaki bombing missions, were organized and administered. Republished in 2020 by Stackpole Books under the title **Atomic Bomb Island**. (E)

16. **On the Home Front: The Cold War Legacy of the Hanford Nuclear Site**, M. S. Gerber, 3rd ed. (University of Nebraska Press, Lincoln, 2007). In February 1986, the Department of Energy released 19,000 pages of documents on the history of the Hanford Engineer Works, which revealed that radioactive and chemical wastes far in excess of what had previously been disclosed had been emitted at the site. Gerber gives a detailed account of the types of processes and contaminations involved, and ongoing remediation efforts. (I)
17. **The Manhattan Project Trinity Test: Witnessing the Bomb in New Mexico**, E. K. Österreich (The History Press, Charleston, SC, 2020). This slim paperback contains little technical detail on the Trinity test, but does gather eyewitness accounts by scientists and local residents and summarizes some of the medical conditions suffered by residents in the years after the test; the implication is that those conditions were linked to the test. There are occasional surprising factual errors, such as misidentifying the bomber which carried the Nagasaki bomb. (E)
18. **Birthplace of the Atomic Bomb: A Complete History of the Trinity Test Site**, William S. Loring (McFarland, Jefferson, NC, 2019). This comprehensive 400-page volume should be on the shelf of anybody interested in the Trinity test. With extensive citations to Los Alamos documents, Loring gives a detailed chronological survey of the Trinity site from 1939 to the present with the lion's share of the discussion covering 1944 and 1945. Topics discussed include site selection, acquisition, surveying, and preparation; road construction; instrumentation and photography requirements; the frustrations of bureaucratic supply chain delays; Base Camp; the Jumbo program; security procedures; weather forecasting; radiation protection; concerns with legal liability; the 100-ton TNT test; the test itself, radiological measurements, and postwar legal wrangling between the Army, Air Force, Atomic Energy Commission, and the National Park Service over administration of the site. Contains many photographs not usually seen. An appendix contains the text of the press releases General Groves prepared in advance of the test. (I)
19. "Project SOLO and the Seborers: On the Trail of a Fourth Soviet Spy at Los Alamos," H. Klehr and E. Haynes, Stud. Intell. **63**(3), 1–14 (2019). This paper, which appears in an open CIA journal, reveals the identity of a fourth Soviet spy at Los Alamos, Oscar Seborer. This conclusion is based on information in FBI files declassified in 2019. Seborer was American-born, but his family was well-connected to communist causes and Soviet intelligence. Trained as an electrical engineer, he worked at Los Alamos as part of a group monitoring seismic effects of the Trinity test. The information he passed on may have been considered to be of some significance as the Soviets awarded him the Order of the Red Star in 1964; he died in Moscow in April 2015. (E)
20. "Rousing the dragon: Polonium production for neutron generators in the Manhattan Project," B. C. Reed, Am. J. Phys. **87**(5), 377–383 (2019). During the Manhattan Project, polonium was extracted from waste radium-mining ores and synthesized in reactors for use in neutron-generating "initiators" used to trigger the Little Boy, Trinity, and Fat Man bombs; see Ref. 13. This paper describes the history of this program and the physics behind computing neutron-generation and synthesis rates. (A)
21. "A diamond in dogpatch: The 75th anniversary of the graphite reactor," S. R. Greene, Nucl. News **61**(12), 38–43 and **61**(13) 28–31 (2018). This two-part article describes the wartime and postwar histories of the X-10 graphite reactor at Oak Ridge. Over its 20-year lifetime, X-10 made not only critical contributions to the success of the Manhattan Project, but also in various areas of neutron physics studies and isotope production. The author is a former director of Nuclear Technology Programs at Oak Ridge National Laboratory. (E)
22. "The fogging of photographic film by radioactive contamination in cardboard packaging materials," J. H. Webb, Phys. Rev. **74**(3), 375–380 (1949). In August 1945, the Eastman Kodak Company began having problems with packages of x-ray film being fogged by radioactive contamination. The culprit proved to be strawboard liners used to separate sheets of film during packaging. The paper used in the liners came from a mill located along the Wabash River in Indiana, and the contamination was traced to fallout of the Trinity test, particularly cesium-141. This isotope is a short-lived beta-emitter (half-life 25 s) but is produced prolifically in nuclear explosions. This paper analyses this curious side-effect of the Trinity test. See also https://interestingengineering.com/when-kodak-accidentally-discovered-an-a-bomb-testing, and a YouTube video available at https://www.youtube.com/watch?v=7pSqk-XV2QM (A)
23. "Modeling the effects of the Trinity test," T. Semkow, P. Parekh, and D. Haines, in *Applied Modeling and Computations in Nuclear Science*, American Chemical Society Symposium Series 945 (American Chemical Society, Washington, 2006), pp. 142–159. This remarkable paper presents a detailed analysis of the Trinity test based on a radiochemical analysis of a piece of Trinitite, including estimates of implosion compression, yield, number of prompt neutrons emitted, fast neutron fluence, and debris characteristics. The derived yield is 21.4 ± 2 kilotons. See Ref. 53 for a more recent estimate. (A)
24. "Chernobyl and trinity—Counting the Curies," B. C. Reed, Federation Am. Sci. Public Interest Rep. **69**(2), 12–15 (2016). In his *Manhattan District History*, David Hawkins (MP-1, Ref. 47) states that one witness to the Trinity test estimated the prompt radioactivity released to be about a trillion curies. Working from an estimate of the Trinity yield and what is known of the distribution of prompt fission products, this article investigates this claim and concludes that the figure was more likely on the order of 14×10^{12}. (I)
25. "Proceeding in the dark. Innovation, project management and the making of the atomic bomb," S. Lenfle. This "working paper" by a French professor of business explores how the management of the Manhattan Project differed in important ways from conventional project management procedures, such as having research, development, construction, and operations proceeding in parallel, accompanied by frequent revisions to processes

and designs as information and experience was acquired (e.g., isotope separation methods and the spontaneous fission crisis; implosion). Available at http://www.sylvainlenfle.fr/images/Publications/Proceeding_in_the_dark_Lenfle_WP08_001.pdf. (E)

26. "Uranium price expectations and stabilization policy formation in the Manhattan Project: An institutional economics approach," A. D. M. Espana, J. Nucl. Eng. Radiation Sci. **9**(3), 031601 (16pp) (2023). It is often thought that General Groves had a virtually unlimited budget and was free to use it as he pleased, but the Manhattan Engineer District operated within the same system of regulations, negotiations, and contracts for procurement as did all government departments. This extensively referenced paper by an economist associated with the Canadian Nuclear Laboratories (Chalk River) uses the Manhattan Project as a case study to explore modern uranium pricing and market policies and, hence, analyzes the Project from a direction not normally encountered in science-oriented treatments. (A)

27. "The ongoing story of Hiroshima and Nagasaki," B. C. Reed, Am. Sci. **106**(2), 88–94 (2018). This popular-level article explores the arguments for and against the bombings of Hiroshima and Nagasaki by presenting them in the form of a three-way dialogue between students who have just heard a lecture on the context of events surrounding the end of the war. (E)

28. "Troy ounces (or tons) of silver," D. S. Edmonds, Am. J. Phys. **69**(6), 629–630 (2001). This Letter to the Editor describes the author's experiences with calutron vacuum systems at Oak Ridge. The title refers to the silver used in magnet coils; see MP-2, Ref. 24. (E)

29. "The Smyth report," H. D. Smyth, Princeton Univ. Library Chronicle **37**(3), 173–189 (1976). In this memoir, Smyth describes the origins, preparation, and clearance procedures involved with his famous 1945 Smyth Report (MP-1, Ref. 2). (E)

30. "A brief history of radiation protection at HEW 1943–1960," D. Marsh, Moderator **27**(2), 4–6 (2021). The level of radiation danger attending the plutonium production reactors at the Hanford Engineer Works (HEW) was unlike anything previously encountered by radiologists. To develop exposure guidelines and monitoring protocols, extensive Medical and Health Instruments departments were set up, staffed by over 500 employees by mid-1945. This brief article in the newsletter of the B Reactor Museum Association (MP-2, Ref. 127; https://b-reactor.org) describes this work. See also Ref. 124. (E)

31. "Early reactors: From Fermi's water boiler to novel power prototypes," M. E. Bunker, Los Alamos Sci. **7**, 124–131 (1983). Reactor development during the Manhattan Project was not limited to sites in Chicago, Oak Ridge, Hanford, and Montreal. Two enriched-uranium reactors were built at Los Alamos during the war, and postwar years saw the development of several installations for research and testing in support of weapons programs and isotope production. Some of the designs were quite unique, such as one which used 93.5%-enriched uranium 235 dissolved in a solution of phosphoric acid, and another fueled by molten plutonium and cooled by molten sodium. This article summarizes this history to the time of its publication in 1983. See also Ref. 52. (I)

C. Technical and historical works

32. **The Discovery of Nuclear Fission: A Documentary History**, H. G. Graetzer and D. L. Anderson (Van Nostrand Reinhold, New York, 1971). This slim volume, although now out of print, is a valuable resource containing an anthology of translations of all or parts of original papers which underlay the discovery of fission. The work of such notable figures as Fermi and his group; Hahn, Meitner, and Strassman; Curie and Savitch; Meitner and Frisch and others appear, supplemented with commentary and explanations of the relevant physics and chemistry by the authors to help tie them together. An excellent adjunct to Ruth Sime's biography of Lise Meitner (MP-1, Ref. 79). (I)

33. **Scientists in Power**, S. R. Weart (Harvard, Cambridge, 1979). During the inter-war years, French scientists, such as Jean Perrin, Paul Langevin, Irène Curie, and Fréderic Joiliot-Curie, were much more involved in politics and government than their British, American, and German counterparts, often successfully advocating for public support of scientists and research institutions. Weart surveys the history of French nuclear physics and technology from the early 1900s through to the establishment of the postwar Commissariat a l'Energie Atomic (CEA) and the development of the first French postwar reactors, along with associated politcal developments. (E)

34. **The Discovery of Isotopes: A Complete Compilation**, M. Thoennessen (Springer, Basel, 2016). This book does not concern the Manhattan Project per se but will be of interest to anyone interested in the history of nuclear physics. Thoennessen chronicles the circumstances of the discovery of every isotope known to the time of publication with subsequent discoveries listed in a companion website at http://www.nscl.msu.edu/~thoennes/isotopes/. The website includes an engaging animation of the timeline of isotope discoveries. For some 3000 isotopes, Thoennessen lists place and method of discovery (instruments and reactions), references to original papers, decay mechanisms and energies, and other associated data. This remarkable reference is a must-have for any student, practitioner, or educator in the field of nuclear physics. (A)

35. **The Age of Innocence: Nuclear Physics between the First and Second World Wars**, R. Stuewer (Oxford U. P., Oxford, 2018). Stuewer, a distinguished historian of science, presents a detailed history of the remarkable experimental, theoretical, and instrumental developments in nuclear physics between the World Wars, when researchers worked in intense but respectful competition, frequently convening to share results and visit each other's institutions. This golden age began to disintegrate with the arrival of Adolf Hitler as Chancellor of Germany in 1933 and the resulting expatriation of many European scientists to England and America. The title alludes to the period before the discovery of fission opened the ominous possibility of nuclear energy as a military weapon. Contains an extensive bibliography and list of references; well-illustrated. (I)

36. **Nuclear Choices for the Twenty-First Century**, R. Wolfson and F. Dalnoki-Veress (MIT Press, Cambridge, 2021). This volume gives an excellent semi-popular

survey of atomic structure, radioactivity, radiation, and its measurement and uses, nuclear energy, how various types of nuclear reactors function, reactor safety, waste and fuel cycles, the history, functioning and effects of nuclear weapons, nuclear defense and strategy, and nuclear terrorism. (I)

37. "Explosive properties of reactor-grade plutonium," J. C. Mark, with an Appendix by Frank von Hippel and Edward Lyman, Sci. Global Secur. **17**(2), 170–185 (2009). This paper is a reprint of one that initially appeared in Sci. Global Secur. **4**(1), 111–128 (1993). The primary author of this paper, J. Carson Mark (1913–1997), headed the Theoretical Division at Los Alamos from 1947 to 1973. The authors present an analysis of the question of whether a terrorist organization or threshold state could make use of plutonium acquired from a light-water reactor to construct a nuclear explosive of significantly damaging yield. They conclude that the difficulties of developing an effective weapon design with reactor-grade plutonium are not appreciably greater than those which would be encountered with weapons-grade plutonium. A pedagogical version of the yield model discussed in this paper appears in MP-3, Ref. 34. See also Ref. 114. (A)
38. "An act of creation: The Meitner-Frisch interpretation of nuclear fission," R. Stuewer, in *Traditions and Transformations in the History of Quantum Physics: Third International Conference on the History of Quantum Physics*, edited by S. Katzir, C. Lehner, and J. Renn, Berlin, June 28–July 2, 2010 (Max Planck Research Library for the History and Development of Knowledge, Proceedings 5, 2013). This paper is Chapter 9 of a conference proceedings available at http://edition-open-access.de/media/proceedings/5/Proceedings5.pdf. Stuewer considers Lise Meitner and Otto Frisch's interpretation of fission as an example of Arthur Koestler's theory of creative acts being a synthesis of two previously unrelated "matrices of thought." Specifically, Meitner was well-versed in the "Berlin" tradition of Carl Friedrich von Weizsäcker's semi-empirical mass formula, an essentially static description of nuclei, while Frisch was more familiar with Niels Bohr's "Copenhagen" considerations of the energetics of nuclear oscillations. In pooling their two different streams of knowledge, Meitner and Frisch came to understand the physics of fission. (I)
39. "Determining optimal fallout shelter times following a nuclear detonation," M. B. Dillon, Proc. Roy. Soc. **A470**(2163), 2013693 (2014). This paper develops a mathematical model for analyzing how long poorly sheltered individuals should remain in their initial shelter before evacuating or heading to better shelter in the event of a single low-yield (0.1–10 kt) nuclear detonation in an urban area. The author concludes that if an adequate shelter can be reached within 15 min, individuals should stay in poor-quality shelters for at most 30 min after detonation, while if adequate shelter is available within 5 min, they should proceed immediately to the better shelter. (A)
40. "Science and politics: The discovery of nuclear fission 75 years ago," R. L. Sime, Ann. Phys. (Berlin) **526**(3-4), A27–A31 (2014). This brief article gives a compact but thorough description of how work performed by Otto Hahn, Lise Meitner, and Fritz Strassmann culminated in the discovery and interpretation of fission, and of how Meitner's role in the work came to be deprecated due to her forced emigration from Germany in mid-1938. See also Sime's excellent biography of Meitner (MP-1 Ref. 79); related papers are MP-2, Refs. 40, 41, 66, and MP-3, Ref. 57. (I)
41. "An examination of the potential fission-bomb weaponizability of nuclides other than ^{235}U and ^{239}Pu," B. C. Reed, Am. J. Phys. **85**(1), 38–44 (2017). This paper examines how the physics of fission barriers and decay modes conspire to make uranium-235 and plutonium-239 the only isotopes feasible for powering nuclear weapons. (A)
42. "Why only U-235 and Pu-239? Classroom-level graphs for understanding heavy-element weaponizability factors," B. C. Reed, Phys. Teach. **58**(8), 556–559 (2020). This paper is a lower-level distillation of Ref. 41, suitable for presentation to a class of non-majors. (I)
43. "A physicists guide to The Los Alamos Primer," B. C. Reed, Phys. Scr. **91**(11), 113022 (2016). This paper describes the background to and analyzes the physics contained in Robert Serber's *Los Alamos Primer*, the notes of lectures given to scientists arriving at Los Alamos in April 1943 (MP-1, Ref. 48). (A)
44. "Revisiting The Los Alamos Primer," B. C. Reed, Physics Today **70**(9), 42–49 (2017). This article reviews the background and contents of Robert Serber's *Los Alamos Primer*, the packet of notes given to scientists as they arrived for orientation lectures at Los Alamos in April 1943 (MP-1, Ref. 48). (I)
45. "A powerful graphical display of technical information: Robert Serber's plot of physical conditions inside a nuclear explosion," B. C. Reed, Am. J. Phys. **88**(7), 565–567 (2020). In his 1943 *Los Alamos Primer* (MP-1, Ref. 48; Ref. 43), Robert Serber presented a striking graph of the time-evolution of conditions of neutron density, energy density, and pressure within the exploding core of a nuclear weapon. This paper presents a fresh version of the graph and describes its preparation. (A)
46. "A toy model for the yield of a tamped fission bomb," B. C. Reed, Am. J. Phys. **86**(2), 105–109 (2018). This paper develops compact expressions for the yield and efficiency of a tamped fission bomb based on modeling neutron growth as a geometric progression combined with an analysis of the physics of a tamped core; see also MP-2, Ref. 32. (A)
47. "The fortuitous chain reaction," J. M. Pearson, Am. J. Phys. **87**(4), 264–269 (2019). This paper is a companion paper to MP-3, Ref. 39. In this paper, Pearson takes an intriguing counterfactual view of physics, arguing how small changes to physical factors such as the alpha-decay half-life of U-235 or the scission point in the fission process would render a fission chain reaction impossible. See also Refs. 48 and 49. (A)
48. "Calculating fissility without Legendre polynomials: A walk in the woods," J. M. Pearson, Am. J. Phys. **87**(9), 739–744 (2019). This paper is a companion paper to MP-3, Ref. 39 and a sequel to Ref. 47. Pearson examines how Lise Meitner and Otto Frisch might have conceived of fission during their famous walk in the woods in Sweden in late 1938, proposing that, instead of dealing with the complexities of Rayleigh's theory of vibrating drops and Legendre polynomials, Frisch's familiarity

with the formation of droplets in a Wilson cloud chamber might have sufficed. (A)

49. "Comment on "Calculating fissility without Legendre polynomials," B. C. Reed, Am. J. Phys. **87**(10), 785–786 (2019). This paper, a response to Ref. 48, presents an alternate view of Lise Meitner and Otto Frisch's walk in the woods, suggesting that the interpretation of nuclear fission might have unfolded over several days and that Frisch might well have worked on a partially related calculation earlier in his career. (A)

50. "Composite cores and tamper yield: Lesser-known aspects of Manhattan Project fission bombs," B. C. Reed, Am. J. Phys. **88**(2), 108–114 (2020). This paper explores the physics of composite bomb cores, which use a combination of U-235 and Pu-239 as opposed to either one alone; such arrangements can achieve a significant saving in the amount of fissile material required for a bomb of a given yield. The issue of what fraction of the yield of the Trinity and Nagasaki *Fat Man* bombs were due to high-energy neutrons inducing fissions in the U-238 tampers of those weapons is also considered. Composite cores were considered by Oppenheimer following the Trinity test but were not put into production at the time.

51. "Pedagogical reconstruction of Bohr and Wheeler's fission-barrier graph," B. C. Reed, Eur. J. Phys. **41**(5), 055801 (10pp) (2020). In their famous 1939 paper on the physics of fission (MP-1, Ref. 123), Niels Bohr and John Wheeler presented an eye-catching graph of the fission barrier energy for various nuclides. Unfortunately, some of the analytic details underlying exactly how this graph was constructed were unclear, and definitions of various quantities in their analysis were not internally consistent. In this paper, a simplified approach to develop this graph is presented. The development is sensibly true to their analysis, and appropriate for an upper-level student audience. See also MP-2, Refs. 29 and 30. (I)

52. "An inter-country comparison of nuclear pile development during World War II," B. C. Reed, Eur. Phys. J. - H. **46**, 15 (22pp) (2021). Between the time of the discovery of nuclear fission in early 1939 and the end of 1946, approximately 90 "nuclear piles" were constructed in six countries. These ranged from simple graphite columns containing neutron sources but no uranium to others as complex as the water-cooled 250-MW plutonium production reactors at Hanford. This paper summarizes and compares these piles. (I)

53. "Special issue on the Manhattan Project nuclear science and technology development at Los Alamos National Laboratory," Nucl. Technol. **207**(S1), S1–S396 (2021). This publication is a special edition of a technical journal for nuclear engineers. In the summer of 2020, a seminar was held at Los Alamos to commemorate the 75th anniversary of the Trinity test. Participants reviewed scientific and engineering breakthroughs made during the Manhattan Project and wrote up their contributions; this publication, edited by Mark Chadwick of the Physics division at Los Alamos, comprises the unclassified ones. The papers are freely available at https://www.ans.org/pubs/journals/nt/volume-207/#number1S and cover nuclear science and engineering, hydrodynamics, high explosives, plutonium metallurgy, nuclear energy and yield, historical technical issues, and Trinity, which is now assessed as having had a yield of 24.8 ± 2 kilotons. Los Alamos has prepared a YouTube video featuring Chadwick; see https://www.youtube.com/watch?v=a_WYcTHco00. Also, the summer 2021 edition of Los Alamos' *National Security Science* magazine contains an article on how the seminar was organized and lists the titles of classified papers; see https://discover.lanl.gov/publications/national-security-science/2021-summer/ (A)

54. "Manhattan Project 1940s research on the prompt fission neutron spectrum," M. B. Chadwick and R. Capote, Front. Phys. **11**, 1105593 (2023). A significant parameter in the design of fission weapons is the spectrum of neutron energies emitted in fissions. This paper, co-authored by the editor of Ref. 53, explores pre-World War II and Los Alamos work on the neutron spectrum, which was remarkably well-determined by 1945. Also available at https://doi.org/10.3389/fphy.2023.1105593. (A)

55. "The earliest DT nuclear fusion discoveries," M. B. Chadwick *et al*., This paper appeared in preprint form as this Resource Letter was being prepared; it is a Los Alamos report available at https://arxiv.org/abs/2302.04206. At Los Alamos during the war, considerable research was carried out on fusion reactions in response to the recognition of the possibility of fusion weapons, an issue which arose during a conference held at Berkeley in the summer of 1942. This paper describes pre-war, wartime, and postwar cross-section measurements, which are in good agreement with modern values. An interesting revelation is that DT fusion was likely first detected in an experiment performed at the University of Michigan in 1938, an event which may have played a role in the 1942 Berkeley discussion. A related article can be found in Nucl. News **66**(4), 70–77 (2023), and an audio clip extracted from a 1986 interview of Emil Konopinski discussing hydrogen reactions can be found at https://www.youtube.com/watch?v=z5cQgu5xCnc. (A)

56. "Comments on the physics of The Frisch-Peierls memorandum," B. C. Reed, Nucl. Technol. **208**(12), 1890–1893 (2022). The Frisch-Peierls memorandum of early 1940 is arguably one of the most important documents of the nuclear age; see MP-1, Refs. 14, 48, 77, and 81. Unfortunately, some republications of the technical part of the document have introduced various errors, which could lead an unaware reader to thinking that Frisch and Peierls got their analysis of the critical mass very muddled. This is in fact not so; this paper points out the problems with incorrect versions and attempts to clarify the situation. (A)

57. "Unclassified controlled nuclear information and restricted data concerning U. S. calutrons," A. S. Quist, Oak Ridge National Laboratory Report ORCA-3 (1999). This 37-page report gives detailed information on the characteristics of the "calutron" electromagnetic separators used to isolate U-235 during the Manhattan Project. Information includes vacuum systems, magnetic fields, ion-beam focusing, and methods used to extract enriched uranium from the equipment. Available at https://www.osti.gov/scitech/biblio/1291336. (E)

D. Biographical and autobiographical works

58. **Atomic Bomb Scientists Memoires 1939–1945. Interviews with Werner Heisenberg, Paul Harteck,**

Lew Kowarski, Leslie R. Groves, Aristid von Grosse, and C. E. Larson, J. J. Ermenc (Meckler, Westport, CT, 1989). Transcripts of interviews conducted in the late 1960s and 1970s by Joseph Ermenc, an emeritus professor at Dartmouth College. The interviews were part of an effort to help address the lack of technological literacy characteristic of liberal arts education. (E)

59. **The Bethe-Peierls Correspondence**, S. Lee (World Scientific, Singapore, 2008). This volume is a companion to MP-2, Ref. 57. Rudolf Peierls and Hans Bethe met as students at the University of Munich in 1926 and maintained a lifelong frienship until Peierls' passing in 1995. During that time, they exchanged numerous letters on both physics and personal matters in both German and English; they also both worked in the Theoretical Division at Los Alamos during 1944–1945. In this volume, Sabine Lee of the University of Birmingham has assembled the original letters plus translations of those in German. The letters are arranged chronologically with occasional editorial additions. (I)
60. **Atomic rivals: A candid memoir of rivalries among the Allies over the bomb**, B. Goldschmidt (Rutgers U. P., New Brunswick, NJ, 1990). This volume is an English translation of the memoires of French physicist and later nuclear administrator/diplomat Bertrand Goldschmidt, in particular covering his experiences at the Montréal laboratory of the Manhattan Project; see Ref. 85. Before the war, Goldschmidt trained as Marie Curie's last assistant at the Radium Institute in Paris and had a first-hand view of research carried out there. In Montréal, he worked on the chemistry of plutonium and polonium extraction and was involved with informing Charles de Gaulle of the development of the bomb. This memoire is full of insider details and observations on the personalities and rivalries of the Montréal group, which felt disrespected by American and British officials. After the war, Goldschmidt became deeply involved with the French nuclear program and served as a delegate to the International Atomic Energy Agency. A limitation of this book is its very minimal number of references. (E)
61. **Churchill's Bomb: How the United States Overtook Britain in the First Nuclear Arms Race**, G. Farmelo (Basic Books, New York, 2013). This carefully referenced volume explores British Prime Minister Winston Churchill's involvement with that country's nuclear programs from its beginnings in 1940 through the development of fusion weapons. The title of this book is somewhat misleading as there never really was a race, but the British-US wartime nuclear relationship was full of twists and turns with the British appreciating early on the potential of nuclear weapons thanks to the Frisch-Peierls memorandum but eventually settling for a status as junior partner in the vast American effort. This book and Kevin Ruane's study of Churchill, Ref. 62, complement each other. (E)
62. **Churchill and the Bomb in War and Cold War**, K. Ruane (Bloomsbury Academic, London, 2016). This book explores Churchill's evolving thoughts on nuclear weapons in three epochs: as a bomb-maker (1941–1945), atomic diplomatist (1945–1949), and, following the Soviets' development of their own nuclear weapons and the emergence of the hydrogen bomb, as a "nuclear peacemaker" who advocated for but never succeeded in getting his American counterparts to agree to a US/UK/Soviet summit. Churchill's thinking eventually arrived at acceptance of a mutual-assured-destruction-like "defense by deterrents" balance of terror. (E)
63. **The Pope of Physics: Enrico Fermi and the Birth of the Atomic Age**, G. Segrè and B. Hoerlin (Henry Holt, New York, 2016). This excellent biography of Fermi is written by Gino Segrè and his wife Bettina Hoerlin; Gino is the nephew of Fermi's student Emilio Segrè, who wrote his own biography of Fermi in 1970 (MP-1, Ref. 72). The authors give a thorough treatment of Fermi's career and personal life from his youth to the stoic way he faced his approaching death due to stomach cancer at the age of 53. (E)
64. **The Last Man Who Knew Everything: The Life and Times of Enrico Fermi, Father of the Nuclear Age**, D. N. Schwartz (Basic Books, New York, 2017). This biography of Fermi is longer than that of Ref. 63 and does a more comprehensive job of setting Fermi's work in the context of the major developments of twentieth-century physics. Both should be read to get a full picture of the life and times of a remarkable physicist. (E)
65. **Half-Life: The Divided Life of Bruno Pontecorvo, Physicist or Spy**, F. Close (Basic Books, New York, 2015). Bruno Pontecorvo was a brilliant physicist who began his career as one of Enrico Fermi's graduate studnets. An avowed communist, Pontecorvo and his wife fled to America in 1940, and in 1942 he was recruited to the Manhattan Project's Montréal reactor group (MP-2 Ref. 20, and 85 below). While there, he conceived seminal ideas regarding neutrino physics, but may have been involved in passing plans for a reactor and a sample of uranium to a US-based Soviet contact. Pontecorvo defected to Russia from Britain in mid-1950; it has been suggested that he might have shared a Nobel Prize for his neutrino theory work had he not defected. Whether or not he was a spy remains uncertain, but he paid a terrible personal and professional cost for what he claimed was idealism. Is this engaging volume, University of Oxford physicist Frank Close surveys Ponetcorvo's life and work. See also Ref. 66. (E)
66. **Trinity: The Treachery and Pursuit of the Most Dangerous Spy in History**, F. Close (Penguin, London, 2020). Frank Close continues his examination of atomic spies with this study of the life of Klaus Fuchs, the member of the British Mission at Los Alamos who passed information regarding the implosion design to Russian agents, as well as notes on a 1946 meeting concerning fusion weapons at which he apparently conceived the idea of radiation implosion. He continued to pass information after moving back to Britain after the war, but was exposed via deciphered via wartime Russian cables. Close meticulously reconstructs Fuchs' actions, the legwork of how his identity was established, and his confession, arrest, and conviction. (E)
67. **The Man From the Future: The Visionary Life of John von Neumann**, A. Bhattacharya (W. W. Norton, New York, 2021). Mathematician John von Neumann is regarded as one of the most brilliant people to have ever lived, making contributions to logic, set theory, quantum mechanics, game theory applied to economics and nuclear strategy, the ergodic theorem, ballistics, hydrodynamics of explosions, non-Euclidean geometry, stored program computers, and, with his second wife Klári, Monte Carlo simulations; he has been said (along with

Edward Teller) to have been the inspiration for the 1964 black-comedy film *Dr. Strangelove* directed by Stanley Kubrick. At Los Alamos, von Neumann was deeply involved in the development of the implosion bomb and computational efforts (see Ref. 53), and in postwar years also consulted with the RAND corporation. This detailed biography explores the life and contributions of this astonishing intellect. (E)

68. **True Genius: The Life and Work of Richard Garwin, The most influential scientist you've never heard of**, J. N. Shurkin (Prometheus, Amherst, New York, 2017). A graduate student of Enrico Fermi, Richard Garwin enjoyed a distinguished career as both a scientist and a policy analyst, with involvement in the initial design of the first hydrogen bomb, service on the President's Science Advisory Committee under Presidents Kennedy, Johnson, and Nixon, as a member of the JASON defemse advisory group, consulting on virtually every nuclear-arms treaty in existence, and contact with many important technological issues of the last half of the twentieth century. This biography contains several garbled technical descriptions but should be read by anyone interested in learning about how true patriot-citizen-scientists can serve society. (E)
69. **General George C. Marshall and the Atomic Bomb**, F. A. Settle (Praeger, Santa Barbara, CA, 2016). In many histories of the Manhattan Project, Army Chief of Staff General George C. Marshall seems a rather remote figure, appearing only in circumstances such as the appointment of Leslie Groves to head the project, meetings of the Top Policy Group, and deliberations of the Interim Committee or at the Potsdam meeting. Settle chronicles how Marshall was in fact very much on top of Manhattan developments during the war and was a key player in the development of American nuclear strategy during his postwar positions as Secretary of State and Secretary of Defense. (E)
70. **Man of the Hour: James B. Conant, Warrior Scientist**, J. Conant (Simon and Schuster, New York, 2017). This excellent biography of James Conant, director of the wartime National Defense Research Committee which first oversaw the Manhattan Project before it was transferred to the Army, is written by his granddaughter. Conant enjoyed a distinguished career as an organic chemist, President of Harvard University, government science administrator, education administrator and reformer, and, after the war, as Ambassador to Germany. (E)
71. **Achieving the Rare: Robert F. Christy's Journey in Physics and Beyond**, I.-J. Christy (World Scientific, Singapore, 2013). Robert Christy was one of Robert Oppenheimer's graduate students and first recruits to Los Alamos (MP-2, Ref. 63). This engaging volume written by his widow Juliana is full of intimate details about Christy's life and career, including his childhood; student days at the University of British Columbia; time as a graduate student with Oppenheimer (1937–1941); his two marriages and families; work at Los Alamos on the "water boiler" reactor and the "Christy core" plutonium bomb; his falling-out with Edward Teller over the Oppenheimer security hearings; efforts at promoting nuclear non-proliferation and halting atmospheric testing of nuclear weapons; opposition to the Strategic Defense Initiative; and seminal contributions to the understanding of pulsating variable stars. Richly illustrated with family and career photographs. (E)
72. **Sam Goudsmit and the Hunt for Hitler's Atomic Bomb**, M. van Calmthout, translated by Michael Horn (Prometheus, Amherst, NY, 2018). Goudsmit will be familiar to physicists as the co-discoverer (with George Uhlenbeck) of electron spin, as the scientific head of the World War II *Alsos* mission which sought to investigate German progress in the nuclear field, and as the founding editor of Physical Review Letters; see MP-1, Refs. 99 and 102 regarding the *Alsos* mission. This very engaging biography relates Goudsmit's upbringing, personal life, emigration to the United States, and overall career. Marred in places by incorrect statements of physics, but this may be a matter of translation from the original Dutch. (E)
73. **Atomic Bill: A Journalist's Dangerous Ambition in the Shadow of the Bomb**, V. Kiernan (Three Hills, Ithaca, NY, 2022). William L. Laurence was a *New York Times* journalist allowed exclusive access to the Manhattan Project; see MP-1, Ref. 1. This biography traces Laurence's life and career, concentrating on the latter. Laurence was one of the first science journalists, and after the war he parlayed his Manhattan access into articles, book deals, interviews, consultantships, and speaking tours, often in ways which would now be regarded as serious conflicts of interest. Tragically, Laurence tarnished his reputation via his desire for fame and association with powerful personalities. (E)
74. "Physics at Columbia University: The genesis of the nuclear energy project," E. Fermi, Phys. Today **8**(11), 12–16 (1955). This article is a transcript of a talk given by Fermi at an American Physical Society meeting held at Columbia in January 1954 in which he describes the early days of pile research there. (E)
75. "Reminiscences of the early days of fission," H. Barschall, Phys. Today **40**(6), 27–32 (1987). When fission was discovered, Barschall was a graduate student at Princeton working on a thesis involving fast neutrons. He and a group of collaborators subsequently made the first measurement of the fast-neutron (2.5 MeV) fission cross-section of uranium. Barschall became an American citizen in July 1943, and in September of that year moved to Los Alamos, where he later witnessed the Trinity test. This article offers some reminiscences of his activities during the wartime period. See also MP-1, Refs. 41 and 93. (A)
76. "John Wheeler's H-bomb blues," A. Wellerstein, Phys. Today **72**(12), 42–51 (2019). In January 1953, John Wheeler (of the Bohr & Wheeler fission theory: MP-1, Ref. 123) was deeply involved in the development of fusion weapons. During an overnight train trip from his home in Princeton to Washington, DC, Wheeler lost pages from a sensitive document on the fusion program. The document, largely the work of that group's chief of staff, William Borden, was highly critical of the Atomic Energy Commission, which the authors felt was mismanaging the program. The documents were never found. (E)
77. "Enrico Fermi's discovery of neutron-induced artificial radioactivity: A case of emanation from divine providence," F. Guerra, M. Leone, and N. Robotti, Phys. Perspect. **22**(3), 129–161 (2020). This paper is a companion to MP-2, Refs. 59–61. In this installment, the

authors focus on the experimental apparatus used by Fermi in his discovery of neutron-induced radioactivity, particularly his radon-beryllium neutron sources. (E)

78. "Drama around a wartime Heisenberg letter," S. Schwarz, Phys. Perspect. **24**(1), 72–92 (2022). Werner Heisenberg and Carl Friedrich von Weizsäcker were friends for many decades, but the relationship had its ups and downs as a consequence of von Weizsäcker's attraction to philosophical ideals and National Socialist rhetoric. This paper examines the two men's long friendship and its vicissitudes, with particular focus on a 1943 letter of Heisenberg to his wife which describes his frustrations with a conversation he had just had with von Weizsäcker. von Weizsäcker's pattern of postwar self-rationalization is also examined. See also Ref. 94 and MP-1 Refs. 110–115. (E)
79. "Not just boys at via Pansiperna: Women at the Royal Institute in Rome," M. Focaccia, Phys. Perspect. **24**(2-3), 154–177 (2022). This paper does not directly concern the Manhattan Project but has a connection to Enrico Fermi. Focaccia reviews the lives and careers of some of the women who attended the Royal Physics Institute in Rome from 1881 to 1937; many went on to distinguished careers at the Institute and as teachers and chroniclers of science. The list includes Laura Capon and Ginestra Giovene, who, respectively, became the wives of Fermi and Eduoardo Amaldi. (E)
80. "Oppenheimer and the cosmos," V. Trimble, Hist. Philos. Phys. Newsletter **XV**(3) 1, 6–12 (2022). This article describes Oppenheimer's work in the area of astrophysics, including his pre-war work with Snyder and Volkoff on gravitational collapse and post-war involvement in conferences dealing with topics such as supernovae, radio sources, and cosmic rays. (E)

E. International wartime programs, allied intelligence, and the use of the bombs

81. **Selected works of Yakov Borisovich Zeldovich. Volume II: Particles, nuclei, and the Universe**, J. P. Ostriker (ed.) (Princeton U. P., Princeton, 1993). Most historiography of the early interpretation and possible consequences of fission focuses on events in Europe and America. The brilliant Soviet physicist Yakov Zeldovich was also active in this area, but his publicatons were largely overlooked in the West as they were in Soviet journals. This volume, an English translation of a Russian work, reproduces many of Zeldovich's papers, including ones on the possibility of a fast-neutron chain reaction in natural uranium (October 1939), slow-neutron chain reactions (including the predictions that heavy water or other moderators and/or enrichment would be necessary; also October 1939), a remarkable paper on diffusion analysis of criticality with particular emphasis on the effects of delayed neutrons (March 1940), and an analysis of the process of fission (June 1940). The papers are co-authored with Y. Khariton and Y. Zysin. That Zeldovich was cognizant of contemporary western literature is indicated by the fact that he cites work by Perrin, Peierls, and Bohr and Wheeler. This volume hard to find but is available from the publisher. See also Ref. 91. (A)
82. **Atomic Energy in Canada**, C. Kennedy (Atomic Energy of Canada, Ltd., Ottawa, 1956). This ~100-page booklet features photographs, schematic drawings, specifications, and descriptions of early Canadian reactors (ZEEP, NRX, NRU, NPD), medical-isotope production facilities, and the Canada-India reactor, as well as descriptions of the basics of nuclear energy, fission, and reactor design and operations. This volume is now probably hard to find, but worth a look if you can; in 1956, it sold for one Canadian dollar. (I)
83. **Canada's Nuclear Story**, W. Eggleston (Clarke, Irwin & Co., Toronto, 1965). Canadian contributions to the Manhattan Project have tended to be overshadowed by the much more gargantuan American effort. In addition to serving as an important source of uranium ores (MP-3, Ref. 29), a very active reactor development group staffed by British, European, and Canadian scientists operated under the auspices of the National Research Council (NRC) of Canada at a site in Montréal during the war. The first operational reactor outside the United States, the group's heavy-water moderated Zero-Energy Experimental Pile (ZEEP) went critical on the afternoon of September 5, 1945. Eggleston reviews both wartime and postwar Canadian nuclear achievements, including the development of the very successful CANDU reactors. (E)
84. **Canada Enters the Nuclear Age: A Technical History of Atomic Energy of Canada Limited**, Atomic Energy of Canada Limited (McGill-Queen's U. P., Montréal and Kingston, Ontario, 1997). This technical history of Canadian reactor developments complements Eggleston's volume above, with particular emphasis on the technicalities of the ZEEP, NRX, NRU, and CANDU heavy-water reactors. Freely available at https://www.nrc.gov/docs/ML0303/ML030360478.pdf. (I)
85. **Montréal and the Bomb**, G. Sabourin (Baraka Books, Montréal, 2021). This book is an excellent complement to Ref. 83. Sabourin relates the history of how the Montréal laboratory came to be, details of the work performed there, and biographical information on some of the lesser-known personalities involved. Illustrated with photos not available in most Manhattan Project sources; also contains many useful references. (E).
86. **Israel and the Bomb**, A. Cohen (Columbia U. P., New York, 1998). This book gives a detailed political history of the Israeli nuclear program from its formation in the early 1950s to about 1970, focusing on the evolution of what Cohen terms the "opacity" of the program. Particularly interesting is his description of exchanges between various Israeli Prime Ministers and United States Presidents. See also MP-3, Ref. 61. (E)
87. **The Winter Fortress: The Epic Mission to sabotage Hitler's Atomic Bomb**, N. Bascomb (Houghton Mifflin Harcourt, Boston, 2016). This book relates the dramatic stories of commando, bombing, and sabotage raids conducted from late 1942 through early 1944 directed at denying Germany supplies of heavy water from the Norsk Hydro plant in Vemork, Norway. Bascomb deals only minimally with the physics of nuclear weapons, but the actions of the commandos, resistance cells, and aircrews involved under incredibly treacherous and difficult conditions serve as a reminder

of what true heroism is. See also MP-1, Ref. 17, MP-2, Refs. 75 and 81, and MP-3, Ref. 64. (E)

88. **The Uranium Club: Unearthing the Relics of the Nazi Nuclear Program**, M. E. Hiebert (Chicago Review Press, Chicago, 2023). During World War II, German scientists attempted to construct a chain-reacting pile by suspending two-inch cubes of natural uranium in a cylinder filled with heavy water. Over 1,000 such cubes were manufactured. This engaging book relates the history of the German nuclear program and the work of the ALSOS mission, which recovered the 600-odd cubes from Werner Heisenberg's last reactor experiment. Most of the cubes are now unaccounted for; some were seized by Russian forces, and some were probably used as fuel for the Oak Ridge X-10 and Hanford plutonium production piles. About a dozen are known to exist in various collections around the United States; the author has been closely involved in tracing down their fates through interviews and archival research. Includes photos not often seen in other sources. (E)
89. **Farm Hall and the German Atomic Project of World War II: A Dramatic History**, D. C. Cassidy (Springer International, 2017). Cassidy, a well-known historian of 20th-century science, gives a brief history of the German nuclear program and the Farm Hall transcripts, and presents the script of a play dealing with the latter. See also Ref. 95 and MP-1, Refs. 103, 104, 106, and 110; MP-2, Refs. 50, 75, 103, and 124. (E)
90. **Taiwan's Former Nuclear Weapons Program**, D. Albright and A. Stricker (Institute for Science and International Security Press, Washington, DC, 2018). This book describes Taiwan's secret efforts to acquire nuclear weapons from the 1950s through the 1980s, with the program being shut down by the United States in 1988 as the Taiwanese were approaching break-out capacity. The Taiwanese strategy was to achieve a "hot standby" capacity under the umbrella of a peaceful nuclear program in order to be able to assemble a few nuclear weapons if a Chinese invasion appeared imminent. Albright and Stricker close with a chapter on lessons for today: The importance that reprocessing and enrichment activities be prohibited; use of political leverage and alliances to achieve desired outcomes; persistence in pursuing consistent policies informed by knowledgeable people; and the importance of inspections, safeguards, export controls; and informants. (E)
91. "The mechanism of nuclear fission (Part I)," Y. Zeldovich and Y. Khariton, Sov. Phys. Usp. **26**(3), 266–278 (1983). This paper is an English translation of a September 1941 paper in which Zeldovich and Khariton review the energetics of fission in much the same way as had Bohr and Wheeler in 1939, albeit with some elaborations, notably speculations on the stability of transuranic elements. Part II [also from 1941; Sov. Phys. Usp. 26(3), 279–294 (1983)] considers the statistical mechanics of excited nuclei, the differing behaviors of U-235 and U-238 under neutron bombardment, and includes an estimate of the critical mass of U-235 of about 10 kg. (A)
92. "Getting even with Heisenberg," N. P. Landsman, Stud. Hist. Philos. Mod. Phys. **33**(2), 297–325 (2002). This article is formally a review of Paul Rose's book on the German nuclear program and Heisenberg's role in it (MP-1, Ref. 107) but gives an excellent overview of the historiography of the German project to the time of its writing. (E)
93. "Tracking the journey of a uranium cube," T. Koeth and M. Hiebert, Phys. Today **72**(5), 36–43 (2019). This article is an abbreviated version of Ref. 88. Senior author Tim Koeth possesses two of the German uranium cubes; readers who might know of others are encouraged to come forward. (E)
94. "The occupation of Niels Bohr's Institute: December 6, 1943 - February 3, 1944," S. Schwarz, Phys. Perspect. **23**(1), 49–82 (2021). In December 1943, German Army police forces occupied the Niels Bohr Institute without warning; Bohr had fled to Sweden in September. Staff members were imprisoned and interrogated, but the occupation seemed disorganized. After a brief visit by an "Expert Commission" which included Werner Heisenberg, the Institute was released without condition on February 3, 1944. Schwarz explores the history of this footnote to the German occupation of Denmark, suggesting how infighting between various occupation-authority offices (military, police, civil) could be involved. (E)
95. In 2022, the German-language journal Berichte zur Wissenschaftsgeschichte/History of Science and Humanities [vol. 45, issue 1 (2022)] published a series of five English-language papers on Farm Hall by historians of science Dieter Hoffmann, Ryan Dahn, Mark Walker, David Cassidy, and Gerald Holton. These were originally presented at a session of an American Physical Society meeting held in March 2021 to commemorate the 75th anniversary of Farm Hall; abstracts can be found at https://meetings.aps.org/Meeting/MAR21/Session/C62. (E)
96. "Why Hitler did not have atomic bombs," M. Popp, J. Nucl. Eng. **2**(1), 9–27 (2021). This paper considers the German nuclear program via an examination of a February 1942 report to German Army Ordnance ("Heereswaffenamt"), which was authored primarily by Kurt Diebner. The only remaining original copy of this report resides in the archives of the Max Planck Society. Popp concludes that Werner Heisenberg and the other members of the "Uranium Club" did not work on nuclear weapons, that Heisenberg felt that doing so would harm Germany's military strength, and that work on reactors was delayed to avoid securing proof of the possibility of utilizing nuclear energy. Particularly interesting is that a report of a large fission cross-section for U-235 (3.7 barns) from a Viennese laboratory was (deliberately?) overlooked as it would have implied a small critical mass. See also Ref. 98. (E)
97. "A new approach on modeling of the B-VIII, The ultimate achievement of the second 'Uranverain,'" M. P. Pešić, Nucl. Technol. Radiat. Protection **33**(1), 1–23 (2023). This paper reports an analysis of the possible performance of the last German wartime reactor, the Haigerloch B-VIII heavy-water pile. The author points out various limitations of an earlier such analysis (MP-2, Ref. 81), particularly in the way the fuel distribution was modeled. Refined modeling indicates that the pile was closer to criticality than its inventors thought, with an effective reproduction constant on the order of ∼0.95, depending on the choice of model parameters.

The overall conclusion, however, is that the pile was subcritical, with the major factor being impurity of the heavy water moderator. (A)

98. "Laboratory life instead of nuclear weapons: A new perspective on the German uranium club," C. Forstner, Phys. Perspect. **24**(4), 181–207 (2022). This paper describes the activities of the Vienna group of the German "uranium club" during the war years. For these researchers, work carried on much as before the war and with the same instruments and techniques as they had already developed for nuclear and radiochemical research except for the focus being on uranium. Measurements of cross-sections, neutron numbers, fission product ranges and energies, and even the possible detection of plutonium were involved. Unfortunately, Forstner passed away while this paper was in press. Some of his conclusions have been questioned in view of the Vienna group's neutron sources being of very broad energy spectra and that the claimed discovery of Pu does not accord with known alpha-decay energies (M. Popp, private communication). (I)
99. "Science and politics: The discovery of nuclear fission 75 years ago," R. L. Sime, Ann. Phys. (Berlin) **526**(3-4), A27–A31 (2014). This article describes how Lise Meitner was written out of the history of the discovery of fission by political circumstances in Germany in 1938. The author, Ruth Sime, has prepared a definitive biography of Meitner (MP-1, Ref. 79) and written several papers detailing the circumstances of the discovery of fission. (E)
100. "Walther Bothe's graphite: Physics, impurities, and blame in the German nuclear program," B. C. Reed, Ann. Phys. (Berlin) **532**(7), 200121 (2020). In early 1941, Walther Bothe and Peter Jensen measured the cross-section for capture of thermal neutrons by graphite. Their graphite contained unappreciated impurities, which caused them to report a large capture cross-section. This in turn led officials in the German nuclear program to reject graphite as a moderating material for a possible nuclear pile in favor of heavy water, a move which set their program back irreparably. Unfortunately, Bothe's reputation came to be tainted by the affair after the war by his being accused of having caused an error which severely damaged the program. This paper, based on a translation of Bothe and Jensen's original 1944 paper, analyses their experiment and results. See also Ref. 101. (A)
101. "Zum unvollendeten ersten deutschen Kernreaktor 1942/1944," L. Koester, Naturwiss. **67**(12), 573–575 (1980). A German-language treatment of Bothe and Jensen's experiment. The title translates as "On the unfinished first German nuclear reactor 1942/1944." (A)
102. "Soviet uranium boosters," R. Mellor, Phys. Today **74**(7), 28–35 (2021). This engaging article surveys the history of uranium prospecting in the Soviet Union from the early 1900's onward. Despite nominal government support which was often derailed by political upheavals, purges, and the outbreak of World War II, a few dogged scientists and mining engineers pursued radium and uranium extraction, with the dirty work often conducted by forced labor. At the end of the war, the Soviets possessed only some 400 tons of uranium ore, far less than the western allies. (E)
103. ""Crucial? helpful? practically nil"? Reality and perception of Britain's contribution to the development of nuclear weapons during the second World War," S. Lee, Diplomacy Statecraft **33**(1), 19–40 (2022). Similar to MP-2, Ref. 21 (see also Refs. 27 and 57 in that installment), this paper discusses aspects of cooperation and competition in the Anglo-American nuclear relationship from the perspective of scientific collaboration and rivalry during the war. (E)

F. Postwar developments

104. **The Traveler's Guide to Nuclear Weapons: A Journey Through America's Cold War Battlefields**, J. M. Maroncelli and T. L. Karpin (Historical Odyssey Publishers, Silverdale, WA, 2002). This CD-based book gives a profusely illustrated guide to nuclear weapons complex sites around the United States, from mining operations to weapon test sites. There is a companion website at http://www.atomictraveler.com/index.htm. See also Ref. 106.
105. **100 Suns**, M. Light (Knopf, New York, 2003). This beautifully produced coffee-table book features 100 compelling photographs of aboveground United States nuclear tests from 1945 to 1962. Contains detailed captions, a chronology, and an extensive bibliography. See also MP-2, Ref. 9. (E)
106. **Complex Transformation: Change in the United States Nuclear Weapons Complex from 1942 to 2015**, G. C. Allen (CreateSpace Independent Publishing Platform, South Carolina, 2016). This remarkable book gives a thorough history of the evolution of the United States' Nuclear Weapons Complex (now properly termed the Nuclear Weapons Enterprise) from its origins in the 1940's to the present day. Dozens of photographs, organizational charts, tables, graphics, and timelines support the text. (I)
107. **The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons since 1945**, N. Tannenwald (Cambridge U. P., Cambridge, 2008). In this book, Tannenwald advances the thesis that a "nuclear taboo" has arisen around the idea of state-sanctioned use of nuclear weapons, with such weapons having come to be considered abhorrent and not legitimate weapons of war even if they would be militarily advantageous and involve no possibility of in-kind retaliation. For a contrasting view based on a public opinion survey, see Ref. 119. (E)
108. **One Physicist's Guide to Nuclear Weapons: A global perspective**, J. Bernstein (IOP Publishing, Bristol, 2016). This brief volume reviews the development of nuclear weapons from the discovery of fission to the 2016 treaty dealing with Iran's nuclear program. Bernstein witnessed two above-ground nuclear tests and knew many of the individuals involved in the development of nuclear weapons, including Robert Oppenheimer, Edward Teller, and Hans Bethe. (I)
109. **Doomed to Cooperate: How American and Russian Scientists Joined Forces to Avert Some of the Greatest Post-Cold War Nuclear Dangers**, Siegfried S. Hecker, Ed. (Bathtub Row Press, Los Alamos, New Mexico, 2016). This high-quality two-volume work runs to nearly 1,000 pages and offers an account of

cooperation between American and Russian nuclear-weapons laboratories from the late 1980s through the 1990s as told in articles by and interviews with about 100 participants on both sides. Much of the focus is on how experts from American laboratories and governmental and non-governmental agencies helped their Soviet counterparts secure nuclear weapons, materials, and facilities following the breakup of the Soviet Union in late 1991, but there is also coverage of cooperation in non-weapons pure-research areas, many of which had civilian applications. Editor Siegfried Hecker is a former Director of the Los Alamos Laboratory (1986–1997) and was deeply involved in establishing in these efforts. (I)

110. **Nuclear Weapons and Related Security Issues**, P. S. Corden, A. Fainberg, D. W. Hafemeister and A. Macfarlane, eds. (American Institute of Physics Conference Proceedings # 1898, Maryland, 2017). This volume comprises papers presented at a "Short Course" sponsored by George Washington University's (GWU) Elliott School of International Affairs, the American Physical Society's Forum on Physics and Society, the GWU Nuclear Science and Security Consortium, the American Association of Physics Teachers, and the Federation of American Scientists which was held at GWU over 21–22 April 2017. Twenty-nine papers review issues in the areas of strategic nuclear weapons, multilateral arms control, nuclear nonproliferation, and terrorism. This course is one in the same series as described in MP-3, Ref. 83 and includes an update of David Hafemeister's chronology of Weapons of Mass Destruction. (I)

111. **The Bomb: Presidents, Generals, and the Secret History of Nuclear War**, F. Kaplan (Simon and Schuster, New York, 2020). In this sobering volume, Kaplan surveys the nuclear strategies of U. S. administrations from that of Harry Truman up through Donald Trump. Particularly horrifying is how decades of Strategic Air Command war plans were predicated on essentially instantaneous escalation to full-scale use of thousands of weapons. Presidents now have more limited-strike options available, but the contradiction of having weapons that can serve only as deterrents remains. This book should be read by anybody interested in the perverse history of nuclear war-fighting strategies. (E)

112. **Restricted Data: The History of Nuclear Secrecy in the United States**, A. Wellerstein (University of Chicago Press, Chicago, 2021). Nuclear secrecy began with scientists censoring their own publications soon after the discovery of fission, grew into General Leslie Groves' procedures of compartmentalization and chasing down leaks during the Manhattan Project, and became bureaucratized with the formation of the Atomic Energy Commission and the concept that nuclear information was "born secret" as codified in the definition of "Restricted Data" during the development of the McMahon Act in 1946. Historian of science Alex Wellerstein traces the development of the United States' nuclear secrecy regime from the early days of censorship to the end of the Cold War, describing a system which has often tied itself in knots in attempting to balance demands of national security, research, industrial development, and foreign relations. (E)

113. "Oh, My darling Clementine: A detailed history and data repository of the Los Alamos plutonium fast reactor," H. K. Patenaude and F. J. Freibert, Nuclear Technology, in press. Clementine was a liquid-mercury cooled, plutonium and uranium-fueled fast-neutron reactor developed at Los Alamos just after the end of the war, when the Manhattan Engineer District was still formally in existence. This compact device was of essentially cubical footprint of about 10-foot side length including tamper and shield materials, and operated at 25 kW. Fuel slugs were cylinders about 6 inches long and 5/8-in. in diameter. Criticality was achieved in September 1946, and the device operated until late 1952, when it was shut down due to high alpha activity in the coolant indicative of a fuel rod rupture. During its operating life, Clementine generated valuable data on fast-neutron fission spectra, cross-sections, liquid-metal cooling, breeding reactions, and materials science. This paper, which is extensively illustrated with original photos, schematics, and graphs, describes the design, construction, operation, and eventual decomissioning of this pioneering experiment. This paper was in press at the time of this writing, but an online version can be found at https://www.tandfonline.com/doi/full/10.1080/00295450.2023.2176686. (A)

114. "Terrorism potential for research reactors compared with power reactors," G. Bunn and C. Braun, Am. Behav. Sci. **46**(6), 714–726 (2003). Many industrial, university, and government-laboratory research reactors use highly enriched uranium (HEU). Unlike large-scale power reactors, many of these reactors and their fuel may not be well-protected, particularly those located at industrial and educational sites. In 1978, both America and Russia began programs to develop less-enriched fuel for such reactors that they had provided to various countries during postwar "Atoms for Peace"-type programs. Many reactors have been converted, but some still operate with HEU. In this article, Bunn and Braun review the research-reactor situation as of 2003, concluding that these devices could be attractive targets for terrorists seeking a supply of HEU that would be both less radiologically dangerous to handle than spent power-reactor fuel and being easier to transport. See also Ref. 37. (E)

115. "The big science of Stockpile Stewardship," V. H. Reis, R. J. Hanrahan, and W. K. Levedahl, Phys. Today **69**(8), 47–53 (2016). This article summarizes experimental and computational facilities developed under the auspices of the United States' science-based Stockpile Stewardship program. (I)

116. "The secret of the Soviet hydrogen bomb," A. Wellerstein and E. Geist, Phys. Today **70**(4), 40–47 (2017). The first Soviet thermonuclear weapon, detonated in August 1953, was known to the Soviets as Sloika or "layer cake," and in the West as "Joe-4." This device, which had a yield of 400 kilotons, was largely disparaged by western scientists and political figures as not being a "true" thermonuclear bomb of the American Teller-Ulam radiation-implosion design, which was tested in November 1952. In this article, the authors analyze the *Sloika* design and argue that it was an important means for the Soviets to explore thermonuclear concepts while still producing deliverable weapons. (E)

117. "Sakharov, Gorbachev, and nuclear reductions," F. von Hippel, Phys. Today **70**(4), 49–54 (2017). This article follows that above by Wellerstein and Geist on the Soviet hydrogen bomb program in the April 2017 edition of *Physics Today*. von Hippel describes how comments made by dissident Soviet physicist Andrei Sakharov in 1987 helped to set in motion a process which resulted in the elimination of thousands of nuclear-armed ballistic missiles from the stockpiles of the United States and the Soviet Union. Sakharov was instrumental in convincing Soviet leader Mikhail Gorbachev to decouple US-Soviet nuclear reductions from discussions of President Ronald Reagan's "Star Wars" ballistic missile defense initiative. (E)
118. "The secret search for Cold War uranium in Morocco." M. Adamson, Phys. Today **70**(6), 54–60 (2017). In early 1953, French and American officials entered into a secret alliance to prospect for uranium in Morocco, then a French protectorate. Against a background of rising nationalist violence, surveys were conducted until late 1955, when the program was suspended. In the meantime, American interests aimed at being able to establish air bases were becoming more aligned with Morocco becoming an independent country, which occurred in early 1956. Uranium is present in Morocco, but the surveys indicated that deposits were not economically viable. This article tells the story of this little-known aspect of the Cold War. (E)
119. "Revisiting Hiroshima in Iran," S. D. Sagan and B. A. Valentino, Int. Security **42**(1), 41–79 (2017). This paper reports the results of a survey of 780 Americans regarding use of nuclear versus conventional weapons in retaliation against Iran in response to a hypothetical attack by that country on an American aircraft carrier which results in the deaths of as many military personnel as occurred at Pearl Harbor. The purpose of this survey was to test Tannenwald's theory that the public has come to adopt a taboo against use of nuclear weapons; see Ref. 107. The authors conclude that the majority of the U. S. public has not internalized either a belief in such a taboo or a strong norm against harm to noncombatants if the result is to lessen American military casualties. (E)
120. "The rise, collapse, and compaction of Mt. Mantap from the 3 September 2017 North Korean nuclear test," T. Wang, Q. Shi, M. Nikkhoo, S. Wei, S. Barbot, D. Dreger, R. Bürgmann, M. Motagh, and Q. Chen, Science **361**(6398), 166–170 (2018). This paper reports the use of satellite radar imagery of ground displacements in combination with seismic data to determine the yield of a claimed North Korean two-stage thermonuclear bomb test on 3 September 2017. The inferred yield is between 171 and 209 kilotons (kt), with a best-fit solution of 191 kt, certainly characteristic of a boosted fission weapon if not a full-blown thermonuclear device. (A)
121. "Getting rid of the Swedish bomb," T. Jonter, Phys. Today **72**(9), 40–47 (2019). Soon after the end of World War II, Swedish military and political leaders began considering whether their country should develop its own nuclear weapons. Jonter, a professor of international relations at Stockholm University, traces how internal and external political issues, notably pressure form the United States, eventually drove Sweden to drop its nuclear aspirations by the mid-1960s. Sweden then became a strong voice for disarmament. (E)
122. "NSF and postwar US science." E. Gibson, Physics Today **73**(5), 40–46 (2020). World War II changed the relationship between science and government. Proposals for a federal office of science and technology mobilization were advanced even before the end of the war, but it was Vannevar Bush's July, 1945 *Science - The Endless Frontier* report that laid out a proposal for the creation of a national research foundation. The National Science Foundation came into being in 1950, initially with a very meager budget. This article describes the early years of the NSF and how its first director, Alan Waterman, was careful to build that organization to be relatively free of bureaucratic interference while maintaining high standards. This article should be read by anyone interested in the development of national science policies. (E)
123. "Who's next?" The Economist **438**(9230), 16–18 (2021). The Economist often runs well-informed articles on current scientific and technological developments. This article in the 30 January 2021 edition explores the current state of nuclear proliferation concerns, with particular emphasis on potentially destabilizing events in East Asia and the Middle East. (E)
124. The October 2020 edition of *Health Physics* (volume **119**, issue (4)) contains six openly available papers prepared by editor Steven Simon and various co-authors reporting the results of a Congressional commission established to assess the health impacts of the Trinity test, and, by extension, nuclear detonations in general. Topics covered include dose estimates from fallout, recommended exposures, and procedures for internal and external dose estimates for various fallout products. Freely available at https://journals.lww.com/health-physics/toc/2020/10000. (A)
125. On December 16, 2022, U. S. Secretary of Energy Jennifer Granholm announced that the 1954 Atomic Energy Commission decision to revoke Robert Oppenheimer's security clearance had been vacated, in part because the AEC failed to follow its own rules. The DoE announcement and a link to Garnholm's order can be found at https://www.energy.gov/articles/secretary-granholm-statement-doe-order-vacating-1954-atomic-energy-commission-decision (E)

G. Educational materials

126. **Strange Glow: The Story of Radiation**, T. Jorgensen (Princeton, 2016). This very readable volume covers the history of radiation from the discovery of x-rays to the present day, with particular emphasis on exposure from sources such as fallout, medical treatments, cell phones, food, radon, and nuclear power plants. Jorgensen avoids dry technical language, opting instead to tell the story of radiation through its human connections. (E)
127. **The Secret Project**, Jonah Winter and Jeanette Winter (Beach Lane Books, New York, 2017) This picture book for very young children (K-3) tells the story of how Los Alamos was turned into a secret bomb-development laboratory; a brief Author's Note fills in

some of the background for parents and teachers unfamiliar with the Manhattan Project. This book would probably serve as a good "primer" before young readers take on Sheinkin's *Bomb: The Race to Build - and Steal - the World's Most Dangerous Weapon* (MP-3, Ref. 93). (E)

128. **Critical Assembly: Poems of the Manhattan Project**, J. Canaday (University of New Mexico Press, Albuquerque, 2017). Canaday has composed several dozen poems about the Manhattan Project, putting them under the names of people associated with the Project, including Oppenheimer, Szilard, Teller, Groves, Bethe, Feynman, and Wigner. This and the following source could serve as reading materials for a literature class on science and society issues. (E)

129. "A compendium of striking manhattan project quotes," B. C. Reed, Hist. Phys. Newsletter **XIII**(3), 8–14 (2016). A compendium of several dozen thought-provoking quotes on the Manhattan Project by scientists and others involved with the work. (E)

130. "Nuclear cartography: Patterns in binding energies and subatomic structure," E. C. Simpson and M. Shelley, Phys. Educ. **52**, 064002 (9 pp) (2017). A summary of the concepts of mass defect, binding energy, fission, fusion, and the chart of the nuclides for high-school students. (I)

131. "Uranium fission and plutonium production in the undergraduate lab," J. V. Willigen, C. Loman, P. Thibaudier, D. B. R. A. Fokkema, and T. W. Hijman, Am. J. Phys. **88**(3), 200–206 (2020). This paper describes an experiment carried out by first-year students at the University of Amsterdam and Vrije Universiteit in The Netherlands wherein 15 g of depleted uranium (U-238) were bombarded by neutrons from a Americium-Beryllium neutron source, and the resulting activation studied by gamma-ray spectroscopy. The experiment demonstrated both fission as detected by emission of gamma-rays from fission products and also the formation of Pu-239 as detected by emission of gamma-rays from decaying Np-239. (A)

132. "Estimating the yield of the Trinity test with a simple kinetic energy analysis," B. C. Reed, Phys. Educ. **55**, 033007 (3 pp) (2020). This brief paper shows how a high-school-level analysis of the kinetic energy of the expanding fireball of the *Trinity* test can be used to roughly estimate the energy released in the explosion. (I)

133. "Estimating the size of Fermi's CP-1 nuclear pile: A classroom approach," B. C. Reed, Eur. J. Phys. **42**, 055801 (12 pp) (2021). This paper uses basic concepts of cross-sections, neutron mean-free-paths, reproduction constants, and expressions for estimating the critical size of a self-sustaining nuclear chain reaction to understand the dimensions of Enrico Fermi's first nuclear pile. Intended for undergraduates. (I)

134. "Estimating the maximum visual intensity of a nuclear fireball," B. C. Reed, Eur. J. Phys. **44**(1) 015802 (4 pp) (2023). Based on data in Glasstone and Dolan's *Effects of Atomic Weapons* volume (MP-1, Ref. 51; updated 1977 edition), this article derives an expression for the maximum visual intensity of a nuclear fireball as a function of weapon yield and distance. Yes, nuclear fireballs can truly be brighter than a thousand suns. (I)

135. "The devil's work: A Maxwell's demon model for understanding the work cost of isotope enrichment," B. C. Reed, Phys. Soc. **52**(1), 1–3 (2023). Formal derivations of the energy involved in separating isotopes, so-called "separative work units," are notoriously complicated. This article provides a simple probability-based pedagogical model for estimating separative work based on a Maxwell's demon-type scenario where the demon is equipped with a beam balance. The model gives results in very close accord with more formal derivations, and is suitable for presentation to students familiar with simple integrals and basic concepts of probability. (I)

III. VIDEOS AND WEBSITES

136. Manhattan Project. This Wikipedia page gives a thorough and well-referenced survey of the Manhattan Project. https://en.wikipedia.org/wiki/Manhattan_Project (E)

137. The online Encyclopedia for the History of Science (ETHOS) is published by Carnegie Mellon University. This resource is intended for historians of science who specialize in one topic to have a way to quickly become familiar with how those in other areas approach their disciplines. Historian of science Alex Wellerstein (Refs. 76, 112, and 116) has an excellent survey of the Manhattan Project and its legacy as part of this site; see https://ethos.lps.library.cmu.edu/article/id/35/. (I)

138. The U. S. Nuclear Weapons Complex, https://www.google.com/maps/d/viewer?mid=16D-GF2of9UXppSRknAN_ApFpHBg&ll=27.322007519566913\%2C-85.61426514999994&z=2. This interactive map prepared by Frank Settle, Director of the ALSOS digital library for nuclear issues (MP-1, Ref. 138), contains the locations of dozens of important offices, mines, mills, plants, laboratories, and test sites that comprised the U.S. nuclear complex from World War II to 2016. More information for many of the sites is available in "The Traveler's Guide to Nuclear Weapons," Ref. 104. Locations can be accessed directly by clicking on their map pins or selected from sections in the legend on the left side of the map. The sections are organized to follow the progression of nuclear materials from mining to weapons testing. A unique color code identifies the locations in each section. Page numbers in the "Guide" refer to the Traveler's Guide referenced above. (E)

139. An interactive isotope app is available on a website of the American Nuclear Society at isotopes.ans.org. Developed by students at the University of South Carolina Aiken, users can select an element from the periodic table, which brings up a slider bar wherein the number of neutrons can be adjusted to select a given isotope. Pictures and captions describe known uses of the isotope and its decay properties. (E)

140. The Physicists Coalition for Nuclear Threat Reduction is devoted to mobilizing physical scientists and engineers who are interested in nuclear arms-control policy. The Coalition is supported by the American Physical Society and the Carnegie Endowment, and offers colloquia, fellowships, and policy and advocacy support. https://physicistscoalition.org (E)

141. Nuclear Attack UK Live Broadcast https://www.youtube.com/watch?v=exY6l4j12Ng This fictional 36-minute BBC "Breaking News" segment describes how an incident between Russian and NATO forces in the Mediterranean spirals out of control into a nuclear exchange. That the commentary is delivered in the usual understated BBC style adds to the chilling nature of the program. (E)
142. A project at Lawrence Livermore National Laboratory is dedicated to digitizing films of Los Alamos and Livermore atmospheric nuclear weapons tests. In March 2017, the first of these declassified videos was released in an LLNL YouTube Playlist available at https://www.youtube.com/playlist?list=PLvGO_dWo8VfcmG166wKRy5z-GlJ_OQND5. Hundreds of videos of various tests are freely viewable. (E)
143. "A" is for atom. This 1952 short cartoon (∼15 min) sponsored by General Electric charmingly explains about atoms, isotopes, nuclear power and explosions, and uses of isotopes in industry and medicine. Available at http://www.atomicheritage.org/tour-stop/atomic-science#.Wez2sUyZNwA (E)
144. The Japan-US Radiation Effects Research Foundation was established to study radiation effects in the survivors of Hiroshima and Nagasaki; the homepage of this organization can be found at http://www.rerf.jp/shared/ds02/index.html. In their 2022 Dosimetry System analysis, RERF researchers estimated the yields of the Hiroshima and Nagasaki bombs at 16 kt and 21 kt, respectively; see https://www.rerf.or.jp/en/glossary/ds02-en/. (I)
145. "Hiroshima 1945—The British atomic attack." There was no British atomic attack, but this speculative 15-minute video is worth watching; see also Ref. 146. This program describes how a squadron of British airmen trained with Lancaster bombers to deliver the products of the Manhattan Project as a backup in case American B-29 bombers proved unequal to the task. I am informed by a contact at Los Alamos that their records offer no support for the purported Lancaster training. Available at https://www.youtube.com/watch?v=5XX9ptCNpik. (E)
146. "Third Atomic Bomb Attack -1945." This video is a companion production to that immediately above. In this 25-minute program, the complex nature of the Japanese surrender is explored, including the possibility of a military coup which would have resulted in the war being prolonged, and the possible use of a third nuclear weapon, which President Truman was reluctant to authorize. Available at https://www.youtube.com/watch?v=I34pxr23Nhw. (E)
147. Encyclopedia of Nuclear Energy. This extensive online encyclopedia published by Elsevier comprises dozens of sections written by experts on topics including radioactivity, nuclear weapons, reactor designs and safety, nuclear waste, medical isotopes, radiation protection, and radioisotope power for space applications. https://www.elsevier.com/books/encyclopedia-of-nuclear-energy/greenspan/978-0-12-819725-7. (A)
148. The Soviet "Tsar Bomba" fusion-bomb explosion of October 30, 1961 was the most powerful nuclear device detonated, producing a yield of 50 megatons. In 2020, Russian authorities declassified a 40-minute documentary about the test. The voice-over is in Russian (complete with dramatic music), but English closed captions can be brought up by clicking on the CC tab of the video. https://www.youtube.com/watch?v=XJhZ3i-HXS0 (E)
149. On August 8, 1945, between the bombings of Hiroshima and Nagasaki, Russia declared war on Japan. A brief YouTube video shows an image of a teletype printout reporting President Truman announcing the news. The printout was saved by a Brooklyn radio station owner. https://www.youtube.com/watch?v=ML5_VE5-1HQ (E)
150. A BBC-produced seven-episode podcast on the development and use of the bomb focusing on Leo Szilard's role was broadcast during the Summer and Fall of 2020; available for download at https://www.bbc.co.uk/programmes/p08llv8n/episodes/downloads. (E)
151. In Our Time: The Manhattan Project. This 48-minute BBC4 radio program aired on October 7, 2021. In a round-table format with this author, Cynthia Kelly of the Atomic Heritage Foundation, and theoretical physicist Frank Close of Oxford University, interviewer Melvyn Bragg explored how the discovery of fission led to the fear of Germany acquiring atomic bombs and the consequent Allied program. Available at https://www.bbc.co.uk/programmes/m00108h1. (E)
152. **Oppenheimer**. This biographical movie directed by acclaimed filmmaker Christoper Nolan is scheduled for theatrical release in July 2023 in IMAX, 70 mm, and 35 mm formats. The film features a high-profile cast and is based on Bird and Sherwin's American Prometheus (MP-1, Ref. 64). A website can be found at https://en.wikipedia.org/wiki/Oppenheimer_(film). (E)

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AUTHOR DECLARATIONS

Conflict of Interest

The author has no conflicts to declare.

[a)]ORCID: 0000-0003-2032-1955.