Dissenting Scientists in Early Cold War Britain

The "Fallout" Controversy and the Origins of Pugwash, 1954–1957

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Introduction

The radiological dangers of the new hydrogen bomb were brought dramatically into view in March 1954 after a U.S. thermonuclear test in the Pacific went badly wrong. The 15-megaton Castle Bravo test at the Bikini Atoll was much larger than planned, causing radioactive contamination to spread over a much wider area than expected.[1] More than 200 Marshall Islanders and more than 20 U.S. military personnel stationed on the islands and on the *Patapsco*, a Navy tanker, were lightly contaminated. These events were briefly reported on 11 March by the U.S. Atomic Energy Commission (AEC) in a short communiqué that described Bravo as a "routine" test and emphasized that all those affected were now well. In Japan, Bravo became a national crisis when it became apparent that the crew of a Japanese fishing boat, the *Daigo Fukuryū Maru* (*Lucky Dragon*), sailing in supposedly safe water some 70 kilometers outside the exclusion zone, had been heavily contaminated by radioactive fallout from Bravo. This came to light only when the boat reached port in Yaizu on 14 March: All 23 crew members were suffering from radiation sickness, and one later died.[2] The incident sparked fears about the radioactive contamination of major fishing grounds. The resulting "tuna panic" proved ruinous for this economically vital industry.[3] Just two years after the end of the U.S.

1. The Castle test series involved six shots. Bravo, on 1 March, was the first U.S. test of a weaponized version of the hydrogen bomb.

2. Ralph Lapp, *The Voyage of the Lucky Dragon* (New York: Harper, 1958). Crew member Aikichi Kuboyama subsequently died.

3. Herbert Passin, "Japan and the H-bomb," *Bulletin of the Atomic Scientists* (*BAS*), Vol. 11, No. 8 (October 1955), pp. 289–292. For recent work on the Japanese experience of Bravo and its aftermath, see the contributions in *Historia Scientiarum*, Vol. 25, No. 1 (2015).

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occupation, Japan perceived itself for a second time as a victim of U.S. nuclear weapons, and Bravo became a diplomatic flashpoint between the two countries.[4] As the organization charged with responsibility for U.S. nuclear weapons tests, the AEC found itself in the spotlight. At a press conference at the end of March upon returning from Bikini, the head of the AEC, Lewis Strauss, further fueled Japanese anger when he disputed the location of the *Fukuryū Maru* at the time of the accident, implying that it might have been involved in espionage. Strauss sought to downplay the dangers of fallout, but his off-the-cuff remark that the new weapon could devastate a city the size of New York triggered widespread alarm in the United States—where reports of elevated radiation levels over the country in the wake of Bravo had already caused unease and consternation.[5]

According to one commentator, Castle Bravo was the "shot that made the world fallout-conscious."[6] In reality, the emergence of fallout as an issue of national and international concern in the mid-to-late 1950s was a slower and more complex process, one in which scientists played a leading role. The governments of nuclear powers sought scientific data on fallout for their own purposes but were concerned above all to manage the flow of information on fallout to the public in the interests of protecting their military and civilian nuclear programs. Dissident scientists, meanwhile, played a key role in fostering both political debate and public concerns about fallout, and their warnings about its potential dangers to health redefined weapons tests as a radiological threat to public safety. Nevertheless, as they heeded Albert Einstein's exhortation to take science and the issues it raised to the "village square," scientists concerned about fallout and critical of official nuclear weapons policy in Britain (and the United States) faced considerable obstacles to getting their views across to the public.[7] The fallout issue thus affords insights into the

4. Glenn D. Hook, "Censorship and Reportage of Atomic Damage and Casualties in Hiroshima and Nagasaki," *Bulletin of Concerned Asian Scholars*, Vol. 23, No. 1 (1991), pp. 13–25. The U.S. and Japanese governments entered into negotiations about compensation for the crew of the *Fukuryū Maru* and the Japanese fishing industry. Payment by the United States of $2 million in January 1955 brought the matter to a swift conclusion. *The Manchester (UK) Guardian* (*TMG*), 1 January 1955, p. 1.

5. Robert A. Divine, *Blowing on the Wind: The Nuclear Test Ban Debate 1954–1960* (New York: Oxford University Press, 1978), pp. 5–9.

6. Attributed to Daniel Lang, science writer at *The New Yorker* magazine, by Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (London: Penguin, 1989), p. 115.

7. Michel Amrine and Albert Einstein, "The Real Problem Is in the Hearts of Men," *The New York Times*, 23 June 1946, p. 44, cited in Jessica Wang, "Scientists and the Problem of the Public in Cold War America, 1945–1960," *Osiris*, Vol. 17, No. 1 (2002), esp. p. 323. See also Paul Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age* (New York: Pantheon Books, 1985).

possibility of dissident knowledge in the context of Cold War science. The struggles of scientists who argued that fallout was sufficiently dangerous to call a halt to nuclear weapons tests resonate with Jessica Wang's characterization of science and scientists as occupying an "uneasy, ambivalent cultural space during the Cold War."[8]

Various scholars, notably Richard Taylor, Lawrence Wittner, and more recently Matthew Grant and Holger Nehring have provided a rich understanding of growing antinuclear sentiment in Britain in the 1950s, including the political context and intensifying protest by the public.[9] This work acknowledges the importance of weapons testing and fallout as a focus of political debate and a major source of public unease. Work by Greta Jones and Christoph Laucht has shed new light on the place and experiences of scientists in the politics surrounding British nuclear weapons policy.[10] However, much remains to be done to uncover how and with what consequences scientists dissenting from government were able to bring fallout into the political spotlight and to public attention in Britain in the thermonuclear age. This article focuses on Bravo and the ensuing fallout/testing issue as a means to understand the characteristics and dynamics of the decisive role played by these scientists in fostering public debate about fallout within this national setting. Britain was a key context for the emergence of the fallout debate for several

8. Wang, "Scientists," p. 325.

9. Matthew Grant, *After the Bomb: Civil Defence and Nuclear War in Cold War Britain* (London: Palgrave Macmillan, 2010); Holger Nehring, "Cold War, Apocalypse and Peaceful Atoms. Interpretations of Nuclear Energy in the British and West German Anti-nuclear Weapons Movements, 1955–1964," *Historical Social Research*, Vol. 29, No. 3 (2004), pp. 150–170; Holger Nehring, "The British and West German Protests Against Nuclear Weapons and the Cultures of the Cold War, 1957–1964," *Contemporary British History*, Vol. 19, No. 2 (2005), pp. 223–241; Frank E. Myers, "Dilemmas in the British Peace Movement since the Second World War," *Journal of Peace Research*, Vol. 10, No. 1/2 (1973), pp. 81–90; Richard Taylor, *Against the Bomb: The British Peace Movement 1958–1965* (Oxford, UK: Clarendon Press, 1988); and Lawrence S. Wittner, *Resisting the Bomb: A History of the World Nuclear Disarmament Movement, 1954–1970*, Vol. 2 (Stanford, CA: Stanford University Press, 1993/2003), pp. 41–60.

10. Greta Jones, "British Scientists, Lysenko and the Cold War," *Economy and Society*, Vol. 8, No. 1 (1979), pp. 26–58; Greta Jones, "The Mushroom-Shaped Cloud: British Scientists' Opposition to Nuclear Weapons Policy, 1945–1957," *Annals of Science*, Vol. 43, No. 1 (1986), pp. 1–26; and Christoph Laucht, *Elemental Germans: Klaus Fuchs, Rudolf Peierls and the Making of British Nuclear Culture, 1939–1959* (Basingstoke, UK: Palgrave Macmillan, 2012). On scientists' political activities in interwar Britain, see Gary Werskey, *The Visible College: A Collective Biography of British Scientists and Socialists of the 1930s* (London: Allen Lane, 1978). On activism by nuclear scientists in the United States, see Alice Kimball Smith, *A Peril and a Hope: The Scientists' Movement in America* (Cambridge, MA: MIT Press, 1965); Martin Kuznick, "The Birth of Scientific Activism," *BAS*, Vol. 44, No. 10 (December 1988), pp. 39–43; Kelly Moore, *Disrupting Science: Social Movements, U.S. Scientists and the Politics of the Military, 1945–1975* (Princeton, NJ: Princeton University Press, 2008); and Donald A. Strickland, *Scientists in Politics: The Atomic Scientists' Movement, 1945–1946* (Lafayette, IN: Purdue University Studies, 1968).

reasons. It was distinctive in being the third nuclear power but not a superpower. Moreover, and inconveniently, the fallout/testing controversy arose at a critical juncture when Britain was striving to realize its ambitions to become the third thermonuclear power, making the fallout issue particularly sensitive. If the UK's distinctive political culture accorded British scientists the freedom to speak out, it also operated, as Greta Jones observes, to place limits on criticisms of government policy and to curtail collective opposition.[11] Developments within Britain are also crucial to understanding both the formation in 1957 of the Pugwash Conferences on Science and World Affairs (Pugwash, or PCSWA) and the importance of the fallout issue for its inception. Radioactive fallout affected nuclear and non-nuclear states alike, as Eugene Rabinowitch, founder and editor of the *Bulletin of the Atomic Scientists*, noted; it was both "universal and compulsory."[12] Fallout posited a relationship between the local and the global, provoking responses within the nation-state while also demanding a transnational response.[13] For scientists who were critical of nuclear weapons and the arms race, fallout served as a rallying point both within and beyond the nation-state, providing a rationale by which, via Pugwash, they could reach across Cold War divides to confront and discuss the scientific, political, and ethical issues posed by the hydrogen bomb, including fallout.

The following analysis builds on three stands of literature— research that has explored the role of scientists and fallout in the United States, work that has examined nuclear culture and the nuclear state in 1950s Britain, and histories of the PCSWA. It adds new perspectives, however, by drawing on wide-ranging sources to develop a more systematic analysis than has hitherto been offered of the discussions within the ranks of nuclear scientists about how to deal with the fallout issue and the attempts by the British government and senior scientists prominent within the nuclear nexus to manage public knowledge of fallout and to rebut dissenting scientific analyses of its potential dangers. This enriches our understanding of the strategies developed by key dissenters, notably Joseph Rotblat and Bertrand Russell, to open up the debate on fallout both within Britain and beyond, strategies that in due course led them, together with other like-minded scientists, to found Pugwash.

11. Jones, "Lysenko." Also see John Callaghan and Mark Phythian, "Intellectuals of the Left and the Atomic Dilemma in the Age of the UK Atomic Monopoly, 1945–1949," *Contemporary British History*, Vol. 29, No. 4 (2015), pp. 441–463.

12. Divine, *Blowing*, p. 142.

13. On the problem and meanings of "transnationalism," see Patricia Clavin, "Defining Transnationalism," *Central European History*, Vol. 14, No. 4 (November 2005), pp. 421–439. On its place in science, see *British Journal for the History of Science* (*BJHS*), Vol. 45, No. 3 (September 2012).

Fallout from Thermonuclear Tests: An Unclear but Present Danger

The responses to the Bravo accident in the United States, among political and military leaders and the wider public, reflected the Cold War context and did not disrupt the U.S. weapons testing program. The remaining five test shots of Operation Castle took place as scheduled at the Bikini Atoll in April and May 1954, and a few months later President Dwight D. Eisenhower approved a further fifteen weapons tests (Operations Teapot and Wigwam) for the following summer.[14] The AEC, however, found itself forced in the wake of Bravo to undertake an investigation into the radiological aspects of weapons tests. The resulting report, published on 15 February 1955, concluded that the "small amount" of additional radiation exposure from testing was not of "serious concern."[15] In what would become a much-used defense of weapons tests, the AEC argued that fallout was less of a hazard than "natural" background radiation (derived, for example, from cosmic rays) or the medical uses of radiation. The AEC also vigorously reminded the public of its view, one shared by the Eisenhower administration and the military, that tests were vital to national security: The potential dangers of fallout had to be balanced against the imperative of staying ahead in the arms race. As the report concluded, "fallout is much less dangerous than falling behind the Russians," and "the degree of risk must be balanced against the great importance of the test program to the security of the nation."[16]

The AEC in its stance on fallout and testing could rely on senior scientists, notably physicist Edward Teller and chemist Willard Libby, to endorse and legitimate the agency's position that fallout was not a major threat to health and did not constitute grounds to end weapons tests.[17] Both had close ties to the AEC. Libby served from 1954 to 1959 as an AEC commissioner and was involved with AEC research into the radiological effects of nuclear weapons, including Projects Gabriel and Sunshine, begun in 1949 and 1953

14. Teapot took place at the Nevada Proving Grounds. Wigwam took place off the California coast near San Diego. Details of the Castle test series and planning for future weapons tests remained secret at the time.

15. U.S. Atomic Energy Commission, *The Effect of High-Yield Nuclear Explosions*, 15 February 1955.

16. Ibid. See also Divine, *Blowing*, pp. 36–57.

17. "Steps to Survive Atom Bomb Given," *The New York Times*, 17 July 1955; "No Danger Seen in Nuclear Tests," *The New York Times*, 20 January 1956; "Nuclear Weapons Tests," *Science*, Vol. 124, No. 3228 (9 November 1956), pp. 925–926; and "Two Scientists Back Tests of H-bombs," *The New York Times*, 6 November 1956, p. 5.

respectively.[18] Like Libby, Teller was a staunch supporter of the hydrogen bomb and of weapons testing. Both men rallied behind the AEC report.[19] Caroline Kopp's analysis of the responses of scientists to the fallout problem has shown that positions taken in the United States were often rooted in factors unrelated to the science and instead connected to a political position, a worldview, an institutional affiliation, or a professional or career-related consideration.[20] The stances taken by Teller and Libby, Kopp argues, reflected their affiliations with the AEC and political outlooks that aligned them with government weapons policy.

By contrast, other scientists and activists viewed fallout as posing potentially serious dangers and were critical of the AEC report and of weapons testing. The Federation of American Scientists (FAS) responded by calling for the United Nations (UN) to coordinate a moratorium on further tests until the dangers were better understood.[21] More forthright criticism came from scientists typically removed from AEC and Washington circles, including Linus Pauling, Ralph Lapp, and Alfred Sturtevant.[22] Convinced that fallout caused leukemia, Pauling—a Nobel Prize–winning chemist who was vehemently antiwar—publicly challenged Teller's and Libby's support for the AEC position.[23] Vilified by some in the United States, Pauling found collegiality within the international scientific community, which offered fertile ground for forging anti-nuclear networks. In 1955, he was a signatory of the Russell-Einstein Manifesto, an initiative led by Russell and Frédéric Joliot-Curie, in which scientists drew attention to the dangers of fallout and testing

18. Laura A. Bruno, "The Bequest of the Nuclear Battlefield: Science, Nature and the Atom during the First Decade of the Cold War," *Historical Studies in the Physical Sciences*, Vol. 33, No. 2 (2003), pp. 237–260.

19. Willard Libby, "Radioactive Fallout," *BAS*, Vol. 11, No. 7 (1955), pp. 256–260. This was the text of a speech given by Libby to the Alumni Association of the University of Chicago on 3 June 1955.

20. Caroline Kopp, "Origins of the American Scientific Debate over Fallout Hazards," *Social Studies of Science*, Vol. 9, No. 4 (November 1979), pp. 403–422.

21. The FAS statement was reported in *TMG*, 8 March 1955.

22. Paul Rubinson, "'Crucified on a Cross of Atoms': Scientists, Politics and the Test Ban Treaty," *Diplomatic History*, Vol. 35, No. 2 (April 2011), pp. 283–319. Beginning in summer 1954, Sturtevant became embroiled in a notorious spat with John Bugher, chief of the Biology Division of the AEC, about the genetic dangers of radiation and about the AEC's treatment of Herman Muller for his assertion that all radiation posed a threat to genetic stability. See Kopp, "Origins."

23. For Libby versus Pauling, see *Foreign Policy Bulletin*, 15 June 1957, pp. 148–149; and "Is Fallout Overrated?" television debate between Pauling and Teller, 20 February 1958, KQED, San Francisco. In 1962, Pauling's contributions to building peace, including his book *No More War!* (New York: Dodd, Mead, 1958), were recognized by the award of the Nobel Prize for Peace. Mary-Jo Nye, "What Price Politics? Scientists and Political Controversy," *Endeavour*, Vol. 23, No. 4 (1999), pp. 148–154.

and called for an end to the arms race. In 1956, together with Barry Commoner and Edward Condon, Pauling organized petitions calling for an end to tests. The influence of these petitions, which were signed by thousands of scientists in the United States and abroad and submitted to the White House, the UN, and the Nobel Committee, remains difficult to gauge.[24] They are important, however, as a symbol of scientists' resistance to official policy and in confirming their instinct for international mobilization and protest.

The defiant Cold War rhetoric espoused by the AEC and its emissaries in the wake of Bravo reflected the ethos of the Eisenhower administration, wholly committed to a policy of thermonuclear defense based on the principle of "massive retaliation."[25] The fallout problem did not slow the testing and stockpiling of nuclear weapons by the United States—or by the Soviet Union.[26] Nor did the fallout problem dampen British, French, or Chinese nuclear ambitions. The dangers of fallout were assessed in the context of Cold War priorities and rationalized in terms of risk—one deemed overwhelmingly worth taking. From March 1954 through the end of 1957, 115 tests were carried out by the three nuclear powers.[27] Plumes of radioactive debris continued to spiral upward from test sites in the Pacific, from Kazakhstan and the Barents Sea, and from the Australian desert—and were then carried at high altitude around the world.[28]

Concerns about fallout were meanwhile being raised across the world, not least among the nonaligned countries. As early as April 1954, Indian Prime Minister Jawaharlal Nehru, whose country lay in the path of fallout from the test sites of all three nuclear powers, led calls to suspend atmospheric nuclear tests. Religious leaders continued to vacillate, although the pope in his Easter message of 1954 and his Christmas message of 1955 called for an end to weapons testing.[29] Public responses differed across national contexts

24. In June 1957, a petition signed by 2,000 U.S. scientists was submitted to the White House. This was subsequently circulated internationally and in January 1958 was passed to the United Nations with 9,235 signatures. See Divine, *Blowing*, pp. 127, 182.

25. This policy was set out in 1953 in NSC 162/2.

26. Nor did the power struggle in Moscow following Iosif Stalin's death in March 1953 interrupt the Soviet nuclear weapons program. David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939–1956* (New Haven: Yale University Press, 1994).

27. These all came after Bravo. See Lorna Arnold (with Katherine Pyne), *Britain and the H-Bomb* (London: Palgrave, 2001), Appendix II, pp. 234–236.

28. Barton Hacker, *Elements of Controversy: The AEC and Radiation Safety in Nuclear Testing 1947–1974* (Berkeley: University of California Press, 1994); and Richard G. Hewlett and Jack M. Holl, *Atomic Shield, 1947–1952: History of the US Atomic Energy Commission*, Vol. 2 (Berkeley: University of California Press, 1990).

29. Divine, *Blowing*, pp. 3–35, esp. 21.

in ways that reflected national polity and culture.[30] Some shared concerns can, however, be discerned across national borders and social divides. As Kai Erikson has argued, radiation poses an especially sinister threat—"invisible to the senses at low doses, insidious in its latent effects"—and thus occupies a "special place in the human sense of terror."[31] From the mid-1950s onward, public anxieties began to focus on leukemia amid strengthening evidence of a link between low-level radiation exposure and this form of cancer.[32] Most alarming was epidemiological data emerging from the Atomic Bomb Casualty Commission (ABCC) indicating an increased incidence of leukemia among the *Hibakusha*.[33] Fears of radiation also featured in and were fueled by an emerging nuclear genre of films and books depicting various kinds of nuclear nightmare, from mutant aliens rampaging across the New Mexico desert, to Godzilla, to Nevil Shute's haunting portrayal of lingering death from radiation sickness in a post-apocalyptic Melbourne.[34] As Ralph Lutts noted, "the fall of radiation had become the modern equivalent of the fall of darkness and the stroke of midnight."[35]

30. A recent volume of *BJHS*, Vol. 45, No. 4 (December 2012), edited by Jonathan Hogg and Christoph Laucht has called attention to the pitfalls of the term "nuclear culture" and the need to analyze more closely its different meanings for different "publics"; for example, taking into consideration social factors such as class, gender, race, and religion. In particular, see Jonathan Hogg, and Christoph Laucht, "Introduction," *BJHS*, Vol. 45, No. 4 (December 2012), pp. 479–493; and Jeff Hughes, "What Is British Nuclear Culture? Understanding Uranium 235," *BJHS*, Vol. 45, No. 4 (December 2012), pp. 495–518. For a perspective on earlier British nuclear culture, see Kirk Willis, "The Origins of British Nuclear Culture, 1895–1939," *Journal of British Culture*, Vol. 34, No. 1 (1995), pp. 59–89.

31. Kai T. Erikson, "Radiation's Lingering Dread," *BAS*, Vol. 47 (March 1991), pp. 34–39, esp. 35.

32. Robert Proctor, *Cancer Wars: How Politics Shapes What We Know and Don't Know about Cancer* (New York: Basic Books, 1995); and James T. Patterson, *The Dread Disease: Cancer and Modern American Culture* (Cambridge, MA: Harvard University Press, 1987). For more recent analyses, see *Bulletin of the History of Medicine*, Vol. 81, No. 1 (Spring 2007).

33. W. C. Moloney and M. A. Kastenbaum, "Leukemogenic Effects of Ionizing Radiation on Atomic Bomb Survivors in Hiroshima City," *Science*, Vol. 121, No. 3139 (25 February 1955), pp. 308–309; and N. Wald et al., "Histologic Findings in Hiroshima and Nagasaki Atomic Bomb Survivors: A Ten Year Review," *Proceedings of the 6th International Congress of the International Society of Hematology* (Spurling, MD: National Institutes of Health, 1956), pp. 382–388. On the ABCC, see John Beatty, "Scientific Collaboration, Internationalism and Diplomacy: The Case of the ABCC," *Journal of the History of Biology* (*JHB*), Vol. 26, No. 2 (1993), pp. 205–231; and Susan M. Lindee, *Suffering Made Real: American Science and the Survivors at Hiroshima and Nagasaki* (Chicago: Chicago University Press, 1994).

34. Spencer Weart, *Nuclear Fear: A History of Images* (Cambridge, MA: Harvard University Press, 1988); Allan M. Winkler, *Life under a Cloud: American Anxiety about the Atom* (New York: Oxford University Press, 1993); and Nevil Shute, *On the Beach* (London: Heinemann, 1957).

35. Ralph H. Lutts, "Chemical Fallout: Rachel Carson's *Silent Spring*, Radioactive Fallout and the Environmental Movement," *Environmental Review*, Vol. 9, No. 3 (Autumn 1985), pp. 210–225.

Another shared feature of the fallout debate as it took shape around the world was the central role played by scientists on both sides of the argument about its dangers. Dissenting scientists who were concerned about fallout and opposed to testing found that their ability to force a debate, the roles they fashioned for themselves in so doing, and their relationship to both government and the wider public were powerfully shaped by the specific national context in which they lived and worked.

Bravo in Britain

Bravo came as Winston Churchill and his government were grappling with the question of the British hydrogen bomb.[36] The decision to follow the United States and USSR along the thermonuclear path, taken by Churchill in July 1954, was disclosed in the UK's Defence White Paper of 1955, which committed Britain to a nuclear defense.[37] Two years later, with the British hydrogen bomb project approaching completion, the Defence White Paper put out by Duncan Sandys emphasized thermonuclear capability and the doctrine of deterrence.[38] Although an amendment to the U.S. Atomic Energy Act in 1954 had relaxed restrictions on U.S. nuclear cooperation, thereby paving the way for the further nuclearization of the North Atlantic Treaty Organization (NATO), it had not led to closer Anglo-American nuclear cooperation.[39] In pursuit of the hydrogen bomb, Britain was once again having to "go it alone" to assure its place "at the top table."[40] If, as Churchill somberly observed, the hydrogen bomb was "laden with doom," it was also financially and strategically attractive.[41] As Britain's military chiefs saw it, the weapon gave "more

36. Brian Cathcart, *Test of Greatness: Britain's Struggle for the Atom Bomb* (London: Murray, 1994). News of Ivy Mike in November 1952, less than a month after Britain had tested its first atomic weapon, stunned Whitehall, where unease replaced the earlier sense of success at becoming a nuclear power.

37. *UK Government Statement on Defence*, Cmd. 9391 (London: HMSO, 1955.)

38. John Baylis, "The Development of Britain's Thermonuclear Capability 1954–1961: Myth or Reality?" *Contemporary Record*, Vol. 8, No. 1 (1994), pp. 159–174; and Katherine Pyne, "Art or Article? The Need for and Nature of the British Hydrogen Bomb, 1954–1958," *Contemporary Record*, Vol. 9, No. 3 (1995), pp. 562–585.

39. Jan Melissen, "Nuclearizing NATO: The Anglo-Saxons, Nuclear Sharing and the Fourth Country Problem," *Review of International Studies*, Vol. 20, No. 3 (July 1994), pp. 253–275; and Martin Medhurst, "Atoms for Peace and Nuclear Hegemony: The Rhetorical Structure of a Cold War Campaign," *Armed Forces and Society*, Vol. 23, No. 4 (1997), pp. 571–593.

40. Arnold, *H-Bomb*.

41. House of Commons Debate, Hansard, Vol. 537, 1 March 1955; cited in Arnold, *H-Bomb*, p. 113.

bang for the buck." A small number of thermonuclear bombs would serve as a powerful deterrent. As successive Conservative governments under Churchill, Anthony Eden, and then Harold Macmillan organized defense policy around the principle of deterrence, they saw the fallout issue as a problem to be managed. From 1954 to 1957, Britain built its hydrogen bomb.

British nuclear policy had been determined in secret throughout, with decision-making concentrated in the hands of a small number of senior politicians, sometimes in consultation with handpicked scientists.[42] Successive governments maintained strict secrecy around the making and execution of nuclear policy. Cursory information was given in official documents, but otherwise the British public knew little about the country's nuclear weapons program. Recognizing that fallout constituted a major challenge to this culture of secrecy, and concerned to protect its thermonuclear project, the government responded by downplaying the dangers of fallout, at least in public. Management of the issue took different forms. Recent work by Peter Goodwin, for example, has shed new light on moves by the government to influence coverage at the British Broadcasting Corporation (BBC), and Adrian Bingham has shown how some journalists and editors within the popular press worked to overcome the culture of caution prevailing in Fleet Street regarding nuclear weapons.[43] The government and its supporters relied on a variety of tactics to suppress dissenting views, sometimes formally at other times informally.[44] Scientists who publicly challenged the government position on fallout and testing, especially Rotblat, were at risk of experiencing a backlash. However, Bravo had been an unprecedented and highly publicized drama, one that framed fallout as an international problem and concern—creating difficulties for the British government as it subsequently sought to control what the public knew about this new nuclear danger.

Bravo was covered by the press around the world, including in Britain, as was the Japanese reaction and growing anger about radioactive fallout in the Pacific.[45] The major British newspapers generally reported on Bravo briefly and matter-of-factly, usually through the prism of U.S. responses and

42. Peter Hennessy, *The Secret State: Whitehall and the Cold War* (London: Penguin, 2003).

43. Adrian Bingham, "The Monster? The British Popular Press and Nuclear Culture, 1945–Early 1960s," *BJHS*, Vol. 45, No. 4 (2012), pp. 609–624; and Peter Goodwin, "Low Conspiracy? Government Interference in the BBC," *Westminster Papers in Communication and Culture*, Vol. 2, No. 1 (2003), pp. 96–118.

44. Nicholas Wilkinson, *Secrecy and the Media: The Official History of Britain's D-Notice System* (London: Routledge, 2009).

45. On the H-bomb in the popular press, see Bingham, "Monster."

newspaper reports, although the "astonishment" of U.S. experts at the size of the explosion was noted.[46] In April 1954 the BBC aired a *Panorama* television program featuring Russell and Rotblat discussing Bravo and technical aspects of radiation. Although BBC radio broadcast Russell's *Man's Peril* in December 1954, the government by this time was already moving to restrict media coverage of nuclear weapons and their effects.[47] Churchill sought to prevent the BBC from making and airing further programs about the hydrogen bomb, and he hinted that the government might consider banning such programs by ministerial order.[48] Public fears about fallout could cause problems for a government now wholly committed to a policy of thermonuclear defense and the principle of deterrence. In addition to raising questions about the safety of weapons testing in peacetime, fallout drew attention to the radiological dimensions of nuclear war. Although nuclear war and peacetime weapons testing posed very different radiological scenarios, officials were concerned that the distinction might be lost and blur into a generalized public fear of radiation, sparking opposition to nuclear weapons per se.[49] The government sought, therefore, to conceal the unpalatable realities of both. The aim was to shield the nuclear weapons program from scrutiny and the testing program from criticism. A further aim was to preserve existing commitments to the "peaceful atom," most obviously its development of nuclear energy, which, as announced on 15 February 1955, was to be vastly expanded through the addition of ten new reactors at a cost of £300 million.

Members of the Cabinet and senior civil servants in Whitehall had been made fully aware of the implications of a thermonuclear attack on Britain, including its radiological dimensions, in briefings from senior scientists including William Penney and John Cockcroft. As Sean Malloy has shown they, along with other nuclear "insiders" within government on both sides of the Atlantic had, since the Manhattan Project, been aware of the radiological dangers inherent in nuclear weapons.[50] Late in 1954, one such briefing prompted the government to commission a review of the implications for

46. For example, *TMG*, 26 March 1954; and *The Times* (London), 26 March 1954, p. 7.

47. See Goodwin, "Low."

48. Jeff Hughes, "The Strath Report: Britain Confronts the H-Bomb, 1954–1955," *History and Technology*, Vol. 19, No. 3 (2003), pp. 257–275.

49. The term "radiophobia" was coined by the Soviet government in the aftermath of the Chernobyl accident in 1986 to describe the generalized phenomenon of radiological fears. See Erikson, "Lingering," p. 36.

50. Sean Malloy, "'A Very Pleasant Way to Die': Radiation Effects and the Decision to Use the Bomb against Japan," *Diplomatic History*, Vol. 36, No. 3 (June 2012), pp. 518–545.

Britain of the changed scale of the thermonuclear threat.[51] Overseen by career civil servant William Strath, this committee completed its work in March 1955. Its report painted a grim picture of post-apocalyptic Britain, especially the devastation wrought by radiation.[52] The Strath Committee was, via Cockcroft, privy to U.S. data relating to thermonuclear weapons and gathered, for example, under the aegis of Project Gabriel (ongoing since 1949) and by the AEC as it undertook its report into Bravo.[53] This sharing of sensitive radiological information about nuclear weapons points to the existence and value of transatlantic networks among senior nuclear scientists: It also points to cooperation on some aspects of thermonuclear weapons at the highest levels within government.[54] (Cooperation also took place when, beginning in 1955, Britain and the United States—under the auspices of the UK Medical Research Council [MRC] and the U.S. National Academy of Sciences [NAS] respectively—undertook studies of the radiological aspects of nuclear weapons. As Jacob Hamblin has shown, Cockcroft and Harold Himsworth, secretary of the MRC, discussed and coordinated these studies with senior scientists at the AEC, including biologist Detlev Bronk.)[55] The shocking message of Strath—that there could be "no defense" against the hydrogen bomb—caused consternation among those charged with the country's defense. Considered too disturbing for the public, the findings were kept secret, a decision indicative of the importance the government placed on controlling what the British public knew about thermonuclear warfare, including its radiological aspects. To this end, as Hughes has noted, debate about civil defense was suppressed "both to promote the credibility of the nuclear deterrent and to maintain the social and political order."[56] As Matthew Grant and Melissa Smith have shown, civil defense presented particular dilemmas for a government concerned, on the one hand, not to alarm the public about the devastation that would be wrought by the hydrogen bomb, including its radiological

51. The Strath Committee was convened by Cabinet Secretary Sir Norman Brook following a Cabinet briefing in which Penney outlined the effects on Britain of thermonuclear war. Hughes, "Strath."

52. "The Defence Implications of Fall-Out from a Hydrogen Bomb: Report by a Group of Officials," 8 March 1955. See Hughes, "Strath," esp. pp. 262–264. (The "Strath Report" remained secret until c.2000.)

53. Arnold, *H-Bomb*, p. 112. See also Jacob D. Hamblin, '"A Dispassionate and Objective Effort': Negotiating the First Study of the Biological Effects of Atomic Radiation," *JHB*, Vol. 40, No. 1 (March 2007), pp. 147–177.

54. Arnold, *H-Bomb*, p. 112; and Hughes, "Strath," p. 263.

55. Hamblin, "Dispassionate."

56. Hughes, "Strath," esp. p. 258.

effects, while on the other hand preparing the public for nuclear war.[57] As the Cabinet grappled in private with the Strath Committee's portrayal of a Britain reduced to a radioactive wasteland, it sought to downplay the dangers of fallout to an anxious public. However, controlling what the public knew about fallout soon became much more difficult.

Beyond Bravo: The Fallout Issue Takes Shape

Presented to the Cabinet on 8 March 1955, the Strath Committee's report arrived at a turbulent time in British nuclear policy. February had seen the Defence White Paper and the announced expansion of the country's nuclear energy program. (By this time, construction of the Calder Hall reactor was already well under way on the Cumbrian coast.) February and March 1955 also saw developments that proved decisive for the reemergence of fallout as a hotly contested political issue and a subject of resurgent public concern. Decisive in this regard was the publication on 15 February 1955 by the AEC of its report into the radiological effects of nuclear weapons generally, an investigation prompted by Bravo. All of these developments took place in a context in which emphasis—and a great deal of publicity—was being placed on Atoms for Peace. This followed from Eisenhower's commitment to the "peaceful atom," first announced at the UN in December 1953, and in anticipation of the first international Atoms for Peace Conference, scheduled for Geneva in May, which would showcase the "flagship" peaceful nuclear technologies: civic energy and the medical isotope.[58] Remaining silent about nuclear weapons, the British government showcased its development of the peaceful atom. In particular, from the mid-1950s on, Britain's energy and radioisotope programs were widely covered in the press, and senior figures, notably Cockcroft, portrayed bright visions of the atomic future.[59]

57. Grant, *After the Bomb*; and Melissa Smith, "Architects of Armageddon: The Home Office Scientific Advisers' Branch and Civil Defence in Britain, 1945–1948," *BJHS*, Vol. 43, No. 2 (June 2010), pp. 149–180. See also contributions in Matthew Grant, ed., *The British Way in Cold Warfare: Intelligence, Diplomacy and the Bomb, 1945–1975* (London: Continuum, 2009).

58. On Atoms for Peace, see John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence," *Osiris*, Vol. 21 (2006), pp. 161–181; Ira Chernus, *Eisenhower's Atoms for Peace* (College Station: Texas A&M University Press, 2002); and Medhurst, "Hegemony." On the medical isotope, see Alison Kraft, "Between Medicine and Industry: Medical Physics and the Rise of the Radioisotope, 1945–1965," *Contemporary British History*, Vol. 20, No. 1 (2006), pp. 3–37.

59. John Cockcroft, "The Future of Atomic Energy," *BAS*, Vol. 10 (1955), pp. 285–290; and John Cockcroft, "Britain Plugs into the Atom," *John Bull* (London), 20 February 1956, pp. 16–17, in

In late February 1955 the government's Defence White Paper publicly confirmed its decision to undertake development of the hydrogen bomb.[60] Courtesy of Strath, the Cabinet was aware of both the fallout problem and the radiological dimensions of thermonuclear war as it made and formalized the decision to embark on the development of the hydrogen bomb. The UK's commitment to deterrence and its need to secure a place at the "top table" rendered possession of this weapon imperative. Those considerations underlay Parliament's discussion of the Defence White Paper in early March.[61] At this point, although some left-leaning members of Parliament (MPs)—Frank Allaun, Fenner Brockway, Philip Noel-Baker, Edith Summerskill—registered their opposition to thermonuclear development by Britain, the party executive endorsed the policy set out in the White Paper. For their part, the Trades Unions registered concern and called on the government to cease nuclear testing and work toward disarmament.[62] Jones has described the general position of the Labour Party and Trades Unions as one of "simply 'holding the line' against an increasing volume of protest against nuclear weapons."[63] Later, amid intensifying concerns about fallout, the Labour left would call for a policy of unilateral disarmament—calls that came to nothing but did spur the formation of "splinter" protest groups, such as the Committee for the Abolition of Nuclear Weapons and the Hydrogen Bomb Campaign Committee.[64] The former, through its Golders Green and Hampstead branches, became in November 1956 the National Council for the Abolition of Nuclear Weapons Tests (NCANWT), which subsequently merged with the Campaign for Nuclear Disarmament (CND), becoming the Labour Advisory Committee.[65] Meanwhile, outside the political mainstream, pacifist groups such as the Fellowship of Reconciliation and the Women's International League for Peace and Freedom actively condemned the bomb and testing, as did the Quakers and the National Peace Council.[66]

Churchill Archives, University of Cambridge (CAUoC), Sir John Cockcroft collection, CKFT, File 18/29. Cockcroft's support of the energy and medical applications of atomic energy led to the IAEA awarding him the Atoms for Peace Prize in 1961.

60. The Defence White Paper also almost tripled the civil defense budget to more than £70 million.

61. Wittner, *Resisting*, pp. 14–17.

62. In May 1954 the Allied Engineering Union criticized the government and called on it to stop the tests.

63. Jones, "Mushroom," p. 21.

64. Taylor, *Against*, pp. 5–18; and Len Scott, "Labour and the Bomb: The First Eighty Years," *International Affairs*, Vol. 82, No. 4 (July 2006), pp. 685–700.

65. Taylor, *Against*, esp. pp. 275–314; and Wittner, *Resisting*, pp. 14–17, 185–196.

66. Taylor, *Against*, pp. 5–18.

When the AEC report into Bravo was finally published on 15 February 1955, it downplayed the dangers of fallout and emphasized the safety of testing. Initially, the reception in the British media was low key.[67] The broadsheets focused on the main claims of the report, with little additional comment or analysis.[68] However, the AEC report came to be a turning point in the fallout issue, reshaping the contours of nuclear politics within and beyond Britain. That it did so was because of the response of some scientists who were incensed by the report's content and tone. In the United States, where *Newsweek* described the document as the "terrible truth," the FAS in early March called for the UN to coordinate a test moratorium, and Linus Pauling set about organizing a petition among scientists to the same effect.[69] In Britain, the government remained silent about the AEC document, but the report's quiet debut was dramatically transformed on 23 March when Rotblat took the unprecedented step of openly challenging the AEC's findings in an article that was also sharply critical of what he saw as the report's "misleading" portrayal of the dangers of fallout as "insignificant."[70]

The British government was determined not to allow the fallout problem to derail its thermonuclear plans or its nuclear energy program. Quite how far British officials went in seeking to exercise control over the BBC and press coverage of nuclear weapons remains a subject of debate among historians. Peter Goodwin has shown, however, that beginning in late 1954 the government sought to exert closer control over BBC coverage of all aspects of thermonuclear weapons and especially its "effects."[71] These "effects" included above all "fallout"—a term then gaining currency to describe the radioactive particles generated by nuclear explosions. (The BBC's preference not to use

67. Publication of the report had been delayed by wrangling between the U.S. Senate, the Department of State, and the AEC over concerns about its potential impact on the public, an especially sensitive issue within the United States amid controversy surrounding nuclear weapons tests at the Nevada Proving Grounds.

68. It was, for example, reproduced in full in *TMG*, 1 March 1955, p. 8. The absence of comparable radiological information from the British government was noted.

69. Divine, *Blowing*, p. 39. The FAS statement, made on 7 March 1955, was reported in the U.S. and British press. See, for example, *TMG*, 8 March 1955, p. 7.

70. Joseph Rotblat, "The Hydrogen-Uranium Bomb," *BAS*, Vol. 6, No. 5 (1955), pp. 171–177. This was reported in the British broadsheets—for example, *TMG*, 24 March 1955, p. 3—and in the United States by *The New York Times*, 24 March 1955, p. 3; and *The Washington Post and Times-Herald*, 24 March 1955, p. 8. Rotblat's paper was published first in the *(British) Atomic Scientists' Journal* in March 1955.

71. Goodwin, "Low."

the term in its coverage is perhaps a reflection of the sinister connotations already engendered by it.)[72]

Particularly significant was a high-level meeting on 15 February 1955 among senior Whitehall figures and government ministers, including Macmillan, Norman Brook, and Ian Jacob and Sir Alexander Cadogan of the BBC (director general and chair of the Board of Governors respectively) during which the corporation agreed to restrict coverage of the hydrogen bomb and its effects.[73] The BBC also agreed to consult, informally, the government about the making and airing of reports and programs in these policy areas. This amounted to a subtle but effective means of controlling what the British public knew about these issues. At the same time, it provided the government with the means for suppressing unpalatable views. The fact that the meeting took place on the same day the AEC report into Bravo was published seems a remarkable coincidence: Whether the British government's intervention at the BBC was indeed made in anticipation of the AEC report is unclear. As Goodwin has shown, the BBC seems from February 1955 to have accepted closer censorship of its coverage of the hydrogen bomb and nuclear effects. For the remainder of that year, BBC coverage was minimal and uncritical and did not feature fallout.[74]

In the mainstream British press, coverage of the hydrogen bomb was typically muted, taking the form of short pieces limited to summaries of technical aspects with no wider analysis or comment. Likewise, the popular press was similarly cautious in its coverage and treatment of nuclear policy, although in a recent study of the *Daily Mirror* and *Daily Express*, Adrian Bingham argues that some editors, columnists, and science journalists were more critical than hitherto portrayed.[75] The generally low-key approach in the British media did not change in the wake of the government's thermonuclear decision. Neither the BBC nor the mainstream British press voiced outright criticism of the government over nuclear weapons policy generally, and this posture was extended to the government's stance on fallout and weapons tests. The

72. Earlier terms such as radioactive "(death) dust," "ash," and "debris," gave way to fallout (initially, "Fall-Out"). This was a convenient umbrella term encompassing the many different radioactive isotopes created during the fission reaction. Fallout also described the geographical spread of radioactive contamination, from "local" effects (in the vicinity of the test site) to deposition around the world. Its technical definition was a subject of discussion amongst scientists in this period. See, for example, Joseph Rotblat to the Editor of *New Scientist*, 16 April 1957, in CAUoC, Sir Joseph Rotblat (RTBT) collection, File K123.

73. Goodwin, "Low," pp. 104–107.

74. Ibid., p. 109.

75. Bingham, "Monster?"

official position adopted by the Anglican Church was also to avoid criticizing the government and to shy away from becoming embroiled in discussions about nuclear policy. Senior clerics maintained that the hydrogen bomb was a political rather than moral issue. In the thermonuclear era, the church continued to adhere to this approach, summarized by Kirk Willis as one in which "Britain's leading churchmen preferred caution and acquiescence over boldness and challenge."[76] Dissenting views on the hydrogen bomb, such as those of the dean of Canterbury, the bishops of Exeter and Chichester, and senior figures within the Methodist Church (notably, Donald Soper), were, as Dianne Kirby has argued, suppressed both from within and by a press reluctant to report their views.[77] The British government was accustomed to formulating and executing its nuclear policies largely untroubled by critical interventions from the media and the church, or the wider public. Moreover, the British nuclear program had always been highly secret—the fallout issue raised the prospect of greater public engagement with and scrutiny of nuclear policy and the decisions of government in this sphere. In 1954, anticipating powerful reactions to the hydrogen bomb and to the problem of fallout, the government moved to put in place the means, via informal mechanisms in the case of the media, to control what the public knew about fallout.

The desire of Rotblat and like-minded scientists to inform the British public about the potential dangers of fallout was anathema to British policymakers, for whom the control of public information was "absolutely central to [their] thinking about the hydrogen bomb."[78] As Hughes has noted, the "last thing" the government wanted was a "consistent policy of education"—exactly what Rotblat, for one, had in mind. To this end, a small group of scientists suspicious of the official AEC narrative about fallout began openly challenging the British government's position (which echoed that of the AEC), its weapons testing policy, and the secrecy surrounding its nuclear weapons policy generally.

BBC policy and a press cautious in its coverage of nuclear weapons made it difficult for those dissenting from the government position on fallout and testing to bring their views to the British public. In the absence of effective political opposition to government nuclear weapons policy and with the church voicing little concern, scientists came to occupy the vanguard of opposition

76. Kirk Willis, "God and the Atom: British Churchmen and the Challenge of Nuclear Power, 1945–1950," *Albion*, Vol. 29, No. 3 (Autumn 1997), pp. 422–457.

77. Dianne Kirby, "The Church of England and the Cold War Nuclear Debate," *Twentieth Century British History*, Vol. 4, No. 3 (1993), pp. 250–283; and Willis, "God."

78. Hughes, "Strath," p. 272.

to the government on fallout and testing. Yet scientists were divided on the question of the hydrogen bomb and took different positions on the dangers of fallout. Those looking to the British Atomic Scientists Association (ASA) as a means to engage critically with the country's nuclear weapons policy had since the late 1940s been disappointed.[79] As Greta Jones has demonstrated, political differences among the nuclear scientists consistently undermined collective action.[80] In the early 1950s, scientists opposed to nuclear weapons lacked a coherent, effective organization through which to express their concerns or mount protest.[81] Amid the hardening hostilities of the Cold War, they had become onlookers to an accelerating arms race.[82]

The fallout/testing issue exposed and amplified long-standing divisions among scientists about nuclear weapons. The personal decisions taken by scientists after the war about whether to become involved in work associated with the military applications of nuclear energy meant that the postwar generation of physicists moved and lived in different worlds. For scientists, the distinction between the military and peaceful atom had been apparent in 1945, and its implications would be strongly felt in the thermonuclear age. Those involved in the country's nuclear weapons project were welcomed within senior government circles and rose to national prominence. Members of this influential nuclear elite—for example, Cockcroft, Christopher Hinton, and Penney—were privy to government thinking on nuclear policy and were well placed to shape key decisions.[83] These men typified a new breed of scientist-entrepreneur whose roles placed them at the heart of what Ronald Doel has called "science in black," or the history of the "large, unexplored continent of interconnections, maintained in secrecy, between scientists and public officials mutually interested in adopting science to serve (U.S.) interests and the national security state."[84] This dynamic was similarly at work in Britain, where Cockcroft and a small coterie of "nuclear insiders" spearheaded and guided the British nuclear enterprise. After a distinguished career at the Cavendish Laboratory (for which in 1951 he was awarded the Nobel Prize) and wartime work

79. Jones, "Lysenko"; Jones, "Mushroom"; and Laucht, *Elemental*.

80. Jones, "Lysenko"; Jones, "Mushroom"; and Laucht, *Elemental*.

81. That said, in its creation of the *Bulletin of the Atomic Scientists*, the U.S. movement left a legacy that provided a vital forum in which scientists from around the world could discuss nuclear matters.

82. Jones, "Lysenko"; Jones, "Mushroom"; and Laucht, *Elemental*.

83. Cockcroft, Hinton, and Penney were all knighted—they were sometimes dubbed the "atomic knights."

84. Ronald Doel, "Scientists as Policy Makers, Advisors and Intelligence Agents: Linking Contemporary Diplomatic History with the History of Contemporary Science," in Thomas Soderqvist, ed., *Historiography of Contemporary Science and Technology* (Amsterdam: Harwood Academic, 1997), p. 216.

leading the Anglo-Canadian reactor project at Chalk River, Montreal, Cockcroft was appointed director of the Atomic Energy Research Establishment (AERE), Harwell, when it was set up by the Clement Attlee government in 1946.[85] A respected member of the British scientific elite, he increasingly became the public face of the country's nuclear enterprise, especially its research and peaceful dimensions. Meanwhile, scientists such as Rotblat, who rejected nuclear weapons and focused instead on developing the medical applications of nuclear energy, looked on from the periphery of the nuclear nexus. Effectively outsiders, they were privy neither to decisions about the country's burgeoning nuclear enterprise nor, in the post-Bravo setting, to government data on fallout.[86]

The line drawn between the peaceful and military "atom" was, in one sense, artificial and born of political expediency. Scientists such as Rotblat who limited their (nuclear-related) work to "peaceful" applications were able to frame this as an ethical position but could never fully separate themselves from the military uses of nuclear energy.[87] The duality of the reactor—as a source both of energy and medically valuable isotopes and of fissile material for weapons—meant that these very different and, for some, morally distinct applications were inextricable. The huge investment in reactors after the war rested primarily on military considerations. Peaceful uses were largely regarded as a "spin-off." From December 1953 onward, just as the arms race intensified and became thermonuclear, the military/peaceful distinction took on new political import in the wake of Eisenhower's announcement of Atoms

85. For an uncritical treatment of Cockcroft, see Guy Hartcup and T. E. Allibone, *Cockcroft and the Atom* (Bristol, UK: Adam Hilger, 1984).

86. Peter Galison has highlighted the extent in the United States of the practice of classifying nuclear-related data using the categories of confidential/secret/top secret. Rights of access to this kind of material rendered people, institutions, and so forth differently placed in regard to nuclear policy. See Peter Galison, "Removing Knowledge: The Logic of Modern Censorship," in Robert Proctor and Londa Schiebinger, eds., *Agnatology: The Making and Unmaking of Ignorance* (Stanford, CA: Stanford University Press, 2008), pp. 37–54.

87. Although lying beyond the scope of this article, the position of scientists in relation to other radiological hazards is of interest in more fully understanding their relationship(s) to the British government during this period. Of particular interest is British policy regarding the disposal of solid and liquid radioactive waste from research relating to both military and peaceful applications, including, for example, that generated in the production and use of medically valuable isotopes and various kinds of non-weapons-related research undertaken at AERE Harwell. As Jacob Hamblin has shown, Britain relied heavily on the practice of dumping radioactive waste at sea and in the River Thames. Key decision-makers in this policy area included Cockcroft and Marley. The responses of "dissident" scientists in Britain to this radiological hazard have not been adequately explored but may provide an interesting comparison with the positions scientists took on fallout and cast light on the ambiguities underlying the divide between military and peaceful applications. See Jacob D. Hamblin, *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age* (New Brunswick, NJ: Rutgers University Press, 2009).

for Peace. As Ira Chernus, Martin Medhurst, and others have argued, this was fundamentally about winning the hearts and minds of the U.S. public as Eisenhower undertook a vast expansion of the thermonuclear arsenal.[88] The significance of both the entanglement and the distinction(s) drawn between the peaceful and military "atom" in Britain, with regard to government nuclear policy, remains underexplored. Likewise, the tensions engendered by the duality of the reactor for dissenting scientists and its meaning for "nuclear insiders" like Cockcroft, remain poorly understood. How and why this essentially political distinction came about is central to a fuller understanding of the evolving relationship between scientists and the British government as it pursued its Cold War priorities.

Bravo and the fallout/testing issue brought into play the different political and ethical worldviews that in 1945 had led physicists along different paths in the early nuclear age. Those scientists who by the mid-1950s could be considered nuclear insiders, such as Cockcroft, now rallied behind the government because it looked to them to endorse its position on fallout. By contrast, those long opposed to nuclear weapons, like Rotblat, adopted a more critical stance. The fallout/testing debate was marked by a striking asymmetry, of center and periphery, that pitted pro-nuclear government insiders against scientists somewhat removed from Whitehall. This dynamic rested on scientific uncertainty—an uncertainty that sustained the politically charged debate that rendered fallout and testing the most divisive nuclear issues of the mid-1950s and that, to the chagrin of the British government, played out in public.

Russell and Rotblat: "We Cannot Be Silent Bystanders"[89]

Leading the scientists' challenge to the British government's nuclear weapons policy were the philosopher Russell and physicist Rotblat. In the wake of Bravo, Nobel Laureate Russell became deeply alarmed about fallout. In December 1954 he brought his concerns to the British public in a BBC radio program entitled *Man's Peril*, broadcast to an estimated audience of six million.[90] Russell was convinced that scientists, by way of their expertise and a traditionally internationalist outlook, had a key role to play in confronting

88. Chernus, "Eisenhower's"; and Medhurst, "Hegemony."

89. Joseph Rotblat, "A Social Conscience for the Nuclear Age," in Kai Bird and Lawrence Lifschultz, eds., *Hiroshima's Shadow* (Stony Creek, CT: Pamphleteer's Press, 1998), pp. xvii-xxviii, esp. xxiii.

90. This program was broadcast by the BBC on 23 December 1954.

the dangers of nuclear weapons, especially the issues they raised, including the problem of fallout, and in bringing these matters before the public.[91] To this end, he began to think about how best to mobilize and bring together like-minded colleagues from around the world to take a stand against nuclear weapons and to make a meaningful contribution to addressing the issues they raised, including the problem of fallout. This was something that Joliot-Curie, president of the Communist-led World Federation of Scientific Workers (WFSW), had long been urging.[92] Russell's efforts, working with Joliot-Curie and others, culminated in the summer of 1955 in the document that came to be known as the Russell-Einstein Manifesto.

Russell and Rotblat had first met in April 1954 when they appeared on the BBC's *Panorama* program about the Bravo accident. The younger man came to share Russell's concerns, and neither of them was prepared to be a "silent bystander." Polish by birth, Rotblat was notable for having left the Manhattan Project in 1944 upon learning that the nuclear bomb would likely be used against Japan, rather than Germany, and supposedly as a means to intimidate the Soviet Union in the postwar world.[93] On returning to Britain he took up a post at Liverpool University.[94] By the time he met Russell a decade later, Rotblat was professor of medical physics at St. Bartholomew's Hospital in London, having turned away from weapons-related work. This career change reflected his conception of social responsibility, which was grounded in a view of scientists and their work as inseparable from society:

> Scientists cannot live in isolation from other groups that together form the world community; they cannot ignore events that affect this community, particularly those that arise from their work as scientists. The ivory towers in which scientists once pretended to live have been crumbling for many years, and were finally demolished by the pressure and heat waves of the Hiroshima bomb.[95]

For Rotblat, the "world community" was imperiled by fallout. Long opposed to nuclear weapons and deeply concerned about the arms race, he was galvanized into action by the AEC report on Bravo. Rotblat was dismayed by

91. This internationalist outlook was engendered, for example, by practices within science geared to the exchange of ideas and data between researchers, by the drive to publish work to be read and assessed by peers around the world, and by disciplinary networks that transcended national boundaries.

92. On the importance of Joliot-Curie's role, see Wittner, *Resisting*, p. 5.

93. *The Strangest Dream* (Canadian Broadcasting Company, 2007); and Martin Underwood, "Joseph Rotblat and the Moral Responsibilities of the Scientist," *Science, Engineering and Ethics*, Vol. 15 (2009), pp. 129–134.

94. Andrew Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford, UK: Oxford University Press, 2012).

95. Rotblat, "Social Conscience," p. xvii.

the AEC's confident assertion that fallout from the hydrogen bomb was negligible and did not pose a danger to human health. For him, the AEC was claiming certainty where there was none. In the absence of publicly available data on the hydrogen bomb and fallout, he set about his own analysis of the accident using radiological data provided by Japanese biophysicist Yashushi Nishiwaki.[96] His findings differed from those of the AEC, indicating instead that fallout from thermonuclear weapons (involving a fission-fusion-fission mechanism) posed a potentially serious radiological danger to human health, especially in terms of genetic damage. He emphasized the cumulative effects of low-level radiation exposure, which in his view rendered an end to weapons tests imperative. His report was also a protest against the manipulation and suppression of radiological data by the nuclear powers. He described the presentation of data by the AEC as "misleading" and called for the publication of radiological data from nuclear tests. A decade after leaving the Manhattan Project on ethical grounds, that same ethical code positioned Rotblat in the vanguard of opposition to weapons testing. Heavily influenced by Einstein's "village square" metaphor, he considered it essential to bring nuclear matters before the public. Animated and emboldened by a strong sense of social responsibility, Rotblat saw it as a civic duty to inform the public of a potentially serious health risk to which they, and their children, were being exposed.

Rotblat's findings were published in a short, highly technical report that appeared in March 1955 in the *Atomic Scientists' Journal* and two months later in the *BAS*.[97] This was Rotblat's first major public intervention. Bold and provocative, it constituted an open and direct challenge to the AEC. Although these specialist publications offered a limited readership, his Bravo study was picked up by some mainstream newspapers, where it was reported in a characteristically guarded manner. For example, *The Manchester Guardian* published it under the headline "Genetic damage from H-bomb experiments: Scientist demands publication of data," without further comment or analysis.[98] Coverage of Rotblat's article was similar in the United States, although the U.S. press highlighted his criticisms of the AEC.[99] As an expert in radiation biology, he could not readily be dismissed. Framing his argument in a carefully

96. See Yashushi Nishiwaki, "Bikini Ash," *(British) Atomic Scientists Journal*, Vol. 4 (November 1954), p. 97; Maika Nakao, Takeshi Kurihara, and Masakatzu Yamazaki, "Yashushi Nishiwaki, Radiation Biophysics and Peril and Hope in the Nuclear Age," *Historia Scientiarum*, Vol. 25, No. 1 (2015), pp. 8–35; and Brown, *Keeper*, pp. 95–119.

97. Rotblat, "Hydrogen-Uranium."

98. *TMG*, 24 March 1955, p. 3.

99. See, for example, the coverage in *The New York Times*, 24 March 1955, p. 3; and *The Washington Post and Times-Herald*, 24 March 1955, p. 8.

reasoned style, he emphasized the danger of "genetic trouble" from the cumulative effects of increasing numbers of weapons tests and made explicit the possibility that fallout threatened the health of both present and future generations. As he argued, "we are sailing much closer to the wind than many of us thought," and "until we know better we must accept the most pessimistic estimate. There is too much at stake to risk any other approach."[100] For Rotblat, the responsible course of action was to err on the side of caution and stop weapons testing.

For a government wholly unaccustomed to public scrutiny of its nuclear weapons policies, Rotblat's intervention was deeply unwelcome. He was lambasted in the House of Lords, especially by Churchill's scientific adviser, Lord Cherwell.[101] The vehemence of the attack perhaps reflected the transformation set in train by Rotblat. He made a decisive contribution to a shift that saw fallout and weapons testing become a major political issue in his adopted country and, crucially, contributed to growing public awareness of and unease about both. His report brought the hitherto remote practice of bomb tests much more centrally into the everyday lives of people, recasting the tests—via fallout—as a sinister threat not only to people's own health but to the health of their children. Moreover, his intervention had come just as the government had undertaken to expand the country's nuclear energy program and after the latest Defence White Paper had committed Britain to a nuclear defense.

By contrast, Rotblat's study was welcomed by Russell and like-minded scientists. The wider import of Rotblat's actions lay in raising—in public—fundamental questions about the veracity of the government position, with implications for public trust and confidence in, and potentially support for, its decisions on nuclear weapons and other Cold War priorities. Moreover, in questioning the word of the AEC, he had gone some way toward undermining public trust in the official bodies responsible for radiation safety. Rotblat's overt criticism of the AEC was undoubtedly an embarrassing complication at a sensitive moment in Anglo-American relations. For the AEC, which was under fire in the United States for fallout-related incidents involving radioactive contamination of towns and livestock "downwind" of its Nevada Proving Grounds, operational since 1951, Rotblat's intervention was especially discomfiting.[102]

100. Rotblat, "Hydrogen-Uranium," p. 172.

101. Cherwell, or Frederick Lindemann, was a controversial figure in Whitehall because some considered him to be both arrogant and inordinately influential over the prime minister.

102. Stephen Hilgartner, Richard Bell, and Rory O'Connor, *Nukespeak: The Selling of Nuclear Technology in America* (London: Penguin, 1982); Paul Boyer, *Fallout: A Historian Reflects on America's*

Rotblat had spoken out alone on fallout in what was a pragmatic response to the impossibility of working through the ASA on this matter and also reflected what he saw as the urgent need to get his message to the public quickly. Strategically, his paper provided a rare means of reaching the public. Although initially published in specialist journals, it was picked up and reported on by the mainstream press, ensuring that his message about fallout and testing reached a wider "lay" audience. Rotblat thus was at the forefront of a resurgent wave of anti-nuclear sentiment among concerned scientists. For him there was no turning back. Like scientists before him who had strayed uninvited into nuclear politics (e.g., P. M. S. Blackett), Rotblat was criticized by some colleagues—for example, W. G. (Greg) Marley and Penney—and became a figure of suspicion within Whitehall.[103] Discussions between the BBC and senior Whitehall figures in the summer of 1955 afford insights into the way Rotblat was viewed at the highest levels within government. Whitehall, which reportedly considered Rotblat "rather wild," warned the BBC against including him in a further *Panorama* program. Instead, the BBC was encouraged to consult someone who enjoyed the "full confidence" of government.[104] Although perhaps not privy to the details, Rotblat was undoubtedly aware of the negative view of him in Whitehall and its repercussions. Although at ease with the label "dissident," he was later candid about having failed to grasp that "in defying the government (he) had considerably narrowed the possibilities of my influencing public opinion again." He later recalled his Bravo report as an act of "whistle-blowing" born of a sense of "public duty."[105] Having "blotted (his) copybook with the Establishment," he was subsequently watched, criticized, and censured by members of that establishment.

Meanwhile, in spring 1955, Russell was focusing his efforts on bringing scientists from around the world together to make a collective statement against nuclear weapons. A staunch opponent of Communism, Russell

Half-Century Encounter with Nuclear Weapons (Columbus: Ohio State University Press, 1998); and Caufield, C*hronicles*.

103. In the mid-1950s, dissent from scientists *within* government regarding its defense and weapons policies was seemingly absent. Criticism of nuclear weapons policy from within government came about only later, in the 1960s, when Solly Zuckerman became the chief scientific adviser to the Ministry of Defence. This unusual situation was made possible in part by the protection afforded to Zuckerman by his friendship with Lord Mountbatten (the "Zuckbatten axis"). See Richard Maquire, "Scientists Dissent amid the British Government's Nuclear Weapons Program," *History Workshop Journal*, Vol. 63, No. 1 (Spring 2007), pp. 113–135. On Blackett, see Mary-Jo Nye, "A Physicist in the Corridors of Power: P. M. S. Blackett's Opposition to Atomic Weapons Following the War," *Physics in Perspective*, Vol. 1, No. 2 (June 1999), pp. 136–146.

104. Goodwin, "Low," p. 107.

105. Rotblat, "Social Conscience," p. xxv.

focused his efforts on mobilizing scientists, whom he felt to be uniquely and powerfully placed to steer the world away from the nuclear abyss. His efforts first bore fruit in the so-called Russell-Einstein Manifesto, a statement calling for the cessation of tests and an end to the arms race endorsed by an international cohort of leading scientists, including Einstein, Joliot-Curie, Rotblat, and Pauling. The manifesto warned of the "universal peril" of the hydrogen bomb and painted a bleak picture of a world at risk of radiological poisoning. This danger would be inescapably a part of the nuclear apocalypse but, via the "deadly dust" of fallout from tests, was a peacetime problem. The manifesto urged political leaders to develop a new dialogue between East and West and called for "a new way of thinking"—long advocated by Einstein—expressed in its message to "remember your humanity and forget the rest."[106]

In parallel with international initiatives, Rotblat, Russell, and others continued to exert pressure on the British government and bring their views before the public. This was difficult given the influence of government over the media. Instances of official censorship engendered a wider reluctance on the part of newspapers and the BBC to voice criticism of nuclear policy. One approach included public lectures organized, for example, under the auspices of cooperative societies or extramural departments of universities.[107] The extent to which these initiatives were successful is difficult to gauge; however. The letters pages of newspapers and the content of MPs' mailbags evidenced growing opposition within some sections of the British public toward the hydrogen bomb and weapons tests. The writers of these letters objected both to the use of the hydrogen bomb as a weapon of war and to peacetime testing of the weapon because of the dangers fallout posed to human health, both in the present and in the future. The concern expressed by a mother writing to *The Manchester Guardian* in March 1957 that "no longer can we read the scientists' warnings and turn away" suggests that the message of dissenting scientists such as Rotblat reached at least some members of the public and galvanized them into action.[108] Fallout started to be mentioned regularly in parliamentary debates, often prompted by questions from left-leaning Labour

106. Rotblat, "Social Conscience," p. xxv. A week later, scientists from the German-speaking world expressed similar views in the Mainau declaration.

107. For example, Cecil F. Powell, "The Hydrogen Bomb and the Future of Mankind," Central Hall, Westminster, 26 February 1955. Conference organized by the Education Committee of the London Cooperative Society and the Association of Scientific Workers. Lancashire Record Office, File: DOX 1274/17/13; and Joseph Rotblat, "Radiation in the Atomic Age" (lecture), 1957, in University of Nottingham, Special Collections and Manuscripts, Robert Peers Collection.

108. *TMG*, 28 March 1957, p. 8.

and Liberal MPs.[109] An especially lively exchange in the spring of 1955 in the wake of the AEC report and the furor occasioned by Rotblat's intervention induced the prime minister to ask the MRC to undertake a review of the dangers that ionizing radiation posed to health.[110]

After Rotblat's intervention, the fallout/testing controversy gathered momentum in Britain. The report Churchill had commissioned from the MRC in late March 1955 was published in June 1956 under the title *The Hazards to Man of Nuclear and Allied Radiations*. The document set out the government's position on the radiological dangers of nuclear energy, including fallout.[111] Then in April 1957, a small group of scientists led by Rotblat issued their own, very different report dissenting from the government's publication. The "Radiostrontium Statement" challenged the MRC report and emphasized the dangers radiostrontium-90 posed to human health—it was, for example, suspected to trigger leukemia and bone sarcoma.[112] These reports provide a window onto the dynamics and characteristics of the fallout issue as it unfolded in Britain. They also establish a context in which to situate intensifying antinuclear sentiment in Britain across the summer and autumn of 1957 amid preparations for the country's inaugural hydrogen bomb test. The Macmillan government faced mounting international pressure to cancel the test and turn away from becoming a thermonuclear power.

The MRC Report, June 1956: The Government Position on Fallout—and Testing

Several factors appear to have prompted the commissioning of the MRC report, including concerns about fallout from weapons tests—concerns now being expressed in Parliament and by the public. Commissioning a review of the hazards of ionizing radiation also offered strategic advantages, allowing the government to be seen as taking control of the fallout problem and giving assurances that it was aware of and was taking measures to safeguard against the radiological dangers of nuclear energy. The report also worked to create

109. Among the members of Parliament who tabled the question on radiostrontium/fallout were Frank Allaun and Barbara Castle from the Labour Party and Liberal MP Joe Grimond.

110. House of Commons Debate, *Hansard*, Vol. 539, Column 197, 29 March 1955. This debate was opened by Dr. Edith Summerskill (Labour). See also Soraya de Chadarevian, "Mice and the Reactor: The 'Genetics Experiment' in 1950s Britain," *JHB*, Vol. 39, No. 4 (Winter 2006), pp. 707–735.

111. *The Hazards to Man of Nuclear and Allied Radiations*, Medical Research Council, Cmd. 9780 (London: HMSO, 12 June 1956).

112. "The Radiostrontium Hazard," *BAS*, Vol. 13, No. 6 (1957), pp. 202–203.

the appearance of openness on the part of a government that otherwise conducted nuclear policy in secret. The committee responsible for conducting the investigation comprised senior figures from within Britain's nuclear establishment (e.g., Cockcroft and John F. Loutit) and leading members of the medical establishment.[113] The conservative composition of the various panels into which the work of the committee was organized rendered an outcome unpalatable to the government unlikely. The findings on fallout—that it presented a "negligible hazard" and that, "at present," weapons tests gave "no cause for alarm"—sought to draw a line, decisively and authoritatively, under this particular radiation issue and justify the continuation of weapons testing.

The MRC report was a carefully crafted manifesto for nuclear energy. The authors acknowledged uncertainties about the dangers of radiation but emphasized the need for ongoing research. The report's agenda was made clear in its opening assertion that it was "already apparent that the future development of our civilization is closely bound up with the exploitation of nuclear energy." This was the framework within which the radiation hazard was considered. The document noted "widespread public concern about the long-term effects of nuclear weapons testing," but it portrayed fallout and testing as just one part of the broader picture of exciting new technology-driven industries. The principal message was one of reassurance about these dangers. The country's leading scientists and medical specialists decreed that radiation was a manageable problem and should not complicate or impede Britain's nuclear future. The report acknowledged the particular problem posed by strontium-90 (Sr-90), but it struck a reassuring tone by emphasizing the uncertainty surrounding this isotope and stressing that research into it was already under way.

The new nuclear industries encompassed military and non-military applications of nuclear energy, both of which were portrayed as vital to the national interest. These were two sides of the same coin, both of which were crucial to Britain's competitiveness in the changed world order of the Cold War. "Peaceful" nuclear technologies provided a means to offset the negativity surrounding nuclear energy because of its association with the nuclear bomb. Nuclear energy promised an independent fuel supply. In October 1956, Calder Hall, the country's first nuclear power station, became operational, feeding into the national grid. This was celebrated as a national achievement and widely publicized in the press. Less well publicized was Calder Hall's key role in

113. The committee with oversight of the MRC report was chaired by MRC Secretary Sir Harold Himsworth and included Cockcroft, Loutit, C. H. Waddington, Stanley J. Mitchell, Lionel Penrose, and Austin Bradford Hill.

producing plutonium for the country's weapons program. Meanwhile, Britain was in the forefront of a new medical industry based on (artificial) radioisotopes generated within the nuclear reactor and promising new approaches to the diagnosis and treatment of cancer.[114] The "military" atom was portrayed as one part of a much broader enterprise in order to present the radiological risks of weapons testing as "essentially the same" as those attending the development of its "peaceful" counterpart. The implication was that the dangers were minimal and the risks worth taking for the benefits of a limitless, reliable energy supply and the promise of huge advances in the diagnosis and treatment of cancer offered by the medical isotopes. The country's nuclear program was presented to the public as a balanced portfolio of projects, all of which served the changing needs of the country. If, unavoidably, this involved some radiological risks, research was under way to safeguard against them. The report concluded that the risks were "controllable within acceptable limits."[115]

For the UK government, the timing of the MRC report was useful amid the furor created by Rotblat's intervention, arriving as the British thermonuclear project was moving toward the testing stage and beginning to attract increasing criticism. Its findings were routinely deployed by the government and its emissaries within the scientific community as a bulwark against criticism of nuclear weapons testing. The report was a valuable tool in another way: It functioned to define the boundary between science and politics. Scientists who criticized it were construed as having crossed from the laboratory into the realm of politics—an argument not made with regard to those who invoked the report in defense of the nuclear agenda.

As the MRC went about its work, a similar study was under way in the United States. Carried out under the auspices of the NAS and funded by the Rockefeller Foundation, the resulting report was, as Jacob Hamblin has shown, heavily influenced by the AEC.[116] Tellingly, the MRC and NAS reports reached similar conclusions and were published simultaneously on 12 June 1956—a remarkable show of transatlantic cooperation given the extremely limited cooperation that otherwise characterized Anglo-American

114. Kraft, "Between."

115. In its message and language, the report can be read as both an exercise in "science in black," as defined by Doel, and an exemplar of what Chilton, writing in 1982, called "nukespeak": "a controlled response directed by the state in conjunction with other interested parties . . . as a means of constraining possible thought on the nuclear phenomenon." See Bingham, "Monster," pp. 611–612.

116. The process of assembling this report was highly contentious and marked by serious confrontations between scientists with differing opinions on the dangers of ionizing radiation. Some also were concerned that the AEC was wielding too much influence over its content. See Hamblin, "Dispassionate"; and Kopp, "Origins."

nuclear relations during this period.[117] The timing of official reports downplaying the dangers of fallout was propitious, coming amid a major test series (Redwing) by the United States and two tests by Britain that were crucial for its thermonuclear program (Mosaic).[118]

The findings of the reports broadly concurred: The dangers of genetic effects and leukemia were negligible. That said, both documents were more circumspect about the dangers of Sr-90, produced only during the fission process in thermonuclear weapons, and they acknowledged the need for further research into the biological effects of this isotope.[119] (Working behind the scenes and closely with the AERE, the MRC had initiated a nationwide study of the deposition and uptake of Sr-90 via an ongoing analysis of children's teeth and the bones of infant and adult human beings—the latter acquired postmortem via a national network of medical practitioners and pathologists.)[120] The MRC and the NAS also agreed on favoring the "threshold" concept, important in practical terms for the burgeoning nuclear energy industries because it meant that exposure to some radiation was deemed safe.[121] The reports compared the risk of radiation exposure arising from nuclear technologies to that received from background radiation or during a standard chest X-ray. Hamblin has also demonstrated the considerable degree of cooperation between the NAS and MRC to ensure similar conclusions—both bodies being "keenly aware of the crisis in confidence that would occur if the independent reports arrived at significantly different conclusions."[122] Differing conclusions would create confusion and fuel public fears of fallout and radiation more generally, leading to resurgent calls to end weapons testing and the arms race per se. Differences might erode public support for other nuclear technologies, not least civil energy programs. This was unpalatable to both governments, given their heavy

117. *Hazards to Man of Nuclear and Allied Radiations*; and *The Biological Effects of Atomic Energy* (Washington, DC: NAS-NRC, 1956).

118. Redwing included seventeen shots; Mosaic included two.

119. Geneticists tended to express more concern than colleagues from other disciplines and also tended to emphasize dangers arising from the cumulative effects of long-term exposure to low-level radiation.

120. Parallel to the medical studies by the MRC, the Agricultural Research Council was undertaking research into the extent and distribution pattern of strontium-90 through systematic studies of soil and the bones of dairy cattle and sheep. One focus was on the rainy uplands of Wales and Scotland—which were also areas of low-calcium geology (calcium concentration impacted strontium absorption in biological systems).

121. These reports led the International Committee on Radiation Protection to lower the "permissible dose" for those occupationally exposed to ionizing radiation. See J. Samuel Walker, *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000).

122. Hamblin, "Dispassionate," p. 159.

investment in this field and the intense competition between them and the Soviet Union for leadership in it.[123]

Not everyone was reassured by the MRC report. Some in the British press greeted it with skepticism. *The Manchester Guardian* responded with a cartoon by David Low satirizing the government's pronouncements on the safety of fallout. The image depicted umbrella-wielding nannies clutching the MRC report, shielding infants from fallout, especially Sr-90, falling like rain from the sky against a backdrop of nuclear explosions and billowing mushroom clouds. In between the mushroom clouds were lines from a nursery rhyme reworked with a sinister nuclear twist.

Government hopes that the MRC report would draw a line under the fallout problem were misplaced. Rotblat, Russell, and Pauling were dismayed, aware that within radiation science great uncertainty continued to surround the dangers of low-level radiation. Adjudicating its dangers was not yet possible.[124] This was especially true of Sr-90, about which concerns were growing.[125] Sr-90 was increasingly regarded as the most dangerous component of fallout because it was a "bone-seeker" that lodged in and irradiated the bone marrow, where it could increase the risk of leukemia. Leukemia was especially dreaded because it afflicted children disproportionately and remained fatal, rapidly so in its acute forms.[126] In Britain, the connection between fallout and leukemia was a recurrent theme in arguments against weapons testing made in the letters pages of national newspapers and in the mailbags of members of Parliament.[127] Fears about leukemia and fallout became entwined as some experts explicitly linked its rising incidence to increased radiation exposure—not least from bomb tests—in the nuclear age. For British physician Ronald Bodley Scott, leukemia was a "pestilence of the atomic age."[128]

By this time, Sr-90 had become a valuable means for analyzing global patterns and distribution of fallout. Tracking techniques, beyond their import

123. Krige, "Atoms."

124. In particular, the "threshold" versus "linearity" explanations of radiation damage remained unresolved. This was crucial for occupational safety and for the argument about the dangers of exposure to low-level radiation—for example, fallout—and the dangers of cumulative exposure.

125. J. L. Kulp, W. R. Eckelmann, and A. R. Schulert, "Strontium-90 in Man," *Science*, Vol. 125, No. 3241 (8 February 1957), pp. 219–225.

126. Patterson, *Dread Disease*.

127. For example, *TMG*, 28 March 1957, p. 8, clipping in File FD23/1314 [CSO 3010], in The National Archives, Kew, London (TNAUK).

128. Ronald Bodley Scott, "The Treatment of Leukaemia," May 1958, p. 2, in Welcome Trust Archives, London (WTAL), Ronald Bodley Scott Collection, PP/RBS/C41, Folder: Unpublished Papers, 1958–1960.

for the fallout issue, were important in new conceptualizations of the planet as an interconnected ecosystem.[129] Sr-90 became the first pollutant discussed by Rachel Carson in her 1962 book *Silent Spring*, widely acknowledged as marking a turning point in global environmental consciousness.[130] In 1956, its dangers were contested, the science uncertain. Perhaps sensing an opportunity, Rotblat began to focus attention on Sr-90. In late 1956, under the auspices of the newly constituted Radiation Hazards Committee of the ASA, he initiated a study of Sr-90. The resulting report was to be his second decisive intervention in the fallout story. In disrupting the official narrative it, too, proved highly controversial and brought him again into conflict with the government.

April 1957: A Statement about Sr-90

The Radiation Hazards Committee was one of four study groups established in the autumn of 1956 within the ASA.[131] The committee included radiobiologists Jack Boag and Patricia Lindop and the radiologist Sidney Osborn; its driving force was Rotblat. Shortly after being formed, the committee undertook a review of available data on Sr-90 and concluded that the isotope posed a serious hazard to health. These findings were summarized in a "Statement on Radiostrontium."[132] Alluding to the Bravo accident, the statement challenged the assertion in the MRC report that fallout did not pose a serious threat to human health; it also forecast the number of leukemia cases that might be expected as a result of the current rate of thermonuclear tests, emphasizing the particular sensitivity of children to Sr-90. If technical details might be lost on the lay public, the threat of cancer, especially in children, would not. Rotblat

129. Toshihiro Higuchi, "Atmospheric Nuclear Weapons Testing and the Debate on Risk Knowledge in Cold War America, 1945–1963," in J. R. McNeill and Corinna R. Unger, eds., *Environmental Histories of the Cold War* (New York: Cambridge University Press, 2010), pp. 301–322.

130. Daniel O'Neill, "Firecracker Boys," in Hilgartner et al., *Nukespeak*; and Lutts, "Chemical." On the influence of U.S. military interests on environmentalism, see Ronald E. Doel, "The Military's Influence on the Environmental Sciences in the USA after 1945," *Social Studies of Science*, Vol. 33, No. 5 (October 2003), pp. 635–666.

131. This (sub)committee had been established in the autumn of 1956, along with three others focused on: Disarmament (chaired by Hodgson); Scientific Social Responsibility (Bronowski) and the Formation of an International Body of Scientists (Haddow). Minutes of the First Meeting of the Radiation Hazard Committee, 6 October 1956, in CAUoC, RTBT, File K126.

132. H. S. W. Massey and H. R. Allan, "Strontium Hazards," *BAS*, Vol. 13, No. 6 (June 1957), pp. 202–203.

and his colleagues argued that the cumulative effects of radiation exposure made it imperative to stop testing as soon as possible.

The statement was intended as a public document, its timing coinciding with intense preparations, including tests, for the inaugural British thermonuclear test. Following ASA protocol, the statement prior to its release was circulated among senior members, which magnified simmering tensions within the ASA over nuclear weapons. Opinions differed about the dangers of fallout and also about whether the organization should intervene in sensitive matters of national nuclear policy. Some ASA members who supported the statement were typically associated with the Radiation Hazard Committee. For example, the radiologist Osborn urged Rotblat to let the government have sight of it prior to release.[133] Those who opposed the statement and its publication included Alexander Haddow, a leukemia specialist and director of the Chester Beatty Research Institute, who did not consider fallout a major health hazard and thought it inappropriate for the ASA to comment on the issue.[134] More vehement criticism came from those who formed part of the "nuclear establishment," including Marley, division chief at Harwell, and Nobel Prize–winning physicist George P. Thomson. (Marley had served on the Strath Committee, and Thomson was a veteran of the wartime MAUD Committee.) They considered that the MRC report should form the basis of ASA policy. They also saw possession of the hydrogen bomb, and the testing of it, as vital to British interests.[135]

Determined that their findings reach a wider public, the "Radiostrontium Statement" was released to the press on 16 April 1957. It did not carry the imprimatur of the ASA but, apparently at the suggestion of Cockcroft, appeared instead under the aegis of its Radiation Hazard Committee.[136] However, the statement received scant coverage in the press. Disappointed that it had met with "little reaction" in the daily press, Rotblat nonetheless remained optimistic that its appearance in *The New Scientist*, the *British Medical Journal*, and the *Lancet* meant that it "would reach the intelligent layman."[137] In striking contrast to the muted response in the press, the statement proved incendiary in Whitehall, provoking great anger in government and again bringing the

133. Sidney Osborn to Joseph Rotblat, 3 April 1957, in CAUoC, RTBT, File K126.

134. Alexander Haddow to Joseph Rotblat, 20 June 1956, in WTAL, Alexander Haddow (AH) Collection. Haddow had served on one of the panels for the MRC report.

135. W. G. Marley to Joseph Rotblat, 5 April 1957, in CAUoC, RTBT, File K126.

136. Meeting of the ASA Radiation Hazards Committee, 1 May 1957, in CAUoC, RTBT, File K126.

137. The statement was reproduced in *BAS* in June 1957 accompanied by a Vicky cartoon satirizing the "tit for tat" dynamic that now characterized weapons testing. Meeting of the ASA Radiation Hazards Committee, 1 May 1957, in CAUoC, RTBT, File K126.

wrath of Lord Cherwell down on Rotblat.[138] The statement also drew criticism from fellow "establishment" scientists, including Himsworth and Penney.[139]

Rotblat was unrepentant. His position was hardening amid mounting empirical evidence from radiobiological and clinical research indicating that any and all exposure was potentially dangerous to health. Especially sobering were epidemiological studies from within the ABCC and long-term studies of patients treated with ionizing radiation that pointed to a link between radiation exposure and leukemia.[140] Evidence was mounting that Sr-90 caused leukemia—although in the United States Libby was busy downplaying this link.[141] In *Science* in May 1957, the U.S. physicist Edward B. Lewis published findings that lent weight to the argument that there was no safe dose of radiation—any exposure was potentially dangerous.[142] In technical terms, this challenged the threshold concept.[143] Although dismissed within MRC circles as "armchair speculation," his analysis further emboldened dissenting scientists to oppose testing, challenge governments, and steer public opinion in these directions. Calls for a test ban grew louder.[144]

For the British government, all of this was especially unwelcome because it came in the run-up to its first test of a thermonuclear weapon, codenamed Grapple X. This became the focus of worldwide criticism because of the fallout it would generate and because of its meaning for thermonuclear proliferation. Writing in *The Manchester Guardian* in March 1957, Wayland Young—a member of the NCANWT—captured how Grapple X came to

138. Meeting of the ASA Radiation Hazards Committee, 13 June 1957, in CAUoC, RTBT, File K126.

139. Brown, *Keeper*, pp. 131–132.

140. Evidence of an increased incidence of birth defects was also growing. Kathleen Lonsdale to Joseph Rotblat, 19 January 1955, in CAUoC, RTBT, File K112.

141. John F. Loutit, "Strontium-90 and Leukaemia," *Scientific Basis of Medicine Annual Reviews*, 1967, pp. 340–355. Other components of fallout, notably cesium-137 and carbon-14, were also of concern. On the latter, see Christopher J. Jolly, "Linus Pauling and the Scientific Debate over Fallout Hazards," *Endeavour*, Vol. 26, No. 4 (2002), pp. 149–153.

142. Edward B. Lewis, "Leukemia and Ionizing Radiation," *Science*, Vol. 125, No. 3255 (17 May 1957), pp. 965–972. Lewis proposed, in technical terms, that the new data on the effects of radiation damage (from epidemiological studies) supported a (mathematically) linear relationship between radiation exposure and leukemia. Linearity went against the concept of a threshold of radiation exposure for an elevated risk of leukemia.

143. On the linearity-threshold debate amongst scientists, see Angela N. H. Creager, "Radiation, Cancer and Mutation in the Atomic Age," *Historical Studies in the Natural Sciences*, Vol. 45, No. 1 (2015), pp. 14–48.

144. File FD23/1314 [CSO 3010], in TNAUK; and Barry Commoner, "The Fallout Problem," *Science*, Vol. 127, No. 3305 (2 May 1958), pp. 1023–1026. In September 1957, the United States conducted its first underground test of an atomic bomb, the 1.7 kiloton weapon Plumbbob Rainier, at its Nevada Proving Ground. By this time, the United States and the Soviet Union were accelerating research into both a "clean bomb" and underground testing.

mark a crossroads in the spread of the hydrogen bomb. Until now, he said, this weapon had remained the preserve of the United States and the USSR, but now Britain is building it, and "in a few years it will be France, then perhaps half a dozen countries." He depicted the test as a barometer of the country's moral leadership when he asked, "is it not our special duty as the first second-rate Power on the scene to take an initiative in stopping the whole thing; an initiative as risky, as uncomfortable, even as terrifying as all worthwhile initiatives always are?"[145] Britain's position, he maintained, was very different from that of the United States and the Soviet Union, which had become thermonuclear powers in the pre-Bravo era before the fallout phenomenon had been recognized.[146] Britain had developed this weapon despite being aware of its radiological dangers, against the backdrop of the fallout controversy, and amid growing opposition to weapons tests.

From Spring to Autumn, 1957: Countdown to Grapple X

In early 1957, the newly installed Macmillan government announced that in the spring and autumn it would carry out several nuclear tests it considered vital to its development of the hydrogen bomb—the final and most important test, Grapple X, was scheduled for November on Christmas Island in the Pacific.[147] Unsurprisingly, this met with forceful criticism from scientists such as Rotblat, Russell, and Pauling. Within the ASA, Rotblat led moves for an official statement calling for the cancellation of the planned tests. Amid intense disagreement, his efforts came to nothing.[148] The Labour Party mounted a campaign supporting Rotblat's objectives, calling on 3 and 17 April 1957 for a ban on hydrogen bomb tests generally and for the postponement of the forthcoming British test. In contrast to the period from 1954 to 1956, testing and fallout received wide and often critical coverage in the British press throughout the year, reflecting and fueling public unease. Opinion polls

145. Wayland Young, "Testing Atomic Weapons: The Danger to Ourselves," *TMG*, 25 March 1957.

146. That said, in 1956 the United States had faced stern opposition to Operation Redwing (seventeen tests conducted from May to July 1956, several of which were in the megaton range; i.e., thermonuclear) both from pacifist groups within the United States and internationally, especially from India and Japan.

147. These were Grapple (three shots in May/June) and Antler (three shots in September/October). Grapple X in November was considered the decisive test. On the technicalities of the British H-bomb, see Baylis, "Myth"; Pyne, "Art"; and Arnold, *H-Bomb*.

148. ASA meeting, 2 February 1957, in CAUoC, RTBT, File K124.

indicated growing public opposition to testing and to the hydrogen bomb.[149] Outside Britain as well, sentiment against the UK tests was mounting, evidence of the changed public mood toward fallout and weapons testing within nuclear and non-nuclear countries alike.[150]

With the government under pressure, the political milieu in Britain became decidedly confrontational. Those expressing dissenting views faced increasing hostility. In 1957 Lord Cherwell and Secretary of State for Foreign Affairs Selwyn Lloyd conducted a sustained campaign to undermine leading anti-nuclear activists. Rotblat, a particular target of this campaign, was vilified as a "fellow traveler" by Lloyd on the BBC *Woman's Hour* radio program in May.[151] Rotblat was undeterred. Many had come to share his views, as evidenced in rising anti-nuclear sentiment. Influential figures such as J. B. Priestley weighed in, sensing, perhaps, an opportunity to stop the test, to change British nuclear policy, and to rally the public behind the "ban the bomb" agenda.[152]

Macmillan was unmoved. He and his government continued to emphasize (thermonuclear) deterrence as the best way to assure the security of the nation.[153] The British government was averse to changing its weapons testing program except as part of a moratorium involving all three nuclear powers—something that had been under discussion, on and off, without agreement in disarmament talks ongoing since 1955.[154] British policymakers regarded Grapple X as vital to Britain's national security and standing in the world. As Macmillan argued in the House of Commons in March 1957, abandonment

149. "Bomb Test Risks," *The Observer* (London), 17 March 1957; Wittner, *Resisting*, p. 17; and Young, "Testing."

150. Wittner, *Resisting*. There were efforts, too, among and between scientists. See, for example, that by Japanese scientists, "Appeal to British Physicists," 28 February 1957, in CAUoC, RTBT, File K125.

151. Minutes of 7th Meeting of the ASA Radiation Hazard Committee, 13 June 1957, in CAUoC, RTBT, File K126.

152. John B. Priestley, "Britain and the Nuclear Bombs," *The New Statesman* (London), 2 November 1957, pp. 554–556. Priestley called on the government to show moral leadership by abandoning its quest for thermonuclear status and to opt instead for unilateral disarmament. This was influential within leftist intellectual circles and among some sections of the public; it has also been seen as one spur to the formation of the Campaign for Nuclear Disarmament.

153. Another argument against weapons tests viewed this as a way to "slow" the arms race and as a first step toward disarmament. This point, made initially in 1954 by U.S. physicist Philip Inglis, and later by others including Conrad Waddington in the United Kingdom, gained traction as weapons testing became an integral part of the disarmament talks that were ongoing between the United States, Britain, and the USSR throughout the period under study. This was the only context in which the British government was willing to consider changes in its testing program—but not before it had become a thermonuclear power. Conrad H. Waddington, "The Case against Bomb Tests: Fallout May Not Be the Major Risk," *TMG*, 8 May 1958. pp. 6–7.

154. The ongoing disarmament talks are a theme running throughout Divine, *Blowing*.

of the test would "put Britain in a position of inferiority, even for the purposes of negotiation."[155] Moreover, becoming a thermonuclear power was seen as a strategic asset in the prime minister's pursuit of the "great prize"—rapprochement with the United States, which in 1957 entered into a sensitive phase. With this in mind, and also given growing anti-nuclear sentiment among the British public, news of the fire at the Windscale nuclear plant on 8 October 1957 was withheld for a time from public discussion in either Britain or the United States.[156] In the same week, the launch of *Sputnik 1* by the Soviet Union sent shockwaves across the West and provided further justification for going ahead. Grapple X was detonated as planned on 8 November 1957.[157]

In its aftermath, the anti-nuclear sentiment apparent throughout 1957 among some sections of the British public was translated into political action in the form of protest and organized opposition, most obviously the formation of CND. This marked a distinctive moment in British politics in which activists and others, especially the middle class and women, mobilized against government policy.[158] From the outset, CND foregrounded the fallout issue, calling for a test ban and an end to the arms race, set within a wider antiwar agenda.[159] Russell and Rotblat were also active in the inception of CND, although Rotblat resigned from the organizing committee in late 1958, citing his work at St. Bartholomew's and other commitments. Among these, by now, was Pugwash.

For all the difficulties Rotblat's dissenting views had caused him in his adopted country, he remained resolute in his opposition to nuclear weapons and the arms race. Although not faced with the draconian measures introduced in the United States in the late 1940s—notably, Harry S. Truman's "Loyalty Order" and the targeted attacks of the House Un-American Activities Committee—dissenting scientists in Britain, especially Rotblat, faced constraints in the form of criticism from colleagues and personal attacks from within Whitehall. Later, Rotblat recalled that "even in a democracy like

155. House of Commons Debate, 19 March 1957, "Negotiation on Arms Control," in CAUoC, RTBT, File K124.

156. News of the Windscale fire would have been embarrassing for Macmillan in another way, since this was a sensitive moment in negotiations between the United Kingdom and the United States regarding cooperation over nuclear arms. Jan Melissen, "The Restoration of the Nuclear Alliance: UK-US 1957–1958," *Contemporary Record*, Vol. 6, No. 1 (1992), pp. 72–106.

157. Arnold, *H-Bomb*.

158. Nehring, "British"; and Lawrence Wittner, "Gender Roles and Nuclear Disarmament Activism, 1954–1965," *Gender and History*, Vol. 12, No. 1 (2000), pp. 197–222.

159. Taylor, *Against*; Wittner, *Resisting*; and Nehring, "Cold War, Apocalypse."

Britain, the Establishment has powerful means to restrict dissident views."[160] The political impotence of the ASA left dissenting scientists in Britain with no channel for expressing their views effectively. Nor could they act internationally. Even the instinctively conservative Haddow was frustrated at this situation. In June 1957 he wrote to Rotblat lamenting the lack of an "international medium" through which "our scientific responsibility can be expressed internationally."[161] From within the complex mix of constraints on and the freedoms enjoyed by scientists within Britain, and the distinctive nature of the threat posed by fallout, arose an innovative approach to tackling the problems surrounding nuclear weapons. This took the form of a novel transnational initiative organized by scientists, for scientists. Its roots lay in the Russell-Einstein Manifesto, and it came to be known as Pugwash.

Pugwash, Nova Scotia, July 1957: Scientists Launch a Transnational Initiative

Although Rotblat was focusing on Sr-90 and battling a divided ASA and the backlash against him from within Whitehall, Russell was striving to build on the success of the 1955 manifesto. Working behind the scenes with Joliot-Curie and others, including Rotblat, he was trying to convene a meeting of senior scientists from around the world, provisionally scheduled for January 1957 in Delhi, to assess the dangers of nuclear weapons. Because the organizers were keen to include wide-ranging viewpoints, they approached scientists from across the political spectrum. On the list in Britain was Haddow, an establishment figure who had served on the MRC Hazards panel. In 1955, Haddow had been approached by Russell to sign the document that would become the Russell-Einstein Manifesto, but had declined. In June 1956, Russell approached him again with an invitation to attend the Delhi meeting. Haddow again declined, partly because he saw the UN as the vehicle for an international meeting of this kind.[162]

Even so, the invitation is intriguing insofar as it illuminates the strategic thinking behind Russell's Delhi initiative. The dominance of the fallout

160. Rotblat, "Social Conscience," p. xxv.

161. Alexander Haddow to Joseph Rotblat, 20 June 1957, in WTAL, AH Collection.

162. Prompted by Bravo, Haddow had supported moves to create a "Scientific Concilium"—a permanent Scientific Committee—within the UN to consider the problems surrounding nuclear weapons. Alexander Haddow to Bertrand Russell, 18 April 1955, in WTAL, AH Collection. In 1955, the UN established a Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for the oversight of radiation safety, but its remit differed from that envisaged by Haddow.

problem is strikingly clear, as is the emphasis placed on the need for an independent analysis of its dangers. Independence was imperative because, as Russell and his colleagues noted, "the work of a commission of official delegates may sometimes be restricted by political considerations."[163] The suggestion of political influence over scientists on official committees is hard to ignore and could be interpreted as a veiled reference to the recent MRC Committee.[164] The invitation to Haddow also emphasized the need for independence. Scientists would not be "representing Governments" but "following the dictation of their own consciences." This was important, the organizers reasoned, because independent views "may find a wider and more ready acceptance by public opinion." A key theme of the meeting would be the role of nuclear weapons tests "in contributing to a competition in armaments and the resulting danger of an eventual unrestricted nuclear war." Ensuring that the ideas and arguments discussed at the meeting reached the public was another priority for Russell and his co-organizers, all of whom had been signatories to the Russell-Einstein Manifesto.

Financial difficulties and the Suez crisis saw the meeting delayed and relocated. Instead of India, it took place in Pugwash, Nova Scotia, in July 1957, funded by wealthy industrialist Cyrus Eaton.[165] This gathering of 22 senior scientists from ten countries was the inaugural meeting of the Pugwash Conferences on Science and World Affairs.[166] Limited to elite scientists, with attendance by invitation only and governed by Chatham House rules, the Pugwash meetings sought to further the principles, values, and aims set out in the Russell-Einstein Manifesto. Significantly, although the manifesto had not been signed by Soviet or Chinese scientists, these countries were represented in Nova Scotia.[167] The aim was to create a novel forum in which scientists from East and West could discuss nuclear matters in a way that

163. Bertrand Russell, Max Born, Frederic Joliot-Curie, Leopold Infeld, Linus Pauling, Cecil F. Powell, Joseph Rotblat, and Hideki Yukawa to Alexander Haddow, 29 August 1956, in WTAL, AH Collection. All the authors were signatories to the 1955 Russell-Einstein Manifesto.

164. Russell and colleagues may also have had in mind an UNSCEAR report on nuclear radiation hazards, including that presented by fallout. Published in 1958, the report deemed fallout a hazard to human health, lending weight to the argument against weapons testing.

165. Joseph Rotblat, *Pugwash: The First Ten Years* (New York: Humanities Press, 1967); and Leonard E. Schwartz, "Perspective on Pugwash," *International Affairs*, Vol. 43, No. 3 (July 1967), p. 501.

166. Nationality of the delegates: USA, 7; USSR, 3; Japan, 3; Britain, 2; Canada, 2; Austria, Australia, China, France, and Poland, 1 each. Eugene Rabinowitch, "Pugwash—History and Outlook," *BAS*, Vol. 13, No. 7 (1957), pp. 243–248.

167. The Soviet Union sent three delegates. See Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca, NY: Cornell University Press, 1999). China sent one delegate. See the article by Barrett in this issue of the journal.

transcended the narrow interests of the nation-state. The Nova Scotia meeting established the practice of issuing a post-meeting summary statement that was agreed to by participants and distributed to governments around the world. The first Pugwash statement (in 1957) was organized around the work of three committees covering technical, political, and ethical issues: radiation hazards; controls and safeguards; and social responsibility.[168] Pugwash meetings gave practical form and meaning to the manifesto.

Fallout served as a rallying point for a new form of transnational activism developed by the scientists of Pugwash. This unprecedented nuclear problem featured prominently in the manifesto and was an animating force in the inception of Pugwash, a key focus of its early activities, and the dominant topic of the first Pugwash statement. Fallout was a shared danger because it crossed national borders. Radioactive particles were deposited in places thousands of miles from nuclear test sites, contaminating nuclear and non-nuclear countries alike. The *New Republic* proclaimed that fallout had brought an "era of radiation without representation," and the Japanese physicist Mitsuo Taketani spoke for many when he asserted that the "whole population of the world is being used as guinea pigs."[169] The dangers of fallout hung as much over Moscow as they did over London and Washington, DC. In crossing national borders and the bloc divide in this way, fallout created a unique set of scientific and political challenges. At the same time, it was the result of nuclear weapons tests carried out by governments that regarded such tests as integral to their national security. Fallout posited a relationship between the local and the global, between the national and the international. It engendered a clash between the interests of nuclear weapons states and those of the wider international community. By claiming this terrain for itself, Pugwash was breaking new ground, through which it sought to develop the "new way of thinking" called for in the Russell-Einstein Manifesto.

Early Pugwashites were well-equipped for this. As Rotblat later reflected: "It has been a desideratum of the Pugwash movement to be progressive, to foster new ways of thinking, to encourage pioneering ideas. . . . Occasionally this may bring us into conflict with the establishment; it may make us non-conformists, radicals, dissidents. Dissidence can be said to be part of our ethical code."[170] The fallout issue was an early site in which this ethical code was forged. Its dangers provided the basis for the formulation of an ethical

168. See Rotblat, *Pugwash*.

169. Divine, *Blowing*, p. 142.

170. Rotblat, "Social Conscience," p. xxiii.

argument against testing through which scientists could demonstrate social responsibility, in the sense of protecting the public at large, now and in the future.

Fallout served also as a rallying point for scientists who—as this special issue of the journal reveals—lived and worked in very different national settings and, within these settings, were very differently placed in relation to political power. But governments and ordinary citizens around the world were alarmed about the potential dangers that radioactive fallout posed to human health. The peacetime problem of weapons tests and fallout was arguably decisive in rendering possible and legitimating an international meeting of scientists from across Cold War divides. Analyzing this issue within the British context enables us to identify some preconditions for Pugwash. Fallout was a necessary, and perhaps a sufficient, condition for its emergence. The nature of the fallout problem lent itself to and demanded a transnational approach. It was at once a national and transnational problem, on the one hand entwined with national nuclear weapons policy and on the other hand the concern of all countries. The bristling hostilities of the Cold War made conversations across geopolitical divides difficult. As the foremost experts on the radiological dangers of fallout, scientists were uniquely placed to discuss the issue—and to reach across national borders to do so.

In Pugwash, Rotblat found his métier. He presided over these conferences for the rest of his life, overseeing the organization's development, coordinating its activities, and reshaping its agenda amid the changing contours of the Cold War and post–Cold War world. The hostility of the British government followed him to Pugwash. As Wittner has emphasized, British officials for a considerable time viewed Pugwash as "verging on Communist Front gatherings."[171] Many other governments also watched Pugwash carefully, viewing it with suspicion or even outright hostility — differences that are apparent in the other contributions to this special issue.[172] Nevertheless, under the stewardship of a small coterie, including Rotblat, C. F. Powell, Rudolf Peierls, Eugene Rabinowitch and Aleksandr Topchiev, Pugwash came to provide a valuable channel for "second-track" diplomacy. However, the nature of its work means that its influence remains hard to gauge.[173] That it perhaps made an important

171. Wittner, *Resisting*, pp. 113–114.

172. Evangelista, *Unarmed*; and Geoffrey Roberts, "The Communist Peace Movement and the Origins of Pugwash, 1948–1956" (paper presented at the Writing Pugwash Histories workshop, Vienna, May 2012).

173. Schwartz, "Perspective"; and Kai-Henrik Barth, "Catalysts of Change: Scientists as Transnational Arms Control Advocates in the 1980s," *Osiris*, 2nd ser., Vol. 21 (2006), pp. 182–206.

difference is suggested by the Nobel Peace Prize jointly awarded to Pugwash and Rotblat in 1995.

Conclusion

Until 1954, the nuclear powers employed a variety of strategies to play down the radiological dangers inherent in nuclear weapons. These included the denial of radioactive contamination where nuclear bombs had been exploded, protection measures at test sites, and the designation of radiological data as secret. At the same time, the nuclear powers were funding research into the biological effects and dangers of radiation. The tension between these two positions was reconciled under the rubric of "national security" and rationalized by the Cold War. By the early 1950s, the nuclear powers held that weapons tests were essential to the development of the nuclear arsenal and to national security. However, weapons tests came with the risk of radiological accidents. Bravo was the first serious accident, and it laid bare the long-concealed potential for radiological catastrophe that stalked nuclear energy and revealed the unprecedented radiation dangers of thermonuclear weapons. That the Bravo accident led to a sustained and politicized controversy about fallout and weapons testing was a reflection, in no small part, of the efforts of scientists, notably Rotblat and Russell in Britain and Pauling and Barry Commoner in the United States, who sought both to raise the issue with their governments and to bring it before the public. Dissident scientists ensured that fallout became a part of public life in Cold War Britain. The radiological hazards of nuclear weapons testing imbued the arms race with new meaning, through which it affected the everyday lived experience of the ordinary citizen.

This article has emphasized the importance of the fallout and testing issue as it unfolded in Britain at a critical moment in the development of its thermonuclear program. From 1955 onward, Russell and especially Rotblat came into increasingly sharp conflict with the British government, which remained wholly committed to weapons testing as a means to realize its thermonuclear ambitions and protect its investment in and development of various peaceful applications of nuclear energy. The vehement attacks the British government directed at Rotblat and the official attempts to mute public discussion of the hydrogen bomb and its effects were accompanied by moves to mobilize senior government-aligned scientists who would emphasize that fallout was not a major danger to health, would rein in their "dissident" colleagues, and, insofar as was possible, would wield their influence within organizations such as the ASA in order to suppress collective action. The fallout debate left its

imprint on the British scientific community generally but especially on the ASA.

Exploring the twists and turns of this story helps illuminate the fraught relationship between dissenting scientists and the British government, which believed that science and scientists should be assisting rather than hindering the realization of its Cold War priorities. Some scientists, notably those who served on the constituent panels of the MRC review of radiation hazards, were at ease with this role. The MRC report was one response to growing political pressure about and rising public fears of fallout, manifest in mounting opposition to weapons tests. The same was true of the parallel NAS study in the United States. This wave of concern had been initiated and fueled by activist scientists bold enough to challenge the government position and disrupt the official nuclear narrative and place their views before the public. The reports' content, tone, and shared conclusions, and the coordinated manner of their publication signaled the firm commitment of each government to the nuclear path it was pursuing. The radiological hazards were recognized and under control. Here, then, was transnational cooperation between governments, senior scientists, and scientific committees driven by the imperatives of the arms race and, in turn, by the logic of the Cold War.

Tracing the fallout debate also shows how fallout from weapons testing became a key part of nuclear culture in Britain, one essential to understanding the developing sensibility within some sections of the British public toward the country's nuclear weapons policy and the arms race generally. From the mid-1950s, fallout and nuclear weapons testing emerged as key issues for those in Britain opposed to nuclear weapons and became part of the lived experience of the Cold War. Although the Labour Party did not effectively challenge successive Conservative governments and their pro-nuclear, pro-testing policies, and although public opinion appeared for a long time to be silenced by official rhetoric emphasizing defense through deterrence, by 1957 a wider anti-nuclear lobby was emerging, encompassing left-wing intellectuals and a collection of Quaker, Anglican, and pacifist groups among other sections of the British public. From this would come a range of anti-nuclear movements, including CND.

This article has emphasized the salience of the fallout issue as an animating force in the inception of Pugwash. How far Russell and Rotblat consciously exploited the fallout issue to further a broader anti-nuclear agenda is a question that can be resolved only if further sources come to light, but raising the fallout/testing issue clearly served their purposes. For example, it lifted the veil of secrecy thrown over the nuclear enterprise by the British government; it provided a means to engage the public anew in matters of nuclear policy;

and it provided a rallying point that brought scientists together within and beyond Britain to discuss all aspects of nuclear weapons. Scientists opposed to nuclear weapons testing at this point perhaps felt that transnational initiatives were the only viable path left open to them. They had to improvise and innovate to bring Pugwash into being. In conception, form, and aims, Pugwash was a product of the Cold War context in which it arose—a response to the distinctive set of political and societal problems occasioned by nuclear science and technology, specifically nuclear weapons and especially fallout. It was also a pragmatic response to the difficulties scientists faced in mounting effective opposition to the nuclear weapons policies of the nuclear states from within. Pugwash was unique and remains difficult to categorize. Neither a movement nor an organization in the conventional sense, it is perhaps best understood as a network of scientists committed to confronting the dangers of the nuclear age: nuclear weapons, the arms race, testing, and fallout. It can be situated within a lineage of initiatives by scientists concerned about the problems posed by nuclear weapons—although its "network" form and transnational agenda mark it out as distinctive. Pugwash was also a response to the failure of traditional diplomacy to tackle these problems.