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The atomic age was enacted by many scientists as a way to realize health and human rights. Human rights were conceived in this context as rights to economic development, science education, and nuclear medicine. The United States Atomic Energy Commission (AEC) acted hand in hand with UN agencies and educators to spread nuclear knowledge and technology as a tool to advance health and human rights for peace and prosperity. UN agencies such as UNESCO, IAEA, and WHO standardized AEC interpretations of radiation exposure. Academics served as the glue to promote nuclear and health physics, research reactors and uranium prospecting. Technical experts traveled the globe to build nuclear infrastructure and institute ideas of radiation exposure that originated from the AEC.

Trust in the ability of scientific experts to provide radiation health safety was central to the expansion and acceptance of nuclear technology worldwide. Willard E. Libby of the US Atomic Energy Agency, while admitting uncertainty, believed that under a certain threshold, radiation would not be dangerous. The international field of health physics, dominated by the AEC trained scientists, interpreted radiation danger

with one particular and lasting trope: artificial radiation below natural background radiation levels was safe and acceptable. The construction of background radiation as "safe" by American and international agencies was a speculative and exclusive process. Radioactive accidents were interpreted by agencies and nuclear scientists as experiments to improve technology. The AEC created unethical human radiation experiments and disregarded democracy and individual human rights. The expansion of nuclear technology created impingements on human rights, health and peace of mind.

This history calls for a meta-analysis based on both heath and human rights aims and impingements. Contaminated communities access radioactive contamination as a permanent and irrevocable bodily and intergenerational taint that violates human rights. Claims were made after the first use of nuclear weapons that pre-existing international law and rights to "life, liberty and the pursuit of happiness" should protect people worldwide from dangerous, intergenerational radiation exposure. This can be seen in the experiences of the Navajo Nation with uranium mining and in anguished letters sent to Noble Prize winning chemist Linus Pauling during the fallout controversy. This history when transposed with the utopian hopes of nuclear scientists, questions the relationship between rationality, human rights, scientific ideology, regulations, ethics, and knowledge production during the Cold War. The exclusion from nuclear regulatory regimes of those who live contaminated by the nuclear fuel chain and in fear of nuclear pollution and weapons is a result of the lack of recognition of the integrity and sovereignty of one's body as an inalienable human right.

Rocks and Reactors: An Atomic Interpretation of Human Rights, 1941-1979

by
Linda Marie Richards

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APPROVED:

Major Professor, representing History of Science

Director of the School of History, Philosophy, and Religion

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Linda Marie Richards, Author

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My experience at OSU has been phenomenal. My Major Professor, Jacob Darwin Hamblin, was an inspiration to me everyday in his writing, teaching and living. He is an embodiment of my favorite Wendell Berry quote “Be joyful, despite the facts.” He patiently, time after time, and with persistent good humor, helped me to articulate the ideas in this dissertation. He saw what I needed to do and he pushed me to stretch to accomplish more much than I ever thought possible. I am honored to have the good fortune to hold the proud distinction of being Prof Hamblin’s first student to earn their doctorate.

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OSU Nuclear Engineering and Radiation Health Physics Department. I am appreciative of each of my co-graduate students and my undergraduate students who encouraged me. This dissertation likely could never have been written if it were not for the Graduate Writing Center and Meghann Rhynard-Geil who translated my feelings and research into readable text.

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I offer my dissertation tempered by this quotation from Lawrence Alan Rosenwald: "A deeper consolation is my certain sense that the problem is so acute that the solutions will probably start out by looking petty or awkward or peculiar." For this, I apologize in advance.

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Introduction

"Mr. Kennedy, Mr. MacMillon, WE HAVE NO RIGHT TO TEST" protest placard held by Linus Pauling, April, 1961

On April 24, 2014 the Republic of the Marshall Islands filed separate cases against each of the nine nuclear weapon states (U.S., Russia, U.K., France, China, India, Israel, Pakistan, and North Korea) at the International Court of Justice in the Hague. The documents accused the nine nuclear weapons states of "flagrant denials of human justice."[1] The explosive force of the nuclear weapons tests on their islands from 1946 to 1958 was equal to one and a half Hiroshima bombs being exploded daily for twelve years. The islanders continue to suffer from illnesses, birth defects, and the loss for many of their island homes, so irrevocably polluted they are uninhabitable.[2]

Sixty years before, after the 1954 Castle Bravo thermonuclear test, one hundred and eleven Marshallese brought a petition in the spring to the UN about the harm and contamination caused by the US nuclear weapons tests.[3] The UN petition was denied.[4] With few options, two Marshallese families, three Japanese, one Samoan citizen and one

[1] Julian Borger, "Marshall Islands Sues Nine Nuclear Powers over Failure to Disarm: Pacific Nation that was Site of 67 Nuclear Tests between 1946 and 1958 Accuses States of 'Flagrant Denial of Human Justice'" *The Guardian,* April 24, 2014, accessed May 20, 2014, http://www.theguardian.com/world/2014/apr/24/marshall-islands-sues-nine-nuclear-powers-failure-disarm. A suit was also filed against the US in the US Federal Court of San Francisco.

[2] Hiromitsu Toyosaki, *Goodbye Rongelap* (Tokyo: Tsukiji Publishing Co. Ltd., 1986); David Krieger, "The Nuclear Zero Lawsuits: Taking Nuclear Weapons to Court" May 9, 2014, Truthout, accessed May 20, 2014, http://truth-out.org/opinion/item/23599-the-nuclear-zero-lawsuits-taking-nuclear-weapons-to-court.

[3] K.D. Nichols to Dave Key, June 9, 1954, ODA files, lot 60 D 257, "TTPI—Nuclear Testing—1954" Foreign Relations of the United States, 1952–1954, Volume III, United Nations Affairs, Document 945, accessed May 20, 2014, http://history.state.gov/historicaldocuments/frus1952-54v03/d945 The first response of US Ambassador Henry Lodge was to discredit the petitioners themselves as suspect. The complaint "was too perfect to have originated with the Islanders themselves without outside inspiration?"

[4] The details of this first UN petition invite further research. Many of the islanders would, as they feared, however, never be able to return to their homelands. "Affected Marshallese communities, including from atolls of Bikini, Enewetak, Rongelap and Utrik, continue to struggle with impacts, unpaid injury claims, and how to define adequate safety standards." – Press Release from the Office of the President, Majuro, Republic of the Marshall Islands, "Marshall Islands Officials Welcome UN's Focus on Nuclear Legacy Impact" *YokweOnline* March 31, 2012, accessed April 13, 2014, http://www.yokwe.net/index.php?module=News&func=display&sid=2997.

man from Wisconsin sued the US Government to stop any further nuclear weapons tests in the Pacific. The grounds? The US Department of Defense and the Atomic Energy Commission had no right to contaminate the ocean, the atmosphere, those living, and their progeny. It was a powerful claim. They argued nuclear testing was "contrary to the human rights provisions of the United Nations charter."[5] Linus Pauling, Nobel Prize winning chemist, who worked to ban nuclear weapons since their first use in Japan, joined this suit. The combined legal cases became the "Fallout Suits" which from 1958 to 1964 argued that the citizens of the world had every right to live free from nuclear war, weapons, and threats of contamination. This was due to the plaintiffs' shared interpretation of the preexisting and inalienable human rights of "life, liberty and the pursuit of happiness."

Pauling, as lead plaintiff, brought this legal suit simultaneously against the US, Britain, and the Soviet Union. This strategy was used to eventually plead the case in the International Court of Justice. Pauling argued that the legal system, the scientists, and the government had all failed to protect the public from the harms and contamination caused by nuclear technology and radiation. For Pauling, radiation violated the boundaries of the sovereign body to cause, among other acute and delayed effects, disease, cancers, birth defects, and a shortened life span.[6] However, it was not the right to not be threatened or contaminated by nuclear technology that would prevail. Instead, by 1968 the "inalienable

[5] "Complaint for Declaratory Judgment and for Injunction" u.d. Box 6.001 File 1.1. "Court Document "Motion for Leave to File a Brief of Amicus Curiae." Albert Smith Bigelow, William Huntington, George Willoughby, Orion Sherwood; Petitioners vs. United States of America In the Supreme Curt of the United States, October Term, 1957" 13, Section Linus Pauling Peace, (hereafter LP Peace), Ava Helen and Linus Pauling Papers (hereafter AHLPP), Special Collections & Archives Research Center (SCARC), Oregon State University, Corvallis, Oregon.
[6] Linda Richards, "Fallout Suits and Human Rights: Disrupting the Technocratic Narrative" *Peace and Change Journal of Peace History* 38, no.1 (January 2013): 56-82.

right" of nations to develop nuclear science and power for peaceful purposes was enshrined as Article IV of the Non-Proliferation Treaty.

The very bones of all human bodies have been altered by the deposition of fallout. Freedom from threats and contamination however, were not perceived by institutions or legal precedent as a right, or framed as such in public discourse. Instead, seeing risks, not rights, limited moral and ethical questions to a scientific realm, considered by experts and turning on mathematical computations of risk versus gain. A few voices noted, however, that the conceptualization of forced exposure as a risk is inherently in and of itself, a violation of human rights. Working from within the Atomic Energy Commission, scientist John Gofman said,

> The "experts" who are in charge of protecting the public health require careful watching. Of course, watching is futile as long as individuals are denied their *right* to stop the imposition of risk and injury upon themselves and future generations…it is a violation of the most fundamental human rights to impose risks (deaths) upon individuals without their consent. Human rights should not be sacrificed to the pursuit of "a healthy economy," affluence, progress, science or any other goal. The whole benefit versus risk doctrine is a profound violation of human rights.[7]

This connection to human rights has been made in both the scientific and civilian communities. Expressions of the loss of humanity are often focused on Hiroshima and Nagasaki, the sites of the first atomic attacks. One survivor expressed Hiroshima as the very loss of just being human. Translated as "Bring Back the Human" this is one of the most famous poems of the twentieth century in Japan. It was one of many literary attempts that vocalized the experiences of inhumanity by survivors. It is written by Toge

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[7] John Gofman, *Radiation and Health* (San Francisco: Sierra Club Books, 1981), 414-5. To learn more about Gofman and radiation safety standards, see Iona, Semendeferi, "Legitimating a Nuclear Critic: John Gofman, Radiation Safety, and Cancer Risks," *Historical Studies in the Natural Sciences* 38, no. 2 (2008 Spring;): 259-301.

Sankichi (1917-1953), who died at 36 of leukemia from his exposure to radiation from the Hiroshima bomb:

> Give back my father, give back my mother;
> Give grandpa back, grandma back;
> Give my sons and daughters back.
>
> Give me back myself,
> Give back the human race.
>
> As long as this life lasts, this life,
> Give back peace
> That will never end."[8]

Intergenerational contamination as caused by nuclear technology intersects health and human rights history, cold war history, and law. Historians of science, instead, have addressed risk with a careful analysis to explain how risk science developed, but without viewing such risks in terms of human rights. However, historians like Claudia Clarke, Barton Hacker, J. Samuel Walker and Gabrielle Hecht focus on this intersection to address radiation contamination. These historians make clear the importance of human rights, legal cases and labor history to untangle radiation health history in their work.[9] Many authors from other disciplines, like Kristin Shrader-Frechette, Valerie Kuletz, Joseph Masco and Ulrich Beck also raise profound questions about the consequences of

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[8] A bit of a different English translation of the poem is "Give Me Back" but this shorter version is embedded in stone in the Hiroshima Peace Park but the feeling of dehumanization comes across in both versions, "Working Document III Atomic Bombs and Human Beings" in Shoichiro Kawasaki, ed *.A Call From Hibakusha of Hiroshima and Nagasaki International Symposium on the Damage and After-Effects of the Atomic Bombing of Hiroshima and Nagasaki July 21- August 9- 1977, Tokyo, Hiroshima, and Nagasaki* (Tokyo: Japan National Preparatory Committee, 1978) 124.

[9] Claudia Clarke, *Radium Girls, Women and Industrial Health Reform, 1910-1935* (Chapel Hill, NC: University of North Carolina Press, 1997), Barton Hacker, *Elements of Controversy: The Atomic Energy Commission and Radiation Safety in Nuclear Weapons Testing,* 1947-1974 (Berkeley: University of California Press, 1994) and Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Berkeley: University of California Press, 1987). J. Samuel Walker, *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000) and Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, MA: The MIT Press, 2012).

nuclear technology, from the health implications to the threat to democracy.[10] Recent dissertations that outline in detail radiation health and nuclear science by Toshihiro Higuchi and Emory Jerry Jessee, while intensely valuable to this dissertation, do not intersect with a narrative of health or human rights claims. The work of J. Christopher Jolly on the history of the fallout controversy is specific to internal debates of scientists. Mara Drogan outlines the infrastructure of a synergistic economic and foreign diplomacy set in place by research reactors and Atoms for Peace.[11] Like these others, Jacob Darwin Hamblin cannot be read without thought and consideration of the larger implications for humanity.[12] The work of these many authors, taken in the main, suggests the importance of broadening the frame of nuclear history to a meta-analysis. Nuclear history is a story also of contamination and health and human rights. This dissertation discusses not only human rights violations and claims but also the binary of nuclear science as both a Holy Grail and bane to humanity; scientists, the AEC and UN agencies believed in health as a human right and used it as a sincere tool to establish nuclear science.

These connections, while shown suggestively throughout primary documents, need to be made explicit in exploring the relationship between contamination, nuclear

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[10] Kristin Shrader-Frechette, *Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology* (Boston: D. Reidel Publishing Company, 1980), Valerie L. Kuletz, *The Tainted Desert: Environmental Ruin in the American West* (New York: Rutledge, 1998), Joseph Masco, *The Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico* (Princeton: Princeton University Press, 2006) and Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of the Rick Society* (New Jersey: Humanities Press, 1991).

[11] Mara Drogan, "Atoms for Peace, US Foreign Policy and the Globalization of Nuclear Technology, 1953-1960" (PhD Diss. University of Albany, 2011).

[12] Toshihiro Higuchi "Radioactive Fallout, the Politics of Risk, and the Making of a Global Environmental Crisis, 1954-1963" (PhD diss., Georgetown University, 2011), Emory Jerry Jessee, "Radiation Ecologies: Bombs, Bodies and the Environment during the Atmospheric Weapons Testing Period, 1942- 1965" (PhD diss. Montana State University, 2013), J. Christopher Jolly, "Linus Pauling and the Scientific Debate over Fallout Hazards" in *Endeavor* 26, no. 4 (2002): 148-53 and his dissertation "Thresholds of Uncertainty: Radiation and Responsibility in the Fallout Controversy" (PhD. diss., Oregon State University, 2003); Jacob Darwin Hamblin, *Arming Mother Nature: The Birth of Catastrophic Environmentalism* (Oxford: Oxford University Press, 2013).

science and human rights. All three topics are complex, problematic and disputed. Contamination is hard to detect, and the results may never manifest as harm. Nuclear science has two distinct discourses that run parallel and are irreconcilable, those who believe in nuclear technology as a key to progress and others, who are equally convinced of its inevitable negative consequences.[13] What unites these discourses is the promise of health and claims on human rights. Human rights, however, is also debated as both a new path to global citizenship and a failed mirage.[14] The working definition of human rights is "understood to be rights afforded to all people by virtue of the fact that they are human beings."[15] Yet these rights, especially a right to health, while considered by some universal, are also nebulous.[16] International instruments for health and human rights, while dating back to the founding of the United Nations, are still in a process of integration into national legal frameworks.[17] Cultural historian Riane Eisler argues the impediment to the realization of human rights is the intellectual and legal disconnection between the violence that occurs in the private sphere versus the public sphere.[18]

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[13] To simply show the breadth of the nuclear safety scientific dispute, compare J. Newell Stannard, *Radioactivity and Health: A History* (Pacific Northwest Laboratory, WA: Office of Scientific and Technical Information, Battelle, 1988) with Gofman, *Radiation and Human Health*. For nuclear issues as a whole compare the irreconcilable views of Stewart Brand *Whole Earth Discipline: Why Dense Cities, Nuclear Power, Transgenic Crops, Restored Wildlands, and Geoengineering Are Necessary* (New York: Penguin Group, 2010) with Harvey Wasserman and Norman Solomon *Killing Our Own: The Disaster of America's Experience with Atomic Radiation* (New York: A Delta Book, 1982).

[14] See Akira Iriye, Petra Goedde and William I. Hitchcock, eds., *The Human Rights Revolution: An International History* (Oxford University Press, 2012), versus Samuel Moyn *The Last Utopia: Human Rights in History* (Cambridge: Mass: The Belknap Press of Harvard University Press, 2010).

[15] Elizabeth Tobin Tyler, "Small Places Close to Home: Toward a Health and Human Rights Strategy for the US" *Health and Human Rights* 15, no. 2 (December 2013):80-96, see 81.

[16] Tyler, "Small Places," 82.

[17] Tyler, "Small Places." For a complete documentation of these international laws specific to health and human rights, see Stephen P. Marks, ed., *Health and Human Rights: Basic International Documents* (Cambridge, Mass.: Harvard University Press, 2004).

[18] Raine Eisler, "Human Rights and Violence: Integrating the Private and Public Spheres" in *The Web of Violence: From Interpersonal to Global* eds., Jennifer Turpin and Lester R. Kurtz (Chicago: University of Illinois Press, 1997), 161-85. Eisler writes "Recognizing the link between physical and structural violence at the micro and macro-levels can help us develop adequate analysis and solutions" (161).

In a similar way, perhaps a nuclear history of past health and human rights claims could clarify the historical and interpretive meaning of such rights. For example, little of health and human rights literature and protocols mention the lived experience of radiation affected communities such as the Navajo Nation, nor the fallout controversy of the 1950s and early 1960s, despite the magnitude of atmospheric weapons tests as a global pollution problem. James Peck argues that issues of disarmament were excluded from the canon of human rights discourse and literature because the development of human rights was influenced by the needs of the United States security state.[19] Health and human rights claims of both proponents and opponents of nuclear technology can provide a more meaningful frame to nuclear history.

The interpretation of human rights by nuclear scientists, many of them well meaning, also may have created grave violations of human rights. This dissertation attempts to untangle the maze of radiation safety and nuclear technology to understand how the daily operations of scientists in universities and agencies such at the Atomic Energy Commission (AEC) and the International Atomic Energy Agency (IAEA) could have contributed to this loss of rights.

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[19] James Peck, *Ideal Illusions: How the US Government Co-opted Human Rights* (New York: Metropolitan Books, 2010). For examples of leading health and human rights literature and recent environmental history that is disconnected from nuclear history, see Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011), and a popular human rights text, Paul Gordon Lauren, *The Evolution of International Human Rights: Visions Seen* (Philadelphia: University of Pennsylvania Press, 1998). Also see A. Belden Fields, *Rethinking Human Rights for the New Millennium* (New York: Palgrave Macmillan, 2003) and Akira Iriye, Petra Goedde and William I. Hitchcock, eds., *The Human Rights Revolution: An International History* (Oxford University Press, 2012). Recent health and human rights literature and protocols continues to be distinct from nuclear contamination, affected communities and fallout controversy history, see Marks*, Health and Human Rights Basic International Documents* and the leading journal *Health and Human Rights: An International Journal* (HHR) that has little if any mention in its articles of radiation contamination in communities as a health and human rights issue but does discuss in general rights to safety and health, see especially Dinesh Mohan, "Introduction: Safety as a Human Right" in "Violence, Health, and Human Rights " *Health and Human Rights*, 6, no. 2, (2003): 161-7. But for those impacted by nuclear pollution, it is perceived as such a health and human rights issue, as is to be shown especially in chapter 3 of this dissertation.

I argue that the dream of building a better world, with equality for all, and faith in science, did more than justify nuclear pollution. Being so driven to spread nuclear technology distorted the view of scientists in regards to many of the human rights violations they condoned. In this process, as imperceptibly as the radiation, nuclear scientists and agencies relegated rights to the state.

Three themes guide this narrative of human rights, dreams and violations. The first theme is about memory: forgetting has more consequences than first meets the eye.[20] History not captured as history, as a memory, according to historian Walter Benjamin, disappears irretrievably by the act of forgetting.[21] The connection between human rights and nuclear science followed an arc, beginning with a utopian vision of well-being and economic equality and ending with disillusionment. Nuclear scientists were proponents of human rights conceived as rights to economic development, nuclear medicine and nuclear education. Secondly, this work contributes to the recovery of just a few examples of lost human rights claims in both the courts and in historical scholarship. Thirdly, this research is guided by an inquiry into how the daily lives and thinking of scientists and the ordinary conduct of agencies and universities spread ideas of nuclear science as an inalienable human right. This dissertation shows what can be learned from the way various scientists understood radiation exposure and demonstrates how pursuing one version of human rights, embodied by their vision of a nuclear future, ultimately impinged on another understanding of human rights, namely sovereignty over one's own body.

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[20] Mathew Lavine *The First Atomic Age: Scientists Radiations and the American Public, 1895-1945* (New York: Palgrave MacMillan, 2013).
[21] Peter C. Van Wyck, *The Highway of the Atom* (London: McGill-Queen's University Press, 2010).

The first chapter, “Of Rights, Radiation, and Reactors,” explores the relationship between health and human rights and the early legacy of radiation. This is to establish that the pursuit of nuclear technology was not simply a rhetorical or utopian strategy but a sincere drive among visionary scientists like Frederick Soddy to create a better world. This chapter has discussed some of the origins of the dream of nuclear medicine and nuclear power as a tool for peace to understand why scientists were so dedicated to nuclear science. Setbacks to health, and even untimely deaths from radiation exposure in the present, were balanced against the possible gains from nuclear medicine or power in the future. With the discovery of fission and the first use of nuclear weapons, the modern conception of human rights became inextricably bound to the identity of scientists, and the founding of the UN. The same foundations that undergirded nuclear hopes and modernity were common to the development of United Nations agencies with the mission to create world peace through an establishment of universal human rights.

As chapter two “The Hidden Guns of the Atomic Frontier” explains, uncertainty was accepted as a challenge by scientists. Rights to health and peace were interpreted by scientists themselves as the right to economic development, nuclear education and nuclear medicine. Nuclear technology was spread rapidly because of the passion of these scientists acting as UNESCO and WHO technical experts. Their work accomplished the daily administration and instruction of transforming physics education into nuclear programs in developing countries. These programs were geared primarily around research reactors to provide nuclear education as a human right and to aid economic development. UNESCO and WHO distributed perceptions of the nuclear age with AEC norms as instructions, from elementary to adult education. The passion for nuclear technology as a right specifically became embedded in the efforts of not only the agency but also of universities and scientists.

The idea of a right to nuclear technology, however, was intercepted by other human rights claims. Chapter three links the fallout controversy with the history of health and human rights. In "Pauling vs. Libby" the scientific, legal and health and human rights dimensions of the fallout controversy can be seen in the contrasting lives of two chemists, Willard Libby and Linus Pauling. Their relationship erupted into one of the most global, yet little remembered, human rights struggles against nuclear war and contamination in the 1950s and 60s. How radiation exposure has been interpreted and understood by experts melds with what we conceive of as a human right, diverting from the lived experiences of people with contamination. Rights have been circumscribed by the prior claim on them by nuclear proponents for national sovereignty over the individual body, for nuclear medicine and for nuclear power.

The next two chapters compare radiation health safety in uranium mining and American and international college laboratories. Chapter four "The Circulation of Safety" ponders the exclusion of Native American uranium miners from health and safety precautions but also ponders how scientists, concerned so little with their own safety, could provide safety for others. Using archival documents from North Carolina's "First Temple of the Atom" and UN agency technical experts, this chapter explores how safety was thought about and enacted by scientists.

"The Deciders: Nuclear Science at Oregon State," chapter five, makes visible some of the academic relationships and infrastructure that gave the Atomic Energy

Commission (AEC) decision-making power.[22] By following one medium-sized college, Oregon State College (later Oregon State University), this chapter describes the hold on science and scientists that was created by the Atomic Energy Commission's reach and influence during the Atoms for Peace program. From 1944, with the first hire to teach nuclear physics, to the 1960s, radiation safety was established, promoted, and taught by the AEC. Yet, the AEC was as ambivalent about securing safety on campus as in the world. One can see on campus the expansion of nuclear science for peace and war was accomplished by the AEC through its original secretive military genesis and an AEC-cultivated web of academia, industry and international experts and agencies.

The web grows banal in the final chapter "In the Mundane" to show how the infrastructure of the AEC and its management contributed to human rights infringements. The AEC controlled radiation safety science by infiltrating meetings, conferences, studies, and scientific societies as it spread its interpretation of radiation dangers worldwide using technical experts. The dissertation concludes how human rights were defined as a property of governments and UN agencies formed by those with sociopolitical capital.

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[22] For an overview of the relationship of the university to science see Roger L. Geiger, "Science, Universities, and National Defense, 1945-1970" in "Science after '40" *Osiris,* 2nd Series, 7, (1992):26-48. The Manhattan Project transferred to the control of the AEC on January 1, 1947. The twelve facilities that made the first nuclear bombs were transferred from the military to civilian control after the war. This effort to create a civilian agency to oversee and non-militarize the benefits of nuclear power was primarily led by former Manhattan Project scientists, see Donald A. Strickland, *Scientists in Politics: The Atomic Scientist Movement, 1945-1946* (Purdue: Purdue University Studies, 1968); Lawrence S. Wittner, *Confronting the Bomb: A Short History of the World Nuclear Disarmament Movement* (Stanford: Stanford University Press, 2009) especially 1-8; Andrew Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford: Oxford University Press, 2012); Thomas Hagar, *Force of Nature: The Life of Linus Pauling* (New York: Simon and Schuster, 1998); See also "Atomic Energy: Early Legislative History and the Struggle for International Control" in the History of Atomic Energy Collection, 1896-1991, SCARC, which contains the early efforts of former Manhattan scientists to ban the bomb and for civilian control of the weapon. For an especially vivid record of this work, see clippings in Box 3.012 Emergency Committee of Atomic Scientists File 12. 5 "Non-Pauling typescript, Newspaper Clippings, Publicity Clippings 1946-1948," LP Peace, AHLPP, SCARC; "Angela Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago: University of Chicago Press, 2013), 2. Of the five rotating presidentially appointed AEC commissioners that directed the agency over the years, most were involved with the nuclear industry, or lawyers, agency directors, politicians and physical scientists.

Human rights often were not interpreted by governments in the same way that the affected communities or individuals perceived them. The inalienable right to the sovereignty of the body was not legally binding. Instead, the nations who signed the Non-Proliferation Treaty in the late 1960s and early 1970s were accorded the "inalienable right" to nuclear technology if declared for peaceful purposes. The influence of nuclear advocacy remained hidden in terms of diplomacy, human rights regimes, inequality, health and radioactive pollution. This dissertation hopes to activate new scholarship to reflect on how risk, nuclear contamination and human rights have been related to one another, in order to include affected communities in human rights protocols as definers of their own experience. Their claims to bodily sovereignty belong in the stories we tell. Just as in the 1950s, the future is created by how we think about health, human rights and nuclear history.

Chapter One Of Rights, Radiation and Reactors

Scientific men can hardly escape the charge of ignorance with regard to the precise effect of the impact of modern science upon the mode of living of the people and upon their civilisation. For them, such a charge is worse than that of crime. Frederick Soddy[23]

The first radiation age (1895 to 1945) caused a seismic shift in understanding the nature of the world. Previously unseen forces such as X-rays and radiation altered the relationships of humans to reality. With this new reality came hope and excitement, albeit tinged with fear. Turn of the century utopian atomic hopes were connected to ideas of modernity—an imagined future that could bring abundance, health, and perhaps, even human rights for all.[24] After the first use of nuclear weapons, the fear increased, but the hope became an even more powerful motivator.[25] This chapter contributes to previous scholarship by discussing the foundations of nuclear technologies by scientists who believed their work was a beacon for health and human rights. Studying the narrative arc of nuclear history and its changing relationship with health and human rights displays a story ranging from a utopian vision of well- being and economic equality to disillusionment. To understand radiation safety and the inequities that developed in it, we

[23] Frederick Soddy, "Banquet Speech" December 10, 1922, Nobelprize.org, accessed April 22, 2014, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1921/soddy-speech.html.
[24] In terms of the association of culture and advertising with radioactivity and culture in 1910-20, see Mathew Lavine *The First Atomic Age: Scientists Radiations and the American Public, 1895-1945* (New York: Palgrave MacMillan, 2013) 67, 140. These conclusions can be seen in primary materials by viewing subsection 15. Fiction, Poetry, Drama, Music and Literary Criticism, 1914-1989, History of Atomic Energy, 1896-1991, History of Science Collection, Special Collections and Archives Research Center (SCARC), Oregon State University, Corvallis, Oregon.
[25] For cultural perspectives that begin in 1945, see Jeffrey Womack, "Nuclear Weapons, Dystopian Deserts, and Science Fiction Cinema" *Vulcan* 1, 2013: 1-16, Paul Boyer, *By the Bombs Early Light: American Thought and Culture at the Dawn of the Atomic Age (*New York: Pantheon Books, 1985) and Spencer Weart, *Nuclear Fear: A History of Images* (Cambridge, MA: Harvard University Press, 1988). To see this captured in a primary source, see the "The Atomic Revolution: A Nuclear Comic Book from 1957" *Scientific American*, accessed April 10, 2014, http://www.scientificamerican.com/slideshow/atomic-revolution-comic-1957/.

must assess the forces that compelled scientists to create worldwide infrastructures for nuclear technologies and science in the first place.

Many of the proponents of nuclear science for electrical power and medicine were philosophers at heart. Frederick Soddy, one of the first chemists to articulate transmutation and atomic theory, expressed his hopes for the atomic age as a chance to create equality by the redistribution of wealth, away from a cash economy. Soddy was both nuclear scientist and writer, and he authored one of the most influential popularizations of atomic science, *The Interpretation of Radium* in 1909. After his disgust with the complicity of chemists in the deaths of the First World War, and his fears of the potential use of atomic energy for war, Soddy turned to a study of political economy.

Soddy felt the global monetary system was perpetuating poverty and should be radically changed. He wrote four books that interpreted the economy as physics. He felt the way the economy operated, was in reality, rooted in physics and limited by the laws of thermodynamics: the amount of energy put in, created things of real value. For Soddy, economists thus far had incorrectly interpreted the economy as outside the laws of physics. The economy, he argued was not a perpetual energy machine and due to entropy, value of real items depreciated with use. The system of unlimited bank loans and their generation of vast debt interfered with what should be fair exchanges of real value. Soddy argued against the use of virtual paper, coin money and the gold standard as a measure of wealth because the cash value of something was disconnected from the actual tangible physical value of needed objects. Instead, an economy based on physics would redistribute wealth more fairly. He thought wealth should be measured in terms of real objects, such as facilities and access to electricity for power production.[26] Nuclear energy could provide access to tangible wealth to address the inequality that in Soddy's mind, led to war.

In the late 1950s, an optimistic Soddy felt the peaceful side of the atom had the power to finally end the unjust separation between the philosopher and the laborer. The present western civilization was modeled on the Greek, Roman, and Ancient Jewish societies and like these, was founded on slave and physical labor to power their worlds. He defined history as "a tragic story of an enduring dichotomy, of a gulf that opened up and split men in twain, of a yawning chasm dividing the philosopher from the humble unsophisticated worker still unhealed, but which now must be healed if the race is to endure."[27] Soddy felt this division among men ran parallel to the progress of science for twenty- five centuries. The musing about atomic theory by the Greek philosophers had led to its fruition, nuclear technology. Soddy believed this separation between the head and hand was about to radically change with the advent of atomic energy.

For Soddy, both nuclear science and nuclear disarmament were ways out of inequality and war caused by dominance. The struggle against nuclear weapons and for nuclear energy now, he wrote, is uniting all people to "begin to think about how it [the

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[26] Lavine, *The First Atomic Age,* 66-7; Eric Zencey, "Mr. Soddy's Ecological Economy" *The New York Times* Op-Ed, April 11, 2009, accessed April 10, 2014, http://www.nytimes.com/2009/04/12/opinion/12zencey.html?pagewanted=all.

[27] Frederick Soddy, introduction to *The Story of Atomic Theory and Atomic Energy,* by J.G. Feinberg (New York: Dover Publications, Inc, 1960) v, vi. Soddy published many books beyond The *Interpretation of Radium: Being the Substance of Six Free Popular Experimental Lectures Delivered at the University of Glasgow in 1908* (New York: G.P. Putnam and Sons, 1909). His books were written not only for physicists, but for the public to understand atomic energy, including *Radioactivity,* 1904, *Wealth, Virtual Wealth and Debt: The Solution of the Economic Paradox,* 1926, *The Interpretation of Atoms,* 1932, *The Atom Story*, 1949 and *Atomic Transmutation, 1953.* For a feeling for the philosophical thought about atomism and physics during the early 1950s, see Andrew G. Van Melsen, *From Atomos to Atom*, (New York: Harper and Row Publishers, 1952).

human race] is going to survive."[28] Nuclear technology came to represent an existential choice between destruction and construction, war and peace. Like Soddy, many scientists held the conviction that nuclear energy could open the door to a new, unimaginable future, instead of more bloodshed. This was especially true for the very atomic scientists who worked on the Manhattan Project.

The use of nuclear weapons was opposed by many of the very scientists who created them. Some even tried to transmute the horror of nuclear weapons into a force for peace.[29] A few historians have focused on the "atomic scientist movement" from the 1940s to the early 60s. Scientists became overtly political actors, sparked by the intensity of their revulsion over the bombings of Hiroshima and Nagasaki to ban nuclear weapons.[30] Scientists in the United States, Britain and around the world crossed boundaries of science into political realms to advocate for an end to war. Some also promoted nuclear energy as a panacea for the world's ills, conflating their passion "to beat swords into plowshares" with promoting nuclear technology. This was not without sacrifice. Advocacy by these atomic scientists for internationalism and peace made them

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[28] Soddy, introduction to *The Story of Atomic Theory,* v, vi, quotation on page v.
[29] Donald A. Strickland, *Scientists in Politics: The Atomic Scientist Movement, 1945-1946* (Purdue: Purdue University Studies, 1968); Andrew Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford: Oxford University Press, 2012); Karl Z. Morgan and Ken M. Peterson. *The Angry Genie: One Man's Walk through the Nuclear Age* (Norman, Oklahoma: University of Oklahoma Press, 1999); Linus Pauling, *No More War!* (New York: Dodd, Mead and Company, 1958); Thomas Hagar, *Force of Nature: The Life of Linus Pauling* (New York: Simon and Schuster, 1998); John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence" *Osiris* 21 (2006): 161-81; For the larger effort to oppose war and nuclear weapons see Lawrence S. Wittner, *One World or None: A History of the World Nuclear Disarmament Movement Through 1953*, *Volume One, The Struggle Against the Bomb* (Stanford: Stanford University Press, 1993*), Confronting the Bomb: A Short History of the World Disarmament Movement* (Stanford: Stanford University Press, 2009) and *Resisting the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970 Vol. 2 of The Struggle Against the Bomb* (Stanford: Stanford University Press, 1997). For the political framing of the Atoms for Peace project, see Ira Chernus, *Apocalypse Management: Eisenhower and the Discourse of National Insecurity* (Stanford: Stanford University Press, 2008) 66-78.
[30] Strickland, *Scientists in Politics,* 137-8; Krige, "Atoms for Peace"; Jessica Wang," Scientists and the Problem of the Public in Cold War America, 1945-1960"*Osiris,* 2nd Series, Vol. 17, Science and Civil Society (2002): 323-47.

high security risks to the state.[31] Their personal dedication can be obscured by institutional histories and hegemonic rhetoric.[32]

The belief in nuclear power was never just a façade. While it is true that nuclear power for electrical production is inextricably linked to weapons technology, the documents and records of American and international scientists' groups and agencies show the push for nuclear energy was not just a national self-interested pursuit of power: it was also embedded within a sincere quest for a better world. However, the utopian vision of "the peaceful atom" has been realized in the context of a type of nostalgic kitsch for the era. One can indulge in atomic tourism at the Hanford B-Reactor, the Experimental Breeder Reactor I, Arco, Idaho and even Chernobyl and wander amid the displays of children's Atomic Lab science kits, comic books and "Atomic Man" lunchboxes at nuclear museums.[33] But this notion of a "peaceful atom" is nonetheless much more serious and can be connected to the genuine pursuit for economic and social

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[31] Lawrence Badash, "From Security Blanket to Security Risk: Scientists in the Decade after Hiroshima" *History and Technology* 19, no. 3 (2003) 241-256; Hagar, *Force of Nature;* Krige, "Atoms for Peace"; Wang," Scientists and the Problem of the Public"; James G. Hershberg, *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age* (New York: Alfred A. Knopf, 1993); Weart, *Nuclear Fear.*
[32] Chernus, *Apocalypse Management,* especially 66-78; Krige, "Atoms for Peace." For an in depth institutional history of Atoms for Peace, see Richard Hewlett and Jack M. Holl*, Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989) and J.E. Hodgetts, *Administering the Atom for Peace* (New York: Atherton Press, 1964).
[33] The National Museum of Nuclear Science History, located in Albuquerque NM has disarmed warheads on display and shows the atomic age as an exploration of such kitsch in its Atomic Culture-Pop Culture display, accessed April 5, 2014, http://www.nuclearmuseum.org/see/exhibits/atomic-culture-pop-culture/http; The Nevada Testing Museum recently worked with University of Nevada at Las Vegas art department in to create "Cloud 9" an art display using atomic bomb art, including recreating the famous bikini clad atomic beauty queen, see Bryant Nguyen, "UNLV art students collaborate with Atomic Testing Museum" March 23, 2010, accessed April 8, 2014 http://www.unlvrebelyell.com/2010/03/23/students-submit-atomic-art/ and Charlie Jane Anders "Retro Atomic Bomb Art Celebrates The Kitsch Of Nukes" accessed April 1, 2014, http://io9.com/5501657/retro-atomic-bomb-art-celebrates-the-kitsch-of-nukes/; See also atomic tourism to places like Hanford, Chernobyl and Three Mile Island, "New Sight in Chernobyl's Dead Zone: Tourists" *New York Times* June 15, 2005, accessed April 10, 2014, http://www.nytimes.com/2005/06/15/international/europe/15chernobyl.html?_r=0; Leanne Italie "Japan Disaster Boosts Interest in Atomic Tourism" March 30, 2011 *AZ. Central Travel and Explore*, accessed April 5, 2014, http://archive.azcentral.com/travel/articles/2011/03/30/20110330japan-disaster-atomic-tourism.html.

justice. Scientists believed their work was essential for human health and development to create progress in human rights, before the term was utilized as such.

The heart-felt promise of nuclear energy for peace and health never was simply propaganda. Literature and archival research from early physics to the first use of nuclear weapons and the establishment of the UN that same year only reiterates the passion for nuclear science. Eventually this dedication of the scientists themselves, often a utopian wish for equality and sustainability, led to 17% of the world's power by 1994 (the highpoint of thus far of world output) being derived from nuclear reactors. Nuclear power was a technology that had not existed less than fifty years before.[34] By 1970, the pursuit of nuclear power would be enshrined in international law as one of the most fundamental rights usually ascribed to only human beings, as "an inalienable right" of nations, "with due consideration for the needs of the developing areas of the world" by the Nonproliferation Treaty of 1968.[35] Scientists embraced a hope for economic parity that inevitably led to a disaster of inequities in radiation health protection. The loss of individual protection for the few was the result of a utopian wish to repair inequities in the world as a whole.

Early nuclear physics, health and harm

Utopian ideas of the 19th century collided with atomic hopes. To understand the relationship between nuclear science, health, and human rights, it is important to revisit the establishment of nuclear science and technology by scientists aspiring to use it to

[34] Alvin M. Weinberg *The First Nuclear Era: The Life and Times of Technological Fixer* (New York: American Institute of Physics, 1994) 281; In 2013 that percent of worldwide power is at 11% and 19% for the USA according to the World Nuclear Association, accessed April 23, 2014, http://www.world-nuclear.org/Nuclear-Basics/.

[35] The text of the treaty is available at the "2005 Review Conference of the Parties to the Treaty on Non-Proliferation of Weapons" website, see Article 4, 1 and 2, accessed February 2, 2013, http://www.un.org/en/conf/npt/2005/npttreaty.html.

meet human needs. The utopian ideas already in circulation during the end of the nineteenth century found immense promise melded with the surprising discovery of radiation itself.[36] These included the ideas of Robert Owen's socialist utopias and, after the discovery of radiation, a universalist scientists' movement. The goal? To spread knowledge to reduce conflict.[37]

The wonder of science seemed undeniable in the era, as did the potential it offered for commoditization and healing.[38] Nikola Tesla captured shadowgraphs of his bones by radiation in 1892.[39] The existence of rays was confirmed by Wilhelm Roentgen, confirmed the existence of what came to be called X-rays in 1895. Roentgen thought the development so important to humanity and medical care that he did not patent the device that became the ubiquitous X-ray machine. He donated his Nobel Prize money of 1901 to the University of Würzburg**.**[40] Because X-rays allowed people to see inside a human body, they represented a new ability to understand humanity in introspective and unexpected ways.

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[36] Richard E. Sclove "From Alchemy to Atomic War: Frederick Soddy's "Technological Assessment" of Atomic Energy, 1900 -1915" *Science, Technology, & Human Values,* 14:2 (Spring, 1989): 163-94. This utopianism is also seen throughout the literature of the SCARC Atomic Energy Collection.
[37] John Harrison, *Robert Owen and the Owenites in Britain and America: The Quest for the New Moral World* (New York: Routledge Revivals, 2009, first published 1969); W. Boyd Rayword ed., transl., *International Organizations and the Dissemination of Knowledge: Selected Essays of Paul Otlet* (New York: Elsevier, 1990) see in particular the preface and introductions for history of international scientific unions and the dissemination of knowledge as a peace movement; Laura Cray, "Mapping the Universe with Robert Fox" *History of Science at Oregon State University*, accessed April 3, 2014 http://blogs.oregonstate.edu/historyofscience/2013/05/08/mapping-the-universe-with-robert-fox/.
[38] Mathew Levine, *The First Atomic Age*.
[39] Margaret Cheney and Robert Uth, *Tesla: Master of Lightning* (New York: Barnes and Noble, 1999) 75.
[40] G. L. E. Turner, "Röntgen (Roentgen), Wilhelm Conrad" in *Complete Dictionary of Scientific Biography* 11 (Detroit: Charles Scribner's Sons, 2008) 529-31; Robert W. Nitske, *The Life of W. C. Röntgen, Discoverer of the X-Ray* (Tucson: University of Arizona Press, 1971).

Early atomic scientists were aware that the power of the atom, if it were to be understood, could alter human experience beyond imagination.[41] Less than a year after the discovery of Roentgen rays (X-rays), Henri Becquerel in Paris found that a different type of radiation than X-ray radiation was emitted from minerals that contained uranium. Two years later, Marie Curie, also in Paris, isolated the elements of polonium and radium, and the allure of the unusual characteristics of radiation became a worldwide scientific interest.[42] An explosion of inquiry into invisible rays of all kinds occurred in Europe, especially in France from 1895 to 1905, and scientists debated the qualities of different rays such as cathode rays, Becquerel rays, black light and especially X-rays.[43] This genuine optimism at the start of what could be called the radiation age is encapsulated in the hopes of Sir William Crookes in 1898: "The store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the twentieth century to cast into the shade the marvels of the nineteenth."[44]

Science was upended by radiation. The discovery of something artificial (X-rays from the reaction of a stream of electrons inside cathode ray tubes) leading to something natural (radioactivity from uranium salts) inverted the common order of discovery. In

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[41] James W. Behrens and Allan D. Carlson, eds., *Fifty Years with Nuclear Fission, Volume 1 and 2, National Academy of Science, Washington DC and National Institutes of Standards and Technology, Gaithersburg, Maryland April 25-28 1989* (La Grange Park, Illinois: American Nuclear Society, 1989). This belief was mentioned in many of the papers in the above volumes, including by John Wheeler, "Fission in 1939: The Puzzle and the Promise," 45-52, an absolutely gripping account of the era; See also *Proceedings of the Atoms for Peace Awards 1957-1969: A Memorial to Henry Ford and Edsel Ford* (Cambridge: Massachusetts Institute of Technology Press, 1978); Some earlier ideas were connected to spirituality and the occult, see Simone Natale, "The Invisible Made Visible: X Rays as Attraction and Visual Medium at the End of the Nineteenth Century" *Media History* 17, no. 4 (2011): 345-58.
[42] Lawrence Badash, *Scientists and the Development of Nuclear Weapons: From Fission to the Limited test Ban Treaty, 1939- 1963* (New York: Humanity Books, 1995), 12-13. For one of the best detailed histories of early radiation studies from 1900 to 1920, see Badash's *Radioactivity in America: Growth and Decay of a Science* (Baltimore: John Hopkins University Press, 1979).
[43] Mary Jo Nye, "N-Rays: An Episode in History and the Psychology of Science" in *Historical Studies in the Physical Sciences* 11, no. 1 (1980): 130, 151-56.
[44] Alex Keller, introduction, *The Infancy of Atomic Physics: Hercules in his Cradle* (Oxford: Clarendon Press, 1983).

addition, the entire meaning and canon of Newtonian physics and the understandings of the conservation and persistence of matter were smashed by the appearance of rays, emitted without explanation. The discovery of radiation cast doubt upon previous understandings of how the world worked, altering human relationships to matter.[45]

There was enthusiasm for novelty in rays of all kinds among scientists and the public. Electricity had been an essential part of discovering radiation and also influenced its reception. X-ray machines, their development dependent on advances in both electricity and photography, were built rapidly in order to see into the body for treatment of injuries. The machines did help physicians see and set broken bones, but the untested hopes that rays could also be a miracle cure for illness was persuasive, far exceeding the practical applications of X-rays.[46] The excitement for roentgen rays mirrored the excitement during the invention of electric light. A belief in vitamin-like healing effects from electric rays was thought to restore human energies. The belief in rays of all kinds as cures and supplements for health and energy combined with other ideas such as healing waters.[47] Electric light was touted for agriculture, as a type of fertilizer for plants. Until the early 1920s, scientists and doctors thought of X-rays as related to electric current cures, and their writings often discussed electricity and radiation in tandem as

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[45] Bertrand Russell, *The ABCs of Atoms* (New York: E.P. Dutton & Co. 1923) and *The ABCs of Relativity* (New York: Harper & Brothers, 1925); Ulrich Beck shares this thinking on trust and acknowledges the loss of individual ability to create a safe existence. The sensory perception of the individual is subsumed to a risk based society that no longer trusts human instincts, but accepts mathematical modelers, scientists and statisticians as the authorities to determine fate. Beck argues that the very foundations of life have changed in many of his works, as explained in his *Ecological Enlightenment: Essays on the Politics of the Risk Society*, translated by Mark A. Ritter (New Jersey: Humanities Press, 2001) 63-76. This chapter is specific to living after Chernobyl, described by Beck as an event that caused "anthropological shock."
[46] Levine, *The First Atomic Age* see especially 32, 200; Sclove "From Alchemy to Atomic War." This utopianism is also seen throughout the literature of the SCARC Atomic Energy Collection; Cheney and Uth, *Tesla,* 75.
[47] Wolfgang Schivelbusch, *Disenchanted Night: The Industrialization of Light in the Nineteenth Century* (Berkeley: The University of California Press, 1995) 69-76.

electrotherapeutics and radiology.[48] This would all influence the radiation age, with its hopes for health and for agricultural uses, as well as the belief that large scale electric power plants were the most efficient way to produce individual well being.[49] The rays created new ideas of how to best organize society to utilize resources such as electric light and radiation.

Human radiation experiments were a part of this social project. Experimenters used the rays to try to cure illness within one year of Roentgen's 1895 discovery. [50] While odd burns on the skin perhaps indicated the usefulness of radium in treating cancerous tumors, X-rays were used as a medical treatment for breast, nasopharyngeal, and stomach cancer, lupus, and blindness in America, Germany, and France by 1896. Also, fluoroscopy (the taking of X-ray photos) created one of the first biologic reactions on X-ray operators (or as they were called at the time, roentgenists): irritation of the eyes. This led to investigations, against Tesla's insistence that such cures were quackery, of therapeutic effects for blindness and cataracts.

Scientists were unable to control radiation dosage or accurately predict effects. Visible effects upon the skin that later destroyed the hands and arms and shortened the lives of workers at the time was often disregarded, or even misunderstood as therapeutic. Scientist U.V. Portman noted in 1933, the obvious cause and effect of radiation exposure "was not appreciated, being attributed to all sorts of causes except Roentgen rays." Many

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[48] "Electrotherapeutics and Radiology," 1921 box 2 File 14 Frank J. Hartman Papers, 1904-1977 MSS 2/0340 Historical Medical Library at the College of Physicians of Philadelphia, Mutter Museum, Philadelphia and "Electrotherapeutics and Radiology," 1921 box 2 File 14 Frank J. Hartman Papers, 1904-1977 MSS 2/0340 Mutter Museum; Jean Gerard's assistant (illegible name) to Professor Porter, President of the Faraday Society, Feb 7 1921, IUPAC VIII.R. "Commission on Radiochemistry" Box "Radiochemistry, 1920" Chemical Heritage Foundation (CHF), Othmer Library, Philadelphia.

[49] Schivelbusch, *Disenchanted Night,* 69-76.

[50] Levine, *The First Atomic Age*; Michelle Gerber, *On the Home Front: The Cold War Legacy of the Hanford Nuclear Site* (Lincoln: University of Nebraska Press, 1992) 26-7.

scientists, doctors, and radiologists, however, were at the same time experimenting and, it turned out, sacrificing themselves and their patients in the effort to utilize this new confusing force.[51]

In fact, with such intense dedication of scientists, human progress seemed to be unlimited. The scientific tradition colored science as an act of religious devotion. Marie Curie and the other early radiation scientists, personified selfless, heroic effort in the service of humanity. She once wrote of her work, "Life is not easy for any of us. But what of that? We must have perseverance and above all confidence in ourselves. We must believe we are gifted for something, and that this thing, at whatever cost, must be attained." Later, her excruciatingly tedious and difficult labor in extracting radium was published in *Proceedings* as *"*On a New and Strongly Radioactive Substance Contained in Pitchblende*"* with her idealistic husband Pierre Curie and G. Bemont.[52]

Other scientists characterized their work as part of a centuries-long process of tapping into the riches of nature for the common good. Just as medieval alchemists had hoped to make gold from common ingredients laboriously nurtured, Ernest Rutherford and Frederick Soddy seemed to suggest a similar process when they described radioactive decay from one element to another. Soddy, much to Rutherford's embarrassment, described their work as a modern alchemy. Elements were no longer stable, but one element transmuted, and changed into another and another. This notion of a transmutation led to speculation in 1900 by an American chemist, "Are our bicycles to be lighted with

[51] U.V. Portman, "Roentgen Therapy" in *The Science of Radiology* ed., Otto Glasser, (Springfield, Illinois: Charles C. Thomas, 1933) 211-213, 217, quotation is from 213, Mutter Museum; Daniel S. Goldberg, "Suffering and Death among Early American Roentgenologists: The Power of Remotely Anatomizing the Living Body in Fin de Siècle America" *Bulletin of the History of Medicine* 85, no. 1 (Spring 2011): 1-28; Levine, *The First Atomic Age;* Cheney and Uth, *Tesla*, 76.
[52] Eve Curie, *Madame Curie: A Biography*, trans. Victor Sheen (New York: Pocket Books, 1967) 161-173, 362.

disks of radium in tiny lanterns? Are we about to realize the chimerical dream of the alchemists, lamps giving light perpetually without consumption of oil?"[53] Progress seemed inevitable.

While scientists thus speculated, the potential dangers of radiation did not seem as likely as healing effects. Nicola Tesla described accidental radiation exposure to his hand in a *New York Times* article in 1896 as a sharp stinging pain that was felt when the stream of particles entered and exited through his flesh. But Tesla's instinct was not to fear harm. Instead, he thought that this effect suggested healing chemicals of some sort, which could be injected directly into any part of the body as a therapeutic agent. This optimism in the literature from the era shows that utmost in the minds of scientists and physicians was the potential for healing.[54] The popularity of radium and its hopes were expressed by artists with "radium dances in ballets" and the public rush to purchase radium collars, stoves, and glowing polish.[55] Cures such as radium compresses for wounds, radium water to drink, radium bread, and radium toothpaste were pervasive despite known health effects such as vomiting, hair loss, and skin lesions.[56] Consumers were a driving force, but they were fed by experts, too.

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[53] Badash, *Scientists and the Development of Nuclear Weapons,* quotation on 17. Transmutation describes the release of alpha and beta particles, which inherently changes the composition of an atom (and thus it becomes a different element or a different isotope of the same element), a process that continues until a stable, non-radioactive state is reached (lead).

[54] Lavine, *The First Atomic Age;* Cheney and Uth, *Tesla*, 76: Primary sources throughout the SCARC History of Atomic Energy Collection, especially 1. Early Physics, 1896-1942 and 15. Fiction, Poetry, Drama, Music and Literary Criticism. 1912-1989 show this same hope held by scientists and in popular culture.

[55] Dr. W. Hampson *Radium Explained* (London: T.C. & E.C. Jack, 1905) 1, 107-109.

[56] Lavine, *The First Atomic Age*. Lavine also points out that luckily, many of the items marked as having radium in them did not, and in most cases it was a rhetorical marketing device more often than not. Unfortunately the Radithor did contain radium. For more on the first radiation craze, see Edward Landa`, *Buried Treasure to Buried Waste: The Rise and Fall of the Radium Industry*, Colorado School of Mines, 1988; "Warning Against Fake Radium Cures; Dr. Carl Alsberg Says That Impostors and Quacks Are Deceiving the Public," January 2, 1914, *New York Times,* accessed April 2, 2014, http://query.nytimes.com/gst/abstract.html?res=9C01E2D6173EE733A25751C0A9679C946596D6CF.

Radium Explained, a small 1905 primer, warned of the dangers of radioactivity but also explains why it held such promise for generating power. The book, written by Dr. W. Hampson, had a microscope viewing gold emanating rays on its cover. The discovery that elements can change into others is proof, he wrote, that "underlying the differences between the various elements there is some simpler, more elementary" composition of matter. Therefore, radium had prospects for the future in hopes that the reaction could learn to be controlled, one day. Dr. Hampson explained why this future was so tempting: "radium is thirty thousand times more powerful than any other known combustible, one pound of radium equaling the power of fifty tons of coal… due to the scarcity of radium the process of disintegration itself must be studied and mastered so that in common materials the intra-atomic energy can be liberated." [57] The drive for understanding radium was so that one day society could utilize the atomic forces in *all* objects.

The use of x-rays and radium as therapy and medicine only accelerated during the First World War. Madame Curie and her daughter Irène shared a deep conviction that radiation was a benefit for mankind. Together they built the first traveling mobile X-ray machine, powered by the motor of their car engine. They brought the machine into the war zone of the Belgian front at great risk of their lives to aid soldiers.[58] The self-sacrificing attitude of other scientists can be seen by the early practitioners of X-ray therapy and experiments, who often knowingly sacrificed their hands and even their lives to practice and see inside the human body. The visible damage was often interpreted as minor lesions on the skin, yet sometimes practicing X-ray machinists and physicians

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[57] Hampson, 1, 107-109, quotation on 107.
[58] Eve Curie, *Madame Curie,* 305, 306, 309-311.

continued to sacrifice their body to operate machines and handle radium even after the dangers materialized in amputations of fingers, hands and arms.[59]

Even as X-ray machines proliferated during the war, there were rising challenges of how to minimize accidental harm. The inability to calibrate doses of the early machines may have led to many cases of intense exposure to harmful radiation. Historians now look to this as a major cause of malformations and deaths of some of the radiologists who operated the machines. Exposure resulted in painful bone diseases and often led to amputations of fingers, then hands and arms. The radium industry, similarly, would soon lead to ailments and deaths. Far from the hoped for cure, radium inhaled or taken internally continuously emitted radiation inside the body. In the early 1930s, for example, Eben Byers, a wealthy steel magnate, believed drinking radium was invigorating his health. He could afford to drink the manufacturer's recommended amount of four "Radithor" bottles a day, thus ingesting two microcuries of Ra-226 and 228 in a half an ounce of water four times a day. He soon became ill with untreatable leukemia as the radium displaced the calcium in his bones, irradiating him from the inside. The women who licked the tips of their paintbrushes to have a stronger point to paint radium onto glow in the dark watch dials developed strange painful cancers of their

[59] Goldberg, "Suffering and Death" 1-28; Cynthia G. Jones, "A Review of the History of the U.S. Radiation Protection Regulations, Recommendations and Standards" in *A Half Century of Health Physics: A Historical Review* eds., Michael T. Ryan and John W. Poston, Sr., (Baltimore: Lippincott Williams and Wilkins, 2005), 181-97. Jones explains that as early as 1910 skin cancer was being reported and a year later, 94 cases of X-ray harm were reported with conclusions that radiation could cause sterility, bone disease and cancer. Jones concludes that standards eventually were based on risks versus benefits model of early radiation control organizations like the ICRP and that this guiding philosophy is still used by a majority of US federal and state agencies.

jaws. Madame Curie herself would join the many X-ray operators, radium watch dial painters and people who drank "Radithor" who eventually suffered from exposure. [60]

Despite these consequences, the radium industry only grew in the first decades of the twentieth century.[61] This success was due in part to the integration of the industry by the 1930s. Despite the well-publicized tragedies and deaths later in the 1930s, the industry survived by proposing with doctors the idea of a safe threshold combined with amazing benefits yet to be tapped. The benefits were rich, just below these "accidentally" high doses, most often blamed on quackery or negligence. Only experts certified by the American Medical Association could administer doses healthfully. The radiation tragedies only served to grow professionalization and establish more expertise for trusted physicians and scientists.[62]

The foundations for this expertise were in early societies formed by believers in the uses of radiation. Before the more publicized scandals of the deaths of Curie, the radium girls and Byers in the 1930s, the American Roentgen Ray Society had been established in the early 1900s to enable the industry to flourish. This was because of observations as early as 1901 that radiation could cause to animals internal damage and abortion. Calibration of instruments to control or even measure doses, however, was difficult. The volunteer Society met to share papers and findings and was composed of primarily physicians, X-ray operators and radium industry representatives. Decisions were influenced by these presentations and made by resolutions supported by members at

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[60] Lavine, *The First Atomic Age,* 4, 6, 112,146-151, 158, 194; Robley Evans "Origins of Standards for Internal Emitters" in *Health Physics: A Backward Glance: Thirteen Original Papers on the History of Radiation Protection,* eds. Ronald L. Kathren and Paul L. Ziermer (New York: Pergamon Press, 1980) 141-8; Goldberg, "Suffering and Death" 1-28; Claudia Clark, *Radium Girls, Women and Industrial Health Reform : 1910-1935* (Chapel Hill, NC: University of North Carolina Press, 1997).
[61] Jon Agar, *Science in the Twentieth Century and Beyond* (Cambridge, UK: Polity Press, 2012) 233, 256.
[62] Lavine, *The First Atomic Age* 150-5, 161-3.

the meetings, most often reaching for consensus. A British counterpart established a resolution to form a committee to develop standards of radiation protection but no action was taken on the recommendations for five years due to the First World War and "indifference." [63]

This indifference abruptly ended with news reports of deaths from leukemia from the many uses of X-rays during the war. The American and British both soon adopted the first protection recommendations that were rapidly adopted internationally starting in 1922. The International Commission on Radiological Protection (IRCP) began meeting in 1928 to further standardize and institute protections such as shielding. Lauriston Taylor, a key member of the ICRP, returned to the states to unite all the American radiation societies in what became the National Committee for Radiation Protection (NCRP). Overlap of members of the various American and ICRP committees had as a result a certain consensus that implied confirmation of truth. Eventual safety guidelines, however, produced by the committees were based on commonly held assumptions inferred from toxicology models for chemicals that allowed for thresholds of safety and ideas of cellular repair. In addition, the standards were not based on any experimental evidence, but collated from short term individual observations, such as of visible skin burns and loss of hair. Genetic effects, despite awareness of them, were not included in protection, nor were medical patients. The goals were to protect the operators of the machines from sterilization and injury with shielding.[64]

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[63] J. Christopher Jolly, *Thresholds of Uncertainty: Radiation and Responsibility in the Fallout Controversy* (Phd diss. Oregon State University, 2003), 26-45; Lauriston Taylor, *CRC Radiation Protection Standards* (Cleveland, Ohio: Chemical Rubber Company Press, 1971), 9-15 quotation on 11. For much more on radiation regulatory history see J. Samuel Walker, *Permissible Dose A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000) and Catherine Caulfield, *Multiple Exposures: Chronicles of the Radiation Age* (New York: Harper & Row, 1989).

[64] Jolly, *Thresholds of Uncertainty*, 26-45, 36-45; Taylor, *CRC Radiation Protection,* 9-15.

Much of the philosophy of radiation protection can be traced back to an informal survey of less than six hospitals by one man, Arthur Mutscheller. He worked for Wappler Electronic Controller Company, which manufactured X-ray equipment.[65] Mutscheller, typical of the ideas of members of the NCRP and ICRP, did not want to intrude on profits. His directives were based on balancing costs against gains from protection, always taking into account the benefits to be gained from radiation.[66] Mutscheller's work, and the idea of a safe threshold, was interpreted by the NCRP and the ICRP as confirmed by the other surveys, including work by Rolf Sievert of Sweden. , Neither Sievert nor Mutscheller were using quantified numbers, but they both independently came to a common number of an acceptable dose: ".1 of an erythema dose," or one tenth of what it was assumed it took to make a visible skin burn or erythema. In other words, one tenth of what caused a visible injury would be a reasonably safe dose that would not cause harm. Sievert determined his number the same year, also in 1924 and with no experimental evidence. He felt that humans could tolerate a .1 of an erythema dose a year of natural background radiation without harm. These findings, with other estimates, were then used to determine the first quantitative limits adopted. The erythema dose became expressed in terms of a measurable dose, the Roentgen, which is based on a physical measure of photon radiation. The acceptable limit was set as .1

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[65] Jolly, *Thresholds of Uncertainty,* 36-45; Caulfield, *Multiple Exposures,* 18-21; Taylor, *CRC Radiation Protection*, 9-15.

[66] Arthur Mutscheller "Physical Standards of Protection Against Roentgen Ray Dangers" *American Journal of Roentgenology* 13, no. 65, 1925; Ronald L. Kathren and Paul L. Ziermer, eds., *Health Physics: A Backward Glance: Thirteen Original Papers on the History of Radiation Protection,* (New York: Pergamon Press, 1980) 3, 6, 119, 127, 185-9; Federation of American Scientists, "Radiation and Risk : A Hard Look at the Data" accessed February 4, 2013, http://www.fas.org/sgp/othergov/doe/lanl/00326631.pdf.

Roentgen per day by the NCRP and .2 by the ICRP in 1934.[67]As intended, however, these recommendations had no legal teeth. The industries were not regulated and the delay of symptoms from the time of exposure confused the sick individuals as well as the medical community. Perhaps more importantly, physicians saw the cases only as isolated individuals, and did not see themselves in their role as doctors as responsible for protecting the public health at large.[68] Instead, those who were excited by radiation's uses would be the ones to learn the most about its risks.

One of the American radiation enthusiasts was Samuel Colville Lind, a scientist who had traveled to Paris to work with Marie Curie and then worked at the Radium Institute in Vienna.[69] At the US Bureau of Mines, he helped to confirm the ratio of radium to uranium, making radioactive work and commerce more precise. He was a primary investigator of the effects of radioactivity on the coloration of glass.[70] Eventually he would serve on the Radiation Standards Commission of the Union of International Scientists, whose work was decidedly interrupted by the First World War. This international committee for radiochemistry addressed radiation safety, and preceded the formation of the International Commission on Radiological Protection. Lind was the only American in the group for many years. In 1919 it included scientists from Belgium, Brazil, United States, Ireland, Australia, Canada, New Zealand, African Sudan, Greece,

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[67] To add to the confusion of radiation safety, there are several different types of measures for exposure and dose, and several different definitions for even one measure, see Jones, "US Radiation Protection Standards," 182; Caulfield, *Multiple Exposures,* 19; Taylor, *CRC Radiation Protection,* 9-15.
[68] Ian Maddocks, "Evolution of the Physicians' Peace Movement: A Historical Perspective" *Health and Human Rights,* 2, no. 1, Human Rights and Health Professionals (1996) 88-109.
[69] Lind was eventually at the University of Minnesota, where his impact on science led to the naming of a campus building after him; Badash, *Radioactivity in America,* 212.
[70] Badash, *Radioactivity in America*, 164.

Italy, Japan, Poland, Portugal, Romania and Serbia.[71] This worldwide interest in radiation was fueled by measurements by Francis Aston of the Cavendish Laboratory in 1922 that led to statements published in *Nature*. Aston observed that only a pint of water's hydrogen atoms would be needed to either power "a steamship across the ocean and back" or decimate the entire water supply with an uncontrolled release of energy from atomic reactions.[72] With potential forces like this, Lind and many other scientists dedicated their research and careers to promoting more knowledge about radiation.

A number of leading scientists did warn about the risks of advancing too quickly, while assuming this would all still lead to positive progress in science. Among them were Russian geochemist Vladimir Vernadsky and the philosopher and pacifist Bertrand Russell.[73] Russell was author of explanatory books written for the public, the popular 1923 *The ABC of Atoms* and 1925 *The ABC of Relativity.* Russell also wrote in 1924 *Icarus or the Future of Science*, which warns about the risks of competitiveness leading to war, and "over-fighting" with possible future technologies. He also insisted science should not be used "to promote the power of dominant groups" but to secure the right to happiness.[74]

Scientists would take Russell's words to heart during atomic investigations in laboratories making what had been invisible now tangible as a real force to be tamed.

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[71] International Union of Pure and Applied Chemistry (IUPAC) Records, VIII.R. "Commission on Radiochemistry" File "Radiochemistry, 1919" CHF**.** Lind was contacted for his knowledge of the group's history after both wars. He would also work to alert the uranium mining industry about the dangers of uranium mining in the 1950s.

[72] J.L. Heilbron and Robert W. Seidel, *Lawrence and His Laboratory: A History of the Lawrence Berkeley Laboratory Volume 1* (Berkeley: University of California Press, 1989), 37-38.

[73] Lawrence Badash, *Scientists and the Development of Nuclear Weapons,* 19.

[74] Bertrand Russell, *Icarus or the Future of Science* (New York: E.P Dutton 7 Company, 1924), quotation on 5.

It was not warfare that led scientists to begin to fashion the equipment that would later be needed to produce nuclear bombs. It was investigations into understanding atomic forces and with the hope that artificial radioactivity could be a cure for cancer. By the 1930s, science and technology were effectively wedded by industry and academia, despite the ongoing harm and many radioactively caused deaths. The goal to harness nuclear energies developed rapidly from an idea to real instruments and machines.[75] Radiation studies before and after World War I were multidisciplinary and international efforts. Even the League of Nations was involved in supporting scientific advancement as a tool of peace.[76] Different types of currency supported radiation studies and development.

The rootedness of radiation in commerce and society grew with the energy of those whose lives were changed by it. Non-academic self- taught scientists who learned about radium early and invested in producing it into commercial products, such as luminous paint gained a social currency.[77] Frank Hartman was recruited by the army to inspect luminescent dials during WWI in 1917. He was so excited by the usefulness and hopes of radiation, that after the war he found tutors to teach him about radium and atomic energy. He worked with Dr. Cameron, Dr. Sochoky, Dr. Wallet, and Dr. Kabekjian at the University of Pennsylvania. And later he recollected, "I doubt that there were fifty people in the United States at that time that actually knew what was going on in the field of radioactivity, of what Madam Curie has done." He felt she had changed the

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[75] Agar, *Science in the Twentieth Century,* 235-6.
[76] "Coordination des terminologies scientifiques" December 17, 1933. This document had two parts, a report presented by M. C. Marie on the International Chemistry Union and a report presented by "M. Jean Langevin, au nom de L' union internationale de physique pur et appliqué (document D. 18, 1933)" and December 19, 1933 from the Societé des Nations (League of Nations) Institut International de Cooperation Intellectuelle ,"Ordre du jour provisoire de la deuxième réunion du Comitée pour la Coordination des terminologies scientifiques Madrid 4 to 5 May 1933" International Union of Pure and Applied Chemistry (IUPAC) VIII.R. "Commission On Radiochemistry" Folder "Radiochemistry, 1933" CHF.
[77] Badash, *Radioactivity in America.*

world, and perhaps by being a woman, she was not recognized as she should be. He dedicated much of his life to promoting her and her discoveries, so much so that he found a livelihood.

By 1919 Hartman had established his own radium company in his hometown of Philadelphia.[78] He gave lectures about the history of Madame Curie and radiation as his company grew.[79] He also became a "radium hound" and expressed concern about the possible health effects if radium was not properly controlled. He recovered lost radium within industries and hospitals. He constructed a special howling Geiger counter to aid him.[80] The local press often detailed his exploits like adventure stories, with a twist, making palpable the public's emerging new fear of radiation contamination by unseen sources.[81] But Hartman balanced his hunts with education that normalized the sources too. He donated radioactive specimens and equipment such as spinthariscopes to schools and colleges. Often performing experiments for the public and students, using the spectacle of radium's glow, he was thanked by teachers for raising "local radium consciousness."[82] He even helped two high school productions at Warren G. Harding Junior High School,

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[78] Box 4 "Frank Hartman Interview with Richard Hand" File 10, Frank J. Hartman Papers, 1904-1977 MSS 2/0340 (hereafter Hartman Papers) Mutter Museum, Philadelphia.
[79] Box 1 F-2 "Miscellaneous" Folder 22 Frank Hartman Studio, Hartman Papers. A spinthariscope is described this way by Hartman: "This instrument will enable persons to actually observe the effects of a single atom breaking loose from its parent element…The radium is placed on the underside of a wire projector in this instrument …and atoms strike the phosphorescent zinc sulphide that produces brilliant flashes of light which are observable…"
[80] A. O Michener (principal) to Hartman, June 1, 1937 and Correspondence 1952-1962. Box 1 "W-2 Miscellaneous" Folder 62, and John L. Waldman to Hartman, May 24, 1940, Hartman Papers.
[81] Lavine, *The First Atomic Age,* 94-5.
[82] J. William White to Frank W. Hartman, October 10, 1938 Box 1 "W-2 Miscellaneous;" Box 1 "U-4 Miscellaneous" File 59: Box 1 F-2 "Miscellaneous" File 22; and "Radium 'Detective" Roars at Mineral Club Meeting" June 6, 1935 clipping, unknown source in Box 1 A-1; "The Academy of Natural Science of Philadelphia" File 1, Hartman Papers.

using radium to create glowing bones as a backdrop for a "Skeleton Dance."[83] Investment, novelty and education served to propel radiation as synonymous with modernity.

Machines at the new frontier

More compelling for a curious public and physicists than fear was the thought that the atom was a new frontier. This edge of known reality could show how atomic matter and thus nature operated.[84] After the discovery of the neutron (by James Chadwick in 1932) and the inducing of artificial radioactivity by the Joliot-Curies, the neutron seemed the perfect unit to observe nuclear phenomena, because a neutron has no charge.[85] Linear accelerators, which operated by using magnetic forces in a vacuum, had been used to help positively-charged particles overcome the repulsion of the nucleus. With neutrons, scientists wishing to study the impact of a particle upon the nucleus could do so without accelerators because they did not have to overcome magnetic repulsion. By 1937 dedicated attention and funding for the problem of deciphering nuclear forces by industry and government resulted in the development of accelerators that could bombard nuclei using a different technique.[86]

Ernest Lawrence was on the cover of *Time* magazine in 1937 for his work to create nuclear experiments in his invention, the cyclotron. The first cyclotron worked by exciting charged particles and then re-exciting them over and over in what became a

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[83] A. O Michener (principal) to Hartman, June 1, 1937 Frank J. Hartman Papers, 1904-1977 MSS 2/0340Add for later to look at Correspondence 1952-1962. Box 1 "W-2 Miscellaneous" Folder 62, and John L. Waldman to Hartman, May 24, 1940, Hartman Papers. In his thank you A.O Michener wrote "even to those who anticipated the grotesque appearance, that was so remarkable, the result was startling…we shall long remember the glowing skeletal outlines that your paint and lighting set forth."
[84] Ernest O. Lawrence, "The Evolution of the Cyclotron" Nobel Prize Lecture, Dec 11, 1951, accessed January 10, 2014, http://www.nobelprize.org/nobel_prizes/physics/laureates/1939/lawrence-lecture.pdf.
[85] "James Chadwick, Nobel Prize in Physics Biographical" Nobelprize,org, accessed January 10, 2014, http://www.nobelprize.org/nobel_prizes/physics/laureates/1935/chadwick-bio.html; Lawrence, "The Evolution of the Cyclotron."
[86] W.L. Whittemore, "Research Reactors: A Product of the Past, Pathway to the Future" in *Fifty Years with Nuclear Fission* (La Grange Park, Illinois: American Nuclear History Society), 571-6.

spherical path due to the magnetic field. Then this directed the excited particles into a target at high speed. Later his invention led to a Nobel Prize.[87] Lawrence had designed the cyclotron not with an intention to make a weapon, but to study matter and find life's secrets. Lawrence with his brother Jon also saw the potential to use it to generate radioisotopes for cancer treatments and tracers.[88] A one million volt "Sloan-Lawrence" X-ray machine was used to fashion radioisotopes to treat their mother, who had an inoperable tumor. She lived twenty two more years as a result.[89]

This work for health and science was interrupted as war approached in Europe in the late 1930s. Leo Szilard noted that concerns about a possible German atomic bomb prompted scientists to turn their focus away from empowering humanity and toward creating a weapon of their own.[90] Instead of excitement, fear was palpable in scientists' letters and telegrams as the discovery of fission became more likely. [91] Atomic fission was first described as such in the February 11, 1939 issue of *Nature* by Lise Meitner and Otto Frisch. They determined experimental evidence from the work of other scientists, were actually observations of the splitting of an atom's nucleus by neutrons. Later that January, the possibilities of a chain reaction caused by fission were made clear by the

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[87] *Nobel Lectures* (Amsterdam: Elsevier Publishing Company, 1964); Lawrence "The Evolution of the Cyclotron" Nobel Prize Lecture and "The Nobel Prize in Physics, 1939," Nobelprize.org, accessed January 10, 2014, http://nobelprize.org/nobel_prizes/physics/laureates/1939/; Heilbron and Seidel, *Lawrence and His Laboratory.*
[88] Lawrence, "The Evolution of the Cyclotron."
[89] Luis W. Alvarez, *Ernest Orlando Lawrence, 1901-1958 A Biographical Memoir* (Washington, DC: National Academy of Sciences, 1970) 259-60; David S. Jones and Robert L. Martensen "Human Radiation Experiments and the Formation of Medical Physics at the University of California, San Francisco and Berkeley, 1937-1962" in *Useful Bodies: Human in the Service of Medical Science in the Twentieth Century,* eds., Jordan Goodman, Anthony McElligott and Lara Marks (Baltimore: The John Hopkins University Press, 2003), 81-108.
[90] Spencer Weart and Gertrude Szilard, eds., *Leo Szilard: My Version of the Facts, Special Recollections and Correspondence,* (Cambridge: Massachusetts Institute of Technology Press, 1978). This book has telegrams that were exchanged after the first fission was successful in 1939 asking for delay of publication of results to withhold the information from the Germans as well, 56-61. Another excellent narrative is Victor Weisskopf's *The Joy of Insight, Passions of a Physicist* (New York: Basic Books, 1991).
[91] Weart and Szilard, eds., *Leo Szilard,*, 60-5.

published work of Frederic Joliot-Curie. A uranium-235 atom undergoing fission releases more neutrons that will then split more uranium nucleuses and so on, causing a self sustaining nuclear chain reaction.[92] The implications of fission were also that the process could liberate immense stores of energy, due to Einstein's formula of energy equals mass times the speed of light squared. In other words, a very small mass could be converted into vast amounts of energy. Therefore, it might be possible to make a type of super-bomb which might even engulf even an entire city. Szilard deduced that if *he* had thought of using the energy of a nuclear reaction for bombs, so would the Germans, and a super weapon such as an atomic bomb seemed inevitable.[93] Would the secrets of the nucleus be unleashed as a weapon by the Germans? By 1939 physicists confirmed that fission of the uranium nucleus had occurred when bombarded with neutrons.[94]

This left scientists wondering if the neutrons released from fission might lead to more fissions of nearby nuclei—a chain reaction that would release an enormous amount of energy. That same year, Joseph Rotblat (who, like Lind, was inspired by Marie Curie) was working with Ludwik Wertenstein, who had been a pupil of Marie Curie, at the Radiological Laboratory of Warsaw. Rotblat traveled to James Chadwick's laboratory in Liverpool to learn how to build a cyclotron for the laboratory in Warsaw. [95] While at Chadwick's laboratory, Rotblat completed mathematical calculations showing the

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[92] Lise Meitner and Otto R. Frisch, "Disintegration of Uranium by Neutrons: A New Type of Nuclear Reaction" *Nature,* 143, 239-240, (Feb. 11, 1939), Atomic Archive, accessed May 5, 2014, http://www.atomicarchive.com/Docs/Begin/Nature_Meitner.shtml; Jacques Leclercq, *The Nuclear Age* (Paris: Sodel, 1986), 17-8.
[93] Weart and Szilard, eds., *Leo Szilard,* 60-5.
[94] This was confirmed in the main by Lise Meitner, Fritz Strassman, Otto Hahn and Otto Frisch. For an excellent biography that covers this history in depth, see Ruth Lewin Sime, *Lise Meitner: A Life in Physics* (Berkeley: University of California Press, 1996).
[95] "Professor Sir Joseph Rotblat" Obituary in the *Telegraph* September 2, 2005, accessed April 10, 2014, http://www.telegraph.co.uk/news/obituaries/1497409/Professor-Sir-Joseph-Rotblat.html.

possibilities that fission could make a super weapon. Rotblat recalled later his moral struggle at the time:

> Should I be looking at this? By that time I had worked out a rationale for doing research on the possibility of the bomb. I convinced myself that the only way to stop the Germans from using it against us would be if we, too, had the bomb and threatened to retaliate. My scenario never envisaged that we should use it, not even against the Germans. We needed the bomb for the sole purpose of making sure that it would not be used by them.[96]

This emotional struggle would only intensify for Rotblat, but at the time, some way of protecting against Nazism was uppermost in his mind. Much more than morals seemed to be at stake.[97]

By World War II neither health nor happiness was paramount in nuclear research. The focus dramatically altered from ways to create power for humanity to creating a weapon, in order to defend against the presumed efforts of the German scientists who were recognized experts in physics.[98] Amidst the focus on war work, the field of health physics was instituted to ensure that the deaths caused by radium would not reoccur for workers and scientists in the secret atom bomb building project. Karl Z. Morgan, one of the original six men involved in starting the discipline of health physics joined the group instituted at the University of Chicago. They were part of the atomic bomb project, but they were "determined not to repeat the sad experience of the radium industry." Morgan, who had been investigating cosmic rays, was informed by Curt Stearns his first day on the job that the Manhattan Project would produce tons of an element that was even more

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[96] Reiner Braun, et al eds., *Joseph Rotblat: Visionary for Peace* (Indiana: Wiley Publishers, 2007), 283.
[97] Brown, *Keeper of the Nuclear Conscience*. Rotblat would be known as the only scientist to quit the atom bomb building project in protest when he learned the weapon would likely be used not to protect the world from Nazi Germany, but to kill Japanese civilians.
[98] Weart and Szilard, *Leo Szilard.* This book has telegrams that were exchanged after the first fission was successful in 1939 asking for delay of publication of results to withhold the information from the Germans as well, 56-61. Another excellent narrative is Victor Weisskopf's *The Joy of Insight, Passions of a Physicist* (New York: Basic Books, 1991).

potent than “the two pounds of radium available in the world that [had] caused” the deaths of many radium workers in the past.[99] Known information on the “radium girls” and other radium and X-ray deaths were collected by Robley Evans and used to construct a baseline for the first radiation safety precautions by the project’s health physicists.[100]

The spirit of such good intent is pervasive in the recollections of those who participated in the development of nuclear weapons. Many of the atomic scientists that gathered at Los Alamos believed they were performing a sacred duty, motivated by fear and the desire to prevent Hitler from obtaining a monopoly on atomic fission.[101] All the technical know-how and challenge of building the bombs by the Manhattan Project was described as “sweet” by Oppenheimer, but he also later implored historians of science to interrogate the meaning of the nuclear age.[102] Joseph Rotblat recalled that he fled the project in disgust when he overheard project director General Leslie Groves say the bomb would be used on Japanese civilians to intimidate the Russians. Others, like Leo Szilard and James Franck, had tried to stop the bombs from ever being used.[103] They failed, and on August 6th 1945 the first uranium bomb devastated Hiroshima, followed by a plutonium bomb that destroyed Nagasaki.

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[99] “Karl Z. Morgan Is Dead at 91; A Founder of Health Physics” *New York Times Obituaries*, Sunday June 13, 1999; File “PhD Questionnaire” 3, MSS BIOG COLL Call # MB 374, American Institute of Physics, Archives, College Park, MD.

[100] Robley Evans “Origins of Standards for Internal Emitters” in *Health Physics: A Backward Glance: Thirteen Original Papers on the History of Radiation Protection,* eds. Ronald L. Kathren and Paul L. Ziermer, (New York: Pergamon Press, 1980), 141-58. Many more details about standards and health in Clarke’s *Radium Girls* and cultural history in Lavine, *The First Atomic Age* as well as previously cited works by Catherine Caulfield, Barton Hacker, J. Samuel Walker and J. Christopher Jolly.

[101] Mary Jo Nye, OSU Winter term lecture notes, 2008 OSU HSTS 522 but this is the common narrative expressed by most nuclear historians, from Richard Rhoades to Spencer Weart.

[102] Robert W. Seidel, “The Golden Jubilees of Lawrence Berkeley and Los Alamos National Laboratories” *Osiris* 2nd Series, Vol. 14, Commemorative Practices in Science: Historical Perspectives on the Politics of Collective Memory (1999) 187- 202; For a short history of the atomic scientists movement, see Linus Pauling, “Science and Peace” Nobel Peace Prize Lecture, December 11, 1963, Nobelprize.org, accessed May 20, 2014, http://www.nobelprize.org/nobel_prizes/peace/laureates/1962/pauling-lecture.html.

[103] Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford: Oxford University Press, 2012).

A rupture in reality can be sensed in the expressions used by atomic scientists to equate their accomplishment with images of death, birth, and the sublime. Religious overtones are clear in the name "Trinity" for the first bomb test, prior to Hiroshima and Nagasaki.[104] Dorothy Day, of the Catholic Worker organization expressed a month after the bombings in Japan:

> …We have killed 3 hundred 18 thousand Japanese. That is, we hope we have killed them, the Associated Press, on page one, column one of the Herald Tribune says. The effect is hoped for, not known. It is to be hoped they are vaporized, our Japanese brothers, scattered, men, women and babies, to the four winds, over the seven seas. Perhaps we will breathe their dust into our nostrils, feel them in the fog of New York on our faces, feel them in the rain on the hills of Easton…We have created. We have created destruction. We have created a new element, called Pluto. Nature had nothing to do with it.[105]

But nature did have something to do with it. Sociologist Ulrich Beck argues that the very foundations of life changed because of the use of nuclear weapons, and life only appears the same.[106] Perhaps this sense of "nuclear uncanny" has contributed to the mass of human rights protocols on paper since 1945, none of which have acknowledgement of the "toxic trespass" that can be made by radiation contamination.

Atomic panaceas

The scientists Joseph Rotblat and Linus Pauling can be seen as examples of scientists who worked furiously for a better world after reacting strongly to the bombings

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[104] Hugh Gusterson, *Nuclear Rites: a Weapons Laboratory at the End of the Cold War* (Berkeley: University of California Press, 1998) 161-8 and Joseph Masco, *Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico* (Princeton: Princeton University Press, 2006) 119-22; While the origin of the name Trinity is unclear both plausible explanations involve religious motivations on behalf of either Oppenheimer or General Major W. A. (Lex) Stevens, see Trinity Atomic Website, accessed April 8, 2014, http://www.cddc.vt.edu/host/atomic/trinity/trinity1.html.

[105] Dorothy Day, "We Go on Record: the CW Response to Hiroshima," *Houston Catholic Worker* 25, no. 5, July-August 2005 (Reprinted from The Catholic Worker, September 1945, 1).

[106] Masco, *Nuclear Borderlands* explains the idea of the "nuclear uncanny;" Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of the Risk Society*, trans., Mark A. Ritter (New Jersey: Humanities Press, 2001) 63-76. This chapter is specific to living after Chernobyl, described by Beck as an event that caused "anthropological shock."

of Hiroshima and Nagasaki. Both men were scientific leaders during the years preceding and following the atomic first use. Both men had enthusiastically and patriotically served their countries in wartime, completing significant military research projects before 1945, but their future relationships became transformed by their responses to the planned and actual bombings of Hiroshima and Nagasaki. Their lives explain some of the broad scientific oppositions to nuclear weapons that were presented by the scientific community from 1945 until the Limited Test Ban Treaty was signed in 1963. After the test ban, significant scientific opposition has remained to nuclear weapons and power centered on public health and the reliability of radiation health safety standards. However, it is important to understand that the extent of the opposition to nuclear weapons went far beyond a small group of individuals.

The bombs that were built and used would change the lives of the very scientists who constructed "Fat Man" and "Little Boy." Two scientists died at Los Alamos due to accidental overexposures to radiation.[107] Some of the Manhattan Project scientists seemed to have died very young, including Enrico Fermi who died of cancer at age 53, and one wonders if exposures from tests or weapons construction might have shortened their lives. Initially lauded as American heroes, some later would drown in both suspicions cast upon them and suffer from depression.[108] Hundreds of the people involved in the Manhattan project dedicated their lives to civilian and international

[107] See Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Berkeley: University of California Press, 1987), 73. This was Louis Slotin and his good friend, Harry K. Daghlian. Daghlian's accident occurred on August 21, 1945 when he dropped a block onto the almost completed critical assembly. He died a month later. Less than a year later Slotin died when a screwdriver slipped into an assembly. Slotin died nine days later.

[108] "Enrico Fermi Dead at 53; Architect of Atomic Bomb" *New York Times* November 29, 1954 "On this Day," accessed April 10, 2014 https://www.nytimes.com/learning/general/onthisday/bday/0929.html; Lawrence Badash, "From Security Blanket to Security Risk" 241-56.

control of the weapon.[109] Many were equally determined to spread the benefits of nuclear technology as a way to peace itself. These scientists stood not only against the bomb, but they were also *for* nuclear technology as a tool to end secrecy and for internationalism and peace. [110]

Responding to the horror of the devastation inflicted in Japan, scientists broke through previous boundaries to enter the public and political realm. Scientists at the different Manhattan Project labs began to meet and discuss what should, or could, be done. Along with these former Manhattan Project scientists, Albert Einstein (with the help of Linus Pauling) organized the Emergency Committee of Atomic Scientists, which would go on to publish *The Bulletin of Atomic Scientists*.[111] While the first issues of *The Bulletin* are decidedly focused on national and international control of weapons and war, later issues would insist peaceful nuclear technology existed for the welfare of humanity.

The Manhattan Project scientists had already built a reactor at Hanford to make plutonium. They believed they could do it again to generate electricity given the funds and the will. And this electricity source had the potential to power humankind thousands of years into the future. Many scientists, including Enrico Fermi, Leo Szilard, Alvin Weinberg and Eugene Wigner believed that a breeder reactor design was "essential if nuclear fission was to be an important source of energy." Named a "breeder" by Szilard,

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[109] Alex Wellerstein, "How Many People Worked on the Manhattan Project?" *Restricted Data: The Nuclear Secrecy Blog*, November 1, 2012, accessed April 10, 2014 http://blog.nuclearsecrecy.com/2013/11/01/many-people-worked-manhattan-project/. At its highest peak of employment, in 1944 the project employed 125,310 people.

[110] "Emergency Committee of Atomic Scientists" Dec. 1, 1948, Box 3.016 File 16.2 Correspondence: *Bulletin of the Atomic Scientists,* 1947-1949, LP Peace, Ava Helen and Linus Pauling Papers, (hereafter AHLPP) Special Collections & Archives Research Center (hereafter SCARC) Oregon State University, Corvallis, Oregon.

[111] "Atomic Energy: Early Legislative History and the Struggle for International Control" Emergency Committee for Atomic Scientists 3.001- 3.016.12 LP Peace, AHLPP; Linus Pauling, "Science and Peace" Nobelprize.org.

the uranium that started the reaction would make more fissile material than it consumed, “breeding” its own fuel. This meant the plants they envisioned, using their best “engineering judgment” would generate at most a miniscule amount of nuclear waste to dispose of. The puzzle and challenge of how to dispose of the highly radioactive equipment, sludge and liquid wastes from the production processes had become apparent to some already at the plutonium production industrial site at Hanford.[112] In their calculations, waste could be minimized by using breeder reactors. With the proper controls, nuclear energy could fuel prosperity. In addition, these hopeful scientists saw a great future for radioisotopes in medicine. The first post World War II nuclear program to promote peace through nuclear science was based initially on the free provision of radioisotopes to other countries.[113] One of the foremost communication tools to share the excitement for these new technologies was *The Bulletin of Atomic Scientists.*[114]

The Bulletin began as just a newsletter out of the Chicago group of atomic scientists. It bloomed into a popular magazine seemingly of its own accord. The first seven-page issue was published December 10, 1945 by the Atomic Scientists of Chicago, (organized from former Manhattan Project scientists on September 26, 1945). These scientists used their concern and despair to organize for civilian and international control

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[112] Weinberg, *The First Nuclear Era,* 38-40, quotation on 40, and Weinberg *Nuclear Reactions: Science and Trans-science* (New York : American Institute of Physics, 1992), 6, 104, 168, 224, 263-9; Roy E. Gephart*, Hanford: A Conversation about Nuclear Waste and Cleanup* (Columbus Ohio: Battelle Press, 2003); Max S. Power, *America's Nuclear Wastelands; Politics Accountability and Cleanup* (Pullman: Washington State University Press, 2008).
[113] Angela Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago: University of Chicago Press, 2013); “Cancer Program for Fiscal Year, 1953” Box 1 “United States Atomic Energy Commission File 57,” Hartman Papers, 1904-1977, Mutter Museum.
[114] “Emergency Committee of Atomic Scientists” December 1, 1948, Box 3.016 File 16.2 “Correspondence: Bulletin of the Atomic Scientists, 1947-1949,” LP Peace, AHLPP.

of the bomb.[115] As early as four months after Hiroshima and Nagasaki, the *Bulletin* published a page of "News of Scientific Societies." The news shared the history and extent of the sheer numbers of scientists involved in international and civilian control of nuclear technology. Atomic scientists now became popular writers, as well as lobbyists, editors, publishers, fundraisers, and traveling speakers. A speaker's bureau resulted in over 40 talks given nationwide by December of 1945. A national organization of scientists was formed that same winter, and the Chicago group was joined by six "atom bomb associations" and seven other scientists' organizations.[116]

This movement was not a fringe group. The groups of atomic scientist in former Manhattan Project labs linked together to become the Federation of Atomic Scientists (FAS). Five hundred members of the Chicago group alone attended an organizing meeting. The meeting was held by the Independent Citizens Committee of the Arts, Sciences and Professions (ICC) with keynotes Glenn Seaborg and Eugene Rabinowitch (Seaborg would later become chairman of the Atomic Energy Commission, while Rabinowitch would become a key editor of *The Bulletin*). Also in 1945, the National Committee on Atomic Information was formed as well from FAS members, with over fifty national organizations, including not only peace organizations but also labor groups, lawyers, civic and civil rights groups and women's groups and churches. The group intended to reach "10 million citizens." The diverse groups were recorded as having "unusual unanimity on the paramount issue of nuclear energy." [117] This consensus of

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[115] Eugene Rabinowitch, "Five Years After" editorial reprint from July 1951 issue of *The Bulletin of Atomic Scientists* and "Application to the Ford Foundation for *Bulletin of the Atomic Scientists*" Box 3.016. File 16. 3 "Correspondence: Bulletin of Atomic Scientists, 1950-53" LP Peace, AHLPP.

[116] *Bulletin of Atomic Scientists,* 1 no. 1 (Dec 10 1945) 6.

[117] Ibid, 6. The FAS formed on September 26, 1945, and other groups included Association of Cambridge Scientists, the Association of New York Scientists, Alleghany Ballistics Lab, Association of Philadelphia Scientists, University of Rochester Radiology Group, Dayton Laboratories, and the Washington Science

interest was apparent when on December 3, 1945 the ICC held a meeting in Madison Square Garden in New York on the topic of atomic energy. The meeting was attended by 18,000 people. The crowd was addressed by astronomer Harlow Shapley, physicist H.C. Urey and Julian Huxley.[118]

The spread of nuclear technology is connected to the hopes for peace by some atomic scientists. This can be seen in the policy of one of the "atom bomb" groups. The Association of Los Alamos Scientists (ALAS) supported the creation of an "international authority" to control nuclear energy and believed "this policy is supported by the overwhelming majority of scientists everywhere." They believed while the United Nations is pivotal to the quest for peace, it may or may not necessarily be the proper format for control of nuclear weapons. However, an outright ban of the weapons was not what the group sought. The ALAS policy stated "we will not be satisfied with proposals of a merely formal character" to outlaw the weapons. Instead, "our aim is a material unification of the nations of the world for the purpose of controlling and exploiting the potentialities of nuclear energy."[119] It was a nuclear peace they were after.

The atomic scientists were not alone. Other established and international scientific societies reacted. Many joined the work for international control of nuclear weapons and articulated the need to end war and promote nuclear technology. The American Physical Society, the French Academy of Sciences and the American Chemical Society all stood united in public statements for international control of nuclear weapons. The French

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Society." The 50 organizations represented at the organizing meeting for the Atomic Information had an amazing cross section of US citizens, including the Carnegie Endowment for International Peace, the Presbyterian Church, the National Lawyers Guild, the Brotherhood of Railway Trainmen, the American Association of University Women, the National Negro Congress, the American Association of University Professors, and the National Congress of the PTA.

[118] *Bulletin of Atomic Scientists,* 1 no. 1 (Dec 10 1945) 6.

[119] "News of Scientific Societies" *Bulletin of Atomic Scientists,* 1 no. 1 (Dec 10, 1945) quotation on 5.

Academy of Sciences passed a December 3 resolution, modeled on the Netherlands Academy "to ask all governments to turn scientific research on atomic energy to peaceful uses." The American Chemical Society demanded in a strong editorial in its November 25 ACS publication a return to international relationships among scientists and that "we must seek and develop without delay international action that will promote the use of recent and future advances in scientific knowledge for peaceful and humanitarian ends and prevent the use of atomic energy for destructive purposes."[120] Scientists felt their actions were rational and that they could be leaders for the universal best interests of humanity.

This clamoring for peaceful nuclear technologies and the control of nuclear weapons coincided with the launch of the United Nations.[121] A primary goal of the UN at its founding was to establish human rights in the pursuit of peace. The first proposal by the UN of an agency to promote the peaceful uses of atomic energy was introduced January 24, 1946 "when the General Assembly- acting on a joint proposal by Canada, China, France, USSR, United Kingdom, and United States- unanimously created the UN Atomic Energy Commission." The UNAEC mimicked the American Atomic Energy Commission more than in name; it provided the international infrastructure for nuclear technology development and commerce. The commission created proposals for the exchange of scientific information, "to control atomic energy to the extent necessary to insure its use only for peaceful purposes and for the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction," and

[120] Ibid, 5.
[121]The first official gathering of the UN was in San Francisco, to sign the charter in June of 1945, less than 2 months before the bombing. The UN officially came into existence that October. United Nations, "History of the United Nations" accessed April 10, 2014, http://www.un.org/en/aboutun/history/.

for safeguards by inspection and other means “to protect complying states against the hazards of violations and evasions.” [122] An early aim of the UN was nuclear control and ironically, the dissemination of nuclear technology intended for peaceful uses.

The task of outlawing weapons and controlling uranium proved to be intractable. Early UN documents preceding the official formation of the UNAEC proposed to control the risks of nuclear weapons development in particular by controlling raw uranium supplies, something the FAS had also recommended. This was because existing maps of uranium stores could easily be studied. The groups shared the belief that surveillance of any “clandestine” mining would be much easier than after the materials were already ensconced, and being manipulated, in factories. Raw uranium ore could easily be monitored by aerial surveillance. By Monitoring illicit mining for the raw ore would provide the earliest recognition of the problem to prepare a UNAEC response.[123] The danger of the radiation in the uranium itself was also noted: ““It is important to realize that, until the radium and uranium have been separated, the mixture is radioactive, especially with respect to gamma rays. After the uranium is separated from the radium, it is less radioactive, giving off only alpha and beta rays.” [124] Thought of as only toxic, and weakly radioactive, the dangerous internal exposures of uranium were underestimated, as was the ability of UNAEC to institute controls on nuclear weapons at their source. But the heart felt efforts for disarmament seemed within reach at the time.

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[122] United Nations Atomic Energy Commission, 1945-1956” Box 3.018 Folder 8.6 “The International Atomic Energy Agency, by International Review Service, January, 1957” quotation on 29, LP Peace, AHLPP.
[123] *Bulletin of Atomic Scientists,* 1 no. 2 (Dec 24 1945) 1, 6.
[124] Pamphlet: “Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Representative,” Box 3.018 United Nations Atomic Energy Commission, 1945-1956, File 18.4 “Pamphlet: Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Representative,” Volume VI, Technological Control of Atomic Energy Activities, October 14, 1946, Prepared in the Office of Mr. Bernard M. Baruch, quotation on 9, LP Peace.

The efforts by scientists involved in the UNAEC embedded nuclear science as a key and central part of a massive internationalist "trans science" effort. This term was coined by Alvin Weinberg to describe the modern effort to realize human rights for economic equality by creating successful, safe and affordable nuclear power technologies.[125] The first Atomic Supplement published by *The Washington Post* in association with the National Committee on Atomic Information may be somewhat of a measure of the focus of that group by 1947. Delivered on the second anniversary of the August 6th Hiroshima bombing, the supplement was an update on the progress and frustrations of seeking international control, with a photo showing the effects of an atomic weapon if one was used on Washington DC. However, much of the large supplement was dedicated to the wonders of atomic energy, from how a reactor worked to generate electricity written by E.U. Condon to radioisotopes and their uses in medicine, for biology as tracers, and in industry.[126] Their articles were not fantastical, however, but measured, making their efforts for peace and prosperity appear all the more rational and inevitable.

UNAEC, however, would disappoint. UNAEC failed to come up with any agreement to control atomic weapons in 1947. Atomic scientists in Britain were emboldened. They too promoted peace through nuclear technologies, but even more creatively. Joseph Rotblat with his Atomic Scientists Association (ASA) organized an "Atomic Train."[127] Two train cars full of experiments and interactive science models

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[125] Weinberg, *Nuclear Reactions,* 1.
[126] Atomic Supplement, *Washington Post* August 6, 1947, Box 3.017 File 17.3 "Newsletters: United Nations Atomic Energy Commission, 1946-1947" LP Peace, AHLPP. A schematic drawing of a nuclear power plant is on page 10B "Must Compete with Coal: Cheap Atom Power is the Real Goal."
[127] Brown, *Keeper of the Nuclear Conscience,* 73-4, 88-90; See a flyer announcing Rotblat's and Pugwash's 1995 Peace Prize, Box 336, File .51, LP Correspondence, AHLPP; Braun, *Joseph Rotblat*. Rotblat received the Nobel Peace Prize in 1995 for his work for nuclear disarmament with the organization

were designed to spark international educational action against nuclear weapons and build support for nuclear science. The educational project traveled for 46 weeks throughout the Middle East, Scandinavia, and the United Kingdom and stayed in towns for three days to a week for walk-through viewing, events and lectures. The Atom Train was the first nuclear education effort in Eurasia to explain to the public basic atomic physics, radioactivity, and the peaceful applications of atomic science. The train had pictures, experiments, a cloud chamber, radioactive samples, a small cyclotron, displays, demonstrations, and lectures. One hundred and seventeen thousand people bought tickets. An additional tour to Paris and Lebanon for the Atom Train was arranged by the United Nations Educational, Scientific and Cultural Organization (UNESCO).[128]

A year after the Atom Train, the UN would continue to advance human rights in spite of nuclear weapons. Article 27 of the 1948 United Nations Universal Declaration for Human Rights established access to health and scientific technology as a human right.[129] The preamble of the resulting Declaration encapsulated late President Roosevelt's four freedoms of speech, worship, want and fear. It read “"Whereas disregard and contempt for human rights have resulted in barbarous acts which have outraged the conscience of mankind, and the advent of a world in which human beings shall enjoy freedom of speech and belief and freedom from fear and want has been proclaimed the

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he spearheaded, Pugwash. Rotblat used his atomic bomb background to assist him in applying radiation to health physics and the development of nuclear medicine. By 1949 he became chief physicist at St. Bartholomew's Hospital in London. Rotblat organized the Atomic Scientist Association (ASA) in early 1946, a group that was pivotal to arranging the later international Pugwash group of scientists. This group, composed of some of the MED scientists held their first meeting at Pugwash, Nova Scotia in 1957.

[128] Brown, *Keeper of the Nuclear Conscience,* 88-90; Braun, *Joseph Rotblat* 46, 149-153 and Rotblat's CV at the Nobelprize.org mentions the train as the first atomic education event for the public, accessed April 10, 2014,
http://nobelprize.org/nobel_prizes/peace/laureates/1995/rotblat-cv.html.

[129] Richard Pierre Claude and Bernardo W. Issel, “Health, Medicine and Science in the Universal Declaration of Human Rights” *Health and Human Rights* 3. no. 2 (1998): 127-42. The identification of human rights universals had been previously charged to a UN commission formed in 1946.

highest aspiration of the common people…" The third article was an expression of the philosophy of individual integrity and sanctity. The eighteen members of the UN Commission based the third article on *The Declaration of the Rights of Man* from 1789 and the United States Constitution. The ideas were made gender inclusive: "Everyone has the right to life, liberty and security of person." The document also secured the rights to science in Article 27.1: "Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits." In addition, these rights were to be brought to life by Article 28, "a social and international order in which the rights and freedoms set forth in this Declaration can be fully realized."[130]

Few scientists did more to make these promises real than Niels Bohr. Bohr was known for his application of quantum theory to the structure of atoms, and for his work in quantum mechanics. He also played a major role in the Manhattan Project. He was instrumental in the creation of the European non-military laboratory CERN and the spread of the idea that science itself could provide peace and human rights. Bohr used his reputation to work for openness in science on an international scale. One example is his speech to the United Nations in 1950, preceding the Atoms for Peace Program. For Bohr, scientific internationalism was an imperative for survival in the nuclear age. He believed this very openness about peaceful nuclear technology would improve life. He hoped the intensity of the choice between massive contamination from weapons versus peaceful

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[130] The eighteen member UN commission began their work in January 1947 to draft the declaration. Due to her facilitation skills, the group was chaired by Eleanor Roosevelt, see Mary Ann Glendon, *A World Made New: Eleanor Roosevelt and the Universal Declaration of Human Rights* (New York: Random House, 2001); Claude and Issel, "Health, Medicine and Science" 127- 142; Universal Declaration of Human Rights, General Assembly Resolution 217A, accessed April 10, 2014, http://www.un.org/cyberschoolbus/humanrights/resources/universal.asp.

applications of nuclear science for health and wellbeing would make “all mankind a cooperating unit.” With scientific openness, the pursuit of “fundamental human rights” and “prospects for improving material conditions for civilization by atomic energy sources” would be supported all around the world. [131]

Niels Bohr’s vision was amplified by his sincere belief in nuclear science as a way to peace. He was the first person to receive the Ford Atoms for Peace Award in 1956. Bohr was recognized for his international “great moral force in behalf of the utilization of atomic energy for peaceful purposes.”[132] He was also lauded in particular for his effort to create openness for nuclear science in his ideas and that both peace and the advance of civilization depend upon shared information on nuclear technology and scientific openness. Bohr in his speeches and work linked his conception of human rights, as individual economic and healthy well-being, with the expansion of nuclear science. He thought of nuclear science as above all, capable like nothing else for international peace building if not bound by national secrecy.

His words spoken in the past were praised by physicist John A. Wheeler at the Atoms for Peace event as evidence of Bohr’s humanitarian concerns: “The goal to put above everything else is an open world where each nation can assert itself solely by the extent to which it can contribute to the common culture and help others with experience and resources…Such a stand would…appeal to people all over the world, fighting for fundamental human rights, and would greatly strengthen the moral position of all supporters of genuine international collaboration.” Bohr felt that all over the world there

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[131] Niels Bohr, “An Open Letter to the United Nations,” June 9, 1950, quotations from respectively from 13, 11, Box 3.016 Bulletin of the Atomic Scientists, 1947-1949 File 16.2 Correspondence: Bulletin of the Atomic Scientists, 1947-1949, LP Peace, AHLPP.
[132] Niels Bohr, “Response” in *Proceedings of the Atoms for Peace Awards, 1957 – 1969; A Memorial to Henry Ford and Edsel Ford* (Cambridge: MIT Press, 1978) quotation from page 14.

is a need to create "the demand for an open world." Wheeler ended his speech honoring Bohr with his own revealing prayer, a prayer penned by Benjamin Franklin: "God grant that not only the love of Liberty but a thorough Knowledge of the Rights of Man may pervade all Nations of the Earth, so that a Philosopher may set his Foot anywhere on its Surface, and say 'This is my Country.' "[133]

This chapter has discussed some of the origins of the dream of nuclear medicine and nuclear power as a tool for peace to understand why scientists were so dedicated to nuclear science. The modern conception of human rights became inextricably bound with the discovery of radiation, the identity of scientists, and the founding of the UN. Evidence from the utopianism and self-sacrifice of scientists to the lives of "radium hounds" show a connection to science as an embodiment of hoped for humanitarian gains. This and educational efforts against weapons were wedded to the development of nuclear science, and inseparable. This can be seen in the documents and records of the FAS and the ASA and in the words and lives of Soddy, Bohr, Morgan, Rotblat, and many others. By following this premise of human rights as a narrative, one can see as the author of *The Atom Story* J.G. Feinberg observed in 1953, "for better or worse, for richer or poorer, in peace or in war, the destinies of the atom and the Human Race are now insolubly wedded." [134] Some historians, such as Spencer Weart, have framed the opposition to nuclear power as irrational and emotional.[135] Yet, modern scientists had an equally fierce

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[133] Niels Bohr, "Response" and John Archibald Wheeler, "No Fugitive and Cloisterred" in *Proceedings of the Atoms for Peace Awards, 1957 – 1969; A Memorial to Henry Ford and Edsel Ford* (Cambridge: MIT Press, 1978) quotations from 12, 13.

[134] J. G. Feinberg, foreword to *The Story of Atomic Theory and Atomic Energy,* formerly titled in 1953 *The Atom Story: Being the Story of the Atom and the Human Race* (New York: Dover Publications, Inc, 1960) v, vi, quotation on page v; John Pfeiffer, review of *The Atom Story* by Joseph George Feinberg, *The Saturday Review*, March 14, 1953, 58.

[135] Weart, *Nuclear Fear*.

dedication to their utopian dreams following in the footsteps of Frederick Soddy, alchemist of his generation who hoped true wealth and health could be shared.

Chapter 2 The Hidden Guns of the Atomic Frontier

Almost from the day the atom was split and its energy harnessed, scientists around the world have been longing for such an opportunity to climb over national fences to talk, teach, speculate and dream about the atom's future…They stood like the openmouthed shepherd boys in an ancient tale who stumbled on the entrance of a cave heaped high with jewels. The deeper they looked the more treasure they saw — and the cave went on for ever. [136] *Time,* August 15, 1955

Frederick Soddy's dreams for a just society seemed in reach when the first reactor generated electricity. The reactor (ZEEP) in Chalk River, Canada, began operating almost a month after the atomic bombing of Hiroshima, on September 5, 1945. This jewel of potential unlimited power seemed too god-given and sacred not to be shared. The conviction among scientists was that good had to come from the peaceful side of the destructive atom after Hiroshima and Nagasaki.[137] Nuclear scientists and nations would eventually come to claim nuclear power for all as an inalienable right by 1968 in Article IV of the Non-Proliferation Treaty. How did a new science, with fission technology just a few decades old, come to be claimed by some as both redemption and a right? Nuclear technology was described by Gerald Wendt of UNESCO as the "lifeblood of the underprivileged peoples." For others, nuclear weapons and science was perceived as a

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[136] "Science: The Philosopher's Stone" *Time* August 15, 1955, referring to Geneva conference in an article that highlighted Willard Libby, who was featured on the cover of the magazine as the philosopher, 44-53.The quote continues with great passion: "What the scientists had found, they told one another with growing excitement, was the modern counterpart of the Philosophers' Stone, which medieval alchemists searched for in vain as the tool to transmute gold from base metals. The atom has turned the medieval dream into 20th century reality. Modern atomic science can actually transmute metals —plutonium is a transmuted metal, and gold could be made from other elements if it were worth the expense and effort."

[137] David E. Lilienthal, *Change, Hope and the Bomb* (Princeton: Princeton University Press, 1963); For the role of spirituality and ideas of a godly connection and transcendence to nuclear technology, see Ira Chernus, *Dr. Strangegod: On the Symbolic Meaning of Nuclear Weapons* (Columbia: University of South Carolina Press, 2006) and Chernus, *Eisenhower's Atoms for Peace* (College Station: Texas A&M University Press, 2002). Also see John Krige, "Techno utopian Dreams, Techno political Realities: The Education of Desire for the Peaceful Atom" in *Utopia/Dystopia: Conditions of Historical Possibility,* eds., Michael Gordin Helen Tilley and Gyan Prakash, (Princeton: Princeton University Press, 2010) 152- 75.

violation and transgression.[138] To answer the first part of this question, archival documents and writings by scientists and international agencies show nuclear science was conceptualized as a frontier whose practice would serve as a "treasure house…to lift the burdens of hunger, poverty and disease."[139] Like the Wild West, however, not all the rules were in place: radiation was incompletely understood. Nuclear expansion was dependent on a belief that the atomic frontier could be tamed. Italian physicist Giuseppe Paolo "Beppo" Occhialini felt "the Geiger Müller counter was like the Colt in the Far West: a cheap instrument usable by everyone on one's way through a hard frontier."[140]

J. Robert Oppenheimer once implored historians of science to make sense of how the world was won by atomic forces.[141] Some answers to this question of how nuclear infrastructure came to be can be found in studies of material culture, education and international relations. Artifacts like radioisotopes can act as "historical tracers" to show

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[138] Gerald Wendt, *UNESCO and Its Program: Nuclear Energy and its Uses in Peace* (Paris, UNESCO, 1955), 72. For just a few general examples of the redemption of nuclear power from nuclear weapons, see Gerard H. Clarfield and William M. Wiecek, *Nuclear America: Military and Civilian Nuclear Power in the United States, 1940-1980,* (New York: Harper and Row, 1984); Niels Bohr, "Response" and John Archibald Wheeler, "No Fugitive and Cloistered" in *Proceedings of the Atoms for Peace Awards, 1957 – 1969: A Memorial to Henry Ford and Edsel Ford* (Cambridge: MIT Press, 1978); Alvin M. Weinberg *The First Nuclear Era: The Life and Times of Technological Fixer* (New York: American Institute of Physics, 1994). For the view of nuclear history as a crime and a violation of human rights, see David Kauzlarich and Ronald C. Kramer*, Crimes of the American Nuclear State: At Home and Abroad* (Boston: Northeastern University Press, 1998); Robert Jay Lifton and Eric Markusen, *The Genocidal Mentality Nazi Holocaust and the Nuclear Threat* (New York, Basic Books, 1990); Howard Ball, *Cancer Factories: America's Tragic Quest for Uranium Self Sufficiency* (London: Greenwood Press, 1993); Leslie J. Freeman, *Nuclear Witnesses: Insiders Speak Out* (New York: W.W. Norton and Company, 1981); Daniel Ford, *The Cult of the Atom: The Secret Papers of the Atomic Energy Commission* (New York: Simon and Schuster,1982); Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (New York: Harper and Row, 1989).

[139] Wendt, *UNESCO and Its Program,* 63, 67.

[140] M. Kokowski, ed., "The Global and the Local: The History of Science and the Cultural Integration of Europe" Proceedings of the 2nd ICESHS (Cracow, Poland, September 6 –9, 2006) 507, accessed April 22, 2014 http://www.2iceshs.cyfronet.pl/2ICESHS_Proceedings/Chapter_17/R-9_Tucci_Gariboldi.pdf.

[141] Robert W. Seidel, "The Golden Jubilees of Lawrence Berkeley and Los Alamos National Laboratories" in *Commemorative Practices in Science: Historical Perspectives on the Politics of Collective Memory Osiris Second Series***,** 14 (1999): 187- 202.

how all things atomic spread.[142] After WW II, government and science education merged to support economic and national security interests, creating a powerful class of experts, a "scientific estate." [143] Historical investigations range from the establishment of national laboratories to cities like Richland, Washington, home to the US plutonium production facility, Hanford Nuclear Reservation.[144] Military and Atomic Energy Commission (AEC) patronage extended the nuclear frontier to disciplines from agriculture to industrial processes to earth sciences, and not just in the United States.[145] The nuclear age took hold deeply by diplomatic proxy and can be seen in the techno-politics of international agencies and scientific committees. Detailed studies of the 1950s in particular show the influence of national security and the AEC on international projects.[146] Historical studies have looked at the cooperative and combative role of

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[142] Atoms for Peace capitalized on the success of the earlier radioisotope distribution program (that embedded nuclear science into many disciplines nationally and internationally) to also then spread reactors, see Angela N H Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago; London: The University of Chicago Press, 2013) quotation on 4-5; J. E. Hodgetts, *Administering the Atom for Peace* (New York: Atherton Press, 1964); Richard Hewlett and Jack M. Holl. *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989): Arjun Makhijani, Howard Hu and Katherine Yih eds., *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects* (Massachusetts Institute of Technology, 1995).

[143] Donald Price, *The Scientific Estate* (Cambridge, Mass: The Belknap Press of Harvard University Press, 1965); James H. Capshew and Karen A. Rader "Big Science Price to the Present" *OSIRIS* 2nd Series, Vol. 7, Science after '40 (1992); Brian Balough, *Chain Reaction: Expert Debate and Public Participation in American Commercial and Nuclear Power, 1945-1975* (New York: Cambridge University Press, 1991) 12-15.

[144] John M. Findlay and Bruce Hevly, *Atomic Frontier Days: Hanford and the American West* (Seattle: University of Washington Press, 2011); Peter Westwick, *The National Labs: Science in an American System, 1947-1974* (Cambridge: Harvard University Press, 2003).

[145] Ronald Doel, "Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA After 1945" *Social Studies of Science* 33, no. 5 (2003): 635-66.

[146] For a study of US bilateral agreements and a detailed analysis on how diplomacy was influenced specifically by the technology of research reactors, see Drogan, "Atoms for Peace." These projects include the 1955 Conference on the Peaceful Uses of Atomic Energy, the International Geophysical Year and the easing of radiation concerns by supposed scientifically neutral and objective bodies like the National Academy of Science Biological Effects of Atomic Radiation (BEAR) and the United Nations Scientific Advisory Committee on Atomic Radiation (UNSCEAR). See Jacob Darwin Hamblin, "Exorcising Ghosts in the Age of Automation: United Nations Experts and Atoms for Peace" *Technology and Culture* 47 (2006): 734-56; John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence" *Osiris* 21 (2006): 161-81 and John Krige and Kai Henrik Barth, "Introduction: Science, Technology and

scientists, the AEC and international agencies, such as the Food and Agriculture Organization, the International Atomic Energy Agency (IAEA) and the United Nations Education and Scientific and Cultural Organization (UNESCO) in the construction of norms while vying for scientific authority.[147]

Scientists working through agencies such as UNESCO embodied the aspirations of human rights and peace to establish nuclear programs in developing countries.[148] Archival sources record the view point of the scientist or technical expert and the daily development of physics and science departments in universities. This history can make visible the critical role of personal networks and localized decision making in the larger national and international context.[149] In addition, not much has been written about the establishment of nuclear programs or radiation health safety in medium sized colleges, research reactors, or the technical assistance given by international agencies that so remarkably spread nuclear apparatus and science.[150] This chapter offers an account of

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International Affairs." *Osiris* 21 (2006): 1-21; Jacob Darwin Hamblin, "'A Dispassionate and Objective Effort:' Negotiating the First Study on the Biological Effects of Atomic Radiation" *Journal of the History of Biology* 40 (2007): 147-77 and for more particulars about interagency rivalry and roles concerning radioactive waste dumping in the ocean see Hamblin, *Poison in the Well: Radioactive Waste in the Oceans at the Dawn of the Nuclear Age* (New Jersey: Rutgers University Press, 2008) 107-16. For global efforts to regulate radiation risks, see Soraya Boudia, "Global Regulation: Controlling and Accepting Radioactivity Risks" *History and Technology* 23, no.4 (2007): 389-406.

[147] Ioanna Semendeferi "Legitimating a Nuclear Critic: John Gofman, Radiation Safety, and Cancer Risks" *Historical Studies in the Natural Sciences* 38, no. 2 (Spring 2008): 259-301; Gabrielle Hecht, "Negotiating Global Nuclearities: Apartheid, Decolonization, and the Cold War in the Making of the IAEA" in John Krige and Kai-Henrik Barth, eds., Global Power Knowledge: Science, Technology, and International Affairs, *Osiris* (July 2006): 25- 48 and *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, Mass.: MIT Press, 2012); Jacob Darwin Hamblin, "Hallowed Lords of the Sea: Scientific Authority and Radioactive Waste in the United States, Britain, and France" *Osiris* 21, no. 1, Global Power Knowledge: Science and Technology in International Affairs (2006): 209-28.

[148] For current thinking on how to construct global histories, see Kapil Raj, "Beyond Postcolonialism … and Postpositivism: Circulation and the Global History of Science" *Isis* 104, no. 2 (June 2013): 337-47.

[149] See Mark B. Adams "Networks in Action: Khrushchev Era, the Cold War and the Transformation of Soviet Science" in *Trondheim Studies on East European Cultures and Societies* (October 2000).

[150] However, this is an admittedly truncated, limited starting point, a one sided view recorded by western voices. This work is offered and intended to be intercepted by additional research. This history, however is well explained as it pertained to uranium mining in Gabrielle Hecht, *Being Nuclear* and "A Cosmogram for Nuclear Things." *Isis* 98 (March 2007): 100-8. Also see Mora Drogan "Atoms for Peace, US Foreign

"the encounter, power and resistance, negotiation, and reconfiguration that occur in cross-cultural interaction" involved in the circulation of nuclear science.[151] This chapter uses the intellectual roots of UNESCO's nuclear ambitions and correspondence by technical experts predominantly at UNESCO, but also at the World Health Organization (WHO) to investigate the connections between human rights aims and the infrastructure of nuclear expansion. As in the United States, global nuclear expansion was made possible by the trust in technical and health safety experts to successfully ascertain benefits and contain dangers and risks.

UNESCO: Nuclear Power in the Periphery, Before Atoms for Peace

The UN and the Universal Declaration of Human Rights in 1948 are responsible for the conceptualization and dissemination of nuclear science and education as a human right. Western scientists after WW II envisioned the nuclear project as essential to survival, to progress for human rights and equality from economic development. After WW II "scientists had played an essential role in the war effort; now many hoped to do the same for keeping the peace."[152] Nuclear science was a way to create peace by quickly repairing the disparity among war ravaged, developing and underdeveloped nations. For example, in section two of the Statement of the Lake Geneva (Wisconsin) Conference of Scientists (adopted by the Emergency Committee of Atomic Scientists on June 21, 1947) the gathered scientists vowed "We will work toward the extension and international distribution of the peacetime benefits of atomic energy," and urged the United States to

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Policy and the Globalization of Nuclear Technology, 1953-1960" (Phd Diss. University of Albany, 2011); Mathew Hersch, "Book Reviews *Science in Flux*" *Technology and Culture* 49:1 (2008): 246-47. Hersch wrote "Scattered around the world in labs and college campuses, research reactors produce no electricity, just data and headaches, and … few historians have written about them."

[151] Raj "Beyond Postcolonialism … and Postpositivism," 337-47, quotation on 343.

[152] Patrick Petitjean "Introduction: Visions and Revisions: Defining UNESCOs Scientific Culture, 1945-1965" *Sixty Years of Science at UNESCO 1945-2005*, (Paris: UNESCO, 2006), 29, accessed April 22, 2014, http://publishing.unesco.org/chapters/978-92-3-104005-4.pdf.

assist “even at the cost of substantial sacrifice, to a program of world economic reconstruction under the auspices of the United Nations.”[153]

This idea of “scientism” was not unique to the aftermath of WW II. It was an enlightenment idea put to task in the 20th century. Following WW I, many intellectual groups built upon early enlightenment ideas to link science to peace, humanism, and internationalism. Physicists Marie Curie and Albert Einstein were members of what would become the League of Nations International Institute of Intellectual Cooperation (IIIC) to foster peace by increasing understanding and science education.[154] The informal group the Vienna Circle also embraced scientism as a solution to the world’s ills of war and injustice. The Vienna Circle published a pamphlet in 1929, “the Scientific Conception of the World.” Inspired by the ideas of Ernst Mach, the manifesto stated that “the spirit of a scientific conception of the world is alive.” Science (and math), if stripped of philosophy, had the potential to be a universal language for international peace between cultures.[155] Also to promote internationalism, the International Council of Scientific Unions (ICSU) was founded in 1931.[156] While the Vienna Circle itself was short lived, the IIIC and ICSU would have long lasting influence with other groups, such as the British "Social Relations of Science Movement" (SRSM) of the 1930s and 1940s.

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[153] “Statement of the Lake Geneva Conference of Scientists, Adopted June 21, 1947” Box 3.017 United Nations AEC, 1945-56, File 17.2 “Correspondence: United Nations Atomic Energy Commission, 1946-7, 1951-2, 1956” LP Peace, AHLPP, SCARC; Gail Archibald, “How the S Came to be in UNESCO” *Sixty Years of Science at UNESCO, 1945-2005,* (Paris: UNESCO, 2006), 36-9.

[154] United National Office at Geneva Archives, “Sub-Fonds Intellectual Cooperation and International Bureaux Section (1919-1946)” UNOG, accessed April 22, 2014, http://biblioarchive.unog.ch/Detail.aspx?ID=408.

[155] See the actual manifesto “Wissenschaftliche Weltauffassung: Der Wiener Kreis” translated on line, accessed April 22, 2014, http://evidencebasedcryonics.org/pdfs/viennacircle.pdf. This history is much more complex, however, see Friedrich Stadler, *The Vienna Circle: Studies in the Origins, Development, and Influence of Logical Empiricism* (New York: SpringerWein, 2001), 9-51.

[156] Archibald, “How the S,” 36-9.

SRSM impressed the thinking of the first leaders of UNESCO, friends Julian Huxley and Joseph Needham.[157]

UNESCO the organization formed from enlightenment ideas magnified by the deep humanitarian concerns raised during the Second World War. As early as 1942 educators and governments pondered how education could recover from the disruption of World War II in Europe.[158] Education was not only devastated by bombings and warfare; Nazis had ransacked many laboratories and shuttered universities. UNESCO was driven by a priority of reconstruction and relief activities in war torn areas of Europe.[159] Soon this rescue effort for economic and educational equality became universalized. While science in the past had been a tool of western colonialism and subjugation, now science could serve as liberator and in the service of making amends. Science could be applied as objective altruism to bring technological, thus economic parity, for once colonized countries now acting independently with self determination.[160] The biologist Huxley served as the first Secretary General of UNESCO from 1946 until 1948. He designed the agency to use education, culture and science as a means to promote ideas of equality. He believed in an evolutionary humanism, far beyond dichotomies like capitalism and

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[157] To learn more about the British group, see Robert E. Filner "The Social Relations of Science Movement (SRS) and J. B. S. Haldane" *Science & Society* 41, no. 3 (Fall, 1977): 303-16; Patrick Petitjean, "Defining Unesco's Scientific Culture", in UNESCO (2006) and "The Periphery Principle: Unesco and the International Commitment of Scientists after World War II" Proceedings Krakow, Poland, 2007, accessed April 22, 2014,
http://halshs.archives ouvertes.fr/docs/00/11/24/17/PDF/PP_proceedings_Krakow.pdf.

[158] Other groups however preceded UNESCO before the UN was formed. UNESCO was based on several models, including the International Committee on Intellectual Cooperation, Geneva, 1922-1946, the International Institute of Intellectual Cooperation in Paris, 1925-1946 and the International Bureau of Education, Geneva, 1925-1968 (the IBE became a part of the UN Secretariat after 1969), Archives and Records Management Unit, *UNESCO Archives: A Short Guide* (Paris: UNESCO, 2011) 4.

[159] "Report of the Director General on the Activities of the Organisation in 1947" UNESCO Presented to the Second Session of the General Conference at Mexico City November- December 1947, 7, AG 4/6, UNESCO Archives, Paris; Archibald, "How the S," 36-9.

[160] Patrick Petitjean, "Introduction: Vision and Revisions" (UNESCO, 2006), 29-34 and "The Periphery Principle."

communism, communal and individual-- life itself was a process of learning and understanding.[161] The preamble of the Constitution of UNESCO reads "since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed."[162]

Huxley convinced his friend, biochemist and historian of Chinese science Joseph Needham, to be the first director of UNESCO's Natural Sciences Section. Needham instilled his 'periphery principle" into UNESCO. He believed that math and science, as products of the east originally, in their present form were now universals to be taught and shared with the world. Needham was deeply dedicated to the idea that scientists should venture into the periphery to serve others and sacrifice some temporary comfort to willfully create equality for the Third World.[163] While Huxley and Needham would quickly be forced from their positions by the USA's anticommunist fervor, the two men's ideas continued to influence the agency.[164]

UNESCO was bound to a belief in human rights as a force for peace. On the occasion of the 1949 "solemn consecration" of the Universal Declaration of Human

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[161] Julian Huxley, *UNESCO: Its Purpose and Its Philosophy* (Washington DC: Public Affairs Press, 1947); John Toye and Richards Toye "Brave New Organization: Julian Huxley's Philosophy" *Sixty Years of Science at UNESCO, 1945-2005*, (Paris: UNESCO, 2006), 40-2; "UNESCO: The Organization's History" accessed April 22, 2014, http://www.unesco.org/new/en/unesco/about-us/who-we-are/history/; "The Constitution" accessed April 22, 2014, http://www.unesco.org/new/en/unesco/about-us/who-we-are/history/constitution/.

[162] The purpose of the organization is to advance world peace and "general wellbeing for all mankind." UNESCO would accomplish these goals by "promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the rule of law and for the human rights and fundamental freedoms which are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations." "UNESCO: The Organization's History" and "The Constitution."

[163] For a recent analysis see Raj, "Beyond Postcolonialism": 337-47; Patrick Petitjean, "Blazing the Trail: Needham and UNESCO Perspectives and Realizations" *Sixty Years of Science at UNESCO 1945-2005* (Paris: UNESCO, 2006) 43-7 and "Defining UNESCO's Scientific Culture", UNESCO (2006) and "The Periphery Principle." Needham also plays a controversial role in assessing the use of bacterial warfare weapons by the US in Korea and China, see Hamblin, *Arming Mother Nature,* 51-5.

[164] Petitjean, "Introduction" 29-34 and "The Periphery Principle;" Huxley, *UNESCO*; Toye and Toye "Brave New Organization;" "UNESCO: The Organization's History."

Rights, the second Secretary General of UNESCO, J. Torres Bodet, addressed the Sorbonne in Paris. His speech connected the mission of UNESCO to the legacy of the 1789 "Rights of Man." Bodet felt nothing linked the UN and the work of UNESCO more than the Universal Declaration of Human Rights and said, "…it must not be forgotten that science and culture are, by nature and vocation, instruments of peace. They must therefore dedicate themselves, selflessly and without reserve, to improving the lost of the masses."[165]

Such proclamations can often be mere rhetorical devices.[166] Indeed, however, UNESCO, with nuclear science education part of its educational milieu since the exhibit of the Atom Train in 1947, sent advisors around the world to establish nuclear physics programs among other sciences. By 1950, UNESCO had in place a system to share expertise that included some quite famous nuclear scientists, such as Giuseppe Occhialini and Lars Bergstrom. UNESCO also provided equipment and grants**.** By 1951, UNESCO dismissed the category of race as an error, and its "Statement on Race," banished ideas of innate inferiority. All were equally capable and none inferior due to their ethnicity or poverty.[167] This philosophical commitment to equality manifested as distribution of nuclear education and technology to developing countries.

[165] J. Torres Bodet "The Mission of UNESCO" pages A-C and "Torres Bodet's Sorbonne Address on Declaration of Human Rights" page D *The UNESCO Courier Supplement,* March 1949.
[166] A summary of the history of the expansion of nuclear science shows the UNESCO mission in Article I indeed fostered nuclear "cooperation among the nations in all branches of intellectual activity, including the international exchange of persons active in the fields of education, science and culture and the exchange of publications, objects of artistic and scientific interest and other materials of information." In addition, this dissemination of information was to be uninhibited by economic limitations of member countries. The Constitution was signed on November 16, 1945 and came into force when ratified by 20 countries, a year later November 4, 1946. "UNESCO: The Organization's History" and "The Constitution."
[167] Michael G. Kenny, "Racial Science in Social Context: John R. Baker on Eugenics, Race, and the Public Role of the Scientist" *Isis* 95, no. 3 (September 2004): 403-4, 410; Huxley, *UNESCO.*

UNESCO answered eighty five requests for technical assistance between 1947 and 1951. In one four- month period in 1951, UNESCO spent $879,098 on travel, salaries, equipment, materials and grants for undergraduate and graduate students. Projects in eighteen countries were primarily directed to economic development and ranged from "establishing peasants' schools" in Columbia to teaching English in Ceylon to training for displaced Pakistani refugees. Most projects concerned general education but did include a variety of topics, from a focus on "problems for women" in Iraq to seismic earthquake detection and wind power research in Israel to requests for advisors to be sent to Brazil to identify mineral resources, specifically uranium.[168]

Nuclear physics was already spreading. In 1951, two years before Eisenhower's Atoms for Peace speech at the UN which accelerated the interest in nuclear programs, nuclear directed physics was being institutionalized with the help of UNESCO advisors in Liberia and Brazil.[169] In particular, Brazil requested two UNESCO specialists in thermodynamics, plus a specialist for "magnetic investigation and mapping" for mineral and uranium prospecting.[170] Part of the interest in physics was directed to establishing a permanent laboratory in the high elevation mountainous area of Bolivia to conduct

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[168] How countries requested help requires further inquiry. UNESCO Executive Board "Progress Report on UNESCO's Participation in the United Nation's Expanded Programme of Technical Assistance" October 25, 1951, Executive Board Documents, 1946- , accessed April 1, 2014, http://unesdoc.unesco.org/images/0016/001624/162411eb.pdf. Also in this document the World Meteorological Organization was invited to provide assistance as a part of UNESCO; UNESCO Index of Field Mission Reports 1947 -1968 Mathematics and Natural Sciences (General) University Level, Microfiche Physics, AG 8 UNESCO Archives, Paris.

[169] Further research is required for a complete accounting of all the nuclear programs that year and the events in all the countries that compiled reports on physics. This is preliminary research using just a few examples to show the usefulness of these archival documents.

[170] UNESCO Executive Board "Progress Report" October 25, 1951; UNESCO Index of Field Mission Reports 1947 -1968 Mathematics and Natural Sciences (General) University Level, Microfiche Physics, AG 8, UNESCO Archives, Paris.

cosmic ray research.[171] Understanding cosmic rays were essential to physics, for both understanding of natural radiation sources and for studies of the origins of the universe. "Beppo" Occhialini had left behind him a legacy of cosmic ray research at Sao Paulo in Brazil when he organized a school of physics in Rio de Janeiro from 1937-1942.[172] His experiment to observe cosmic ray showers with Wilson cloud chambers and counters, however, was interrupted when Brazil joined the war against Italy in March of 1942. Occhialini was ordered to return to Italy and fight, but instead he fled into the rugged mountains of Brazil, surviving as a mountain guide until 1944 when he returned to a devastated Europe.[173]

Occhialini's ground work resulted in important cosmic ray research. In 1951, the UNESCO technical advisor Ugo Camerini arrived in South America from his home in Italy. Camerini was sent to establish a very important research outpost, "the highest permanent cosmic ray laboratory in the world located near the geomagnetic equator." Camerini transformed a hut already in use in Chacaltaya (at an elevation of 5300 meters) and a "personnel base in La Paz [Bolivia]" as laboratories. Experimental equipment initially consisted of a cloud chamber and "associated triggering control circuits." The cosmic ray research was mainly Camerini's responsibility as he was one of only two people who knew how to use such equipment. The other was a local faculty member, Professor Lattes, who had first found the location of the Chacaltaya station. Chacaltaya

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[171] "Report in Training on Photoemulsion Technique, Period Oct1 to Dec 1" File "Brazil Camerini U. Physics July 1951 – 1952" UNESCO Index of Field Mission Reports 1947 -1968 Mathematics and Natural Sciences (General) University Level, Microfiche Physics, AG 8, UNESCO Archives, Paris.
[172] Valentine L. Telegdi, "G.P.S. Occhialini" *Physics Today* 47, no. 6 (1994): 90; "Progress Report Covering Period November 1st to January 1" File "Brazil Camerini U. Physics," UNESCO Archives.
[173] Pasquale Tucci and Leonardo Gariboldi "Giuseppe Paolo Stanislao Occhialini: A Cosmopolitan Scientist" in "The Global and the Local: The History of Science and the Cultural Integration of Europe" Proceedings of the 2nd ICESHS M. (Cracow, Poland, September 6 –9, 2006) ed., M. Kokowski, 508-9, accessed May 26, 2014, http://www.2iceshs.cyfronet.pl/2ICESHS_Proceedings/Chapter_17/R-9_Tucci_Gariboldi.pdf.

was in an excellent geographical position, "granting a cosmic ray flux 100,000 times greater than" what Occhialini had found in 1944 on the Pic du Midi observatory in the French Pyrenees.[174]

Camerini taught nuclear physics courses and more. He directed students to develop a system for "determining the quantity and nature of radioactivity in rocks and sands." [175] He taught the Brazilian physics professors emulsion and nuclear photographic skills. He constructed scintillation counters and the other needed equipment to conduct cosmic ray research. One overwhelming problem he identified, however, was the lack of physics students. Much as some historians of science have observed, technology itself can drive recruitment and research projects.[176] Camerini felt similarly, and wrote that a physics high tension set that was soon to be installed "will enable me to find many more problems suitable for young research workers- the "Glamour" of the machine will also help in attracting people to the field."[177] He felt their interest would also be aided by other new equipment that had been ordered from UNESCO and was on its way.

Camerini's UNESCO field reports noted the poor condition of the laboratory for cosmic ray research and his low pay. Being paid in Brazilian dunares, and not US dollars, he was earning 60% less than he had anticipated. His work however was determined by UNESCO officials thought his work was critical to nuclear and economic development

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[174] "Progress Report Covering Period November 1st to January 1" File "Brazil Camerini U. Physics," UNESCO Archives; M. Kokowski ed., "The Global and the Local," 510.
[175] Belo Horizonte was the location of IPR, Institute for Radioactive Research, founded in 1952, according to P.C. Tofani and M.C. Paiano, "Uses of a Small Research Reactor in Brazil" International Symposium on Research Reactors, December 6- 9, 1988, Hsinchu Taiwan (Belo Horizonte: Comission National de Energia Nuclear, CNEC, 1989); " Report in Training on Photoemulsion Technique, Period Oct1 to Dec 1" File "Brazil Camerini U. Physics" UNESCO; UNESCO Executive Board "Progress Report" October 25, 1951.
[176] See Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: The University of Chicago Press, 1997).
[177] "Report in Training on Photoemulsion Technique" file "Brazil Camerini U. Physics."

for South America, as well as for international cosmic ray research. Camerini was laying the preparation work for an UNESCO sponsored six- month return of Occhialini, who was expected to “set things going with a bang.” [178] When Occhialini came to the Brazilian Centre of Physical Researches in Rio de Janeiro he helped Lattes and Camerini organize both long term research and the laboratory on Chacaltaya. Eventually this contributed to the founding of the Institute for Radioactive Research (IPR) in Belo Horizonte in the School of Engineering at the Federal University of Minas Gerais in 1952.[179] A relationship between UNESCO and the US AEC was also established with Camerini’s groundwork. In the early 1950’s two data points in secret AEC Sunshine Project graphs of fallout from nuclear weapons tests in soils came from the Belo Horizonte location.[180] This was just one of the connections forged by the expanding nuclear frontier.

Merging Nucleonics with Pomp and Circumstance

UNESCO was instrumental in connecting nuclear science with humanitarian aims. One UNESCO pamphlet extolling the virtues of nucleonics (a term interchangeable with nuclear science in the 1950s meaning the study of the nucleus, like electronics is a study of electrons) predicted that before the children of today had grown into young adults, nuclear power would be ubiquitous, transforming their lives as well as deserts into agricultural plenty.[181] The patronage, organization, educational and media access of the US AEC, UNESCO and national identity politics served to embed nucleonics with

[178] T. Grivet NS to Mr. Kinany TAD, January 11, 1951 UNESCO memo, file “Brazil: Camerini U. Physics.”
[179] File “Brazil Camerini U. Physics”; Tofani and Paiano, “Uses of a Small Research Reactor in Brazil”; Kokowski, “The Global and the Local” 511.
[180] W.F. Libby, “Radiostrontium Fallout: Project Sunshine” July 1956, WASH-406 Human Studies Project Team, Los Alamos National Laboratory, April 29, 1994, unclassified with deletions, 24.
[181] Wendt, *UNESCO*.

modernity. A desire on the part of industrialists and educators to make the civilian uses of nuclear technology and research a reality was accelerated by AEC chair David Lilienthal by 1949. He directed the dissemination of nuclear information for industry by forming an advisory committee of industrialists, publishers and scientific society members.[182] Soon more academic scientists joined the AEC in a meeting in support of international atomic engineering education. The American Society for Engineering Education and the Atomic Energy Commission (ASEE-AEC) at Hanford Works sponsored the meeting about the time Camerini left Brazil in 1951. The joint committee and the experiences of the radioisotope program, and early educational efforts by UNESCO and former Manhattan Project scientists at US universities resulted in mechanisms for "Atoms for Peace." By the time President Dwight D. Eisenhower in 1953 announced the "Atoms for Peace" initiative at the United Nations, the academic research base was already in place. This base was fueled by enthusiasm by many former Manhattan Project scientists committed to making social advances from atomic weapons.[183]

Eisenhower's speech roused passions for peace. He said, "It is not enough to take this weapon out of the hands of the soldiers. It must be put into the hands of those who will know how to strip its military casing and adapt it to the arts of peace." [184] He

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[182] This file has interesting correspondence between Charles A. Thomas (Monsanto Chemical Company) to Lilienthal as Thomas is frustrated by the slow progress, even after a trial program for sharing technical knowledge with industry is announced, see Thomas to Lilienthal September 6, 1949 and Carroll L. Wilson and Morse Salisbury memo "Establishment of Temporary Advisory Committee on Technical Information" February 3, 1949 in File "Correspondence- Advisory Committee [on Raw Materials] to Make Technical Information Available to Industry" and also see Phillip Sporn (of General Electric) to Lilienthal, June 7, 1948 File "Correspondence-Advisory Committee on Cooperation between Electrical Power Industry and Commission" in Box 1 Records of the Office of the Chairman, Office Files of David Lilienthal, Subject Files, 1946-1950, RG 326 Records Group of the AEC, NARA II, College Park, MD.

[183] Hewlett and Holl, *Atoms for Peace and War,* 253-6. This section explains how the college infrastructure was established. For example, the military Brookhaven National Laboratory by 1953 had an academic culture because so many professors came to visit and study. See also Creager, *Life Atomic*; Krige "Atoms for Peace" and "Techno utopian Dreams"; Westwick, *The National Labs.*

[184] Chernus, *Eisenhower's Atoms for Peace*, xvii.

then proposed to supply an international body with fissionable materials for an expansion of nuclear science for peaceful purposes such as agriculture and medicine, but also for a unique purpose--to give abundant electrical energy to the power-starved areas of the world.[185] This call for equality by the Atoms for Peace project was embraced by a global public and by academic scientists.[186]

The management of the AEC acted quickly to advance nuclear science but soon the AEC was accosted by a controversy over the safety of fallout. The AEC provided declassified information, funding, support, training, and equipment. Programs were supported by generous fellowships to international and American students, and research reactors were an essential mechanism to spread reactor knowledge. [187] The first research reactor had already been installed on a college campus, previous to Atoms for Peace, and was named romantically the "Temple of the Atom." The story of this reactor at North Carolina State University (NCSU) and Clifford Beck (who would later go on to head the safety arm of the Nuclear Regulatory Commission, NRC) shows the determination of scientists to pursue nuclear technology despite overt safety concerns.[188]

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[185] The speech continues to be analyzed by academics. Ira Chernus explains the use of images, words, and emotions to manipulate the public to support continued nuclear development by Operation Candor in his *Eisenhower's Atoms for Peace*.
[186] Hewlett and Holl, *Atoms for Peace and War, 1953-1961;* Hodgetts *Administering Atom for Peace.*
[187] The Atoms for Peace program also resulted in phenomenal growth of nuclear science. Research reactors grew worldwide from 30 reactors in 1955 to 375 in 1975, W.L. Whittemore, "Research Reactors: A Product of the Past, Pathway to the Future" in *Fifty years with Nuclear Fission* (La Grange Park, Illinois: American Nuclear History Society) 572. Page 571 also points out the distinction between "test" and research reactors, and how this designator is often fluid and leads to different counts of reactors. One of the best resources for articles on research reactors is *Physics Today.* See Toni Feder, "Issues and Events; University Research Reactors and DOE Handouts" *Physics Today* 55, no. 4 (April 2002): 23-6, concerning the decline of university reactors to only 27 in 2002, and 24 nuclear engineering departments in 2001. Some discrepancy is admitted as to what "counts" as a research reactor, and numbers can vary of operating reactors from 27 to 29. Once famous programs, such as the University of California at Berkeley, Cornell University and the University of Virginia have been closed as have several DOE research reactors.
[188] More details about the AEC management in chapter 6, and the NCSU reactor in chapter 4 and the OSU program in chapter 5. Sixty-four university research reactors were licensed and built in the US since the beginning of the Atoms for Peace campaign. Twenty five of these were TRIGA research reactors, built by the company instigated by Edward Teller, General Atomics. The TRIGA was designed to be so safe that

Safety concerns and distrust frustrated UNESCO's initial ambition to be included in the organizing of Atoms for Peace and the IAEA. Less than four months after Eisenhower's Atoms for Peace speech, a worldwide controversy over global fallout dangers was sparked because of the March 1, 1954 Bravo thermonuclear weapons test. The weapon was one thousand times the size of the Hiroshima bomb. This test, like the majority of weapons tests, was held in the Pacific Islands. It harmed U.S. soldiers, Japanese fishermen and especially Marshallese Islanders, hundreds of whom were forced to evacuate and in the end, lost their health and homes. The "Lucky Dragon" incident, which was the name of the Japanese fishing boat, brought into the public concerns about the dangers of radiation.[189] Fallout began to make international headlines.

Under these public conditions, the AEC was unsure it could trust UNESCO scientists. The internal debate among scientists -- some of them former employees of the AEC -- who disputed AEC reassurances of safety, came to the attention of the media.[190] To most nuclear involved scientists at the time, however, the benefits and promise of atomic power were considered to far outweigh the risks. In 1955, Geneva hosted the first International Conference on the Peaceful Uses of Atomic Energy. It was an international success with the public and for scientists, who could freely associate on the once secret topics of nuclear science. Some spied on one another, but the exchanges at the time were

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even a teenager could operate it. Thirty five TRIGA reactors were also built in 22 countries around the world as part of the program. Training, Research and Isotopes General Atomic is the acronym TRIGA. Whittemore, "Research Reactors" 571-6. The number of reactors appears to be inconsistent in the literature. See *Nuclear Research Reactors in the World,* Reference Data Series No. 3, International Atomic Energy Agency, 1988. Teller's work and General Atomics is recorded in Freeman Dyson's *Disturbing the Universe* (Basic Books, 1979).

[189] For a primary source and view of an AEC employee of the Lucky Dragon, see Ralph E. Lapp, *The Voyage of the Lucky Dragon* (New York: Harper, 1958).

[190] See chapter 3 and Carolyn Kopp, "The Origins of the American Scientific Debate Over Fallout Hazards" *Social Studies of Science* 9, no. 4 (November 1979): 403-22; J. Christopher Jolly, "Linus Pauling and the Scientific Debate over Fallout Hazards" *Endeavour* 26, no. 4, (2002): 149-54; Hewlett and Holl, *Atoms for Peace and War;* Hacker, *Elements of Controversy.*

recorded by the media as beneficial and sincere, a real step towards a future peace.[191] One exception to this new openness was the treatment of American geneticist Hermann J. Muller. He attended the conference but he was not allowed by the AEC to present his research on the dangers of low level radiation. While side-lined from the conference, the issue of danger from fission products and leaking power plants did attract some international media attention there.[192]

Even more importantly for this study, Lew Kowarski submitted a paper on behalf of UNESCO to the conference that explained the virtues, uses, types and costs of research reactors. Kowarski was a French physicist who worked with Frederic Joliot-Curie to understand nuclear chain reactions and how to generate electrical power from nuclear reactions. Later, he helped build the first reactor in 1945 (ZEEP) in Chalk River. A research reactor is a specialized type of reactor that operates at low power and does not generate electrical power. The versatile machine is used as both a research object itself and an educational tool. Kowarski explained, "New ways of using a reactor for research purposes are invented and tested…everyday." Students can learn how to operate reactors and study reactor behavior itself. Training can occur while also conducting a multitude of experiments, from studying radiation exposure of personnel to generating isotopes.[193] Most of the papers on using research reactors came from military labs, including Oak Ridge National Laboratory, Harwell (a British military lab) the UK AEE and Argonne

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[191] *Proceedings of the Atoms for Peace Awards, 1957-1969,* 12; Krige, "Atoms for Peace,"161- 81.

[192] Larry Badash, however, credits this to the word "Hiroshima" in the text of Muller's paper. For more explanation of the anticommunist fervor of the era and fear of nuclear scientists, see Lawrence Badash, "Science and McCarthyism" *Minerva* 38 (2000):53-80 and "From Security Blanket to Security Risk: Scientists in the Decade after Hiroshima," *History and Technology* 19, no. 3 (2003): 241-56; Spencer Weart, *Nuclear Fear*: *A History of Images* (Cambridge: Harvard University Press, 1988) 200-01, 48-49, 296.

[193] Lew Kowarski, "Report on Research Reactors," *Proceedings of the International Conference on Peaceful Uses of Atomic Energy Geneva 8 – 20 August* Vol. II Physics: Research Reactors (New York: United Nations, 1956) 233-47, quotation on 233; Wendt, *UNESCO*.

National Laboratory. Clifford Beck presented "Observations on Operations, Training and Research Experiences with the Raleigh Research Reactor." His paper did not mention the reactor core problems that led to his dismissal from NCSU in the early 1950s before he was hired by the AEC.[194]

UNESCO used the conference to highlight their vision of modernity and human rights. They distributed what they called "a little book" explaining all things atomic for the public to commemorate the 1955 Geneva Conference. *Nuclear Energy and Its Uses in Peace* swooned with excitement for the new frontier of the nuclear age, extolling its virtues as "a turning point in man's destiny." Finally, the striking economic "disparity among nations" could end. The book reassured the public that safety would be investigated by competent agencies such as FAO, WHO and UNESCO but it did end with a warning. If UNESCO failed to teach science to the world, "a forced nuclear economy could be dangerously incompatible with an unscientific culture."[195]

The AEC was still concerned UNESCO scientists might too freely and independently investigate the dangers of worldwide fallout.[196] But coordinating educational conferences and exchanges, however, was UNESCO's forte. Often the agency was solicited for support. While conferences are important to study because they show how important research questions are defined, an Israeli conference shows

[194] Clifford Beck, "Observations on Operations, Training and Research Experiences with the Raleigh Research Reactor" 314-17, *Proceedings of the International Conference on Peaceful Uses of Atomic Energy Geneva 8 – 20 August* Vol. II Physics: Research Reactors (New York: United Nations, 1956). How much of a role UNESCO played in arranging for the papers on education with research reactors is still to be researched, and if they coordinated the entire session 8, "Research Reactors" or only submitted the Kowarski paper among the papers on pages 233-318.

[195] Wendt, *UNESC,* quotations respectively, 72, 35, 71.

[196] For much more detail on the work of UNESCO's social studies department and the "public health" matter of those opposed to nuclear technology characterized as people unable to adapt to inevitable technology and modernity, see Hamblin, "Exorcising Ghosts."

UNESCO's support of the growth of national nuclear educational programs.[197] In 1956, UNESCO helped to send 250 scientists from around the world to Israel to a conference on nuclear structure. All that was required for this financial assistance was some limited correspondence to the agency. While the UNESCO director Dept of Natural Science, Pierre V. Auger (who followed Needham in 1948 and was director until 1958), sent his regrets, other notable scientists like Rudolf E. Peierls, Hans Bethe, Neils Bohr and Wolfgang Pauli attended. The event was presided over by the President of Israel, Mr. I Ben Zvi. As in the 1955 conference, many of the invitees were from military laboratories, but this was a way academics had access to nuclear research. Impressively, two planes were put at the disposal of the participants by the US Military Transport Service. A more typical aspect of this conference was the lack of research on radiation health safety. Of the 22 papers only one paper, Anatole Abragam's "General Theory of Extra nuclear Effects" linked remotely to the topic of radiation safety.[198]

Like Israel, many nations by this time had established their own independent national Atomic Energy Commissions or Atomic Energy Establishments. A network of national commissions, originally facilitated by the US AEC and then the UN AEC, streamlined correspondence with the AEC and later, international agencies such as the IAEA, UNESCO, and WHO. Some years earlier than 1950, the Administrative Committee on Coordination (ACC) was established to facilitate coordination among the

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[197] More about conferences and research is explained in chapter 6 but the large amount of requests for help to organize and participate in conferences was clear in the records from the IAEA, UNESCO and WHO archives and in the Gordon Cain collection at the Chemical Heritage Foundation (CHF).

[198] Auger could not attend because he was needed at the same time in Paris for the International Conference on Radio-isotopes in Scientific Research. A. de_Shalit of the Weizmann (Institute of Science located in Hovoth) to Prof Auger, December 18, 1956, G. Racah to Prof Auger, January 15, 1957, Auger to Racah February 13, 1957 July 1, 1957 Memo and "Israel International Conference on Nuclear Structure held in Rehovoth September 9 – 13, 1957" and "Report on the International Conference on Nuclear Structure held at Weizman Institute of Science Rhovoth, Isreal" Box 620.992 A 06 "57" 569.4 AMS - 620.992 A 06 (44) "58" First file 620.992 A 06 "57" 569.4 AMS, AG 8, UNESCO Archives, Paris.

UN, the UN specialized agencies and the AEC. On the whole, this vertical arrangement allowed opportunities for scientific unions and nation state representatives to easily connect for participation in conferences and funding opportunities with the AEC and the United Nations organizations.[199] This assisted in the rapid growth of nuclear infrastructure, just as predicted by the 1955 "little book" on nuclear energy by UNESCO.

Often lavish ceremonies surrounded the "start up" of both research and commercial reactors. Records of these events show the extent of national and international scientific pride, and perhaps the desire of the AEC to demonstrate fallout was safe, tied to nuclear science.[200] At the "formal inauguration of the Indian Atomic Energy Establishment and Research Reactor" in Bombay on January 20, 1957, Brigadier General K.D. Nichols attended as one of three US AEC representatives. Nichols had overseen the secrecy and construction of both Hanford and Oak Ridge military laboratories during the Manhattan Project. He was accompanied by Lloyd Berkner, president of the Associated Universities, Inc, (the nonprofit operating Brookhaven, an AEC national laboratory in New York) and John C. Bugher, former director of the AEC's Division of Biology and Medicine (DBM) and of the Rockefeller Foundation. Bugher

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[199] See chapter 1 for information on UNAEC and United Nations Atomic Energy Commission, 1945-1956, Box 3.018, Folder 8.6 "The International Atomic Energy Agency, by International Review Service, January, 1957" LP Peace, AHLPP, SCARC. This is my conclusions from the documents held in multiple archives of the IAEA, WHO, UNESCO, ILO and AEC documents in NARA. The ACC is mentioned as existing before 1950 but this is unclear, see Walter R. Sharp, *International Technical Assistance* (Chicago: Public Administration Service, 1952), 61. The ACC is also discussed as early as 1958 in Rene Maheau to Gagliotti, December 21, 1958 and Cacciapuoti to Sievert November 19, 1958 620.992:539.16 Atomic Radiations (includes UN Scientific CT on the Effects of Atomic Radiation) Part II from 1.1.1957 AG 8 UNESCO Archives, Paris also see the UN webpage Administrative Committee on Coordination, accessed May 6, 2014, http://www.un.org/esa/documents/acc.htm.

[200] This can be seen at the openings of many of the US research reactors as well, from the first "Temple of the Atom" at NCSU. See also brochure titled "Looking Forward with Nuclear Energy" dedication ceremony of the University of Washington Reactor on June 1, 1961 RG 62 Department of Engineering, Series V. Research, Box 8, File Atomic Energy Programs at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

chaired the secret Sunshine Project meetings.[201] The Sunshine Project involved a world wide network to secretly compile samples of human bone and tissue to investigate the uptake of Sr-90. Cadavers were obtained under dubious circumstance and by using the personal contacts of AEC connected scientists.[202] Documents record how Bugher had used his Rockefeller contacts to recruit researchers. He used false pretenses, leading scientists to believe they were participating in studies of natural background radiation (radium) in bone as a cover story for the secret fallout and strontium 90 studies.[203] As early as 1953, now declassified documents show Bugher had sought samples of specimens in this manner from India and Brazil, among other countries.[204] These connections served the AEC in terms of secret research as well as overt establishment of nuclear science.

The Indian reactor christening in Bombay was just the highlight of week- long festivities and tours. Dignitaries toured such facilities as the Indian Cancer Research Center and the Indian Rare Earth factory and saw sights such as the Ajanata and Ellora caves and a dance recital, and participated in a boat trip, and the Republic Day Parade. On the day of the dedication ceremony, an entourage of twenty cars transported the

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[201] It is for further research if Bugher is conducting himself this way in India on this particular visit, but this strategy is well documented in the once secret correspondence "Research Memorandum: Sunshine Project, January 9, 10, 1954 Washington DC" Acknowledgements, (no page number) June 1, 1954, call # MP-1997- 0004, US Atomic Energy Commission Project Sunshine Reports, Folder 1 Miscellaneous Physics Reports, Niels Bohr Library & Archives, American Institute of Physics Archives (AIP), College Park MD; also see "Memorandum: Fallout Data Collection" Robert A. Dudley of the Biophysics Branch of the AEC Division to University of Chicago's Dr. Libby, October 16, 1953, 2, George Washington University National Security Archive (hereafter GWU NSA) accessed April 22, 2014, http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet11/brief11/tab_i/br11i1.txt.

[202] Warren E. Leary, "In the 1950s United States Collected Human Tissue to Monitor Atomic Tests" *New York Times,* June 21, 1995, accessed May 6, 2014, http://www.nytimes.com/1995/06/21/us/in-1950-s-us-collected-human-tissue-to-monitor-atomic-tests.html.

[203] "Research Memorandum: Sunshine Project, January 9, 10, 1954 Washington DC" AIP; Dudley to Libby, October 16, 1953, 2.

[204] "Memorandum: Fallout Data Collection," Bugher to Rockefeller Foundation, December 30, 1953, and Dudley to Shields Warren, October 26, 1953, GWU NSA, accessed April 22, 2014, http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet11/brief11/tab_i/br11i1.txt.

dignitaries to the research reactor. Representatives came from national atomic agencies, such as the Burmese, Pakistani, Japanese, Thai, Belgian and Vietnamese AECs, and the UK AEE. Also in attendance was the Afghani Minister of Mines, and National Academy of Science physicists and experts, including three Soviet scientists. In all, thirty- one countries sent forty- nine representatives to celebrate India's installation of its first research reactor and its atomic agency, the Indian Atomic Energy Establishment.[205]

The events served as a way to build friendship among the international nuclear community. It also impressed the world at large about India's capable, but peaceful nuclear intentions. Indian headlines blazed the day after the occasion "India Will Not Use Atomic Power for Evil Purposes: Mr. Nehru's Assurance to Nations." Prime Minister Nehru vowed the reactor would be solely used for peaceful purposes. Both he and Indian AEC Chairman H.J. Bhabha explained in their dedication speeches that the atomic revolution was at hand and was inevitable; those who had missed the first industrial revolution were left behind. India had reserves of uranium far outweighing their meager coal supplies. There was no doubt that nuclear energy was essential to raise Indian standards of living for all people. In addition, two hundred and fifty university graduates and engineers were to be immediately hired and trained in nuclear energy in June. India would also share its reactor: all Asian and some African countries that did not have a reactor of their own were invited to use the facility.

[205] Enclosure B, "Report by General Nichols on his Attendance at the Inauguration the Indian Atomic Energy Establishment" March 11, 1957, 11-4 File "Research and Development-1-India" declassified HND 947023 AEC 337/8 Box 130 Office of the Secretary, General Correspondence, 1951-1958, Research and Development, RG 326 AEC NN3-326-93-010 NARA, College Park, MD; K.D. Nichols, *The Road to Trinity* (New York: William Morrow and Company, Inc, 1987) 350-1; Nick Ravo, "KD Nichols, 92, Leader in Early Atomic Age" *New York Times Obituary* February 25, 2000, accessed April 5, 2014, http://www.nytimes.com/2000/02/25/us/k-d-nichols-92-leader-in-early-atomic-age.html.

Nehru declared the day a historical moment: India had almost single handedly built the first reactor in Asia, outside of the Soviet Union. He equated nuclear scientists with the "high priests" of the past and christened the name of the reactor "Apsara." The Sanskrit name, meaning both "celestial damsel" and "water nymph", described the beauty of the Indian- designed water- cooled reactor. The plant was engineered, constructed and designed entirely with Indian talent and manufacturing, with U.K. assistance only for enriched uranium fuel elements.[206]

Safety was not addressed by the speakers at the Indian research reactor ceremony. Research reactors implied education and seemed the perfect peaceful launching point as the opening salvo of the atomic frontier. While India built their first small research reactor independent of outright US financial assistance, by 1958, the US AEC had granted nine nations financial assistance under the Atoms for Peace program since 1955. Much of the funds went to the installation of US- manufactured research reactors. The AEC made $350,000 available for the purchase of each reactor, intended for training and multidisciplinary research projects at universities. These costs often left balances usually of just shy of a million dollars for the host country to invest in constructing facilities, laboratories, and programs and to lease AEC provided enriched uranium fuel.[207] But for

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[206] For much more on the identity and nuclear politics of India see Jahnavi Phalkey, *Atomic States: Big Science in the 20th Century* (New Delhi: Permanent Black, 2013); Robert S. Anderson, *Building Scientific Institutions in India: Saha and Bhabha* (Montreal: McGill Univ. Centre for Developing Area Studies, 1975); John Krige, "Techno utopian Dreams" and Krige's website "Atoms for Peace" accessed April 22, 2014, http://johnkrige.com/atomsforpeace; Staff Reporter, "Celestial Damsel" and "India Will Not Use Atomic Power for Evil Purposes: Mr. Nehru's Assurance to Nations, Formal Opening at Trombay" 1 and "Supply of Scientific and Technical Personnel: Training" *The Times of India*, January 21. 1957, and "Souvenir of the Inauguration of the Atomic Energy Establishment, Trombay and the Swimming Pool Reactor by the Prime Minister Jawaharlal Nehru January 20, 1957" (booklet and clippings in an unmarked manila envelope all clippings un-dated and un- sourced) File "Research and Development-1-India" declassified HND 947023 AEC 337/8 Box 130 Office of the Secretary, General Correspondence, 1951-1958, Research and Development, RG 326 AEC NN3-326-93-010 NARA II, College Park, MD.

[207] AEC press release, "AEC Approves $350,00 U.S. Grant for Greek Research Reactor" February 10, 1958 in File "Research and Development-Greece" Box 130, Office of the Secretary, General Correspondence,

scientists like Bhabha, who believed nuclear power could be nothing short of transformative, with the ability to end poverty and release unknown stores of human creativity and abundance, nuclear power was a priceless investment in the future.[208]

Education in the Glow of Blue

UNESCO emerged by 1958, not as the critic the AEC had feared, but as a loyal servant to this aim. UNESCO not only spread nuclear science through its direct establishment in nuclear education programs, but it helped to create the environment that allowed the association of nuclear power with modernity, and the inverse, antinuclear with Luddite, to flourish. Their work labeled those opposed to nuclear expansion as irrational, ignorant and frightened of the inexorable march of technological progress. With the frontier mindset that nuclear progress was the inevitable, healthy path to the future, UNESCO's Thomas H. Marshall used emerging social studies, research papers, and press releases to persuade and reassure the global public. Marshall, who left the London School of Economics to head the UNESCO Department of Social Sciences, explained: "the problem [of acceptance of atomic energy] is not in fact nearly as novel or important a one as is sometimes suggested. I do not see that the introduction of atomic energy as a source of power is essentially different in kind from the introduction of other sources in the past." Through surveys and studies, Marshall intended "to find out what hopes and anxieties exist in the minds of the general public and how far these are based on misconceptions as to the nature and effect of this new kind of energy. With this

1951-1958, Research and Development, RG 326 AEC NN3-326-93-010 NARA II; See AEC grant offers to OSU, RG 62, Series V. Box 8, Atomic Engineering Projects at OSU (Atomic Energy, General), all 3 files, and Box 9 File Nuclear Engineering Education (AEC), SCARC.

[208] Krige, "Techno topia."

knowledge we could try to present a balanced picture of the situation in a form in which it would be likely to remove these misunderstandings" with education and training.[209]

In 1958, Marshall sent a form letter to the International Association of Universities. The letter begins with Resolution 3.75 and 3.76 adopted by the General Conference of UNESCO at its ninth session: "Member states are invited to encourage the study of the social, cultural and moral problems involved in the peaceful utilization of atomic energy and to promote the dissemination of objective information about these problems." Member states are to be particularly assisted to develop high school curricula adult education programs and "in the activities of youth organizations."[210] Multinational surveys were constructed to anticipate young people's attitudes toward nuclear power.[211] The research focused on educating and reassuring the public that nuclear technology was a mere cog in the thus far, successful and modern machine of automation. Marshall determined it was modernity itself that was being irrationally rejected and not nuclear technology per se. [212] The AEC provided radiation health safety standardization and training for radiation safety procedures. Their expertise enabled nuclear technology to be accepted. Persuasive scientists presented convincing statistics and mathematical

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[209] T.H. Marshall to Sir Arnold Plant, August 12, 1957, AG 8, Secretariat Records, 1946- File 620.992 : 3 A 06 (44) "58" Expert Meeting on the Social and Moral Implications of the Peaceful Uses of Atomic Energy, France 1958 Part 1 up to 30/6/ UNESCO Archives, Paris; Hamblin, *Arming Mother Nature,* 107; Hamblin, "Exorcising Ghosts."

[210] T.H. Marshall to International Association of Universities, April 18, 1958, quotations from page 1, File 620.992 : 3 A 06 (44) "58" Expert meeting on the social and moral implications of the peaceful uses of atomic energy, France 1958 Part 1 up to 30/6/58 AG 8 Secretariat Records, 1946-, UNESCO Archives.

[211] H.M. Phillips to Otto Klinesberg, November 28, 1957 "Peaceful Uses of Atomic Energy," AG 8, Secretariat Records, 1946- File 620.992 : 3 A 06 (44) "58" Expert Meeting on the Social and Moral Implications of the Peaceful Uses of Atomic Energy, France 1958 Part 1 up to 30/6/58; Hamblin, "Exorcising Ghosts."

[212] Jacob Darwin Hamblin, "Fukushima and the Motifs of Nuclear History," *Environmental History* 17, no. 2 (2012): 285-99 and "Age of Automation."

computations of safety in scientific meetings and papers that reassured other scientists, the press and politicians.[213]

Abundant nuclear energy became idealized as a future destination point for society. The reasons for this include UNESCO's influence on global education, the AEC's ability to standardize training and regulations, and nuclear promoters like Bhabha, but also working academic scientists like Italian Camerini. These scientists quietly volunteered to go where few had gone before. Scientists, working as advisors at UNESCO, temporarily left their universities and colleges to serve in the periphery, as Needham had first envisioned. These often unknown academic scientists and experts were the glue that cemented the spread of nuclear science and power technology. Or as expert advisor Lars Bergstrom described it, "I was a kind of exchange particle."[214]

Due to hopes for economic and energy development in South American countries, following the example of Brazil, general physics programs became nuclear focused. Just one example that shows both agency and localized decision making of UNESCO experts is the establishment of nuclear physics in Argentina. As early as 1950, Enrique F. Gonzales of the Argentinean National Commission on Atomic Energy (or Comisión National de la Energía Atómica, CNEA) asked the US AEC to provide further information on how to disseminate atomic technology but also, how to defend their population from atomic radiation. Gonzales requested exchanges of personnel for technical assistance. His inquiry appears to have been rebuffed but this is hard to

[213] This will be discussed through out the dissertation and in particular chapter 3, but these are my conclusions from the primary documents in the IAEA, WHO, AHLP, NARA, and the KZ Morgan collection at the University of Tennessee at Knoxville and the secondary literature on radiation health safety and nuclear history.

[214] "Project Number 5 for Argentina" in Folder "Argentina Bergstorm L.I. October 1958-June 1959" Teaching of Science, Nuclear Physics, UNESCO Index of Field Mission Reports 1947-1968 AG 8 UNESCO Archives, Paris.

determine as the AEC documents remain classified.[215] The significance of the request, however, shows health centered priorities for the CNEA, and that the requests for technical advisors came genuinely from the periphery. Seven years later, four of the six academic UNESCO experts sent to Argentina were nuclear physicists: S. Devon from England, T.R. Gerholm, Bergstrom, and Torsten Lindqvist, all from Sweden.

For UNESCO, South America and Argentina, the specific step to nuclear and economic development was education. Education for students in nuclear science was the main priority. Previously, students used to obtain education by traveling to universities in Europe and North America. It was just as important to build the program infrastructure with experimental equipment and fellowships. The UNESCO scientists were to design the curriculum and organize and develop the actual physics departments. But by the time of UNESCO expert Lindqvist's 1959-1960 visit, physics centers, which had been built up intensively since 1957 by UNESCO with equipment and assistance, were flourishing beyond Buenos Aires. Physics had spread to other research centers in La Plata, Bariloche, Cordoba and Tucuman. A UNESCO Science Cooperation Office was located at Montevideo, Uruguay, where UNESCO trained the experts. Lindqvist's work focused on specialized nuclear fields including experimental nuclear physics and Nuclear Magnetic Resonance (or NMR).

Lindqvist's visit had effects far beyond the main campus where he was based, at Facultad de Ciencias Exactas y Naturales de la Universidad de Buenos Aires. He gave lectures about nuclear technology and power around the country. During his stay he also visited regularly CNEA and the Universidad de La Plata, where he often gave lectures

[215] Most of the Argentinean files remain classified. AEC 380 "Argentine Request for Information" October 31, 1950 in File "AEC 411.431 (9-13-49) Argentina" Box 66 RG 326 AEC Office of the Secretary, General Correspondence, 1946-1951, NN3-326- 93-007 Declassified 978004, NARA II.

and discussed various problems in physics research education. He also spent time at Centro Atómico de Bariloche, the Universidad de Cordoba and the Universidad de Tucuman. During the course of his year long appointment, Lindqvist also visited the Universidad de Santiago, Chile; Universidad Mayor de San Andreas, La Paz, Bolivia; Universidad de San Marcos, Lima, Peru; Universidad de Rio Grande de Sol, Porto Alegre, Brazil; Universidad de Sao Paolo, Brazil; and Universidad de Rio de Janeiro, Brazil, to discuss and assess nuclear physics and education.[216]

Lindqvist decided the Buenos Aires campus program needed drastic change. It needed to be more technological and less theoretical. Also, the equipment thus far provided by UNESCO was not enough to ensure the longevity of the program. Lindqvist analyzed what type of improvements would increase the robustness of the nuclear physics programs in the country as a whole. He recommended that the Argentinean universities have a much closer relationship with CNEA. In fact, he recommended that the budding nuclear program at University in Buenos Aires merge with the experimental physicists at CNEA. CNEA staff should not just be visiting occasional professors, but become full time faculty at the university to ensure the viability of the program. In the next few years, students would need problems to work on in neighboring fields, too. While presently the students preferred theoretical physics to experimental, "with all the new equipment now delivered and planned such a change will definitely come."[217]

Lindqvist felt an obligation to create success for nuclear energy in Argentina as a whole. The mission to create economic equality and development in Latin America

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[216] Argentina, Lindqvist, T. "Teaching of Science (nuclear physics)" F/60, UNESCO Index of Field Mission Reports 1947 -1968, Mathematics and Natural Sciences (General) University Level, Microfiche Physics, (microfiche film 69 FR 0281 E LIM Lindqvist, T. Argentina, Nuclear Physics, 1959/60 ARGES 6 16 pages) UNESCO Archives, Paris, France.
[217] Ibid., 5.

would only be realized if an investment were made. He advised practical steps like higher pay for physicists and said, "Physics in industry is not much developed. Therefore physics as a profession is not very popular… but nuclear energy seems to be suitable for Argentina."[218] Lindqvist predicted physics research will be

> of extreme importance for Argentina in the near future. The power situation is such that the atomic age is near and justified to come. The country needs physicists, graduated from universities. In order to graduate sufficient numbers of physicists the universities must be well-established research centers with complete staffs of full- time scientists… Argentina is so near a real scientific breakthrough that UNESCO-help through experts is surely to give obvious results in 3-4 years from now.

Otherwise, "the universities do not have now enough physicists" to do this "in a decent time."[219]

Lindqvist was thinking in continental terms too. He learned on his visit to Chile at Universidad de Santiago de Chile that its one year old physics and mathematics department was already doing international-class research on X-ray crystallography. Most of the physicists had gotten their degrees from abroad (USA, England, or even Argentina occasionally) since the teaching of physics was not well established at the university level in Chile. Lindqvist recommended that UNESCO should help with equipment and experts as an emergency action, due to Chile's recent earthquake. He felt Bolivia was a natural match to do cosmic ray research, with high mountains and two laboratories already supported by UNESCO, Universidad Mayor de San Andreas with its cosmic ray station at Chacaltaya and in La Paz. While all the scientists there were from abroad, these were very important labs, Lindqvist wrote, "in a chain of laboratories all over the world."[220]

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[218] Lindqvist, T. Argentina, Nuclear Physics, 1959/60, 7.
[219] Ibid., 7-9.
[220] Ibid., 10.

However, beyond cosmic ray work, there was no physics research or teaching in Bolivia. This meant it was too soon for UNESCO experts to come to build research groups, and Lindqvist concluded the same for Lima, Peru. For now, the best way to build physics was with fellowships given to students to study abroad to meet the rapid demand expected soon for physicists.[221] Lindqvist recommended ongoing support for the outstanding Rio de Janeiro summer school. His tour was unusual due to the large geographical area he was responsible for, but like most other UNESCO experts, his recommendations were submitted to university administrators and government officials.[222] Also in Argentina in the previous year, Lindqvist's Swedish colleague Bergstrom had already recommended that UNESCO continue to bring internationally known physicists to the country, where, he said, there were excellent research facilities, as this was the key to the future.[223] UNESCO, with the commitment of its technical experts, connected South America to a growing network of expertise while establishing the infrastructure that could anchor the continent in the new nuclear age.

UNESCO was not alone in sending nuclear experts worldwide. WHO sent experts in radiation health safety protection, and after 1957, the IAEA also sent nuclear technical experts.[224] In a frontier, it is only natural that there should be some wrangling, but on the whole, WHO and UNESCO technical experts disseminated AEC instigated

[221] Ibid.

[222] In some cases, the reports seemed to become the host government's recommendations. These documents require much more analysis but include surprising material, such as that not all physics experts were men, and that UNESCO was setting up physics labs in countries such as Liberia as early as 1951.

[223] "Project Number 5 for Argentina" in Folder "Argentina Bergstorm L.I. October 1958-June 1959" Teaching of Science, Nuclear Physics, UNESCO Index of Field Mission Reports 1947-1968, AG 8, UNESCO Archives, Paris.

[224] This agency infighting over responsibility for radiation health safety however, was clear in all three agency archives notes in correspondence between the IAEA, WHO, UNESCO and even in the ILO archives. This will be discussed more in chapter 6 and some of the agency wrangling and history is explained in Hamblin, *Arming Mother Nature,* 105-107 and Hecht, *Being Nuclear.*

standardization. Visiting experts on radiation safety were trained with AEC approved and suggested materials. Health physics and safety officers were certified by the US AEC or national AECs or AEEs which used US AEC standards, suggestions, materials and manuals. The correspondence between the AEC, educational institutions, and international agencies reflects a deep preoccupation with standardization of educational training materials, certifications of programs, course work, syllabi and requirements. This preliminary study included documents from international meetings on radiation safety on the Oregon State campus and from agencies such as UNAEC, UNESCO, IUPAC, WHO, and the IAEA, which are all linked by extensive AEC correspondence over training, curriculum and standards. This vertical control model by the AEC and the ACC simplified the task of providing certain standards of radiation health and safety, yet limited the discourse on safety itself.[225] Few would have reason to question the expertise of the AEC, honed with the mystique of the Manhattan Project. This was enhanced by the AEC's ability to disseminate simplified and standardized model curriculum. Enthusiastic and educated academics were easy to trust. Who would not want to believe in the miracle age ahead? Yet the actual daily conduct of radiation health safety could be more complex.

WHO sent technical experts to work toward radiation health standardization. The example of Thailand's radiation protection program in the early 1960s illustrates the challenges of implementing radiation health safety. Hanson Blatz of the AEC was sent by

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[225] These are my overall conclusions from my research at SCARC in the atomic energy collection and the AHLP collections and the OSU Nuclear Engineering records, the IAEA, WHO, UNESCO, and CHF IUPAC collection archives. The IAEA documents primarily addressed conferences and the way radiation health safety was taught and interpreted but was also revealing that the primary concern was for standardization so the technology could be both as safe as possible and easily transportable across national boundaries.

WHO to establish a standardized radiological protection program for Thailand. He arrived in Bangkok and was met by an in country IAEA expert physicist R.A. Borthwick and a research reactor in place that was built by the US company Curtis Wright. As was common for research reactor establishments outside of the USA, the director of the Thai Radio Chemistry Laboratory, Mrs. Onareee Swateganit, was trained by the US AEC Health and Safety Laboratory in New York City. Her laboratory monitored soil and water near the reactor by investigating rice samples, finding only strontium-90 which was accredited to atmospheric testing and considered without question, by both Swateganit and Blatz, as not caused by the research reactor.

Blatz nonetheless found unexpected problems. In Bangkok, water from the reactor pool had leaked. He tested the extent of the contamination only to find stored nuclear waste in underground tanks had also leaked during frequent flooding. Inside the reactor facility, IAEA expert Borthwick had previously instituted a film badge service. However, the service was slow to find any overexposures: there was only the capacity for the badges to be tabulated on a three month cycle. Because of the heat and humidity in Thailand, the film badges did not always work properly. In addition, of the 1, 074 total film badges, thirty five were unaccounted for and ten of the badges showed exposures between 1,000 to 2,000 millirems. Blatz dismissed this as of no concern as this exposure was far below the 5,000 millirems per year limit as the "generally accepted maximum." Due to his training in the AEC protection and standards, the exposures were determined to be inconsequential.[226] The AEC radiation standards were based on the idea that if

[226] For comparison to today NRC dose limits for the public is less than 100 millirems per calendar year from internal and external sources. For workers, occupational limits are much higher, and vary for body part exposed from 5 rems per year for whole body (the same as in 1963 5,000 millirems per year equals 5 rems) however, the standards are in reality much more complex, and will change based on exposed area,

artificial radiation were far under the limits of natural background radiation from natural sources, like cosmic rays and uranium, the limits would provide more than enough safety.

Blatz felt the problems of providing radiation health safety in Thailand were not unique. Despite careful written rules for the Atomic Energy for Peace Act in Thailand, "…it is soon realized that many aspects of radiation protection – often the most important aspects – are not covered…This has occurred in both the USA and England. In these countries there has been the general realization that radiological health was primarily a public health problem." Beyond the radiation badges, no specific actions in Thailand for radiological protection had been taken before his arrival. The act of writing regulations was not the same as enforcing them. The conclusion of his meetings with his Thai colleagues was that they preferred safety measures to be enforced by an outside party. It was too hard to work and to also monitor themselves.[227] Scientists engrossed in research did not have protection from their own work. Radioactivity presented additional challenges to safety even in the controlled scientific laboratory environment.

A new frontier, however, is not for the faint hearted. Tarnished hopes tempered some of the early enthusiasm for nuclear power, as new questions about safety arose. These included the fire at a British plutonium and tritium processing facility for nuclear weapons, Windscale, in England. The fire of 1957 released large amounts of airborne radiation, which then, like nuclear weapons fallout, fell to ground to contaminate the grass eaten by cows and thus, could be ingested by humans and infants who drank milk.

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such as skin or eye. For example, each year only .15 rems is allowed to expose the lens of the eye or .5 rems over nine months for a pregnant female, etc. To compare historical doses to today is complicated but for today's standards see Nuclear Regulatory Commission, "Dose Standards and Methods for Protection" u.d. accessed May 6, 2014, http://www.nrc.gov/reading-rm/basic-ref/teachers/08.pdf.

[227] Hanson Blatz, "Assignment Report on the Development of Radiological Protection Services in Thailand, April 1963" SEA/Rad/13. 26.6. 63 Restricted Radiation-Thailand D63.1360, 2-7 quotations from 6, 7 respectively, Records of the Project Files: 1945-1986, WHO Archives, Geneva.

The reassurances of safety with the confiscation by the government of the milk drew the global public's attention to the dangers of fallout.[228] The accident was also used as a chance to study the effects of a nuclear war, and alarmed the public about the dangers of both power plants and nuclear arms.[229] That same year, Willard Libby of the AEC shared his findings from the Sunshine Project. Instead of reassuring the public about the small amount of Sr-90 comparative to natural background radiation, the release of the findings dismayed both the public and scientists that Sr-90 (a radionuclide not in the environment until after 1945) was accumulating in human bones and even children's teeth.[230] Disillusionment with nuclear technology was apparent in even in an ardent supporter. David Lilienthal is one unique example of an original frontiersman, having pushed for nuclear education since 1946. However, the former AEC chair wrote a book in 1963, "Change, Hope and the Bomb." He lamented that the atom was still tied to the destiny of every human being, but now like a sinking anchor, attached to the unsolved riddles of weapons proliferation, contamination and how to dispose safely of nuclear waste. We were, he said, "bewitched" and led by only convictions that nuclear power, born of such violence, had to be for good. [231]

The scientists' hopes for economic parity worldwide were not fully realized. Another less famous, but still significant voice is a Dr. Daw of the IAEA. In a 1970

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[228] Hamblin, *Poison in the Well,* 121-125; Gayle Greene, *The Woman Who Knew Too Much: Alice Stewart and the Secrets of Radiation* (Ann Arbor: University of Michigan Press, 1999), especially 162-5; K.S. Shrader-Frechette, *Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology* (Boston: D. Reidel Publishing Company, 1980), 96.
[229] Hamblin, *Arming Mother Nature,* 79.
[230] For more on Sunshine and Libby, see chapter 3; Robert A. Divine, *Blowing on the Wind: The Nuclear Test Ban Debate, 1954-1960* (New York: Oxford University Press, 1978) especially 129-32,184-7;To learn about the independent actions of scientist to assess Sr-90 contamination by collecting baby teeth, "The Tooth Fairy Project" see Michael Egan, *Barry Commoner and the Science of Survival: The Remaking of American Environmentalism* (Cambridge, Mass: The MIT press, 2007), 64-74.
[231] The book was donated to the OSU Library in memory of Manhattan Project (and later, OSU faculty) scientist Richard R. Dempster who is mentioned in chapter 5, Lilienthal, *Change, Hope and the Bomb*, quotation from 18.

seminar on radiological protection held in Kuwait, he predicted that although by the year 2000 50% of the electricity in the US would be provided by nuclear power "in developing countries, there are economic restraints and difficulty in obtaining nuclear fuel."[232] This was despite the enthusiastic response of Pakistan, for example, to Eisenhower's Atoms for Peace speech in 1953.[233] The Atoms for Peace announcement was followed by the excitement of the 1955 United Nations Conference on Peaceful Uses of Atomic Energy held in Geneva, (with the stunning operational research reactor installed) but became in fact, only a reality for the very few.[234] A 1975 IAEA study concludes however, "One of the most reliable indicators of economic development of a country is its per capita consumption of electrical energy. Seen in this context, the situation in Pakistan, though much improved since independence, is still not satisfactory…the per capita consumption is still one-tenth of the world average."[235]

For Pakistan, likely, by the 1970s, the inalienable right to peaceful nuclear technology encoded in the Non Proliferation Treaty became perceived by the west as instead, too illicit.[236] The relationship between power for electricity and nuclear weapons became acknowledged as too difficult to control in non-western developing countries. And the lack of control of nuclear power was magnified by the increasingly fierce and frequent accidents of the technology. The predictions from 1976 of one core melt "in

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[232] "Seminar on Radiation Protection, Kuwait, 28 February - 5 March, 1970" EM/SEM.RAD.PROT./22, 7 Records of the Project Files: 1945-1986, WHO Archives, Geneva.

[233] Ashok Kapur, "1953-59: The Origins and Early History of Pakistani Nuclear Activities," in *Pakistan's Nuclear Development* (New York: Croom Helm, 1987) 35.

[234] John Krige, "Atoms for Peace" and "Techno-Utopian."

[235] IAEA, *Nuclear Power Planning Study for Pakistan* (Vienna: IAEA, 1975) 1, STI/PUB/416.

[236] To learn more about the Non-Proliferation Treaty of 1968 (NPT) see Reaching Critical Will, accessed May 7, 2014, http://www.reachingcriticalwill.org/. The text of the treaty in Article IV guarantees the "inalienable right" to nuclear technology for peaceful purposes for all nations who sign on, in exchange for not developing nuclear weapons. Those that have nuclear weapons are required to reduce their current stockpiles to zero, see the actual text at United Nations, Non Proliferation Treaty, accessed May 7, 2014, http://www.un.org/en/conf/npt/2005/npttreaty.html.

20,000 reactor years…perhaps 25,000 reactor years we might expect only one core melt" were exceeded with the Three Mile Island accident three years later.[237] In addition, the inability to provide convincing evidence of a safe radiation exposure threshold to non-physicists is often deflected, as by nuclear scientist Alvin Weinberg: "We simply could not conceive that the public would be afflicted with a radiation phobia-that an additional radiation at background level would be viewed as posing an unacceptable hazard." [238] In his memoir, Weinberg reflected on his earlier ideas of economic parity through nuclear energy: "In 1966, at the height of my nuclear euphoria, I visualized nuclear energy--and by implication, other technological marvels--as being magical panaceas for much of what troubled us. From today's [1991] standpoint my optimism about nuclear energy seems utopian; however, the basic idea of a technological fix is still sound." [239]

Conclusion

As with any frontier, the ones who got there first likely made the rules. The AEC was years ahead of other countries in terms of expertise and capacity for nuclear education and making radiation health safety standards. UNESCO was able to distribute perceptions of the nuclear age with AEC norms as instructions, from elementary to adult education. UNESCO's motivation to expand nuclear education was embedded in a claim for human rights and economic development. The passion for nuclear technology as a right specifically became embedded in the efforts of not only the agency but also of universities and scientists. In this endeavor, UNESCO and WHO were aided by scientists,

[237] Weinberg, *Nuclear Reactions,* 5 and Weinberg, *The First Nuclear Era,* 276.
[238] Weinberg, *The First Nuclear Era,* 277; For more on the threshold debate, see chapter 3 and among other sources previously cited, see Walker, *Permissible Dose* and Divine, *Blowing in the Wind.*
[239] Weinberg, *Nuclear Reactions,* 1.

AEC grants and fellowships, conferences, articles, materials and influential believers, like Nehru and Bhabha.

The rhetoric of human rights worked reciprocally and hand in hand with nuclear science to bring values to developing nations that likely reinforced American hegemony.[240] The risks of contamination from nuclear science for these scientists were far eclipsed by their passion for experimental science. Scientists' dedication to nuclear development can be seen in their technical reports submitted to UNESCO and WHO. The technical experts established nuclear physics outposts, often with research reactors and armed with the AEC interpretation of threshold radiation health safety science. This chapter has examined examples of the agency and localized contributions of scientists and the countries they visited to contribute to scholarship on the circulation of nuclear science and health and human rights history. The story of how nuclear technology transgressed the boundaries of the known frontier and the body is intimately connected to a global effort to increase human rights. The expansion of nuclear science can explain how ideas of modernity, contamination and rights came to be ideas that were taken for granted. And one is left to wonder, as with any frontier, if and when it closes.

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[240] Human rights historian James Peck only provides non nuclear examples but he does mention the separation of disarmament and peace from human rights. To clarify, however, the nuclear case is my addition. James Peck, *Ideal Illusions: How the U.S. Government Co-opted Human Rights* (New York: Henry Holt and Company, 2010); Krige, "Atoms for Peace" and Krige and Barth, "Introduction."

Chapter 3 Pauling vs. Libby

The atom can ultimately move mountain ranges, drain seas, irrigate entire deserts, transmute poverty into plenty, misery into mercy. Such are the offerings of the Philosophers' Stone if man, having found its secret, can find the trust and will to use it well. Time Magazine, 1955[241]

As the *Time* cover story about Willard Libby attested in 1955, the issue of trust in science dominated during the 20th century.[242] At the time, scientists such as Libby, with organizations like the AEC and UN agencies like UNESCO and WHO, were rapidly disseminating nuclear technology as a human rights claim. Other scientists, even those opposed to nuclear weapons, often aided this rapid technological spread. Some opposed to nuclear weapons testing focused on questions of health and human rights and saw nuclear weapons as an expression of a new type of scientific techno-political totalitarian control. Many historians write about the culture of both public distrust and the known secrecy of the Manhattan Project that laid the foundations of what is considered the modern nuclear age. Primary source documents also attest to this. The notes in daily logs kept by David Bradley, one of the radiological monitors during nuclear tests known as Operation Crossroads in the Pacific, show clear links among radiation health safety science, human rights, and trust. Bradley's 1948 account "No Place to Hide" begins by saying people "for their own protection will have to match natural laws with civil laws. Science and sociology are as inseparable now as man and his shadow."[243] The present

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[241] "Science: The Philosophers Stone" *Time* 66 no. 7 (August 15, 1955) 48-55, quotation on 55.
[242]Steven Shapin argues that the issue of trust is the issue of the science, the 20th century and modernity, writing,"The place of science in the modern world is just the problem of describing the way we live now: what to believe, whom to trust, what to do." Steven Shapin, "Science and the Modern World," accessed April 23, 2014, http://www.fas.harvard.edu/~hsdept/bios/docs/shapin-Science_Modern_World_2007.pdf.
[243] David Bradley, *No Place to Hide 1946/1984* (London: University Press of New England, 1948, 1983); The centrality of radiation health safety to nuclear history is clear in several works by Walker but especially in J. Samuel Walker, *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000).

chapter aligns debates over science and rights through the lives of two trusted scientists. The scientific disagreement over the safety of fallout from nuclear weapons tests can be illustrated by Willard Libby and Linus Pauling. Both men made assumptions, without conclusive evidence at times, about the relative safety or harm of background radiation from naturally occurring uranium and cosmic ray radiation. The men also stood opposed in their interpretations of the limits to state power and human rights. This comparison of lives and claims between the two men embody the different definitions of both radiation safety and human rights.

According to K.Z. Morgan in 1999, a founder of health physics, the risk of cancer caused by radiation exposure was fifty times greater than the risks were concluded to be in 1947.[244] According to both J. Samuel Walker and Barton Hacker, the controversy over radiation safety has been misunderstood because radiation safety standards were in actuality socially constructed by health physicists to the best of their ability and never intended as a pronouncement of safety.[245] This history is problematic, because if the guidelines were not measures of safety, what were they intended to be? This history also suggests that, as Gabrielle Hecht argues, the way radiation danger has been addressed is more a reflection of the value of what is being irradiated than a scientific evaluation of effects. The actions and thinking of Pauling and Libby on the topic of radiation safety provides a way to understand the sociopolitical workings of science. How these men came to their disparate scientific conclusions is documented in recent works of several

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[244] Karl Z Morgan and Ken M. Peterson, *The Angry Genie: One Man's Walk through the Nuclear Age* (Norman: University of Oklahoma Press, 1999) 118.

[245] Walker, *Permissible Dose*; Barton C. Hacker "The Writing of the History of a Controversy; Radiation Safety, the AEC, and Nuclear Weapons Testing" *The Public Historian* 14, no. 1 (Winter, 1992): 31-53, see especially 48-9 and Hacker's *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Berkeley: University of California Press, 1987).

historians and historians of science, yet juxtaposing them directly will inform us about the assumptions and humanitarian motivations in radiation health safety science.[246]

The divergent interpretations of the safety of "natural" or background radiation is central to the issues of both environmental justice and human rights.[247] Some argue that the general public has accepted the valuation of radiation safety by those invested in obscuring dangers. The projection of radiation health safety by industry, governmental agencies and international agencies like the IAEA continue to be seen as scientific facts, and taken at face value, rather investigated as a historical social construction throughout the nuclear era.[248] This was true in the 1950s, during massive thermonuclear weapons tests and as Atoms for Peace research reactors and nuclear programs were spreading infrastructure into developing nations.[249] The story highlighted here is often hard to recognize in health and human rights histories and protocols. Since it is not explicit, the claim of a human right not to be contaminated is not broached by historians of science,

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[246] Toshihiro Higuchi "Radioactive Fallout, the Politics of Risk, and the Making of a Global Environmental Crisis, 1954-1963" (PhD diss., Georgetown University, 2011); Emory Jerry Jessee, "Radiation Ecologies: Bombs, Bodies and the Environment during the Atmospheric Weapons Testing Period, 1942- 1965" (PhD diss. Montana State University, 2013) ; J. Christopher Jolly, "Linus Pauling and the Scientific Debate over Fallout Hazards" in *Endeavor*, 26 no. 4 (2002): 148-53 and his dissertation "Thresholds of Uncertainty: Radiation and Responsibility in the Fallout Controversy" (PhD diss., Oregon State University, 2003); Jacob Darwin Hamblin, *Arming Mother Nature: The Birth of Catastrophic Environmentalism* (Oxford: Oxford University Press, 2013).

[247] This is not only because many indigenous people live in areas with high natural background radiation from uranium deposits and live in areas with increased background radiation from previous nuclear weapons testing, but it is an important issue. Using an average "background" dose will lead to disproportionate overexposure, threshold or nay; Gabrielle Hecht, "A Cosmogram for Nuclear Things." *Isis* 98 (2007): 100-108.

[248] Frank Newport, "Americans Still Favor Nuclear Power a Year after Fukushima: Majority Still Sees Nuclear Power as Safe" *Gallup Politics* March 26, 2012 57% favored just as immediately before the Fukushima accident accessed May 9, 2014, http://www.gallup.com/poll/153452/americans-favor-nuclear-power-year-fukushima.aspx; 59% favor nuclear energy in the US as of May 2009 Gallup poll, see Jeffrey M. Jones, "Support for Nuclear Energy Grows to a New High: Majority Believes Nuclear Power Plants are Safe" accessed May 9, 2014, http://www.gallup.com/poll/117025/support-nuclear-energy-inches-new-high.aspx.

[249] Krige John, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence," *Osiris* 21 (2006): 161-81; This point is more fully developed in chapter 2 but it is important to note that Libby as an AEC Commissioner oversaw this massive and quick growth in worldwide nuclear infrastructure.

human rights activists, and organizations such as the UN.[250] Protection from radioactive contamination has been considered a scientific question rather than as a human rights claim, but both aspects converged during the fallout controversy. The lives, science and ideas of Libby and Pauling encompass this confluence.

Two Men In the Light of Present Knowledge

To illustrate how notions of safety could be interpreted quite differently, depending on one's social values, we can examine the contrasting outlooks of these two prominent scientists in the fallout controversy. Both were widely respected in the field of chemistry. Yet, the two men had divergent scientific outlooks about the dangers from radionuclides. Willard Libby, first as a scientist, then as a commissioner of the Atomic Energy Commission, assured the public of their safety from fallout created by nuclear weapons tests. By contrast, Linus Pauling framed the exposure of mass populations to radiation as dangerous experiments that were conducted without consent.[251]

The contrast between Libby and Pauling also shows the importance of trust and the conception of rights in developing, and countering, the discipline of health physics.

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[250] However, much new literature on "toxic trespass" is being written and there are many books about contamination, see Nancy Langston's *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2010), but the claim that was made in the 1950s that human rights already circumscribed the right to the integrity of one's body is not explicit in current literature.

[251] Linus Pauling repeatedly framed nuclear weapons tests as experiments on humans. Although not concerning radiation experimentation, other authors discuss human experiments from 1933 to 1945, see Gerhard Baader, et al., "Pathways to Human Experimentation, 1933-1945: Germany, Japan, and the United States" *Osiris,* 2nd Series, 20, Politics and Science in Wartime: Comparative International Perspectives on the Kaiser Wilhelm Institute (2005): 205-231. As the work of philosopher Kristin Shrader-Frechette explains no mechanism for consent to mass radiation exposure exists. Shrader-Frechette feels nuclear technology undermines democracy, which is based on equality for all, by subverting this goal of equality for a utilitarian sacrifice of some, mostly the poor and of color, for the good of the white majority who benefit from resource extraction and colonialism. Just a few selections of her recent work include *What Will Work: Fighting Climate Change with Renewable Energy, Not Nuclear Power (*New York: Oxford University Press, 2011), *Taking Action, Saving Lives: Our Duties to Protect Environment and Public Health* (New York: Oxford University Press, 2007), *Environmental Justice: Creating Equality, Reclaiming Democracy* (New York: Oxford University Press, 2002). Fallout as an experiment is discussed in Jacob Darwin Hamblin, *Arming Mother Nature,* see especially 103.

New emerging disciplines like health physics often test boundaries between lay and expert, popular press and scientific journals.[252] The discipline of health physics was established by 1942 at the Chicago Met Lab as part of the Manhattan Project. Some historians and those involved assert it was named "health physics" to obfuscate the need for radiation safety in order to keep secret the atom bomb project. The discipline focused on developing instrumentation for monitoring radiation, and mathematical calculations of safety for atomic workers and scientists. This was based on the essential insight that there was a threshold for dangerous exposure.[253]

Libby and Pauling were similar in many respects, and perhaps one might have expected their views of radiation to be similar. Both Libby and Pauling won Guggenheim fellowships; Pauling in 1926 for chemistry and Libby in 1941 for natural sciences and physics. Later, both would become Nobel Prize winners for their work in chemistry. Pauling won his Nobel in 1954, the same year Libby became appointed to the Atomic Energy Commission (AEC). Libby received his Chemistry Nobel prize in 1960 for his work using Carbon-14 for radiocarbon dating. There much of the similarity between the men ends. Libby perceived his role as on the AEC as a reward for his support of the hydrogen bomb, and his assailing against Robert Oppenheimer. For Pauling, both the terror of thermonuclear explosions and the Oppenheimer hearings were threats to democracy, freedom of speech, and human rights of epic proportions. Pauling became the central figure in raising the ethical and practical questions of the responsibility of the

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[252] Jim Endersby, "Mutant Utopias; Evening Primroses and Imagined Futures in Early Twentieth-Century America" *Isis* 104, no. 3 (September 2013): 471-503, see especially 473-7.

[253] Michigan State University, Environmental Health and Safety, "Radiation Safety: Robley Evans" accessed May 9, 2014, http://www.orcbs.msu.edu/radiation/resources_links/historical_figures/evans.htm; Morgan and Peterson, *The Angry Genie,* 21; Ronald L. Kathren and Paul L. Ziemer eds, *Health Physics: A Backward Glance, Thirteen Original Papers on the History of Radiation Protection* (New York: Pergamon Press, 1980); J. Samuel Walker and George T. Mazuzan, *Controlling the Atom: The Beginnings of Nuclear Regulation 1946-1962* (Berkeley: University of California Press, 1984), 36.

scientist to the public and to the state. Pauling did this with his wife, Ava Helen, as they opposed nuclear weapons and war, by lecturing, writing, protesting, and educating throughout the fifties, while laying the foundations for an emerging American environmental movement that focused on the interactions of human-made pollutants within the ecosphere.[254]

Libby, in contrast, was a nuclear utopian. Libby, a key scientific figure of the AEC, was once described as "a man who saw a Communist under every bed."[255] Libby believed that nuclear power would itself end war by the abundance it would produce, far overshadowing the power of nuclear weapons, which perhaps soon would no longer be needed in a world of such limitless wealth, that would satisfy human "needs for all time" including extended and disease-free lives healed with nuclear medicine.[256] With funding from the AEC Libby established the methods for using radioisotopes to study and monitor the environment. Libby and his wife Leona, an environmental engineer, founded the first distinctly multidisciplinary environmental PhD program in UCLA by 1972.[257]

Both Libby and Pauling sought to simplify, for the general public, the concepts of nuclear radiation. Both would become trusted voices and thus, representative of two distinct interpretations of radiation health safety. Libby assured the public at every

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[254] Interview of W.F. Libby by Greg Marlowe on April 12, 16, 1979, Niels Bohr Library & Archives, American Institute of Physics (AIP) College Park, MD, USA, accessed May 13, 2014, http://www.aip.org/history/ohilist/4743_1.html; Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York: Random House, 1999) 300; Nicole de Messieres "Libby and the Interdisciplinary Aspect of Radiocarbon Dating" *Radiocarbon* 43, no. 1 (2001): 1-5; Hamblin, *Arming Mother Nature*, 104-107; Jolly, "Linus Pauling" and "Thresholds of Uncertainty"; Thomas Hager, *Force of Nature: The Life of Linus Pauling* (New York: Simon and Schuster, 1995); Clifford Mead and Thomas Hager, (Eds) *Linus Pauling: Scientist and Peacemaker* (Corvallis: Oregon State University Press, 2001) Mina Carson, *Ava Helen Pauling: Partner, Activist, Visionary* (Oregon State University Press, 2013).

[255] James G. Hershberg, *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age* (Stanford: Stanford University Press, 1993), 489

[256] William L. Lawrence, *Men and Atoms: The Discovery, the Uses and the Future of Atomic Energy* (New York: Simon and Schuster, 1959) 243-6 quotation on 243.

[257] Marlowe, "W. F. Libby" AIP; de Messieres, "Libby"; Hamblin, *Arming Mother Nature* 104-107.

opportunity of fallout safety. Pauling framed the exposure of mass populations to radiation as scientifically specious and a violation of human rights to "life, liberty and the pursuit of happiness."[258] Surprisingly, both were collegial and even friendly to each other in their correspondence, even during the height of the fallout controversy.[259] Pauling's life-long best friend, Paul Emmett, worked with Libby to develop the chemistry for the gaseous diffusion process and barriers that made enriched uranium possible during the Manhattan Project.[260] Libby's initial mentor, Dr. Harold Urey, would go on to be one of the Vice Presidents of the group which formed out of the Emergency Committee of Atomic Scientists and later the Federation of American Scientists to work for international control of nuclear weapons and energy. With Pauling, Urey sponsored *The Bulletin of Atomic Scientists.*[261]

Politically, Pauling was more vulnerable than Libby. For example, Senator Joseph McCarthy criticized Pauling soon after the first Soviet bomb test in 1949. Pauling was startled by the intensity of the smears against him. Having organized much of the chemical war work done in WW II at Caltech, and receiving the highest honor accorded

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[258] Linda Richards, "Fallout Suits and Human Rights: Disrupting the Technocratic Narrative" *Peace and Change Journal of Peace History* 38, no.1 (January 2013): 56-82 http://onlinelibrary.wiley.com/doi/10.1111/pech.12003/pdf; Hagar, *Force of Nature.*

[259] Despite a clear difference of opinion on the hydrogen bomb, Libby had also, (along with Edward Teller, who would later also debate Pauling on live TV) signed letters of support for Pauling in 1952. Libby's signature was part of a large, predominantly European outcry after Pauling's passport had been withheld by the US Passport Office. This caused Pauling to miss a Royal Society meeting held in his honor to discuss his work on the structure of proteins, but he sent a thank you letter to Libby for his efforts. Pauling to Libby, June 16, 1952 LP Correspondence File 217. 2 Libby W.F. 1950-2,1954-5, 1957-8, 1960-3, 1965, Ava Helen and Linus Pauling Papers (AHLPP), SCARC, OSU, Corvallis, Oregon; Tom Hager, *Force of Nature,* 400- 405. Their correspondence seems warm and involves peer reviews, job placements, ongoing researches and Pauling even wanted Libby to help him to prove Scandinavians were the first to settle America by using his radiocarbon dating on a sandal. Box 217 File 217. 2 Libby W.F 1950-2,1954-5, 1957-8, 1960-3, 1965, LP Correspondence, AHLPP, SCARC.

[260] Paul Emmett to Libby, March 6, 1976, Box 1.010 File 10.4 "Libby, Willard F. 1976-1981" and Manhattan Project/SAM Laboratories, Columbia University 1941-7, 1983 Box 1.011 File 11.3 Paul Emmett Papers, History of Science Collection, SCARC. Emmett's MED contract is in this file and he earned $35 a day, or adjusted for inflation in 2013 dollars, $463 dollars a day.

[261]Alice Kimball Smith, *A Peril and A Hope: The Scientists Movement in America: 1945*-47(Chicago: The University of Chicago Press, 1965) 495.

to civilians by President Truman, Pauling felt he was unflinchingly patriotic. McCarthy, however, believed otherwise. He named Pauling as one of eight atomic scientists known to be communists in October of 1950. Pauling attempted to correct this mistake that was printed widely in newspapers by saying that he was neither an atomic scientist, nor a communist, but in favor of 'international policies that would lead to peace."[262] In 1950, Pauling was invited by the *Bulletin of Atomic Scientist's* editor, Eugene Rabinowitch, to contribute to the public discussion of the development of the "Super" or hydrogen bomb.[263]

The scientific differences between the men can be similarly isolated. The scientific dispute between Libby and Pauling can be distilled to one key assumption about the relative safety or harm of background radiation from naturally occurring uranium and cosmic ray radiation. Pauling, like geneticists, felt that even if it was natural, there was no safe level of radiation exposure. This was due to known birth defects, diseases and cancers established as caused by this natural radiation.[264] Libby saw the evidence inversely. He felt there was a practical level of natural radiation exposure that would likely cause not harm. Libby's epidemiological approach was in step with the tradition of a threshold approach. This can be traced to the field of industrial hygiene, and the creators of early X-ray and radium industry standards. Standards were recommended by volunteer membership organizations such as the International Commission on

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[262] Pauling to Charles Newton, October 23, 1950 "Interviews with United Press and Associated Press" LP Biographical: Academia: (California Institute of Technology: Administrative Files, 1938-1971.), Box 1.030, Folder 30.2, AHLPP.

[263] However, Pauling never worked on the atom bomb, so to call him an atomic scientist as McCarthy did is in error, Eugene Rabinowitch to Pauling, January 17, 1950; Pauling to Rabinowitch, February 1, 1950 LP Peace, Box 3.016 Folder 16.3 "Correspondence *The Bulletin of Atomic Scientists* 1950-3" AHLPP.

[264] The only doubt at this time was whether somatic effects were also caused, but in terms of genetics, Pauling states "there was no doubt" among geneticists and that no amount of radiation could be deemed "safe" as only one radioactive atom could destroy genetic material, see Pauling, *No More War,* 92-93.

Radiological Protection (ICRP). Early animal studies by the Manhattan Project in the 1940's "lent comfort to," as Lauriston Taylor, (a founder of radiation safety) put it, the threshold approach that was already in use. This was despite the early death and birth defects found in radiation-exposed mice, guinea pigs and rabbits at the Manhattan Project laboratories and universities.[265] Other secret human experiments, performed without knowledge or consent upon ill patients, even some children, some disabled, and pregnant women, reinforced a belief in a threshold, despite some inconsistencies.[266]

Taylor in 1971 wrote proudly of the fact that while "changes in numerical values and … some developments, particularly in the genetic field…modified the approach to the genetics problem," there had never really been "important or fundamental" changes "in the philosophical approach to the problem" since the original recommendation of 1949.[267] The 1949 "NCRP Report on External Exposure," published for the public in 1954, established the first tolerance dose for the population at large. The standards relied on the reiteration of what was known at the time about how external radiation operated and applied this knowledge to internal exposures, calculated with water as the stand in for

[265] Large scale experiments began in the 1940s at the National Cancer Institute, The University of Rochester, the University of Chicago, and Oak Ridge, see Lauriston S. Taylor, *Radiation Protections Standards* (Cleveland: CRC Press, 1971), 21. Also the extent of Manhattan Project and AEC studies on radiation is vast and recorded, with commentary and context, in 1,777 pages in J. Newell Stannard, *Radioactivity and Health: A History* (Springfield, Va: Battelle Memorial Institute, 1988).
[266] For more on these experiments, see Stannard, *Radioactivity and Health;* Welsome, *The Plutonium Files,* for an additional history on MED health physics, see her chapter "Tolerance Dose.;" Wasserman, *Killing Our Own,* 1992; See the documentation of human experiments at "Spotlight on Human Radiation Experiments" US Department of Energy Opennet webpage, accessed April 23, 2014, https://www.osti.gov/opennet/spotlight.jsp. It is important to note recent articles on this topic of radiation experiments on African American and pregnant women recently coming to light and as well, the efforts to suppress this information, see Jeff Kaye, "Early US Experiments on Black Children" *MY FDL Reader Diaries* May 25, 2011, accessed April 23, 2014, http://my.firedoglake.com/valtin/2011/05/25/documentary-on-early-u-s-radiation-experiments-on-black-children-video-trailer/.
[267] Taylor, *Radiation,* 1971, 24-5, quotation from 25.

organs and tissues.[268] Genetic concerns were left for further study, despite the "universally accepted" findings that there was a linear relationship between radiation and genetic mutation and the inclusion of Hermann J. Muller, who had worked on these issues, on the committee.[269]

Pauling marked this first definition of an acceptable dose on his copy of the regulations that he had requested. Pauling requested many of the studies and findings of not only the AEC but the UN AEC and later, the IAEA. In his copy of the regulations, he highlighted the definition that would guide radiation protection, "Permissible dose may then be defined as the dose of ionizing radiation that, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his lifetime."[270] Many years later, however, Taylor saw the lack of change in this original way of thinking about radiation exposure as proof of the threshold exposure model's efficacy and protection.[271]

Like Taylor, Libby viewed dangers from fallout to be relatively small. Libby based his thinking on the notion that any radiation below background, which was a barely measurable amount itself, would be relatively safe. Natural radiation was all around. Fear of radiation on the part of the public could be credited to the recent human recognition of these facts of life, as Libby often explained. Libby took a comparative, relative approach

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[268] Ryan and Poston, *A Half Century of Health Physics.*
[269] Taylor, *Radiation,* 1971, 21-3; "Booklet: *Permissible Dose from External Sources of Ionizing Radiation* US Dept of Commerce, Sept 24 1954" Box 7.001 File 1.4 LP Peace, AHLPP; For more perspectives on Muller and the genetics of the Atomic Bomb Casualty Commission, see John Beatty, "Genetics in the Atomic Age: The Atomic Bomb Casualty Commission, 1947-1957" in *The American Expansion of Biology*, eds., Keith Rodney Benson, Jane Maienschein, Ronald Rainger (New Brunswick, NJ: Rutgers University Press, 1991).
[270] "Booklet: *Permissible Dose"* 1954, LP Peace 7.001.4, quotation on 27. Pauling also writes a correction to the conversion factor for the math equation on page 77 that determined radiation biological effectiveness, and notates his concern about the exposure of minors, followed by his attention to that short term exposure limits could be calculated as an average that would not exceed the limit for over one year annotated on 57.
[271] Taylor, *Radiation,* 1971, 24-5.

to potential harm, instead of an additive or cumulative approach, as his detractors did. Pauling, for example, found the views of Libby irreconcilable with his own morality. Pauling felt ending suffering was the essence of scientific and medical practice. His belief in ending suffering predated World War II but aligned with the Hippocratic Oath and Nuremburg Code in that science should do no harm.[272] This was because, to Pauling, man-made radiation exposure would be adding to an already elevated risk of birth defects, illness and cancers caused by the existing "natural" background radiation.

For Libby, he could only do his best, using his present knowledge. He indeed had more knowledge of the natural sources of radiation than almost any other scientist. Libby published papers on natural radioactivity throughout his career, as early as 1933. He was one of few experts on the subject, and had helped to create methods to study and measure first natural radioactivity, then fallout, building Geiger counters and experimenting with ways to measure radiation. He was keenly interested in cosmic rays and Carbon-14 (C-14) before the war, wondering how radiocarbon came into being.[273] His professional experience was with cosmic rays, which carried far more radiation than fallout. Libby

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[272] Pauling's and the fallout controversy contribution to the articulation of the precautionary principle is worthy of investigation. The precautionary principle is most often dated as coming to fruition in 1992 UN Conference on Environment in Rio de Janeiro, see Timothy O'Riordan and James Cameron, *Interpreting the Precautionary Principle* (London: Earthscan, 1994) 12, 16-7 but this history is quite connected to enduring conceptualization of humane medical treatment with the German idea of the 1930s of foresight planning. Pauling's dedication to ending suffering is well accounted for in his work on sickle cell anemia to nuclear weapons, see Hagar, *Force of Nature*. Pauling however, speaks for himself about the idea of alleviating suffering and "do no harm" in almost all his personal notes to himself and most of all his speeches, interviews and public lectures on nuclear weapons and war in the LP Peace collection in SCARC. His involvement in development of the precautionary principle began even before his opposition to nuclear weapons, as can bee seen in the medical section he wrote for Vannevar Bush's "Science the Endless Frontier" that speaks to the importance of ending suffering from illness and birth defects. Pauling's copy is available at SCARC. One later particular speech that elucidates the culmination of his ideas relative to elucidating the precautionary principle is in his preparatory notes and the speech itself. He writes that a moral principle should be agreed upon of doing no harm (see page 4 of the speech) LP Speeches, 1971s. 14, Folder "Manuscript Notes, Abstract, Correspondence "The Basis for Decisions" Commencement Address, University of Berkeley, June 5, 1971" AHLPP.

[273] Serge A. Korff, *Willard F. Libby Collected Papers Volumes III & IV Radioactivity and Particle Physics and Radioactive Fallout & Technology* (Los Angeles, University of California, 1980) Preface.

viewed dangers from fallout to be relatively small, compared to just these much more potent natural cosmic rays. He had big questions, and he wanted to find the answers to them to understand how the universe worked. [274] His pre-war expertise on C-14, which did occur naturally as part of cosmic rays, would later lead to his discovery of radiocarbon dating, leading to his Nobel Prize and to his stature and legacy in various fields.

Libby relied not only on his pre-World War II measurements and research on natural sources of radiation, but also on findings from the emerging field of health physics about primarily external radiation effects. How could harm or safety even be measured when the exposures from artificial radionuclides were so new? In 1941 an internal inhalation limit for radon was based on the ideas of what was known thus far about external exposures and was for one source, radium.[275] Uranium was investigated by the Manhattan Project scientists in secret experiments but they saw the element as more of a toxic threat than a radiological danger.[276] Yet, the evidence for the dangers of radium inhalation exposure that can be caused by the radon and radon daughters in uranium by the 1950s was also extensive. This was due to lung cancers found in underground coal and silver miners as far back as the fifteenth century, the deaths and illnesses of workers and technicians in the radium industry, and patients and people caught up in the toxic radium health craze of the early 20th century. Links were made between uranium miners and dangerous airborne radiation exposures by Pirchan and Sikl (1932) and Peller (1939)

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[274] Korff, *Willard F. Libby Collected Papers*.
[275] Michael G. Stabin, *Radiation Protection and Dosimetry: An Introduction to Health Physics* (New York: Springer, 2008), 105-19, especially page 115; Kathren and Ziemer eds, *Health Physics,* 1-7; Korff,, *Willard F. Libby Collected Papers.*
[276] C.A. Potter, "Internal Dosimetry—A Review" in *50th Anniversary of the Heath Physics Society- A Half Century of Health Physics* eds., Michael Tryant and John W. Poston, Sr. (Baltimore: Lippincott Williams & Wilkins, 2005) 50.

but secret uranium mines in the southwest during WW II continued to be operated without adjustments to provide ventilation. Libby, however, did his best to infer overall safe exposure limits from naturally occurring radiation, ignoring qualitative differences between artificial and natural radiation from uranium in the soil and cosmic rays. [277]

The times were intense and cavalier during the war effort.[278] Safety could not be paramount, but sacrifice was. The natural rates of background radiation rates were measured by surveys designed by Libby at different locations and elevations and then the numbers averaged.[279] He spoke and wrote as if he believed that what was natural would not be harmful, and this was a logical conclusion because humans must have evolved with radiation in their environment.[280] It was inherent in this assumption that what was

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[277] John Gofman, *Radiation and Human Health* (San Francisco: Sierra Club Books, 1981), 431-3 It is conclusive by the 1994 Advisory Committee on Human Radiation Experiments that that this led to the lung cancers and deaths of the miners, see "Advisory Committee on Human Radiation Experiments" DOE openet. It is also important to be clear that certain other assumptions beyond the safety under background level were also made, for example in the NCRP 1954 published report previously discussed: all ionizing radiation would behave qualitatively the same, fractional doses would decrease intensity of cell damage and that radiation's interaction with biological systems could be calculated as equivalent to action on water, see "Booklet: *Permissible Dose"* 1954, 7.001.4 LP Peace; For a history of radiation biology, see R. Julian Preston, "Radiation Biology: Concept for Radiation Protection" in *50th Anniversary of the Heath Physics Society- A Half Century of Health Physics* eds., Michael Tryant and John W. Poston, Sr. (Baltimore: Lippincott Williams & Wilkins, 2005). Not all radiation is qualitatively the same, J.E. Turner, "Interaction of Ionizing Radiation with Matter" in *50th Anniversary of the Heath Physics Society- A Half Century of Health Physics* eds., Michael Tryant and John W. Poston, Sr. (Baltimore: Lippincott Williams & Wilkins, 2005) 11-2, 14-6, 21, 26-7.

[278] Email communication with author, John J. Compton his article "Arthur Holly Compton: The Adventures of a Citizen Scientist" *Perspectives on Science and Human Faith* 62 no.1 (March 2010) galleys provided, no page numbers.

[279] Willard F. Libby, "Dosages from Natural Radioactivity and Cosmic Rays" [previously published in *Science* v.122 July 5, 1955, 57-58] in Congressional Hearing *Nature of Radiation Fallout and its Effects on Man* 1459 – 1462, LP Peace, 7.022, AHLPP, with Pauling's extensive annotations.

[280] For more about the early radium craze, uranium miners and radiologists, see Walker, *Permissible Dose*; Judy Pasternak, *Yellow Dirt: An American Story for a Poisoned Land and A People Betrayed* (New York: Free Press, 2010); Raye C. Ringholz, *Uranium Frenzy: Saga of the Nuclear West* (Logan: Utah State University Press, 2002); Otto Glasser, *The Science of Radiology* (Springfield, Illinois: Charles C.Thomas, 1933), 211; Rebecca Herzig, "In the Name of Science: Suffering, Sacrifice, and the Formation of American Roentgenology," *American Quarterly* 53, no. 4 (December 2001): 563–89; Daniel S. Goldberg, "Suffering and Death among Early American Roentgenologists: The Power of Remotely Anatomizing the Living Body in Fin de Siécle America," *Bulletin of the History of Medicine* 85, no. 1 (Spring 2011): 1–28; MED scientist Robley Evans actually created the standard of radium inhalation from his surveys of this history, Michigan State University, Environmental Health and Safety, "Radiation Safety: Robley Evans" accessed

determined safe for humans would protect the environment. The environment on the whole was looked at by Libby as not poisoned or radioactive by nuclear weapon explosions. He believed most of the radioactivity exploded far into the atmosphere, and was consumed within the fireball of the bombs. Like many engineers and scientists of his era, he also conceptualized the earth as indestructible and the environment as a "sink." Winds, the stratosphere, the ocean, lakes and streams and soils, would dilute and mediate the radiation, keeping it safely away from human populations until the radioactivity decayed to a less dangerous amount, whether in the ocean, the atmosphere, or the soil.[281]

Pauling however, had different views. He believed that environmental radiation would accumulate and damage human health. The idea of a safe background level was inconsistent with his ideas of how mutations and radiation worked. At the time, Libby's method of calculating background radiation was of concern to Pauling because the estimates could be in error, either underestimating or dangerously overestimating dangers. For example, one scientist, James Paul Wesley who informed Pauling's views, countered Libby's estimates. He thought the estimates could be mistaken by as much as a factor of ten. Wesley believed that "a 3 or 4 fold increase in background radiation might endanger" the entire human race. Wesley concluded that "a threshold radiation dose rate of the order of the natural background radiation does not exist." He predicted 14,000 lives a year would be lost due to the influx of artificial radioactivity into the Untied States since the

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May 9, 2014, http://www.orcbs.msu.edu/radiation/resources_links/historical_figures/evans.htm; Libby, "Dosages from Natural Radioactivity and Cosmic Rays" in , 7.022 Congressional Hearing *Nature of Radiation Fallout and its Effects on Man,* 1459-62, LP Peace, AHLPP.

[281] Stabin, *Radiation Protection,* 2008, 105-19, especially page 115;Kathren and Ziemer eds, *Health Physics,* 1-7; Hamblin, *Arming Mother Nature,* 101-103.

1940s.[282] But Libby's estimated valuation of natural background radiation stuck, long before any conclusive research could be decisive on its validity**.**

Pauling was first and foremost an expert in chemical bonds, for which he won his first Nobel Prize. He believed that radiation broke such bonds. His early work as an X-ray crystallographer as a student at Cal Tech was influenced by the weekly genetics lectures of Thomas Hunt Morgan.[283] His ideas about health developed from his own knowledge of cellular and molecular processes in the disease of sickle cell anemia. His understanding of disease as a molecular process was complemented by his ability to link the fields of biology, chemistry, physics and genetics. After the first use of the atomic bombs, Pauling began a veracious survey of all things atomic. This massive project included compiling all radiation studies and papers available in his effort for international control of the nuclear weapons he abhorred. He collected and studied hundreds of available multidisciplinary studies on radiation exposure, declassified AEC and non-AEC studies, especially international papers. From genetics alone, Pauling felt it was already proven that there was a linear relationship between radiation and mutation, as Muller had found in fruit flies.

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[282] "Reprint: Background Radiation as the Cause of Fatal Congenital Malformation" and James Paul Wesley to Pauling, November 4, 1959 Box 7.004 File 4.3 and James Paul Wesley, "Background Radiation as the Cause of Fatal Congenital Malformation" Box 7.0012. File 12.14 "Correspondence, Offprint: Background Radiation as the Cause of Fatal Congenital Malformation, James Paul Wesley, 1959" LP Peace, AHLPP. Wesley said he had been inspired to study the situation after reading Pauling's *No More War* in the late 50s. Wesley also felt that the NAS Committee on the Genetic Effects of Radiation in 1956 assumed, without any convincing basis, that only 10% of all congenital infant deaths are caused by background radiation. Wesley's work, published in the *International Journal of Radiation Biology* however, showed it was more likely 96% or almost all of these deaths could be attributed to background radiation. He called for a strong reevaluation of safety standards since they were based on the 10% assumption. Wesley's work was published eventually in 1960 in the IJRB 2, no.1 (1960) after revisions to his 1959 paper, which also concluded that X-rays have contributed to a 6% increase in congenital malformations in the last 30 years. Wesley eventually left the country and established the field of ecophysics.

[283] OSU SCARC, "It's in the Blood! A Documentary History of Linus Pauling, Hemoglobin and Sickle Cell Anemia: Narrative-4. Shifting Gears and Bridging Disciplines" accessed May 9, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/blood/narrative/page4.html.

Genetics research implied that any dose, no matter how small, could cause mutations.[284] The AEC came to accept a very small but possible genetic potential of harm, but resisted any application of a non-threshold dose to somatic (or cellular) disease potentials that existed during an individual's lifetime.[285] While Pauling had developed strong views against thresholds of radiation safety, Libby had become one of the major proponents of them. Much of the specific construction of background radiation as a conclusive benchmark for safety was also amplified by Libby with his unfettered access to the press, politicians and leading figures.

The events of World War II shaped Libby's life. He had walked into Dr. Harold Urey's Columbia office the day after Pearl Harbor and asked how he could help.[286] Urey brought Libby into the Columbia group working for the Manhattan Project, where Libby used his expertise to work on the chemistry for the gaseous diffusion process that was being planned by engineers.[287] For a short time immediately after the war, Libby like many of the former atomic scientists worked for civilian control of nuclear weapons. After the Soviet explosion in 1949, he redirected his energies to protect the free world

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[284] To see the hundreds of studies collected by Pauling, see the 25 boxes of material he collected in the AHLPP, in LP Peace Section 7. 001 to 7.025 "The Debate over Fallout and Nuclear Contamination." For much more on the development of radiation protection and health physics see Walker, *Permissible Dose* and Kathren and Ziemer eds., *Health Physics.* One of the best clear summations is in a health physics textbook, Stabin, *Radiation Protection,* 2008, 105-19.

[285] Korff ed., *Willard F. Libby* 1980, Introduction to Volume IV, 'Papers on Radioactive Fallout" no page number. It is also important to note that in the main, the composition of the AEC Commissioners were not scientists, but predominantly politicians and former military men. While they funded and directed almost all the funds for both secret and public studies on radiation, during the years of the fallout controversy, only Willard Libby and John Von Neumann (who would die of cancer at the age of 57 in 1957) were scientists. After Von Neumann's death, Libby was the sole scientist.

[286] Marlowe, "W. F. Libby," AIP.

[287] The ICRP is the international arm of the NCRP, which is the US organization. Marlowe, "W. F. Libby", AIP; Unknown was the chemistry to separate the fractional amount (.72%) of uranium 235 (which is able to sustain fission) from the rest of natural uranium, which is predominantly uranium 238, and not fissile nor able to sustain a chain reaction like Uranium 235. Libby worked for fifteen months with Paul Emmett, Paul Emmett to Willard Libby, March 5, 1976 Paul Emmett Papers, Correspondence L Box 1010. File 10.4 "Libby, Willard F, 1976-1981" History of Science Collection, SCARC.

from what he felt was the impending nuclear aggression from the Soviets. His dedicated nuclear work continued at the Institute of Nuclear Studies (now Fermi Lab) and the chemistry department at the University of Chicago. By 1950 he was a member of the General Advisory Council to help the AEC. He was also, however, buoyed not just by fear of the Soviets, but by his faith in nuclear technology itself as a certain path to world peace.[288]

Libby shared the ideas of Frederick Soddy, often expressed by science writer William Lawrence. Lawrence wrote nuclear power,

> holds out the promise of giving man everywhere for the first time limitless power with which to build an industrial civilization with a standard of living superior to anything ever known on earth…It will conquer the world by building instead of destroying, by giving life instead of taking it…it is a positive force that makes peace inevitable, as it totally eliminates the basic, elemental reasons that has led to all the major wars in history—the have-nots coveting the possessions of the haves.[289]

Libby, with many nuclear scientists, believed that nuclear power would itself end war by the abundance it would produce, far overshadowing the power of nuclear weapons. War soon would no longer be needed in a world of such limitless wealth, that would satisfy all human "needs for all time" including extended and disease-free lives healed from the fruits of nuclear medicine. [290] Yet, there would be obstacles.

In order for nuclear technology to be spread safely, Libby needed to decipher radiation. This was a daunting and complicated new science. First, even detecting and measuring radioactivity had been a challenge for early health physicists. Measuring devices and shielding swamped the health physics group's activities at the Manhattan

[288] "A Bomb Russ to Save US Earle Urges" undated clipping in LP Peace 6.012 File 12.2 "Assorted Peace Research Notes" AHLPP; Encyclopedia Britannica, "Willard Frank Libby" http://www.britannica.com/EBchecked/topic/338917/Willard-Frank-Libby; Libby to Pauling, December 11, 1963 LP Correspondence 217.2 L, AHLPP.
[289] Lawrence, *Men and Atoms,* 242.
[290] Ibid., 243-6, quotation on 243.

Project. After the war, their expertise was in measuring, not in *determining*, how radiation interacted with biology and ecology. Until 1953, most of the secret human experiments and studies were directed at either how to conduct or defend against atomic attacks or to attend to the pressing need of assigning an acceptable dosage for atomic worker safety.[291] This desire to establish and measure exposure thresholds for atomic workers was taken to the point of using uranium miners in 1949 without consent as a study group, sacrificing their lives, to study an already established link between radon and lung cancer.[292]

With this expertise in measurement, Libby wanted to scientifically reassure the public and the AEC of the safety of weapons testing. He instigated and directed Project Sunshine, a huge project that secretly gathered thousands of pages of data on worldwide fallout and Strontium-90 a radionuclide from nuclear reactions that can mimic calcium to be deposited into bones. Libby had sought to validate in particular the claim that the diluted, dispersed global fallout from the weapons tests was not dangerous.[293] Local effects could of course be extremely dangerous, but not the tiny amount of fallout that would enter into the vast atmosphere and stratosphere. Libby's ideas in constructing the study were informed by his beliefs about the risks from communism. Libby believed the

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[291] Merril Eisenbud, *An Environmental Odyssey: An Environmental Odyssey, People, Pollution and Politics in the Life of a Scientist,* (Seattle: University of Washington Press, 1990); Morgan and Peterson, *Angry Genie;* Walker, *Permissible Dose;* Hacker, *Elements of Controversy* and Barton Hacker's *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Berkeley: University of California Press, 1987); Hamblin, *Arming Mother Nature.*

[292] Details in Pasternak, *Yellow Dirt* and Peter Eichstaedt, *If You Poison Us, Uranium and Native Americans* (Santa Fe: Red Crane Books, 1994). The secret PHS/AEC study is just one of many unethical human radiation experiments, established as unethical by the ACHRE, previously cited. For details on just a few other experiments, see Welsome, *The Plutonium Files*; Howard L. Rosenberg, *Atomic Soldiers: American Victims of Nuclear Experiments* (Boston: Beacon Press, 1980); Hiromitsu Toyosaki, *Goodbye Ronglap* (Tokyo: Tsukiji Shokan Publishing Co., 1986).

[293] Alice L. Buck, "A History of the Atomic Energy Commission" (Washington DC: Department of Energy, 1983), 4;Hamblin, *Arming Mother Nature*; Walker, *Permissible Dose*; Hacker ""Radiation Safety, the AEC, and Nuclear Weapons Testing" see 48-9 and *The Dragon's Tail.*

nuclear tests were needed to perfect and increase the kill power of bombs, and keep the Soviet threats at bay.[294] The ideas of relative risk and the need for sacrifice, in retrospect, created a pattern of thinking that could obscure basic fundamental human rights. Risk implies choice, but there was never a democratic mechanism for choice in relation to exposure. There had been no process for consent.[295] But fear of Stalin and World War III were acutely felt among many Americans, not just Libby. However, none but a few elites were asked.[296]

Pauling saw testing in the era, however, in just this light, as an experiment without consent. The tests infuriated him.[297] Pauling had spent his whole life as a scientist trying to end suffering. Pauling had been preoccupied with the anguish caused by disease, birth defects and mental illness before WW II. To him, the purposefully sanctioned explosions of huge thermonuclear weapons, thousands of times more powerful than the Hiroshima and Nagasaki bombs, brought him grave unease. He saw his own government inflicting pain, not just in America, but around the world with the dispersal of global

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[294] Stewart Udall, *Myths of August: A Personal Exploration of Our Tragic Cold War Affair with the Atom* (New York: Pantheon Books, 1994) 248; Michael Egan, *Barry Commoner and the Science of Survival* (Cambridge, Mass: The MIT Press, 2007) 39.

[295] Hamblin, *Arming Mother Nature,* 98-9; Soraya Boudia, "Global Regulation: Controlling and Accepting Radioactivity Risks." *History and Technology* 23, no.4 (2007): 389-406; K.S. Shrader-Frachette, *Nuclear Power and Public Policy: The Social and Ethical Problems of Fission Technology* (Boston: D. Reidel Publishing Company, 1980): Gofman, *Radiation,* 414-5.

[296] For a feeling for the Cold War fear as it related to nuclear technology, see Spencer Weart, *Nuclear Fear: A History of Images* (Cambridge, MA: Harvard University Press, 1988). For Cold War politics concerning the abolition of weapons and anti-communism, see Lawrence S. Wittner, *One World or None: A History of the World Nuclear Disarmament Movement Through 1953, Volume One, The Struggle Against the Bomb,* (Stanford: Stanford University Press, 1993) and for a rich American cultural history of nuclear weapons, see Peter Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age* (New York: Pantheon Books, 1985) and Jon Agar, *Science in the Twentieth Century and Beyond* (Malden, Mass: Polity Press, 2012). For more on expertise and democracy see Jessica Wang, "Scientists and the Problem of the Public in Cold War America, 1945-1960" *Osiris,* 2nd Series, Vol. 17, Science and Civil Society (2002): 323-347 and also for a feel of the time for scientists, Lawrence Badash, "From Security Blanket to Security Risk: Scientists in the Decade After Hiroshima" *History and Technology,* 19 no. 3 (2003): 241-56.

[297] "Assorted Peace Research Notes" Box 6.012 File 12.2 LP Peace, AHLPP. Pauling's outrage, however, can also be seen throughout the entire 25 boxes on fallout in the 7.0 series but also particularly in his annotations, handwritten speeches and notes, and in his scrapbooks from 1954-1963.

radioactive fallout. But even Pauling's most likely supporters, such as geneticist H J Muller, disappointed him. Muller warned against the dangers of radiation in his 1946 Nobel Prize acceptance speech. However, later, Muller would "straddle the fence" as Pauling noted with dismay, to also insist while no radiation was safe, nuclear testing was a reasonable alternative to communism.[298] Libby's argument for testing as a much lesser evil than risking "the survival of the free world" easily painted those concerned about the health effects of nuclear weapons as outliers, as likely pro-Communist and anti-American.[299]

Constructing Sunshine

When asked years later about research projects under AEC direction, Libby answered in an oral history for the American Institute of Physics, "Well, we were essentially running the whole damn country."[300] Libby felt his earlier work on Carbon-14 had informed him how to "set up the whole matter of the worldwide circulation of radioactive fallout." [301] Libby used his unique knowledge to instigate the top secret Project Sunshine under the auspices of the RAND Corporation.[302] Aspects of the study,

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[298] H.J. Muller, "Genetic Damage Produced by Radiation" *Science* 121, no. 3155 (June 17, 1955): 837-40.Box 7.015 File 15.3 LP Peace, with Pauling's annotation.
[299] Hager, *Force of Nature.* 471-2; For more of a Cold War context for this history, see Boyer, *By the Bombs* 1985 and *Fallout: A Historian Reflect on America's Half Century Encounter with Nuclear Weapons* (Columbus: Ohio State University Press, 1998) and Agar, *Science,* 2012.
[300] Marlowe, "W. F. Libby" AIP, quotation on 49. This was later changed for the published on line version of Libby's oral history, adding "at least physical research."
[301] Marlowe, "W. F. Libby" quotation on 47.
[302] RAND, a nonprofit think tank ensured a technological edge for the Air Force in Santa Monica. As a part of Project Horn, RAND had studied the non-biological aspects of fallout. Libby convened at RAND a secret but significant conference to review the findings of Project Gabriel in 1953 that identified the most serious health threat of fallout was the radionuclide strontium-90 (Sr-90). Gabriel's findings would establish a focus to study Sr-90's biological effects in Libby's Project Sunshine, coordinated between the AEC and Rand beginning in 1953. It included 300 projects and millions of AEC dollars. It was just one secret study program of eight to research nuclear weapons testing radiation effects that were ongoing in 1953. US AEC and USAF Rand, "Worldwide Effects of Atomic Weapons, Project Sunshine" August 6, 1953, accessed May 10, 2014, http://www.rand.org/content/dam/rand/pubs/reports/2008/R251.pdf. Most historians cite the beginning of Sunshine as 1953, but the planning for the study began (according to

Libby believed, needed to be conducted openly. Libby felt the worldwide collection of specimens to study the radiological fallout problem should be shared with the public, to assuage critics who felt that the AEC was doing nothing to protect safety, as was directed by the Atomic Energy Act. However, he was overruled, and the study remained secret until international and American howls over the fallout problem reached a new fever pitch in 1956.[303] The evidence was needed for persuasion of safety, to calm the clamor down.

At the time of the start of the Sunshine Project in the early 1950s, much of the interaction between radiation and biology was not understood. With its long half life, Strontium-90, a byproduct of fallout, was known as a "bone seeker" due to its chemical likeness to calcium. If taken up by the human body, Sr-90 could cause ongoing internal radiation exposure in the bone or bone marrow.[304] The Sunshine reports show this was was a concern at the time of researchers involved as it was known leukemia might result from even a tiny dose of radiation.[305] In total the 300 Project Sunshine research projects included studies of fallout, bomb debris, and uptake of radionuclides in the environment by plants, soils, animals, milk, rainwater, wheat, and humans. In sum, data on Sr-90 deposits were collected worldwide, from Tifton, Georgia to Kikuyu, Kenya. Sheep and cow bones, human body parts, fetuses and the bodies of fraternal twins were used in the

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Libby's oral history and the above document) in 1952; Barton Hacker, *Elements of Controversy,* 180-4; Hamblin, *Arming Mother Nature,* 102; Hewlett and Holl, *Atoms for Peace and War,* 264-6.

[303] Hewlett and Holl, *Atoms for Peace and War,* 264-6.

[304]"Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 6, in Miscellaneous Physics, Atomic Energy Commission, Project Sunshine Reports, Folder 1 call # MP 1997- 0004 AIP Archives, College Park, MD; Libby, "Papers on Radioactive Fallout: Current Research Findings on Radioactive Fallout,1956" in *Collected Papers* Vol. 1V, 1981.

[305] K.R. Kampen, "The Discovery and Early Understanding of Leukemia," *Leukemia Research* 36, no. 1 (January 2012): 6-13. Leukemia has been studied for 200 years. It was named leukämie in 1847 by Rudolf Virchow and he identified it as a reversed white and red blood cell balance. The Sunshine researchers explain they have identified Sr-90 in an earlier study (Gabriel) as the most severe risk to man because of its ability to be absorbed so easily by human bone. It was known since the early 1920s that leukemia had been responsible for the deaths of early radiologists over exposed to radiation.

secret studies as well, notoriously conducted in an unethical manner.[306] Libby marshaled findings to support the idea of a safe level of exposure of Sr-90 by comparing something artificial to something natural, like levels of background radiation. Not unaware of the experimental nature of the nuclear weapons tests, the secret Sunshine report recommended further study, but not necessarily to protect populations: "Today we are afforded the opportunity of doing a radioactive-tracer experiment on a world scale."[307]

One goal of the study was to establish the elusive radiation tolerance dose in humans. Of particular interest to the Sunshine study was to determine how much internal contamination to humans from weapons tests had already occurred.[308] The 1953 preliminary report inquires what the effects will be on non-human populations if their numbers are decreased because of Sr-90 contamination. Did the scientists *expect* to see a mass extinction of some sort in the animal or plant realm? Strontium-90 is a man made artificial radioactivity and had never existed in nature; no Sr-90 had been found in older soils preserved from before atomic first use in 1945. In addition, concerns about the

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[306] For records of the conclusions that the Sunshine Project was deemed unethical by a 1994 investigation into human radiation experiments, see "Advisory Committee on Human Radiation Experiments, Chapter 17, Findings for the Period 1944-1974: Biomedical Experiments, NNSA/NSO Nuclear Testing Archive Address - P.O. Box 98521 City, Las Vegas (September 22, 1995) Document Accession Number NV0758667, draft, 826-8, accessed May 9, 2014, https://www.osti.gov/opennet/detail.jsp?osti_id=16007745&query_id=0 An article that mentioned the agony of a mother whose dead baby had it legs removed for the study without her consent or knowledge at the time, see Leela Jacinto, "World Wakes up to Horrific Scientific History" *ABC News* June 7 (year unknown, but after 1995) http://abcnews.go.com/International/story?id=80970; For an overview of all human radiation experiments (including that the radioisotope distribution programs encouraged human experimentation), see "Advisory Committee on Human Radiation Experiments" Department of Energy, accessed May 9, 2014, https://www.osti.gov/opennet/spotlight.jsp ; "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 6, AIP; Libby, "Papers on Radioactive Fallout" in *Collected Papers* Vol. 1V, 1981.

[307] It is important to note the internal exposure to Sr-90 would not be the same as exposure to natural background radiation outside of the body. US AEC and USAF Rand, "Worldwide Effects of Atomic Weapons, Project Sunshine," 7.

[308] "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" iii, AIP; US AEC and USAF Rand, "Worldwide Effects of Atomic Weapons, Project Sunshine."

weather impacts of nuclear tests had been discussed among researchers, as well as that Sr-90 has high carcinogenic potential and possibly no threshold for damage.[309]

The Sunshine study report of 1954 found Sr-90 had accumulated in American midwestern fetuses one hundred times more than expected. The authors surmised that either fallout from U.S. continental testing in Nevada was being unevenly distributed or more radiation from the Pacific Islands weapons tests had reached the Chicago area than expected. A noted correlation was found for the amount of Sr-90 in soil and in the examined fetuses, showing that the link between environment and human bodies was not as protected by "discrimination against Sr-90" as Libby expected, but would continue to espouse.[310] Also, they found children were at a much higher risk for fallout health impacts due to their high cellular activities of rapid growth and "greater uptake in proportion to mass." Despite this, on the whole, the researchers felt confident that the previous sixty years of studies of radium, X-ray, and cyclotron injury showed that under certain levels of dosage, the exposed body would recover from exposure, but above 300 milliroentgens of Sr-90 per week, injury was a likely result.[311]

Certain assumptions and speculations in the earliest Sunshine reports would later be shown to be incorrect. Researchers at the time shared they felt the correct estimates balanced out the mistakes.[312] The scientists hoped that a calcium rich diet would displace the Sr-90, and follow-up studies were suggested. The public was not instructed to take calcium as a preventative but Libby eventually published a paper suggesting potassium

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[309] US AEC and USAF Rand, "Worldwide Effects of Atomic Weapons, Project Sunshine" 3, 4, 7.
[310] Libby believed that the environment and bodily systems would protect against the dangerous radioactivity naturally, by inherently selecting against incorporating the radioactive form of strontium. "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 2, AIP Archives; Libby, "Papers on Radioactive Fallout" in *Collected Papers* Vol. 1V, 1981.
[311] "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 12-13, AIP Archives.
[312] US AEC and USAF Rand, "Worldwide Effects of Atomic Weapons, Project Sunshine"iii.

could prevent the uptake of Sr-90.[313] Pauling also suggested the government fortify foods with a form of calcium to inhibit the uptake of radionuclides.[314] Within three years the Sunshine researchers wrote in their reports that the felt many of the early study's assumptions and errors were corrected. However, new mistakes eventually took their place (such as the underestimate, also by 1/3, of how long radioactive fallout would stay in the stratosphere).[315]

By the time Willard Libby shared the secret project with the public, he had been an AEC Commissioner for two years. His expertise backed up the reassurances of Chairman Lewis Strauss to keep quiet the growing clamor of journalists such as Joseph and Stewart Alsop and scientists such as Linus Pauling that thermonuclear explosions actually were much more than atom bombs: they were radiological weapons.[316] Libby used only select findings, and certainly not the secret methodology to acquire bodies, body parts and fetuses without knowledge or consent, to reassure the public that studies

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[313] Libby, "The Beneficiation of Soils Contaminated with Strontium 90: Beneficial Effects of Potassium" *Science* 128, no. 3332 (1958): 1134.

[314] Pauling wrote a letter that was printed in the *New York Times* September 13, 1959 recommending this and a dosage for concerned parents to give youngsters after he received so many letters from parents who wanted to know how to protect their children, see Richards, "Breathing Fallout." One New York woman, Mrs. Florence M. Gersman wrote to Pauling to ask for 100 prints of his letter to distribute. She wrote, "I have discussed the matter of nutritional defense against radiation with our Health Insurance group and with our pediatrician, and have met with only denial of the hazards." However, his letter "offered citizens (particularly parents) the first tangible hope for protection against radiation since 1945!" see Mrs. Florence M. Gersman to Pauling, September 16, 1959 Box 7.012 Materials re: Strontium-90, June 1959-November 1959 File 12.7 "Correspondence, Data re:Strontium-90, 1959" LP Peace, AHLPP. Pauling also solicited drug companies to make a special calcium phosphate supplement, and one company of the many he contacted did pursue it, see the records in box 7.013 "Materials re: sr 90, 1960" especially in file 13.19 "Correspondence Sr-90, 1960" and box 7.014 "Materials re: sr 90, 1961-3 file 14. 21 "Assorted Materials re-Sr 90" LP Peace, AHLPP.

[315] These included how much Sr-90 was generated by fission reactions (overestimating the hazard); the background level of Sr-90 in soil (overestimated, underestimating the danger); and the half life of Sr-90 was estimated at the time to be 1/3 less than its real value of 28 years, see "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 12-13, AIP; Divine, *Blowing in the Wind.*

[316] Hewlett and Holl, *Atoms for Peace and War*, 278-9; Hamblin, *Arming Mother Nature,* 103-109. He was appointed Oct 1, 1954.

of fallout had been done.[317] The amount of knowledge about Sr-90 had been dramatically increased. Libby, however, did not share other things he knew at that time, that the radioactivity of 165 of the 900 radionuclides from nuclear fusion and fission exists long enough to meld with the chemistry of soil, air, and water to affect the cellular structures of plants, animals, and people and throughout the food chain.[318]

Initially few from the American public at large questioned government assurances of safety when nuclear testing began in the Pacific in 1946. Even the increase in radioactivity by thermonuclear and hydrogen bombs that were developed after the 1949 nuclear explosion by the Soviets became a negligible sacrifice to be made by patriotic Americans. However, March 1, 1954 the second hydrogen bomb test went awry. The test explosion, Castle Bravo, was larger than expected (15 Megatons, a thousand times the earlier atomic bombs), spreading highly radioactive fallout over 7,000 square miles. At first, the US government tried to keep secret the injuries to Japanese fisherman on the boat *Lucky Dragon,* military men, and 238 Marshall Islanders, many ill with visible burned skin and serious radiation sickness. TV news reels around the world, however, showed the visibly harmed Japanese fishermen.[319] The test was much more dangerous than even the AEC anticipated or admitted, and caused almost unanimous global public

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[317] Hamblin, *Arming Mother Nature,* 101-109; "Memorandum: Update on Project Sunshine "Body Snatching,"" 5, Advisory Committee on Human Radiation Experiments ACHRE June 9, 1995 and includes transcripts of a January 18, 1955 "Biophysics Conference" convened by the AEC DBM, George Washington University, National Security Archives, accessed May 10, 2014, http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet15/brief15/tab_d/br15d2.txt.

[318] Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations* (Washington, DC: National Academies Press, 2003) 1-14.

[319] "Collateral Damage" Episode 6 from the PBS miniseries "Unnatural Causes: Is Inequality Making us Sick?" accessed April 24, 2014, http://www.unnaturalcauses.org/video_clips.php?vid_filter=Episode%206%20-%20Collateral%20Damage also see http://www.unnaturalcauses.org/assets/uploads/file/UC_Transcript_6.pdf.

expressions of health and human rights concerns against the tests and the forced contamination.[320]

A feeling of helplessness was palpable. When one hundred and eleven Marshallese brought a petition that spring to the UN about the contamination, the damage was again minimized authoritatively by Major General K.D. Nichols acting as General Manager at the time of the AEC. He stressed to the UN the excellent care provided for the injured and how no long term effects on health or land were anticipated.[321] The UN petition was denied.[322] Yet, the feared radioactive particles also fell indiscriminately and unpredictably from the upper atmosphere. Global protests, from the streets to diplomatic

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[320] Divine, *Blowing on the Wind;* Hacker, *Elements of Controversy*; Samuel Walker "The Atomic Energy Commission and the Politics of Radiation Protection, 1967-1971" *Isis*, 1994, 85 see especially p. 58; Atomic Archive "Operation Castle -1954 Proving Grounds" http://nuclearweaponarchive.org/Usa/Tests/Castle.html.

[321] K.D. Nichols to Dave Key, June 9, 1954, ODA files, lot 60 D 257, "TTPI—Nuclear Testing—1954" Foreign Relations of the United States, 1952–1954, Volume III, United Nations Affairs, Document 945 http://history.state.gov/historicaldocuments/frus1952-54v03/d945. The first response of US Ambassador Henry Lodge was to discredit the petitioners themselves as suspect. The complaint "was too perfect to have originated with the Islanders themselves without outside inspiration?" Lodge was also angry that the authority of the US President had been undermined by the petition being directed to the UN and that "Commissioner's staff" did not anticipate the petition, see Lodge to Dave Key, May 6, 1954 ODA files, lot 62 D 225, "Trust Territory of Pacific" Foreign Relations of the United States, 1952–1954, Volume III, United Nations Affairs, Document 940 http://history.state.gov/historicaldocuments/frus1952-54v03/d940. Lodge was apologized to for the over liberal attitude that led to the petition submission by Frank E. Midkiff, the High Commissioner of the Trust Territory of the Pacific Islands. Midkiff also described the illnesses and fears of the islanders, and their grief. He wrote, "They value their home islands and land far more than we of America, with vast miles of unused areas, can appreciate." Foreign Relations of the United States, 1952–1954, Volume III, United Nations Affairs, Document 949ODA files, lot 62 D 225, "Trust Territory of Pacific Islands" The Director, Office of Territories, Department of the Interior (Strand) to the Director of the Office of Dependent Area Affairs (Gerig) Washington, June 24, 1954 and Enclosure, The High Commissioner of the Trust Territory of the Pacific Islands (Midkiff) to the Director, Office of Territories, Department of the Interior (Stroma)En Plane Majuro to Kwajalein, May 21, 1954, US Department of State, Office of the Historian
http://history.state.gov/historicaldocuments/frus1952-54v03/d949.The fate of this first UN petition requires further research. Also see Nick Ravo, "K. D. Nichols, 92, Leader in Early Atomic Age" *New York Times* Obituary, February 25, 2000 http://www.nytimes.com/2000/02/25/us/k-d-nichols-92-leader-in-early-atomic-age.html.

[322] Many of the islanders would, as they feared, never be able to return to their homelands. "Affected Marshallese communities, including from atolls of Bikini, Enewetak, Rongelap and Utrik, continue to struggle with impacts, unpaid injury claims, and how to define adequate safety standards." – Press Release from the Office of the President, Majuro, Republic of the Marshall Islands, "Marshall Islands Officials Welcome UN's Focus on Nuclear Legacy Impact" *YokweOnline* March 31, 2012, accessed April 13, 2014, http://www.yokwe.net/index.php?module=News&func=display&sid=2997.

channels, were countered by AEC chair Strauss with authoritative claims and well publicized press releases that reinforced the idea that since radiation occurred naturally; the global fallout was below any found in background radiation and therefore was harmless. Others argued that the radiation from background creates different effects on the human body than the radionuclides such as plutonium that did not exist until 1945.[323] Behind the scenes, high level secret talks by Japanese official Katsuo Okazaki and US Ambassador John Allison began several months later over the right for Japanese victims of the Bravo experiment to be compensated.[324] The Marshallese had no such diplomatic capacity to negotiate on their own behalf. Lurking behind their visible burns and illnesses, however, were developing cancers and "jellyfish babies" yet to be born, without eyes, limbs or faces.[325] Yet it is rare to see anything in the canon of human rights or health and

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[323] Divine, *Blowing on the Wind*, 38-39; "Committee to Review" 2003; United States Atomic Energy Commission, *Atomic Energy in Use*, Government Printing Office, Washington, DC 20402 0-787-1691965, 12-3;"The Facts about A-Bomb 'Fallout" *US News and World Report,* March 25, 1955; Chet Holifield, "Radiation and Man: Broad Studies, Congressional Hearings on Radioactive Fallout," *Bulletin of the Atomic Scientists* 14, no.1 (1957) 52-4. The paradigm that "below background" provides some reasonable safety continues to be used as fact despite uncertainty, most recently during the nuclear crisis in Japan at Fukushima as a comfort to people who many thought should be evacuated, see *ABC News/Health* "Radiation Exposure: Five Things You Need to Know" March 14, 2011, accessed May 10, 2014, http://abcnews.go.com/Health/radiation-exposure-things/story?id=13131122. There continues to be a lack of distinction in the press and government information between health risks from non-naturally occurring radioactivity and natural background, but studies do question this approach. For example, see John D. Harrison and Alan W. Phipps "Comparing Man-made and Natural Sources of Radionuclide Exposure" paper presented at the British Nuclear Society Conference (Health Effects of Low-level Radiation) in Oxford, 22-24 September 2002 on p.6 concludes "Doses to members of the U.K. public from radionuclides introduced into the environment by human activity are generally small in comparison with doses from naturally-occurring radionuclides and with dose limits. However, such comparisons of artificial and natural radionuclides and the acceptability of dose depend on assumptions regarding the summation of dose from radionuclides with very different characteristics and the equivalence of internal and external radiation…It is important that uncertainties in dose and risk estimates are recognized."

[324] Undated, untitled and redacted document, page 2, Box 163, Materials 5, Medicine Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958 Office of the Secretary, RG 326 Records of the Atomic Energy Commission, NARA; WN McCool, "AEC: Exchange of Notes with Japan Concerning Possible Future Thermonuclear Experiments," November 12, 1954, page 1, and Katsuo Okazaki to John Allison, October 5, 1954 Box 163, Materials 5, Medicine Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958 Office of the Secretary, RG 326 Records of the Atomic Energy Commission, NARA.

[325] Darlene Keju-Johnson, "For the Good of Mankind," *Seattle Journal for Social Justice* 2, no. 1, Article 59 (2003): 311, accessed May 10, 2014, http://digitalcommons.law.seattleu.edu/sjsj/vol2/iss1/59; Holly M.

human rights laws and discourse that refers back to the history of this contamination and the Islanders' final exile.

The Bravo test, despite world outrage, was followed less than a month later by another thermonuclear detonation in the Bikini islands. While the AEC and military planners revised the test schedule calendar, this seems likely primarily only due to the destroyed equipment from Bravo. The test series "Castle" proceeded, undeterred by worldwide outrage and the recent visible injuries to Islanders, the Japanese fishermen, and military men. On March 27th, the "Romeo" test was conducted, another explosion that exceeded its predicted power from 8 to 11 megatons.[326] Testing would not miss a beat. In fact, the Bravo incident was an opportunity to utilize the press to re-educate Americans about the dangerous world they lived in and the need for sacrifice to defeat communism.[327]

After Bravo, Libby felt no work was more important than the Sunshine Project. However, it became difficult to find a supply of fetuses and dead bodies and obtaining more was almost impossible to do legally. At a conference convened by the AEC Division of Biology and Medicine in 1955, Libby was recorded in the transcripts as saying, "if anybody knows how to do a good job of body snatching, they will really be serving their country."[328] At the same meeting, Dr. J. Laurence Kulp, a lead researcher

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Barker, *Bravo for the Marshallese: Regaining Control in a Post-Nuclear, Post-Colonial World*, (Boston: Wadsworth, 2004); Lisa Rumiel, 'Random Murder by Technology: The Role of Scientific Experts in the Anti-Nuclear Movement 1969-1992" (PhD diss., York University, Toronto, 2009).

[326] The Barton Hacker, *Elements of Controversy,* 131-158; For a government list of all declassified tests see US DOE Nevada Operations Office, "United States Nuclear Tests, July 1945 through September 1992" Revised 2000, Romeo is on 137, accessed May 10, 2014, http://www.nv.doe.gov/library/publications/historical/DOENV_209_REV15.pdf.

[327] Udall, *Myths of August,* 246, Philip L. Fradkin, *Fallout: An American Tragedy* (Tucson: The University of Arizona Press, 1989), 121.

[328] "Memorandum: Update on Project Sunshine "Body Snatching,"" Advisory Committee on Human Radiation Experiments (ACHRE) June 9, 1995, 1, 2, George Washington University, National Security

from Columbia, shared that new bodies and body parts had been secured by using personal contacts and finding locations, such as Houston, where "they don't have all these rules…They have a lot of poverty cases and so on." Another lead researcher on the study, Dr. John Bugher of AEC Division of Biology and Medicine reiterated that this was an opportunity to study "trace elements of all kinds." [329] Here there is no talk of individual or human rights, only opportunities to learn more with secrecy and sacrifice, in service to the state.

The differences between Pauling and Libby became as visible as the weapons tests themselves in the wake of the Bravo incident and Libby's appointment to the AEC.[330] Pauling had traveled on a round the world trip to celebrate his 1954 Nobel Prize in Chemistry. Pauling realized the world at large was depending on him to confront the safety of fallout. He knew he was uniquely placed with his credibility and expertise to counter the safety claims of the AEC, no matter the cost. As far as Libby was concerned, the testing program was also worth the cost and essential to national defense. Patriotism called for each individual citizen to accept a small bodily contamination for the protection that nuclear weapons provided from the Russians. Libby, privy to many secret studies, felt confident in reassuring the public that risks from fallout were small. Yet, he was aware that artificial long-lived radioisotopes were contaminating the environment at a rate far higher than expected. He was steadfast and continued to reassure the public that the security of nuclear weapons demanded this patriotic sacrifice against communism. If artificial radiation was below "background" levels, then he said repeatedly, it was

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Archives, accessed May 10, 2014, http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet15/brief15/tab_d/br15d2.txt

[329] Ibid., 3, 4.

[330] Box 217 File 7.2 Libby W.F. 1950-2, 1954-5, 1957-8, 1960-3, 1965, LP Correspondence, AHLPP; Hewlett and Holl, *Atoms for Peace and War,* 241.

comparatively, of little to no concern. From 1956 until 1960s, AEC scientists felt there was not enough conclusive evidence that fallout was more harmful than stopping preparations to defend against a possible Soviet attack.[331] Concerns and questions raised about "low levels" of radiation would be treated in the future as irrational, ignorant, unrealistic, and emotional. These fears were characterized as inspired by enemies who duped Americans to defeat their nuclear power supremacy of the free world.[332]

Kept under wraps at the time were the secret Sunshine studies. However, in a 1955 letter to Linus Pauling, Libby either accidentally or by design revealed some of his Sunshine findings. Maybe to reassure Pauling he wrote, "But as a matter of interest, the amount of radio-strontium found in the bones is thousands of times below any level which could produce detectable bone cancer."[333] Pauling left two bold lines and a question mark annotating the words with his heavy ink pen. Pauling had been collecting, analyzing, and translating for the public the meaning of most every study specific to radiation and fallout effects published since the 1940s. The finding of Sr-90 in bones was a new development he was not aware of. Pauling's collection included influential papers by that time from respected scientists, including George Beadle, Muller, E.B. Lewis, and Alexander Hollaender, all confirming there was as yet, no basis to assume artificial radioactivity at any dose would be safe. Beadle forthrightly asked, "does this speculation make sense?"[334] Pauling had already felt that the AEC's guarantee of safety was suspect, but how to best address it?

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[331] Interview of Dr. J. Laurence Kulp by Ron Doel on April 11, 1996, Niels Bohr Library & Archives, AIP, accessed May 9, 2014, http://www.aip.org/history/ohilist/6932_1.html.
[332] Fradkin, *Fallout;* Divine, *Blowing in the Wind;* Boyer, *Fallout.* The term "low level" is problematic, as is argued by other scientists, see Gofman, *Radiation and Human Health* 385, 700.
[333] Libby to Pauling, May 6, 1955, LP Correspondence 217.2 L, AHLPP.
[334] See all the studies through out the 25 boxes in the Fallout series of LP Peace. These three specific studies are in Box 7.015 Folders 15.3-5, LP Peace.

Pauling wrote to Libby a year after the *Lucky Dragon* incident: "Dear Bill, I see you and I have been put in the position of apparently being on the opposite sides in an argument, in the article in *US News and World Report* of 25 March 1955." Pauling asked, was there some mistake? Did Libby really say as he was quoted, that "the world is radioactive. It always has been and always will be. Its natural radioactivities are evidently not dangerous and we can conclude from this fact that contamination from atomic bombs, small in magnitude or even of the same order of magnitude as these natural radiations, is not likely to be at all dangerous"?[335]

Libby's words were quoted in an article written with the cooperation of the AEC that reassured the public on the safety of fallout:

If you are one of those worried about 'fall-out' from A-Bomb tests you can forget about it. The scare stories are without foundation. A tooth X ray gives you far more radioactivity than "fallout" from all tests to date. The 50,000 children of Japanese who received near fatal doses of radiation at Hiroshima and Nagasaki show no changes from normal. When 128 generations of fruit flies were exposed to the equivalent of heavy fallout in Government tests, they actually improved, got healthier. The full story, from official sources is given to you on page 21.[336]

The article addressed Pauling directly to say his concerns about fallout had been refuted by the Atomic Bomb Casualty Commission (ABCC) studies of Hiroshima and Nagasaki survivors. ABCC policy required that no medical care be given to the survivors so the progress of radiation induced diseases and illness could be studied. While this policy was occasionally undermined by caring doctors and nurses at the facility, on the

[335] "Letter from Linus Pauling to Dr. Willard F. Libby (Atomic Energy Commission) March 30, 1955" LP Correspondence 217.2 L, AHLPP, accessed May 10, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/peace/corr/corr217.2-lp-libby-19550330.html

[336] "The Facts about A-Bomb 'Fallout" *US News and World Report,* March 25, 1955, 21-26, quotation on page 12, LP Peace, Box 7.001 Folder 1.7 AHLPP.

whole survivors were used as study objects.[337] Many were re-victimized as data on their bodies was collected by the ABCC. For example, Koko Kondo was the eight month old child of Reverend Tanimoto, whose memories were recorded by John Hersey in his 1946 book *Hiroshima.* Once a year she was taken to the Hiroshima ABCC facility for an exam. When she entered puberty, the shy girl was forced to stand naked and be observed under bright lights in an auditorium filled with doctors and scientists.[338] The data collected from such survivors, without their knowledge or consent at the time, was then applied to US military nuclear strategy planning[339] and for radiation health safety standards for nuclear workers.[340] This use of already suffering humans as test objects to further nuclear technology expansion began as early as 1944. This experimentation was magnified by the sanctioning of human experimentation by the early Manhattan Project radioisotope distribution program.[341]

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[337] For much more on the history of the ABCC, and the ethical and scientific issues raised by their research, see Susan Lindee, *Suffering Made Real: American Science and Survivors of Hiroshima* (University of Chicago, 1994) and Beatty, "Genetics in the Atomic Age," 1991.

[338] John Hersey, *Hiroshima* (New York: Knopf, 1946):Koko Kondo, personal communication at the Hiroshima RERF "Open House" held each year for former subjects to return and visit the clinic that studied them (Radiation Effects Research Foundation, successor to the ABCC) August 7, 2010 She still cries when she recalls the event five decades before and this same feeling is clear in Evelyn Lindner, "Hiroshima and What we can Learn Today: Koko Kondo" (2004) accessed May 10, 2014, http://www.humiliationstudies.org/documents/evelin/KokoKondo.pdf

[339] "Working Document III Atomic Bombs and Human Beings" in *A Call From Hibakusha of Hiroshima and Nagasaki International Symposium on the Damage and After-Effects of the Atomic Bombing of Hiroshima and Nagasaki* July 21- August 9- 1977 Tokyo, Hiroshima, and Nagasaki (Japan National Preparatory Committee, Tokyo, 1978), 126.

[340] True medical care was not provided at all to the survivors, not until twelve years after the bombing, in 1957 a Law for Health Protection and Medical Care for the Atomic Bomb Explosion Sufferers took effect "Working Document III Atomic Bombs and Human Beings" in Shoichiro Kawasaki, ed *.A Call From Hibakusha of Hiroshima and Nagasaki International Symposium on the Damage and After-Effects of the Atomic Bombing of Hiroshima and Nagasaki July 21- August 9- 1977, Tokyo, Hiroshima, and Nagasaki* (Tokyo: Japan National Preparatory Committee, 1978) 102; Walker, *Permissible Dose,* 129-32.

[341] For an overview of all human radiation experiments and this tradition of what is deemed as unethical research by the AEC (including the framing of radioisotope distribution programs as an AEC program to encourage human experimentation), see "Advisory Committee on Human Radiation Experiments" Department of Energy, accessed May 9, 2014, https://www.osti.gov/opennet/spotlight.jsp; See Welsome, *The Plutonium Files.*

At a hearing to discuss ending continental testing at the Nevada Test Site in March 1955 due to charges by Senator Clinton P. Anderson of New Mexico that the tests he had recently witnessed might actually be dangerous, Libby said, "People have to learn to live with the facts of life, and part of the facts of life are fallout."[342] Perhaps, however, fallout was just as much a fact of life as death itself. Pauling was distressed by the leukemia death of teen Martin Bardoli and other children in Nevada counties downwind from the Nevada Test Site. Bardoli's death in 1956 was the first cancer death publically blamed as linked to the fallout from nuclear weapons testing.[343] In response to Pauling's statements (especially the widely re-printed article by Robert A. Crandall "Local Citizens 'Give Up' 1000 Years") Charles L. Dunham of the AEC wrote Pauling to explain that Bardoli's death could not in any way have been caused by the nuclear tests.[344]

The belief in the safety of natural background radiation made it easy to dismiss the AEC as responsible. How the Bardoli death was dismissed set a pattern for how the AEC could repeatedly deny claims of such disturbing facts of life and human rights violations. Dunham's flat denial of harm was based on his calculation that the likely doses of radiation exposures from the tests had been too low to have caused death. The numbers said so. The idea that those numbers were below what occurred naturally from cosmic rays and natural uranium sources in the dirt meant the tests could not have caused the boy's leukemia. Dunham, the AEC and Libby denied the reality of the accumulating evidence that would reach a crescendo by the late 1950s that the estimate of safe doses

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[342] Stewart Udall, *Myths of August,* 246-7
[343] Fradkin, *Fallout,* 126-9.
[344] Charles L. Dunham, Director Division of Biology and Medicine, United States Atomic Energy Commission to Dr. George W. Beadle (at Cal-Tech with Pauling) November 6, 1956, and To the Editor of the *Tonopah Times Bonanza*, Box 3.017 Folder 17.2 "Correspondence: United Nations Atomic Energy Commission 1946-7, 1951-2, 1956" LP Peace, AHLPP.

had been far too overconfident.[345] Pauling connected the newsman Crandall with Paul Jacobs, who would then follow up by interviewing families downwind. Jacobs published "Fallout from Nevada," May 16, 1957 in the *Reporter* as the first in depth article to link health effects and the testing at the Nevada Testing Site. The AEC had prepared their rebuttals before the magazine hit the news stands and the testing continued unfazed. [346]

Unable to know at the time the fruitlessness of his efforts, Pauling continued collecting, interpreting and broadcasting every study that explained radiation as he understood it. A few people wrote to suggest the idea of a lawsuit to stop the tests, and one scientist wrote Pauling to encourage him to fight to see the actual top secret fallout data, as he was suing for in Oregon.[347] But without data, Pauling could only criticize its speculative nature. A year and half after Pauling's annotation of Libby's Sunshine hint of "found in the bones" Libby revealed the project in a speech at Northwestern University in January of 1956.[348] The extent of the total research project was made public at Joint Committee AEC hearings a year later, and the hearing transcripts would absorb Linus Pauling.[349]

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[345] Ibid. It was specifically an October 22, 1956 Tonopah Times news article by that was picked up by the AP news wire; Stewart Udall, *Myths of August,* 237-8.
[346] Fradkin, *Fallout,* 130-2 and his archival research on 226 footnote 80 "Thompson to all AEC Commissioners, Memo accompanying advance copy of the magazine, March 1, 1957."
[347] Erwin MacEwan, a Portland scientist, sued for the right to see the data collected by the Oregon Public Health Service on gummed filters on top of Portland city hall and in Medford, Oregon. While MacEwan eventually won the right by the courts, the ruling was outmaneuvered by the Oregon legislature to dissolve the state collection system, so MacEwan never could judge the fallout situation without the mediation of the Public Health Service, see Richards, "Fallout Suits and Human Rights."
[348] Buck, "A History of the AEC", 1983, footnote 21; Willard F. Libby, "Radioactive Fallout and Radioactive Strontium," Northwestern University, Evanston, IL, January 19, 1956 and the Joint Committee on Atomic Energy Press Release, No. 80, April 18, 1957; Hewlett and Holl, *Atoms for Peace and War,* 329. The speech would be later printed as an article and submitted as evidence at the 1957 Congressional hearings on fallout.
[349] Pauling's extensive notations on the hearings can be seen in LP Peace, boxes 7.022-4; Jessee, "Radiation Ecologies", 2013, 333; Buck, "A History of the AEC," 4; Libby, "Radioactive Fallout and Radioactive Strontium," Northwestern University, Evanston, IL, Jan. 19, 1956; Joint Committee on Atomic Energy Press Release No. 86, April 18, 1957.

The Sunshine data was marshaled by Libby in the 1957 Congressional Hearing "The Nature of Radioactive Fallout and its Effects on Man."[350] The data presented from Sunshine was so extensive by its sheer volume it was persuasive. However, Pauling noted the studies compiled by Libby as a part of Sunshine still rested on the same assumption weaving through each paper: since the radiation measured in fallout was below background it was a risk, but never a health threat, and perhaps not a threat at all compared to the Russians. The raw Sunshine data, while it pointed to much to be concerned about, only served to reiterate and punctuate Libby's position that "local precautions should be entirely adequate and the worldwide health hazards from the present testing are insignificant." [351] In Libby's paper, "Radioactive Fallout and Radioactive Strontium" submitted as evidence in the hearing, Libby explained how neutrons interact with air to create carbon-14. Carbon- 14 has a half life of 5600 years, but, as Pauling noted in the transcript, Libby maintained that "fortunately, this radioactivity is essentially safe" due to its "long lifetime and the enormous amount of diluting carbon dioxide in the atmosphere." Libby went on to explain that the ocean would capture much of the diluting carbon dioxide, further diluting the C-14. Therefore, this weapon-induced neutron to C-14 reaction would be so small in comparison to the "feeble natural radiation" as to have "no significance from the standpoint of health." Libby insisted the radioactivity could be absorbed by the sea and air and "the activities produced are safe."[352]

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[350] Congressional Hearing "The Nature of Radioactive Fallout and its Effects on Man" vol 1-3, June 4-7, 1957, Box 7.022, LP Peace.
[351] Willard F. Libby, "Radioactive Fallout and Radioactive Strontium" [*Science* 123 no. 3199April 20, 1958, 657-660] 1462-1467 in *Nature of Radiation Fallout and its Effects on Man* quotations from 1463 and 1467, Box 7.022, LP Peace.
[352] Ibid.

Pauling calculated in the margin the amount of C-14 that would be dispersed based on Libby's estimate of how much was created by nuclear air bursts and later, using the lists of nuclear tests that had occurred thus far. In Pauling's view, C-14, being carbon, the main building block of physical life, could scramble carbon based DNA for unknown generations and an increase of it would be very dangerous.[353] Pauling felt the time span needed for disease to develop, and any qualitative difference between naturally occurring and man- made new artificial isotopes was obscured by words like observable, detectable, measurable. What about future generations? Pages and pages of measurements, graphs, scientists' testimony, and data in charts looked like conclusive science. What Pauling suspected the AEC was really studying was not so much assessing safety as using the idea of natural background radiation to easily dismiss with sheer logic and persuasion the genetic argument of a linear relationship between dose and harm. Libby had the advantage of presenting the measures themselves as a persuasive measure of safety. The studies did, however, determine how much strontium 90 would be hazardous. The researchers created a new standard to measure the Sr-90 exposure called the SU or Sunshine Unit. This terminology created problems two years later during the 1959 hearings. The AEC was accused of trying to naturalize artificial radiation exposure and make it much more positive than it was known to be.[354]

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[353] Ibid,; Pauling, "Predicted Genetic and Somatic Effects of Carbon 14 from Nuclear Weapons Tests" 1959 Manuscripts and Typescripts, SCARC website, accessed May 10, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/peace/notes/1958a2.7.html.

[354] Just the example of one such exchanges in the transcripts of the June 1959 U.S. Congressional Hearings on the Biological and Environmental Effects of Nuclear War, is on page 900: Herman Kahn (RAND Corp.): "I suggest that we should be willing to accept something like 50 to 100 sunshine units in our children ..." Then Representative Chet Holifield responds: We have been using the term "strontium unit" rather than "sunshine." Some of us are allergic to this term "sunshine". We prefer the term "strontium." Followed by a sarcastic Senator Anderson: "I think that term sunshine came because the first time they said if the fallout came down very, very slowly, that was good for you. And then later they said if it came down very fast, that was good for you. We decided to take the sunshine, in view of everything." Herman Kahn

Pauling was particularly skeptical of Libby's averages of cosmic ray dosages and his equation of the risk of wearing a wristwatch as being higher than the dangers from fallout. Pauling penned C-14 large in the margin of the hearing transcripts, using Libby's numbers to calculate "therefore about a 10% increase in mutations." For Pauling, Libby's comparative approach was hiding the additional mutation risk. The hearing would fuel Pauling and give him the data he needed to write three of his own papers, explaining how he saw the cumulative dangers of fallout. He particularly felt the threats from all radiation, natural or otherwise, and other radioisotopes beyond Sr-90, were being far underestimated and under-examined. This was hard for some scientists and the public to accept considering the well publicized fact that millions of dollars had already spent by the AEC to study fallout since the early 1950s.[355]

Libby had narrowed the scope of the dialogue, at least within the 1957 Congressional hearing itself, to two main issues that he could dismiss with the Sunshine data: genetic risk and one radioisotope of nine hundred, Sr-90. With both issues, Libby felt scientifically valid in saying that the risks were much smaller than not preparing for nuclear war with the Soviets. In the exhibit of his rebuttal letter to Dr. Albert Schweitzer, published widely and admitted as evidence in the hearing, Libby wrote, "No scientist contends that there is no risk. We accept risk as payment for our pleasures, our comforts

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(RAND Corp.) answers: I prefer not getting into that debate. I deal in a number of controversial subjects, but I try to keep the number down. … But I might point out, no one has ever seen a bone cancer directly attributable to radioactive material in the bone at less than the equivalent of 20 to 30 microcuries. … Ten microcuries of Sr-90 per kg of calcium [an adult has typically 1 kg of bone calcium, so this implies 10,000 strontium units in the bone] would mean a dose of about 20 roentgens a year in the bones."

[355] For much more about how Pauling came to write his two papers on C-14 and Sr-90 submitted as evidence to the 1959 hearings, see Jolly, "Thresholds of Uncertainty"; Willard F. Libby, "Dosages from Natural Radioactivity and Cosmic Rays" in *Nature of Radiation Fallout and its Effects on Man,* 1459 – 62, see especially notations on page 1461, Box 7.022, LP Peace; "Materials re: Strontium-90, 1956-1959" File 11.15 "Reprint: Barclay Kamb and Linus Pauling, "The Effects of Strontium-90 on Mice," *Proceedings of the National Academy of Sciences*, vol. 45, no. 1, January 1959" Box 7.011 LP Peace.

and our material progress." Libby felt it was essential to side with the protection of the free world.[356] But not only scientists and politicians framed the questions.

Testing came to be seen by many not as a way to protect the free world but more likely as a way of ending life on earth. This was from either nuclear pollution from testing or from a nuclear war apocalypse. Ending testing became vocalized as a humanitarian cause, an epic battle to live free of threats and pollution. This was articulated not only by Linus Pauling (informed by the many people who wrote letters of panic and outrage) but also by Albert Schweitzer, Bertrand Russell, Jawaharlal Nehru, Albert Einstein, and Pope Pius XII, as well as billionaire Howard Hughes, all demanding a moratorium on testing because of both the forced contamination and the threat of imposing nuclear war, making a hell on earth.[357] By 1958, from the confines of the Soviet Union, Andrei Sakharov, the once proud father of the Soviet bomb project, joined the chorus. He wrote unequivocally, "each and every test does damage. And this crime is committed with complete impunity since it is impossible to prove that a particular death was caused by radiation. Furthermore, posterity has no way to defend itself from our actions."[358]

Soon calls for a moratorium on testing could not be placated by empty promises, like a "clean bomb" or reassurances of the safety of fallout held in the stratosphere or the oceans. For many citizens and leaders, the forced contamination of human bodies by fallout was tantamount to the specter of nuclear war. Fallout's invisible radioactive

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[356] *Nature of Radiation Fallout and its Effects on Man* 1971-4 quotations 1972 and LP Peace Box 7.022.
[357] Udall, *Myths of August,* 319; Fradkin, *Fallout: An American Tragedy,* 145. Hughes was especially concerned about the contamination and campaigned vigorously against the tests according to Fradkin. Hughes told the Nevada Governor Paul Laxalt that Nevada would be contaminated for forever.
[358] Udall, *Myths of August* 321. The article by Sakharov, "The Radioactive Danger of Nuclear Tests" was sent to Soviet embassies to distribute at large.

dangers were made into a visible artifact by activists and ordinary citizens outraged in the late fifties by what they saw as their forced contamination.[359] Albert Schweitzer, physician and medical missionary in Lambaréné in Gabon, was winner of the 1952 Nobel Peace Prize for his philosophy of "Reverence for Life." His philosophy was summarized as "No person must ever harm or destroy life unless absolutely necessary."[360] Schweitzer wrote in 1958 that Jean Rostrand, a French biologist and geneticist, described nuclear pollution as *"le crime dans l'avenir"* a crime in the future. Schweitzer implored women in particular to "prevent this sin against the future."

Schweitzer asked, "Who is giving the countries the right to experiment, in a time of peace, with weapons involving the most serious risks for the whole world?" International law and the United Nations must "no longer look out on the world from its ivory tower" but "be brought back into the world again so that it may face the facts and do its duty accordingly."[361] These facts were that "the testing and use of nuclear weapons carry in themselves the absolute reasons for being renounced. Prior agreement on any other conditions cannot be considered. Both cause the deepest damage to human rights."[362] The situation for many was intolerable.

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[359] Michael Lehman, University of Illinois, Urbana- Champaign, "Nuisance to Nemesis: Nuclear Fallout as a Secret, a Problem, and a Limitation on the Arms Race, 1954-1964" Presentation and unpublished thesis distributed at the American Society for Environmental History Conference March 16, 2008, Boise, Idaho. Lehman argues that fallout played a profound role as an inanimate object that has been associated with the deepest human fears of the unknown, as an often undetectable, invisible, tasteless and odorless substance that pervades the environment with unknown consequences. Lehman argues that despite government and media reassurances, fallout itself became the primary character in the nuclear narrative to eventually limit the nuclear arms race.

[360] "Albert Schweitzer –Biographical" and "Facts" Nobleprize.org, accessed May 9, 2014, http://www.nobelprize.org/nobel_prizes/peace/laureates/1952/schweitzer-bio.html

[361] Albert Schweitzer, *Peace or Atomic War?* (New York: Henry Holt and Company, 1958), 17.

[362] Ibid, Schweitzer goes on to explain on page 40, " the tests, in that they do harm to peoples far from the territories of the nuclear powers and endanger their lives and their health--and this in peacetime; an atomic war, in that the resulting radioactivity would make uninhabitable the land of peoples not participating in such a war. It would be the most unimaginably senseless and cruel way of endangering the existence of mankind. That is why it dare not become reality."

In the Bones

Government reports, including the work of Merril Eisenbud of the AEC and other researchers, reinforced in the late 1950s the worst of Pauling's fears. The global deposition of Strontium-90 had almost doubled in just a year and a half. Eisenbud concluded that ninety percent of the fission products from weapons testing would continue to fall down on earth from the stratosphere until 1970, contaminating milk and dairy products with Strontium-90 eleven years into the future.[363] Already there was no escaping the fact that there had been an increasing uptake of Sr-90 by fetuses, small children and adults worldwide since 1955. For adults, these rates almost doubled in three years, by 1958. At 20 degrees south latitude the increase was the most pronounced, increasing three times for adults from .07 to .21 micromicrocuries of Sr-90. However, for children in the northern latitudes, in the years 1957-8, they found almost three times the exposure from Sr-90 was measured than for children on the African continent. Children between the ages of 7 months to one year in North America had the highest amount of Sr-90 in their bones: 1.85 micromicrocuries.[364] While this seems like a very low number, it is actually quite concerning as before the use of nuclear weapons, there was no Sr-90 in bones.

By 1959 the consciousness about fallout was mainstream and the horror of the public acute. This was reflected in books and films like *On the Beach* and even editorials in *Playboy*. "The Contaminators: A Statement by the Editors of Playboy" was a message

[363] Merril Eisenbud, "Deposition of Strontium-90 through October 1958" Science, 130 (August 7, 1959):30. Box 7.012 File 12.3, LP Peace, AHLPP.

[364] Eisenbud, "Deposition" Box 7.012 File 12.3, LP Peace; Pauling to Arthur R. Schulert, March 11, 1959, Schulert to Pauling , January 26, 1959 Table 3, Table 4. The data for the children's counts were averaged from AERE report C/R 2583 May 1958 Box 7.012 File 12.17 "Correspondence, Data re: Strontium -90; 1959" LP Peace.

of looming ecocide. Saying it might seem "an odd message appearing in a magazine dedicated, as *Playboy* is, to life's good things….but these good things, this joy and fun, will cease to exist if life itself ceases to exist. And that is precisely what may happen." Pointing out the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) predicted an additional "25,000 to 150,000 cases of leukemia" from the bomb tests held until August of 1958, "surely the only rational thing to do is *stop*…releasing an agent of possible extinction into the air." The men responsible "have lost contact with reality. They must be stopped. Alarmist talk? Yes. It is time for alarm."[365] Newspaper headlines across the nation were dominated by the topic and featured the Public Health Service's determination of local levels of strontium in milk. [366] Pilsener Beer in Oslo, Norway used radioisotopes to study the effects of fallout on grains and surface waters and the ability of the brewing process to decontaminate Sr-90 and Cesium-137. They found that while levels of Sr-90 were reduced by the brewing process, the Cesium-137 was not.[367] It was impossible to completely remove either. The dangers had never been limited to only one isotope, but Strontium-90 because of its potency and known links to leukemia particularly frightened the population.

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[365] Box 7.012. Materials re: Strontium-90, 1959 File 12.1. Reprint: "The Contaminators", Editorial in *Playboy,* October 1959 LP Peace. The editors explained, "The need for this statement springs from the curious silence of the great American press on the subject. The newspapers and the mass circulation magazines have given the matter scanty, spotty coverage, often with a heavily optimistic slant." Other specialized magazines had taken up the issue, including Isaac Asimov's "I Feel it in My Bones" an article published in 1957 in of all places *The Magazine of Fantasy and Science Fiction.* But strontium-90 causes leukemia and with every test, the work is bathed in more, "it penetrates our water, our soil, our milk, our other foods. Eventually it penetrates our bones, and can cause leukemia…sterility and mutations." The editors closed by pleading for their readers to take action, get informed, talk to everyone their readers knew, write their newspapers and their Congress, "and doing it today, for tomorrow may be—literally, too late."

[366] Pauling's scrapbooks show many of these of articles as clippings, as they were also sent in letters to the Paulings from around the world, see Oversized Scrapbooks, especially the year 1959 but the headlines are dominated by nuclear and diplomatic issues of testing from 1954 to 1964, AHLPP.

[367] H. Bergh, H. Kringstad and B. Ottarm, "The Behavior of Sr-89, Cs-137 and Fusion Products Contamination During the Brewing of Pilsener Beer," *Serryk Brygmesteren* (1959): 233-41 Box 7.012 File 12.7 "Reprint: The Behavior of Sr-89, Cs-137 and Fusion Products Contamination During the Brewing of Pilsener Beer, H. Bergh, H. Kringstad and B. Ottarm *Serryk* November 10, 1959" LP Peace.

Linus Pauling received desperate letters from around the world against the ubiquitous contamination.[368] People often sought information. Many wanted to protect their children, including those unborn, from radioactive poisoning. One letter writer enclosed with her letter a copy of her letter to the editor titled "Strontium Peril." Despite following the advice of Pauling to take six calcium tablets daily, the woman was haunted, knowing the fallout from previous tests was going to descend, as predicted, in the mid 1960s. She questioned Pauling directly asking,

> Would you go so far as to say that God has appointed evil men to destroy us…why are we all sick? The sky is hideous…we go to bed at night and try to sleep with poison air coming in our windows…What kinds of minds do you scientists have knowing that the first bomb shot up into the air was going to kill people. We want to know why! The elements are being poisoned they do not belong to man. Why? Why?" [369]

Her questions would go unanswered, even by Pauling, who tried to reassure her as Libby likely would have. He told her the risks were smaller than she understood. She showed in her letter, however, concern for more than herself, and her pleading was for the earth's integrity.

Also like Libby, Pauling had a clear vision of how he wanted to achieve world peace. It was not with peaceful nuclear technology as Libby aimed, but with the democratic elimination of nuclear weapons. Pauling wanted to use the establishment of international laws and treaties in the process of nuclear disarmament to end all war. Pauling was willing to try anything and everything; even to hold Libby as personally responsible for the weapons tests as Libby himself had indicated he was in a letter in

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[368] Letters about the contamination and fear from nuclear technology abound throughout the huge collection, but a representative sample of parents and physicians writing for any remedy or some type of cure to Strontium 90 makes the era's helplessness more than palpable. For a representative sample of letter see Box 7.014 File 14.17 "Correspondence: re: Strontium-90, 1962" LP Peace.

[369] Evelyn (rest of name obscured) to Pauling, November 7, undated 7.012 File 12.17 "Correspondence, Data re: Strontium -90; 1959" LP Peace.

1957. Libby had written to Pauling "I am most seriously charged with responsibility in connection with weapons tests." Libby even shared his vulnerability, "I suppose we know more about radioactive fallout than you do, but I am quite certain that none of us here knows as much about leukemia." Libby asked for Pauling's calculations that led Pauling to say in a speech that one thousand people would die from leukemia from upcoming British hydrogen bomb tests. Libby enclosed his "own speeches on radioactive fallout" asking Pauling to send him copies of his speeches. Libby felt responsible for the safety of the nuclear weapons tests. Because of this, he was "most anxious to learn whether we have made any mistakes, or whether our conclusions are in anyway wrong on the subject of risks from weapons tests." [370]

Yes, there had been errors. Pauling took Libby at his word, becoming the lead plaintiff in the first fallout case *Pauling v. McElroy*, and he sued Libby by name as responsible for the tests. The case was an attempt to stop planned tests in the Pacific, the tests now understood by Pauling as so dangerous to the human germ plasm, that they were in violation of international law, Constitutional and human rights.[371] The *Pauling v. McElroy* suit was built from the merging of Pauling's claims with an earlier case of human rights claims against the US that asked for an injunction to stop the harm from weapons test in the Pacific. The earlier case was brought by 18 plaintiffs: one man from Madison, Wisconsin, thirteen Marshallese, one Samoan and three Japanese plaintiffs (of these, two lived in Hiroshima and one was a Japanese fisherman) sued to prevent any further harm to them by contamination from nuclear weapons tests of their bodies, "germ plasm" or of the Pacific.

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[370] Libby to Pauling, May 2, 1957 LP Correspondence, 271.2 L, AHLPP, SCARC.

[371] Nell H. McElroy was Secretary of Defense. For much more detail on the fallout suits and the fallout controversy, see Richards, "Fallout Suits."

This original case contained two families and ten children who had lived on Laplap and Majuro Atolls in the Marshall Islands, represented by their fathers.[372] Two plaintiffs were residents of Hiroshima as well, who likely had been denied any other recourse by the renunciation of any claims of war damages. The Japanese government, when it signed the Peace Treaty to end the US occupation of Japan, voided the right for the Hibakusha, the bomb victims, to sue for compensation.[373] They argued in their case that the US had overreached, polluting the very components of their subsistence. They saw their homes with no boundaries, borders or "sinks" to protect their bodies from man made radiation. Their suit claimed the US was in violation of international treaty law such as the Law of the Freedom of the Sea and United Nations trusteeship laws. The heart of the merged cases was the same: the US government had no right to contaminate the ocean, the atmosphere, those living, and their progeny. Nuclear testing was "contrary to the human rights provisions of the United Nations charter (59 state 10355ff)."[374]

Between working on the case *Pauling v. McElroy*, and the many speeches and papers, Pauling sought United Nations action and a larger voice. He delivered with his wife Ava a petition with 11,021 signatures for a moratorium on testing to Dag Hammerskjold Secretary-General of the United Nations, in January of 1958. Pauling

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372 "Complaint for Declaratory Judgment and for Injunction" u.d. Box 6.001 File 1.1. "Court Document "Motion for Leave to File a Brief of Amicus Curiae" Albert Smith Bigelow, William Huntington, George Willoughby, Orion Sherwood; Petitioners vs. United States of America. In the Supreme Curt of the United States, October Term, 1957" LP Peace.

373 "Atomic Bombs and Human Beings" in Kawasaki, *A Call From Hibakusha of Hiroshima*, 102. Hibakusha is the term for atom bomb survivors. The peace treaty was signed on September 9, 1951 to end the official military occupation of Japan, A War Relief law for civilian victims of war in Japan had been enacted in 1942, to provide medical relief, help and payments of aid, but first aid stations for Hiroshima and Nagasaki closed in October of 1945. The Japanese law was repealed by 1946. During the US occupation, which began September 19, 1945, no medical or relief aid had been provided for the Japanese in the aftermath of the two bombings. The occupation enforced a press code that silenced information about the medical aspects of the bombings.

374 "Complaint for Declaratory Judgment" 13, LP Peace. The defendants in the Marshallese case were Neil H. McElroy, US Secretary of Defense and the five AEC Commissioners, Libby, Harold S. Vance, John S. Graham and John Floberg.

began seriously writing a book for a general audience.[375] That March, Pauling wrote Libby to say he had started work on a book, *No More War!* Pauling said the book was a response to *Life* magazine's refusal- to print a retort to an article with misstatements by Edward Teller. Pauling wanted Libby's help to be accurate in his information. He asked Libby to correct for him some of the discrepancies he had found in reports of the AEC. He warned Libby of the lack of credibility of the claims of "the Denver argument," i.e. that safety is proved by showing there is no increase of genetic mutation where natural radiations, such as cosmic rays at a higher altitude, are increased. For Pauling, and other researchers such as Cal-Tech geneticist Edward Lewis, Libby had not produced any evidence that the statistics he produced actually proved there was any threshold to protect against radioactive harm. Pauling asked if Libby had "any information about the average incidence of leukemia and bone cancer in Denver, New Orleans and San Francisco for years other than 1947?" No, Libby replied, he only has data for that one year.[376]

Evidence soon suggested that the estimates of how long Sr-90 would stay in the stratosphere were wrong, and radiation levels were, instead of decreasing, rising. Thus, once the moratorium came, the fears only seemed to increase.[377] Evidence of the fears and anger in society came to Pauling in the mail: letter after letter implored him to do something to defend against the falling strontium and the risks of nuclear annihilation. Some sent drawings and jagged poems but most who wrote were despairing mothers and

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[375]"Appeal by American Scientists to the Governments and People of the World" Presented to UN January 15 1958, accessed May 10, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/peace/papers/peace5.008.1.html
[376] Pauling to Libby, LP Correspondence, 217.2 AHLPP; Jennifer Caron, "Edward Lewis and Radioactive Fallout: The Impact of Cal Tech Biologists on the Debate over Nuclear Weapons Testing in the 1950s and 60s," (Undergraduate Thesis, BS in Science, Ethics and Society, California Institute of Technology, 2003) accessed May 9, 2014, http://thesis.library.caltech.edu/1190/1/LewisandFallout.pdf.
[377] Divine, Blowing on the Wind, 262-3; Richards, *Breathing Fallout.*

fathers.[378] In the two years since the first 1957 Congressional hearing, much had changed. And Pauling was ready to strike at the heart of Libby's expertise, C-14. Linus Pauling later remarked that most people ignored his pleas in 1957 about the dangers of fallout, instead trusting the AEC reports that the fallout from atmospheric tests was not statistically dangerous, but by 1959, the AEC was discredited. [379] It was clear that radioactivity could bioaccumulate and concentrate in unexpected ways; there was no safe "sink." Twice as much fallout was being measured. The evidence and the situation were out of Libby's control.[380]

To prepare for the fallout case *Pauling v. McElroy* and confront Libby's claims, Pauling reconstituted the very same AEC data from 1957 in a different light. While unknown to Pauling at the time, the actual pages of the raw Sunshine data record the ages, locations and descriptions of individual human and animal body parts tested for strontium 90. These corporeal body parts, fetuses, animal bones and baby cadavers would be the basis for later mathematical calculations of risk. The once living parts became statistics. The resulting findings conveyed on radiation exposure a type of cold realism, a numerical stand in for protection of the population at large.[381]

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[378] . See AHLP LP Peace, ; LP Peace, 5.012.3; LP Correspondence, 257.1-3 M 1959; 258.1-2 M 1959-1961; 258.1 M Correspondence re: "The Fallout Suits" 6.001.9.Paulings own desperation and anxiety seems expressed in this handwriting in this mathematical efforts to calculate the deaths and leukemia's from the strontium 90 and other radioisotope doses from the tests and he registers the neglect of concern of the AEC for DNA in file 6.0001.1 "Assorted LP Notes, re the Fallout Suits." The emotional correspondence is preserved in the Ava Helen and Linus Pauling Special Collections at Oregon State University. The letters are scattered throughout the correspondence sections but are particularly desperate in the correspondence from 1961, after huge thermonuclear tests were conducted in the upper atmosphere by the US and by Russia, which broke the moratorium with a 58 megaton bomb.

[379] Stewart Udall, *Myths of August*, 241.

[380] Divine, *Blowing on the Wind,* 262-3.

[381] "Appendix A Project Sunshine Bulletin, April 1, 1954" in "Rand Sunshine Project, Conference January 9, 10, 1954 Washington DC" 17-29, in Miscellaneous Physics, Atomic Energy Commission, Project Sunshine Reports, Folder 1 call # MP 1997- 0004 AIP Archives, College Park, MD; Most of Pauling's personal papers in LP Peace boxes 7.001-7.025 are filled with his equations as he works out this math, turning AEC statistics into human numbers that would be harmed. The math was used in his book, *No*

Pauling then reinterpreted and translated these same publically released AEC statistics back into real human lived experience. Pauling played the numbers game right back at the AEC, using their own numerical methods against them. He used the AEC's statistical estimates of risk and personalized them by estimating the numbers of people or babies affected, not just this year, but many years into the future. He counted up the early and additional deaths, the cancers, the leukemias, the birth defects, the diseases: the real tangible, individual consequences. In just one example, Pauling tabulated for the increase of C-14 just one of hundreds of artificial radionuclides: 170,000 stillbirths and childhood deaths, 55,000 children with gross physical or mental defects, 425,000 miscarriages. He was relentless and the numbers were astounding.[382] All his scientific calculations would serve a dual purpose to inform his testimony for the fallout case.

At the 1959 May Congressional Hearings, studies were included from not only the AEC but even detractors science was inserted into the record. At the hearing, "Fallout from Nuclear Weapons Tests," errors in the fallout testimony and papers that had been discussed as uncertainties in 1957 by AEC scientists, especially Libby, were now glaring as errors. This was acknowledged throughout the hearings by Libby himself, the Congressmen and both AEC and non-AEC scientists, such as members of the NAS Biological Effects of Atomic Radiation committee. Libby's calculation of the amounts of C-14 released by nuclear weapons tests underestimated the impacts of the tests. His estimate of how many years Sr-90 would stay in the stratosphere had been found to be

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More War, his affidavit in the fallout cases, his speeches and his scientific papers. He scribbled the numbers on other scientist's studies, the backs of playbills, dinner napkins, receipts and in the margins of news clippings.

[382] While Pauling lived surrounded by the effects of fallout in more ways than one may at first imagine as he calculated numbers from AEC numbers time and time again, these particular numbers are from his paper, Genetic and Somatic Effects of C-14" (2457-60) Congressional Hearings, "Fallout from Nuclear Weapons Tests," May 5-8 1959 Box 7.023, LP Peace.

incorrect. It would be only a year and half to two years before massive fallout would descend from tests. Pauling's two papers, one on Sr-90 and the other "Genetic and Somatic Effects of C-14" and his statement reinforcing that there was no safety in a threshold were included in the hearings. The acting AEC chair, H.S. Vance, even confirmed that Pauling's numbers, based on Libby's, were reasonable, and not in scientific error.[383] It seems it is no coincidence that Libby would be testifying as one of his last acts as an AEC commissioner in the June Congressional hearings later that summer.

The June hearings made a clear political case, not a scientific one. The AEC argued for continued testing, and the focus was then directed at preventative measures against an imminent Soviet launch by preparing in fallout shelters. Libby testified he was going to build one, which he did.[384] Later that year, it burned to the ground in a fire.[385] The AEC's credibility was so compromised by 1959 that President Eisenhower established a new agency, the Federal Radiation Council (FRC) to oversee radiation health standards, removing oversight of the AEC of public health. It became clear that the entire nuclear project and the hopes for nuclear power expansion could be damaged. The

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[383] Congressional Hearings, "Fallout from Nuclear Weapons Tests," May 5-8 1959 Box 7.023, LP Peace. Pauling and Barclay Lamb refutation of Miriam Finkel's claims that mice had a threshold to Sr-90 were also included in the hearing. Her paper "Mice, Men and Fallout" infuriated Pauling as particularly fallacious. His retort "The Effects of Strontium-90 on Mice" was included in the hearing (2347- 62) as well as Pauling's statement (2455-6) and his paper , "Genetic and Somatic Effects of C-14" (2457-60) HS Vances comments in support of Pauling 's accuracy is on page 2464-5.

[384] The second hearings that June, Congressional Hearings, "Biological and Environmental Effects of Nuclear War" June 22-24, 1959 Box 7.024, LP Peace.

[385] William H. Short to Pauling, LP Correspondence, 217.2 L; Encyclopedia Britannica, "Willard Frank Libby" http://www.britannica.com/EBchecked/topic/338917/Willard-Frank-Libby

commercial nuclear power industry was building infrastructure for a future expansion during the fallout controversy, but distrust of the AEC undermined that expansion.[386]

There was no satisfaction for Pauling's lawsuits, either. The government strategy was discussed in several high level meetings between the Department of Justice, the Department of Defense, the Department of State and the AEC. The group wanted to avoid any impression, however, that they were concerned with the suit and to show the science as represented by the plaintiffs was "either incorrect or grossly exaggerated." However,

> At this meeting, it was pointed out that the factual allegations of the Complaint had apparently been drawn with considerable care and that it was unlikely that the Government would be able to take the position that the allegations were false. The Governments position would probably have to be along the lines that some factual statements were somewhat exaggerated, and others were based on scientific opinions that were not generally accepted and at the same time not rejected because they fall in an area of unproven scientific fact. [387]

The first lawsuit would fail and was ruled against primarily due to the establishment of the test ban moratorium that took effect for the U.S. on October 30, 1958. The suit was revived when the moratorium was broken in 1961 with massive thermonuclear tests, which devastated Pauling. The new suit, despite being argued in the midst the Cuban missile crisis during tit for tat space weapons tests between the US and Russia, also failed. This was because the Limited Test Ban Treaty of 1963 rendered moot the question. The treaty also resulted in a second Nobel Prize for Linus Pauling.[388]

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[386] Walker, "Politics of Radiation Protection," 1994, Walker. *Containing the Atom: Nuclear Regulation in a Changing Environment 1963-1971* (Berkeley: University of California Press, 1992); Walker *Permissible Dose*; Hacker, *Elements of Controversy.*

[387] AEC Meeting Minutes 620/27 May 21, 1958, "Complaint to Enjoin Future Nuclear Tests" quotation page 2, File "Legal 6 Claims and Litigations" Box 36 Declassified NND 947010 AEC Secretariat Subject Files 1951-8, RG 326 Atomic Energy Commission, NARA II.

[388] Richards, "Fallout Suits."

Pauling's ideas of human rights were founded on what he learned from science. His work on structures led him to believe that shape defined behavior. Just as nature created structures that then defined the behavior, the structure of society could create just behavior and a just world if it were built on just laws. What Libby and Pauling did share in common was that they both believed they could create a better world. Libby wrote the day after Pauling's Noble Peace Prize was announced to congratulate him, saying "…I have always admired your courage and persistence and I am certain that both of us have always had the same end in view—world peace.…we have both always wanted the same thing."[389] The legal questions raised by the fallout suits, however, have still not been answered. What is the relationship of the courts and global citizens to government technology that can cause intergenerational, genetic, indiscriminate, worldwide pollution?[390]

Conclusion

In the early to mid 1950s many Americans relied upon the pronouncements of fallout safety from the AEC as scientific fact and used these facts as a basis for irreversible decisions that committed the nation to a legacy of nuclear pollution.[391] Pauling initially had very limited access to official data. He could only criticize the speculative nature of the AEC, but in 1957 data was released in the press and during the proceedings of the first Congressional Hearings on fallout. Within less than two years,

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[389] Libby to Pauling, Dec 11, 1964 LP Correspondence, 217.2 W.F. Libby, AHLPP.
[390] Richards, "Fallout Suits."
[391] "How the Pentagon Protects Itself from Fallout" *I. F. Stone's Biweekly,* June 24, 1963, 1; H. Jack Geiger, et al., *Dead Reckoning: A Critical Review of the Department of Energy's Epidemiologic Research, A Report by The Physician's Task Force on the Health Risks of Nuclear Weapons Production* (Washington, DC: Physicians for Social Responsibility, 1992). Available from P.S.R. 1000 Sixteenth Street, NW, Suite 810, Washington, DC 20036. The crisis in trust was not for the long term averted by the Eisenhower's creation of the FRC. Historians suggest that the FRC only continued to frame radiation health safety within the original AEC scientists and National Committee for Radiation Protection health physics framework that saw radiation contamination as preventable, controllable, and understandable.

Pauling and other scientists were able to dismantle the AEC's hold on expertise. Nonetheless, Libby's research, however in error, was much more resilient.

Libby's papers remained as credible sources and the paradigm that equated background radiation as a reasonable reliable measure of safety when analyzed among other relative risks endured. This belief in the comparative safety of radiation if it is below a natural level from uranium in the soil and cosmic rays persists as the operational premise of health physics.[392] One outcome of the AEC "running the whole damn country," as Libby put it, is that the AEC ran it to stay invisible, just like the radiation. But no amount of AEC studies could completely put the public at ease. By 1959, the AEC had spent about $125 million on "biomedical investigations on radiation."[393] Later the large influence of the AEC on the academic field of health physics and the AEC's role in human rights violations would be blurred. Libby retired early from his role as AEC Commissioner. Along with John von Neumann, Libby had been one of only two AEC commissioners during that era who were scientists. When he left the agency, Libby left it without a scientific voice (von Neumann died in 1957). But Libby would have a more influence in his new role. He left the AEC to design an environmental studies curriculum that would professionalize and accredit "the new Health Physicist to make independent measurements."[394] His work would build the field of environmental studies.

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[392] Hamblin, "Fukushima and the Motifs of Nuclear History," *Environmental History* 17 no.2 (2012): 285-299; "Information, Radiation Leak Slowly in Japan" Interview with Kathryn Higley, NERHP OSU, on NPR March 29, 2011, accessed May 10, 2014, http://www.npr.org/2011/03/29/134956176/information-radiation-leak-slowly-from-japan

[393] "News of Science: Radiation Hazards Pose Problem of How Government Can Best Be Organized to Protect the Public" *Science,* New Series, Vol. 129, No. 3357 (May 1, 1959): 1210-12, quotation page 1210 and for a feel for this time of persuasive distrust, see previously cited "The Contaminators", editorial in *Playboy*, October 1959 and the 1959 May Congressional Hearings.

[394] Korff ed., *Willard F. Libby Collected Papers,* Introduction to Volume IV, 'Papers on Radioactive Fallout" no page number.

Linus Pauling's belief that threats from nuclear war and contamination were an impingement on health and human rights has not been as enduring. The discourse of nuclear safety has not revolved around rights or choice, but acceptable risk. Who feels entitled to even articulate rights for clean air, water and land on behalf of people and the earth? The unacknowledged acts and lack of accountability for the "toxic trespass" of nuclear weapons testing often seems irrelevant, excised from legal and health and human rights history and protocols. While Pauling, Pacific Islanders and the Japanese once made this case, their stories were in the main drowned out by industry and academic radiation experts from Los Alamos to Japan, who have insisted instead on a discourse about scientific proof of harm. Concerns about harm from radiation have been dismissed as antithetical to modernity, "unrealistic" and silent in the academic discourse on the need for nuclear expansion.[395]

How radiation exposure has been interpreted and understood by experts melds with what we conceive of as a human right, diverting from the lived experiences of people with contamination. Rights have been circumscribed by the prior claim on them by nuclear proponents for national sovereignty over the individual body, for nuclear medicine and for nuclear power. How human rights are defined is a property of governments and UN agencies formed by those with sociopolitical capital. The influence of nuclear advocacy remains hidden in terms of diplomacy, human rights regimes, inequality, health and radioactive pollution. Perhaps this history even hides what is conceived of as a human right.

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[395] Steven E. Miller and Scott D. Sagan, eds. "On the Global Nuclear Future, vol. 1," Special issue, *Daedalus Journal of the American Academy of the Arts and Sciences* 138, no.4 (Fall 2009): 1-167 and "On the Global Nuclear Future, vol. 2," Special issue, *Daedalus Journal of the American Academy of the Arts and Sciences* 139, no.1 (Winter 2010): 1-140.

Chapter 4 The Circulation of Safety

You will find that this is a typically American story…of people working together in a land where great resources abound, and where everyone is free to reap these resources and enjoy the benefits that they bring. This is the story of what these people are doing with uranium…the magic metal that is bringing new wonders to our world.

From *Mesa Miracle,* promotional material
by Union Carbide Nuclear Corporation[396]

From the outset the era of radiation was shaped by utopian pursuits of both health and human rights. However, the pursuit of nuclear technology also quietly violated these very rights to "life, liberty and the pursuit of happiness." Historian Gabrielle Hecht posits that the practice of health and safety regulation of the nuclear fuel cycle is more reflective of the value of what is being irradiated than a remedy for the dangers of radiation. Hecht explains: "Nuclearity is not so much an essential property *of* things, as it is distributed *in* things." Responses to an item's "nuclearity" may or may not mean how radioactive it is, nor how dangerous.[397] This has created a "holiday from history" in terms of the reflection

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[396] Union Carbide Nuclear Corporation. *Mesa Miracle in Colorado…Utah…New Mexico…Arizona…Wyoming* (New York: Union Carbide and Carbon Corporation, 1952, 1956) Call No. TN490.U7 U55 1952, Monograph Collection, Othmer Library, Chemical Heritage Foundation Othmer Library, Philadelphia, PA.

[397] Gabrielle Hecht, "A Cosmogram for Nuclear Things" *Isis* 98 (2007) 100-108, quotation on 101. See also an abstract from her presentation "Mapping Nuclear Ontologies" at a 2005 conference "Bodies, Networks, Geographies: Colonialism, Development, and Cold War Technopolitics" accessed May 13, 2014, see http://sitemaker.umich.edu/bng/paper_abstracts#hecht; See also her article "Negotiating Global Nuclearities: Apartheid, Decolonization, and the Cold War in the Making of the IAEA" *Osiris* (2006):25-48 and *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, Mass.: MIT Press, 2012). The actual working definition of whether something is nuclear is not necessarily based on a scientific measure of a substance's radioactivity, but is a socially and scientifically constructed measure that indicates the value of what is being irradiated. Hecht's main premise is that the lack of definition of what makes something nuclear continues to privilege nuclear producers, and maintains the dominance of nuclear colonialism. In a French nuclear power facility, for example, workers have health protections like protective clothing, dosimeters and regular monitoring while risks in a uranium mine with indigenous miners can be ignored.

on both radiation health and human rights discourse and protections.[398] In much of nuclear history, it can be said there is a "massive mismatch between dominant characterizations of the sources of our factual knowledge and the ways that in which we actually secure that knowledge." Scientific communities, however, can be described through their own "economy of truth." [399] Historians also agree that the circulation of knowledge is a taken for granted aspect of science, yet few global studies address the interaction of radiation health safety as a circulation that intersects with specific communities, places, and times.[400]

By viewing the artifacts, scientists, laboratory spaces and organizations that are engaged together in a process of scientific inquiry, one can unravel some of nuclear science. Sociology of science has informed historians to show how facts, which may in fact be true or false, are socially constructed in the lab. [401] Radiation health safety and nuclear history is ripe to be viewed as a circulating social construction and can act as a preliminary inquiry into objectivity.[402] This inquiry is directed not to the center/periphery spread of western discovery, but asks what knowledge is included or excluded from findings and practice.[403] As with all forms of norms and conduct, a key but often

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[398] See chapters one and two and Mathew Lavine, *The First Atomic Age: Scientists, Radiations, and the American Public, 1895-1945* (New York: Palgrave McMillan, 2013) quotation from Ron Rosenbaum, "Welcome to the Hotel Hiroshima" page 2.

[399] Steven Shapin, *A History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, The University of Chicago Press, 1994) xxv, 6.

[400] Kapil Raj, "Beyond Postcoloialism …and Postpositivism: Circulation and the Global History of Science, *Isis* 104, no. 2 (June 2013): 337-47.

[401] Bruno Latour, and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 1979, 1986).

[402] Jan Golinski *Making Natural Knowledge, Constructivism and the History of Science* (Chicago: The University of Chicago Press 1998, 2005); Lorraine Daston, "On Scientific Observation" *Isis,* 99 *(*2008): 97-110. For much more analysis of objectivity see Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007)

[403] Kapil Raj, "Beyond Postcolonialism," 341; Some examples in the field of nuclear history are Soraya Boudia, "Global Regulation: Controlling and Accepting Radioactivity Risks" *History and Technology* 23, no.4 (2007): 389-406; Sheila Jasanoff, "Science, Politics, and the Renegotiation of Expertise at the EPA"

unrecognized role of regulatory standards is in their adjudications of power, rights, consequences, and justice.[404] What is significant to radiation safety in a historical context is worthy of inquiry because it can reveal "contestations over power, knowledge and ethics."[405]

This chapter will analyze the process of circulation to identify who or what is included and excluded in determining safety. This chapter is a study of juxtapositions of culture and the pragmatic judgments that measure radioactive exposure's meaning. Here the circulation and mechanisms of exclusion and inclusion of radiation protection include uranium miners, workers and students at the first academic research reactor, and international bodies assessing and exchanging knowledge of radiation effects. Radiation safety hid many of the consequences of radiation exposure in the midst of the pursuit of utopian nuclear hopes.

The Rocks

The wider historical context of nuclear exposure is often removed from discussions of radiation health safety, as though this particular science is limited to a neatly defined site. To provide context it is important to share some of the reality and details of nuclear pollution as a whole. Man made radionuclides resulting from nuclear weapons explosions and nuclear energy accidents can be deposited as fallout at different

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Osiris 2nd Series, 7, Science After '40 (1992); 194-217, see also Scott D. Sagan, *The Limits of Safety: Organizations, Accidents, and Nuclear Weapons* (Princeton, NJ: Princeton University Press, 1993); C.A. Hooker, *Reason, Regulation, and Realism: Toward a Regulatory Systems Theory of Reason and Evolutionary Epistemology* (New York: State University of New York Press, 1995).

[404] Lawrence Busch, *Standards: Recipes for Reality* (Cambridge Mass: The MIT Press, 2011) see especially page 240-1, 247, plus chapters five and six.

[405] Hecht, *Being Nuclear,* 354 discussing Ian Hacking's influence on creation of a historical ontology as a category of inquiry for science studies, see Ian Hacking, *Historical Ontology* (Harvard: Harvard University Press, 2002); For more on the cognitive approach, see Nancy J. Nersessian, "Opening the Black Box: Cognitive Science and History of Science" in "Constructing Knowledge in the History of Science," *Osiris*, 2nd Series, 10, (1995): 194-211.

rates and speeds. It takes an average of ten half lives for most of the 900 radionuclides released from nuclear fission, such by a nuclear weapons explosion, to become nonradioactive. Half life varies from seconds to hours to many hundreds of thousands of years**.** For example, plutonium will be radioactive in the environment for seven to ten half lives that equal 24, 000 years each or, in total, as much as 240,000 years.

The radioactivity of 165 of the 900 radionuclides released by fission exists long enough to meld with the chemistry of soil, air, and water to affect the cellular and genetic structures of plants, animals, and people.[406] This nuclear pollution from cold war practices has contaminated the earth's biota, particularly from the mining, manufacture and testing of the equivalent of 34,000 Hiroshimas. These tests have been exploded underground, in space, underwater and in the atmosphere worldwide since 1945.[407]

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[406] Committee to Review the CDC-NCI Feasibility Study of the Health Consequences from Nuclear Weapons Tests, National Research Council *Exposure of the American Population to Radioactive Fallout from Nuclear Weapons Tests: A Review of the CDC-NCI Draft Report on a Feasibility Study of the Health Consequences to the American Population from Nuclear Weapons Tests Conducted by the United States and Other Nations* (Washington, DC: National Academies Press, 2003) 1-14.

[407] Simon L. Steven, Andre Bouville and Charles E. Land, "Fallout from Nuclear Weapons Tests and Cancer Risks: Exposures 50 Years Ago Still Have Health implications today that will continue into the Future". *American Scientist*, 94 (2006):48-57; Total worldwide tests were estimated in 1996 as 510.3 megatons, with the majority (427. 9 megatons) as atmospheric tests. 510,300 kilotons divided by 15 kt (the middle estimated measure of Little Boy, estimates are 12ktk and 18kt) equals 34,200 kilotons, rounding up the equivalence of 29,600 Hiroshima bombs. For the starting numbers 510, 300 see "Known Nuclear Tests Worldwide, 1945-1996" *Bulletin of Atomic Scientists,* (May 1996): 61-4. The US atmospheric tests took place predominantly in the Pacific and the Nevada Test Site, but also in the south Atlantic. Tests also occurred underground and under deep water in various locations, including Alaska, Mississippi, New Mexico, Colorado, and Nevada, see "United States Nuclear Test July 1945 through September 1992" DOE/NV--209-REV 15 December 2000, accessed April 25, 2014, http://www.nv.doe.gov/library/publications/historical/DOENV_209_REV15.pdf. For a much more thorough account of nuclear weapons testing, see Barton Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Berkeley: University of California Press, 1987) and *Elements of Controversy: The Atomic Energy Commission and Radiation Safety in Nuclear Weapons Testing, 1947-1974* (Berkeley: University of California Press, 1994) and Richard L. Miller, *Under the Cloud: The Decades of Nuclear Testing* (New York: The Free Press, 1986). See also a recent dissertation by Emory Jerry Jessee, "Radiation Ecologies: Bombs, Bodies, and Environment During the Atmospheric Nuclear Weapons Testing Period, 1942-1965" (PhD diss., Montana State University, 2013). For the difficulty of determining the size and implications of tests, see Donald MacKenzie and Graham Spinardi "Tacit Knowledge, Weapons Design, and the Uninvention of Nuclear Weapons" *American Journal of Sociology,* 101, no. 1 (Jul., 1995):44-99; also, see Isao Hashimoto's "1945 1998" a visual expression to convey these tests at the Project for the Comprehensive Nuclear Test Ban Treaty website, accessed April 25, 2014,

Because of the long lived nature of radioisotopes, geneticists and other researchers argue that the nuclear legacy will persist millions of years into the future. Thus the nuclear past will continue to expose populations to unknown genetic and hereditary effects.[408] Fallout from U.S. tests alone, only one element of the nuclear fuel chain, has resulted in an estimated 70,000 to 800,000 deaths due to cancer caused by the atmospheric explosions that occurred between 1945 and 1963.[409] While no place on Earth has escaped the signature of atmospheric nuclear testing (as radionuclides unknown before 1945 are found in soil, water and even polar ice) some communities have suffered incalculable loss.[410]

Clear examples of the health effects caused by nuclear development are ubiquitous but remain isolated from discourse on radiation health safety science and human rights impingements. The experience of uranium miners on the Navajo Nation is important to study because it is a well documented example of how excluded knowledge

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http://www.projectforthectbt.org/hashimotomultimedia; This pollution is in addition to local effects from nuclear weapons productions such as at Hanford, which now have growing complex groundwater contamination issues, see Max Power's *American Wasteland :Politics Accountability and Cleanup* (Pullman: Washington State University Press, 2008). There are other numbers of tests including 1054 for the US but I could not verify them as reliably as in Stephen I. Schwartz ed. *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940* (Washington D.C: Brookings Institution Press, 1996), 52. For worldwide tests, the number 2000 is most often used. For the US total, of these 215 were atmospheric and 815 were underground. The total world number of tests is estimated as 2045 in 1996 adding to the US number 715 from the USSR, 45 from Britain, 210 by France and 45 tests by China. The fallout contained radionuclides that had never occurred in nature before 1945. Also see B.G. Bennett "Worldwide Panorama of Radioactive Residues in the Environment" in *Restoration of Environment with Radioactive Residues Papers and Discussions Proceedings of an International Symposium* Arlington Virginia USA 29 November to 3 December 1999 (Vienna: International Atomic Energy Agency, 2000) , 11-24.

408 3.3 million feet of declassified records released by DOE Secretary Hazel O'Leary in 1994 have been made accessible at this website, including experiments that took place in Oregon State Hospital and Oregon prisons at the DOE, "Spotlight on Human Radiation Experiments" accessed April 25, 2014, https://www.osti.gov/opennet/spotlight.jspDOE Openness. DNA scrambling is explained in Kadhim, M.A.et al, "Transmission of Chromosomal Instability after Plutonium [Alpha]-Particle Irradiation" *Nature* 355, (1992): 738-740.

409 Arjun Makhijani and Stephen I. Schwartz, "Victims of the Bomb" in *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons since 1940* (Washington, DC: Brookings Institution, 1998), 395.

410 Simon, "Fallout from Nuclear Weapons Tests" (2006):48. For a global overview of the consequences to particular communities see Makhijani, *Nuclear Wastelands*.

can kill. This example is selected because it is a proven case of disproportionate radiation exposure of indigenous people.[411] Many Navajo lived in the path of fallout clouds from the Nevada Test Site and are eligible for Radiation Exposure Compensation Act monetary compensation due to their status as down winders; miners and millers are also eligible due to admitted government negligence.[412] The Navajo however, are only one example: eighty percent of the nuclear fuel chain, the mining, processing, testing and waste storage of nuclear materials occurs on or near indigenous communities worldwide.[413] This statistic raises grave concerns and ought to be a locus for literature on nuclear history, health, and human rights. This is also an important case study because the most exposed group to ionizing radiation in the construction of nuclear weapons and later, nuclear energy, was uranium miners.[414]

These miners would also be the last to know about their exposures. Native American uranium miners in Navajoland in particular were excluded from health protections and even the very knowledge of what they were mining during the Manhattan

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411 While never fully taking responsibility for the secret Public Health Studies or other human experiments, the US government did establish a small monetary compensation for miners who had been harmed. For more on the current Radiation Exposure Compensation Act (RECA) as the initial 1981 RECA was amended in 1990, see the Department of Justice website, accessed May 13, 2014, http://www.justice.gov/civil/common/reca.html.The Department of Justice had opposed the claims of the miners and now administer the claims process. For more on this history in detail, see Peter Eichstaedt, *If You Poison Us: Uranium and Native Americans* (Santa Fe: Red Crane Books, 1994).

412 Eichstaedt, *If You Poison Us;* In addition, the Navajo are disproportionately exposed by the nearby WIPPS, the largest nuclear repository located where many Navajo live near Carlsbad, New Mexico see "State of the World's Indigenous People" United Nations (New York: UN, 2009) 29, 225, accessed April 25, 2014, http://www.un.org/esa/socdev/unpfii/documents/SOWIP_web.pdf ; Map showing the double eligibility of the Navajo for RECA, accessed April 25, 2014, http://en.wikipedia.org/wiki/File:RECACoveredAreas.jpg.

413 Steven M. Hoffman, "Negotiating Eternity: Energy Policy, Environmental Justice, and the Politics of Nuclear Waste" *Bulletin of Science Technology & Society* 21, no. 6 (2001): 456-472 see especially page 462; For mention of disproportionate effects from resource extraction and nuclear waste storage on the Navajo see "State of the World's Indigenous People" 2009, 29, 225.

414 Hecht, *Being Nuclear*, 37-8; Robert Alvarez, "Uranium Mining and the U.S. Nuclear Weapons Program." *Public Interest Report* 66, no. 4 (Fall 2013).

Project.[415] The traditional ecological knowledge of the Navajo (Diné) warned against uranium mining. In a Diné creation story, the birth of the tribe was preceded by the choice between two yellow powders, and the powder of the corn pollen was chosen. The Diné were instructed to leave the other mysterious yellow dirt in the soil, and to never dig it up. It is considered a crime against nature to dig in the ground, which creates chaos by mixing what is supposed to be bounded: earth and sky.[416]

The creation story anticipates the dangers of uranium which is both toxic and radioactive. The health effects caused by exposure to uranium are generally lung cancers, kidney damage and birth defects.[417] When uranium in the ground is disturbed, such as in underground mines and in mining debris, uranium decays to dangerous radioactive elements, including radon gas. The gas is undetectable to human senses and the radon then decays to become even more dangerous particles. Once in the body, some of the "daughters" of radon, Radon- 222, Polonium- 218, and Bismuth -214, can continue to

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[415] "Transcripts of Trial Proceedings" File "John N. Begay vs The United States, 1981-3, file 3,4 of 9", Pope A. Lawrence Papers, 1924-1983, MS C 539, Box 13, History of Medicine Collection, National Library of Medicine Archives, National Institute of Health, Bethesda MD; Peter Eichstaedt, *If You Poison Us*; Judy Pasternak, *Yellow Dirt: An American Story for a Poisoned Land and A People Betrayed* (New York: Free Press, 2010).

[416] Eichstaedt, *If You Poison Us,* 47. This quote is repeated also by authors Carol A. Markstrom and Diné elder Perry H. Charley "Psychological Effect for Technological/Human Caused Environmental Disasters: Examination of the Navajo People and Uranium" in *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2006), 105-106.

[417] The Nuclear Regulatory Commission website "Background Information on Depleted Uranium-Health Effects" Birth defects are omitted by this NRC fact sheet, accessed April 25, 2014, http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams/bg-info-du.html#health; A March of Dimes study found rates of birth defects in babies born near the mining areas between 1964 and 1981 to be 2 to 8 times the national average, depending on defect, see Shields, et al.,. "Navajo Birth Outcomes in the Shiprock Uranium Mining Area" in *Health Physics* 63, (1992):542-51. For a recent review of health effects studies see "Uranium Exposure and Public Health in New Mexico and the Navajo Nation: A Literature Summary" Compiled by Chris Shuey, MPH Southwest Research and Information Center P.O. Box 4524, Albuquerque, NM 87196 505-262-1862 accessed April 25, 2014, http://www.emnrd.state.nm.us/mmd/marp/Documents/MK023ER_20081212_Marquez_NNELC-Acoma-Comments-AttachmentE-UExposureSummary.pdf

emit alpha radioactivity in the body and are particularly drawn to the lungs, causing lung cancer.[418]

The circulation of nuclear technology has affected the Diné on physical, cultural and spiritual levels. In Diné stories a monster roamed the sacred mountain Tsoodzil. The mythical monster, before it was slain, gave birth to many small monsters, which the Navajos today equate with the radionuclides that emit from the decaying uranium.[419] The Diné recently invented a name for uranium in their language, Leetso, the yellow monster.[420] Diné traditions teach that the Diné are protected within the boundaries of four sacred mountains in the four directions, with mountain *Tsoodzil* at the southeast corner.[421] In spite of sovereignty rights stated in the Treaty of 1868, prospecting began less than a year after Native reservation lands had been opened to leasing in 1919 by the Secretary of Interior.[422] Mines on the Navajo reservation supplied caronite, uranium, and vanadium for the radium craze, until prices fell due to finds in 1923 in the Belgian Congo.[423]

The decline in demand would prove to be only a respite. In 1939, one year after fission was discovered by Lise Meitner, Otto Hahn, Otto Frisch and Fritz Strassman,

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[418] It is important to note that also beta and gamma radiation is given off in the decay chain by Pb 214 and Bi 214 see in G.R. Yourt "Ventilation and Other Problems in Controlling Radon Daughters in Uranium Mines" in *Radon in Uranium Mining* Proceedings of a Panel on Radon in Uranium Mining, Organized by the IAEA and Held in Washington DC 4-7 September 1973 63-5 (Vienna: IAEA STI/PUB, 1975); J. Samuel Walker and George T. Mazuzan, *Controlling the Atom: The Beginnings of Nuclear Regulation 1946-1962* (Berkeley: University of California Press, 1984), 306. It is important to note that more than lung cancers are caused by exposure to uranium: esophageal cancers and many other diseases and illness such as kidney and reproductive disorders and birth defects are also caused by this exposure.

[419] Esther Yazzie-Lewis and Jim Zion, "A Navajo Cultural Interpretation of Uranium Mining" in *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2006), 1-11 and these stories were repeated often by elders and spiritual leaders at the Uranium Mining Ban Summit.

[420] Esther Yazzie-Lewis and Jim Zion, "Leetso: The Powerful Yellow Monster: A Navajo Cultural Interpretation of Uranium Mining" in *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2006), 3, 6.

[421] Seen on American maps often as Mt. Taylor and Tsoodzil means Turquoise, information from Indigenous Uranium Mining Ban Summit November 30 to December 2, 2006 Window Rock on the Navajo Nation.

[422] Without the consent of the tribes, see Peter Eichstaedt, *If You Poison Us,* 19-20. A leaseholder paid $1 a year rent for 40 acres in 1919.

[423] Peter Eichstaedt, *If You Poison Us,* 20-4.

prospecting for vanadium began on the then Navajo Reservation by the Vanadium Corporation of America (VCA).[424] The secret hunt for uranium and the announced need for vanadium in strengthening steel for armaments led to a frantic revitalization of older forgotten mine claims. After US entry into World War II, the Navajo were pressured to approve a resolution supporting the development of their natural resources.[425] This increased the incursions on their lands for uranium and for many other resources. While drilling for oil, at a depth of 6,950 feet, oil geologists also found helium- bearing gases three miles outside of the monument of Shiprock. This helium was then used to supply helium ships.[426] On the isolated area of Monument Valley and Carrizo Mountains, New Mexico, uranium was taken from a vanadium mine that was supplying the war effort.[427]

The mining of vanadium was conducted under the secret purview of the military by 1940, circumventing any oversight by the Bureau of Mines. The Bureau of Mines had thirty years of experience with monitoring ventilation in mines.[428] Prospecting for uranium began in earnest in 1944 by the Manhattan Project, later carried on by the AEC

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[424] Peter Eichstaedt, *If You Poison Us,* 23-24; Roger F. Robison and Richard F. Mould, "Historia Medicinae: St. Joachmistal: Pitchblende, Uranium and Radon –Induced Lung Cancer" *Journal of Oncology* 56, no. 3 (2006): 277.

[425] Peter Eichstaedt, *If You Poison Us,* 22-27.

[426] The oil company transferred their lease to the Dept of Interior for this gas mining. R.A. Cattell, "War Work of the Helium Section of the Petroleum and Natural Gas Division, 1945" page 48-51 in RG 70 Bureau of Mines, Draft History of Bureau of Mines, Activities of WW II, 1944 "Chapter 7 to 10", Entry 12 Box 4 HM 92 NARA II, College Park, MD.

[427] In 1942, an original mining claim found by explorer John Wetherhill in 1898 was put up for bid. Won by VCA, the claim was renamed as Monument No. 1, and the mining for uranium began, Peter Eichstaedt, *If You Poison Us,* 22-27; Valerie L. Kuletz, *The Tainted Desert: Environmental Ruin in the American West* (New York: Routledge, 1998), 21.

[428] Draft History of the Bureau of Mines, Activities During World War II, 1944 Folder "War Work of the Bureau of Mines, Bok Draft Chapters 26- 29" "Explosives Division, Fuels and Explosive's Service" and "Health and Safety" Entry 12, Box 2, HM 92 RG 70 Bureau of Mines , NARA II, College Park, MD. Concerns over ventilation in all mines and mine explosions dominate these Bureau of Mines' records from the first half of the twentieth century; "History of Mine Safety and Health Legislation" United States Department of Labor website, accessed April 25, 2014, http://www.msha.gov/MSHAINFO/MSHAINF2.HTM**.** Founded in 1910, the Bureau of Mines did seek to protect against severe mining accidents due to the loss of 2,000 lives annually, particularly in coal mine explosions, most brought on from lack of proper ventilation. The Bureau, unlike the European counterparts, did not have any inspection powers without the agreement of the owners until 1941.

after 1946 and the US Geological Survey. No other material had ever been surveyed so completely in such a short period of time. [429]

Despite the Navajo cultural prohibition warning against mining the yellow powder in the ground, the sacred mountain Tsoodzil would become the largest underground uranium mine in the United States and be eventually surrounded by seven other mines. The miners who worked these mines were not all Diné, but also included nearby Havasupai, Hualapai, Pueblo and Hopi men. Often they lived near the mining sites with their wives and families. When the mining began, most of the miners had had no previous interaction with the capitalist economy, or employment, and had been living a subsistence lifestyle. No records of their employment were kept, nor were their exposures ever measured or recorded as was common practice in the Manhattan Project laboratories at the time. Most spoke little to no English,[430] and lived in poverty at the beginning of World War II, a poverty primarily caused by US government enforced

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[429] Introduction by Jesse Johnson and Thomas B. Nolan, *Contributions to the Geology of Uranium and Thorium by the United States Geological Survey and the Atomic Energy Commission for the United Nations Conference on the Peaceful Uses of Atomic Energy, 1955 Geneva, Switzerland* (Washington DC: US Government Printing Office, 1956) iii, accessed April 25, 2014, http://babel.hathitrust.org/cgi/pt?id=mdp.39015003996819;view=1up;seq=3.

[430] Yazzie-Lewis and Jim Zion, "Leetso" 2006 , 3, 6 and Doug Brugge and Robe Goble "A Documentary History of Uranium Mining and the Navajo People" in *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2006), 39 and Peter Eichstaedt, *If You Poison Us,* 19- 27 and map "Uranium Mining Areas on Native American Lands in the Four Corners Area, 1920 to the Present." Thirty tribes united to gain protected permanent status by the state of New Mexico for Tsoodzil against further mining, but it is still under threat. For this history in environmental injustice context see also Robert Gottleib, *Forcing the Spring: The Transformation f the American Environmental Movement* (Washington DC: Island Press, 1993), 250-3. For more on the history of uranium mining from the perspectives of the miners, see Eichstaedt, *If You Poison Us,* Doug Brugge (ed) *Memories Come To Us in the Rain and the Wind* , *Oral Histories and Photographs of Navajo Uranium Miners and Their Families* (Jamaica Plain: Red Sun Press, 2000) and Pasternak, *Yellow Dirt.* For more information on the actual radiation safety practices of the Manhattan Project see Ronald L. Kathren "Before Transistors, ICs and All Those Good Things: The First Fifty Years of Radiation Monitoring Instrumentation" in *Health Physics: A Backward Glance, Thirteen Original Papers on the History of Radiation Protection,* eds., Ronald L. Kathren and Paul L. Ziemer (New York: Pergamon Press, 1980), 73-81.

livestock herd reductions in the 1930s.[431] For context, miners during the depression just a few years earlier in the south were often forced black laborers, who lived under the bodily threat of lynching and by then, an established peonage system.[432] Navajo miners later recalled that they too, were treated "like slaves."[433] The history of mining is in fact one of slave labor in the Americas. This occurred elsewhere too. The uranium used in the Hiroshima bomb came from forced labor in the Shinkolobwe mine in the Belgian Congo.[434]At the St. Joachimstahl mines, first Nazi and later East German governments used both prisoners of war and slave laborers to mine uranium.[435] The Native American miners were not only physically abused with militant treatment in dark dangerous working conditions, and pushed past their physical strength and limits; without well ventilated mines, they were also being exposed to radon and radon's daughters from being underground. [436]

The Navajoland mines were not ventilated, as most other mines were at the time, and no protective gear was issued. No health warnings were given to the miners, who drank water from the cracks in the mine walls and went home in a fine layer of yellow

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[431] The reductions were supposedly to prevent further soil erosion and overgrazing in the desert landscape. Peter Iverson, *The Navajo Nation* (London: Greenwood Press, 1981), 23-47; Marsha Weisiger, *Dreaming of Sheep in Navajo Country,* (Seattle: University of Washington Press, 2009).

[432] The lack of academic and health and human rights inquiry into manual labor as a whole, and miner's working conditions specifically perhaps has contributed to the continued dangerous working conditions and disconnection from issues of health and human rights in even labor law. John W. Blassingame, ed., *Slave Testimony*; Two *Centuries of Letters, Speeches, Interviews, and Autobiographies* (Baton Rouge, Louisiana State University Press,1977) xliv.

[433]Brugge, *Memories Come To Us*. This phrasing is repeated by former miners and their widows and children throughout the book.

[434] The uranium had been mined in the 1920s and 30s in slave like conditions, see Tom Zoellner, *Uranium, War, Energy and the Rock that Shaped the World* (New York: Penguin Books, 2009) 1-7; Hecht, *Being Nuclear,* ix, 49-50. For the earlier colonial history of the Congo, see Adam Hochschild, *King Leopold's Ghost: A Story of Greed, Terror and Heroism in Colonial Africa* (Boston: Mariner Books, 1999).

[435] Robison and Mould, "Historia Medicinae: St. Joachmistal." 277; Tom Zoellner, *Uranium: War, Energy and the Rock that Shaped the World* (New York, Penguin Books, 2009); Arvid Nelson *Cold War Ecology, Forests, Farms, and People in the East German Landscape, 1945-1989* (New York: Yale University Press, 2005), 50-52.

[436] Eichstaedt, *If You Poison Us*; Brugge, *The Navajo People and Uranium Mining*, 2006.

uranium dust. The Native American miners, because they were not warned of any health effects, also gathered radioactive rocks from the mines and used them as building materials.[437] According to their oral histories, these men were excluded from even the name or knowledge of what the yellow or black green powdery substance was that they mined. Given no health protections, gloves, nor proper ventilation the miners and their families later responded with disbelief that their patriotic work during the war as miners had made them "guinea pigs." Others felt betrayed because the 1868 Treaty obligated the United States to protect the tribe. [438] The miners were not unionized and were paid very low wages, less than a dollar an hour in 1949 and by the late 1960s, just $1.62 a day.[439] The low pay and non-seclusion of uranium mine wastes from waterways and the land kept the price of uranium artificially low.[440] Uranium, as Carbide Corporation explained it in *Mesa Miracle*, was part of "the overall program that has grown to be the single largest business in the country. For the atomic energy program represents an investment of several billion dollars…." In addition, "the Atomic Energy Commission was set up by the Government to control every phase of activity having to do with development of the

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[437] Eichstaedt, *If You Poison Us*; Brugge, *The Navajo People and Uranium Mining*, 2006.
[438] Brugge, *Memories Come To Us.*
[439] Brugge, *The Navajo People,* 2006, 26-30; Winona LaDuke, "Uranium Mining, Native Resistance, and the Greener Path: The Impact of Uranium Mining on Indigenous Communities" in *Orion Magazine* (2009) accessed May 13, 2014, http://www.orionmagazine.org/index.php/articles/article/4248.
[440] See Associated Press, "Top toxic sites in Anadarko Petroleum settlement" in *Business Week* April 3, 2014, accessed May 13, 2014, http://news.yahoo.com/top-toxic-sites-anadarko-petroleum-settlement211432051.html;_ylt=A0SO804Dl3JTCgUA1QJXNyoA;_ylu=X3oDMTEzZHFkcGhwBHNlY wNzcgRwb3MDMQRjb2xvA2dxMQR2dGlkA1ZJUDI4Nl8x; Also see "Federal Actions to Address Impacts of Uranium Contamination in the Navajo Nation Five Year Plan Summary Report Federal Actions to Address Impacts of Uranium Contamination in the Navajo Nation Five Year Plan Summary Report" January 2013 , 9, 31, accessed April 25, 2014, http://www.epa.gov/region9/superfund/navajo-nation/pdf/NavajoUraniumReport2013.pdf; The US government never intended for uranium to be a free market with a free market price, according to other historians and Hecht, *Being Nuclear* 49, but the costs of disposal of waste and dealing with contamination on just the Navajo Nation alone in federal EPA projects since 1971 has totaled more than $13.5 million according to EPA Region 9 and on April 3, 2014 a federal $985 million dollar settlement was reached with Anadarko Petroleum Company as owners of the former Kerr McGee company that abandoned contaminated uranium mines on the Navajo Nation. Thus, almost 1 billion in costs was externalized during the mining, and the costs avoided for decades.

atom. One of its most important jobs, these past few years, has been to obtain uranium-the basic source of atomic power."[441]

Obtaining uranium involved the unwitting sacrifice of miners and their communities. The uranium prices and supplies were controlled by the AEC in the early years, then later by a syndicate of mining companies.[442] But it was just these exclusions and deaths that unwittingly allowed the high tech worlds of nuclear accelerators and nuclear technologies to flourish. There is also much evidence to dispel the often repeated claim that radon dangers were not yet recognized in the 1940s.[443] The belief that risks were taken "because we did not know any better" is not historically accurate and it is particularly mistaken in this instance.[444] Inhaled radon became suspected as the specific cause for miner's lung cancer in the 1920s.[445] Excess cancers in the mines of Joachimsthal were linked directly to radon in the air of the mines by 1932. An American journal in 1937 reported a death rate of 30 percent among uranium miners. However, the finding in the US was not fully accepted according to a 1991 assessment by a National Academy of Science research panel. A causal relationship between radon and death was "not informally" accepted as fact until it was proven by "epidemiological evidence" with

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[441] *Mesa Miracle in Colorado,* quotation on 5, CHF, Philadelphia.
[442] The extent of the control of uranium is in entire boxes and includes Box 128 and 129 "Research and Development I" with files by nation name. Materials on control of uranium are spread thru out the 326 RG, such as "Memorandum for the General Manager through Assistant General Manager for International Activities, Continuation of the Arrangement for a Joint Cooperative Program for the Reconnaissance and investigation for Uranium Resource in Brazil" January 20, 1956 File "Materials, Uranium, Brazil" Box 40 Correspondence 1951-1958 NN3-324-93-010HM 1993 Office of the Secretary RG 326 Records of the AEC NARA II, College Park, MD.
[443] The most detail to dispel this claim is in Eichstaedt, *If You Poison Us,* while Hecht also concludes this in *Being Nuclear,* 178; Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York: Delta, 1999).
[444] Lavine, *The First Atomic Age,* 5.
[445] Hecht, *Being Nuclear,* 178.

"excess cases of lung cancer in other groups of exposed miners."[446] This same 1937 evidence, however, did spur the Nazis to attempt to regulate the uranium industry.[447] In the US, by 1941, a standard was established for internal exposure of radon based on the accumulation and estimates of internal exposure that caused the previous deaths of European miners.[448] Dr. Wilhelm Hueper, a pioneer in occupational medicine, stated in a 1942 occupational health textbook that mining was the oldest known source of cancer from exposure. This recognition can be traced back to Paracelsus's observations of miner's illnesses in the 16th century and the 1879 diagnoses of malignant tumors in miners.[449]

Persistent and tenacious attempts were made over decades to stimulate action. For example, Hueper found a causal link between radon and cancer in 1942, but he was forbidden to share his findings when he worked at the National Cancer Institute.[450] Ralph V. Batie, chief of health and safety for the Colorado AEC, alerted both the AEC and state officials, but he was ignored and forced to transfer out of the area.[451] Another example, PHS doctor Henry Doyle and PHS epidemiologist Duncan Holaday studied the high morbidity of miners and dangerous conditions in southwestern mills and mines. Samples specifically of the air in Navajo mines and mills found the radiation levels were very dangerous. Doyle and Holaday tried to spur action by sharing their findings and meeting with a long list of parties. These included uranium company representatives, federal and

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[446] National Research Council Panel on Dosimetric Assumptions Affecting the Application of Radon Risk Estimate, Board on Radiation Effects Research, *Comparative Dosimetry of Radon in Mines and Homes,* (National Academy Press, 1991)11; Hecht, *Being Nuclear,* 178.
[447] Hecht*, Being Nuclear*, 37-8.
[448] J. Newell Stannard, "Radiation Protection and the Internal Emitter Saga," Lauriston S. Taylor Lecture Series Radiation Protection and Measurement, Lecture 14 (Bethesda, MD: National Council on Radiation Protection and Measurements, 1990), 15.
[449]Hecht*, Being Nuclear*, 37-8.
[450] Brugge, *The Navajo People,* 31, 34.
[451] Pasternak, *Yellow Dirt,* 66-76, 92.

state health and Navajo (Diné) officials, to spark some action from the industry or regulators to eliminate the dangerous working condition. Specifically the need was acute for ventilation of the Navajo mines on the then reservation.

Just blowing fresh air in and out of the mines alone could have mitigated the radon daughter threats in general. The ventilation was calculated by Holaday to only add to the price of uranium less than a dollar per ton of mined ore. However, their conclusive evidence about the dangers, beginning as early as the late 1940s, was ignored. An interim report in early 1952 of the dire conditions was reproduced and sent to companies and myriads of officials, but was not shared with workers so they would not flee the mines and mills. It was in the interest of the industry and the AEC to keep the price of production low by making no improvements and thus, they believed, to ensure national security. No progress was made by the AEC or uranium companies to improve the miners' conditions until ordered to by Willard Wirtz, Secretary of Health, Education, and Welfare the late 1960s.[452] From the beginning of the 1946 Atomic Energy Act, the AEC did not take responsibility for control of uranium until after the uranium had been milled (except in the case of the handful of government- owned mills).[453]

The AEC downplayed the dangers and claimed it was not their jurisdiction to set uranium safety standards, so none were set, although standards were established for

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[452] Eichstaedt, *If You Poison Us;* Hecht, *Being Nuclear,* 188-93. See also Eisenbud, *An Environmental Odyssey* Eisenbud had also tried to remedy the mines as a part of HASL. Eisenbud had personally measured the high radiation levels in the mines in the southwest.

[453] Walker and Mazuzan, *Controlling the Atom*, 307-308; Stannard, *Radioactivity and Health: A History* (Pacific Northwest Laboratory, WA: Office of Scientific and Technical Information, Battelle,1988) although Stannard accuses those concerned about this as guilty of "Monday Morning Quarterbacking" and he blames the fallout controversy among other reasons, saying "The AEC already had its hands full with the fallout ruckus," 154-5.

beryllium.[454] This may be because of the attitudes of responsibility on behalf of individual scientists and administrators. Health physicist Merril Eisenbud retained power over beryllium as director of AEC's Health and Safety Laboratory (HASL).[455] HASL instituted safety regulations based on the reasoning that the dangerous beryllium exposure would not be occurring if it weren't for the business of the AEC in nuclear production. But others felt much differently. [456]

Just as serious investigations of the mines in the southwest were beginning by the AEC's HASL it was stymied. Oversight of uranium was transferred from Eisenbud's New York Operation Office (NYOO) of HASL to Jesse C. Johnson's AEC's Raw Materials Division in the late 1940s. Johnson, with a background in metals mining and pricing, had joined the AEC in 1948. He became director of the division in 1950 and oversaw a uranium exploration boom in the Southwest.[457]By the time Eisenbud of HASL took samples of the dangerous air in the southwest uranium mines in 1948, scientists knew that the miners were at risk for lung cancer and other diseases within 15 to 20 years after their mining exposure. Eisenbud claimed the lack of oversight of the mines was due to the interpretation of the ambiguous nature of the AEA as not requiring oversight of such raw materials. Eisenbud's office interpreted the AEA regulations as requiring health and safety but Jesse Johnson, of the Raw Materials Division, wanted quotas for uranium filled. Johnson felt he and the AEC were not in any way obligated by law to enforce

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454 Doug Brugge and Rob Goble "Public Health Then and Now: The History of Uranium Mining and the Navajo People" in *The American Journal of Public Health* 92:9 (2002): 1410; Walker, *Containing the Atom: Nuclear Regulation in a Changing Environment 1963-1971*(Berkeley: University of California Press, 1992), 231-266; Eichstaedt, *If You Poison Us*, 81-94.
455 Wolfgang Saxon, "Merril Eisenbud, 82, Safety Expert Known for Work on Atomic Energy" *New York Times* Obituary, August 21, 1997. Eisenbud was also a consultant on radiation safety for the World Health Organization from 1956 to 1980.
456 Eisenbud, *An Environmental Odyssey* 58-62.
457 "Johnson, Jesse C." Mining Hall of Fame Inductees Database, accessed May 13, 2014, http://www.mininghalloffame.org/inductee.asp?i=129&b=inductees.asp&t=n&p=J&s=.

safety for such raw materials. Oversight was left for state regulators who had no nuclear or radioactive expertise or capacity to regulate the mining industry.[458] By the 1950s one of the first cancer mechanisms to be explained was how radon decayed to alpha emitting daughter isotopes that stayed in the lung to cause lung cancer.[459] Although radon was a serious concern, known health risks would be ignored. Eisenbud wrote, "It was a tragic decision…an epidemic of lung cancer would take the lives of about 500 miners."[460]

By 1966 the increasing numbers of miners who had died from lung cancer led the U.S. Bureau of Mines to begin oversight of the mines, but not the AEC. Mines were conveniently conceptualized as still outside of the nuclear purview. Rocks were distinct from the glitz and glamour of sleek nuclear technology. Yet, even the Bureau of Mines with their experience in mine safety and ventilation was powerless. Without an established safety standard for radon inhalation, no real action was taken until an outraged government administrator, US Secretary of Labor W. William Wirtz, at great professional cost, instituted a standard at the end of 1967. However, he was forced to allow 18 months to elapse before enforcement of the standards.[461] In the case of the miners, scientific uncertainty was given as the reason why no federal standards were established until 1969.[462] The exclusion of health protections for the Native American miners during the war and after is clear in the secondary literature as well as in many primary sources, from the sworn testimony of scientists and health physicists in later

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[458] Eisenbud, *An Environmental Odyssey* 58-62; Walker, *Containing the Atom*, 234-235;Pasternak, *Yellow Dirt,* 68; Brugge, *The Navajo People,* xvii, 29-31, and Eichstaedt, *If You Poison Us*, 47-57.
[459] Brugge, *The Navajo People,* 31.
[460] Eisenbud, *An Environmental Odyssey* 60-1.
[461] Walker, *Containing the Atom*, 233-266; Eichstaedt, *If You Poison Us*, 81-94.
[462] Walker and Mazuzan, *Controlling the Atom,* 306-307 and Walker, *Containing the Atom,*, 233-266.

legal cases, to the oral histories of the miners themselves and in declassified government documents.[463]

But the injustice did not end there. Secret medical studies used the miners as experimental subjects to set standards for other nuclear workers. While excluded from any rights to health and safety as nuclear workers, the bodies of uranium miners, their lungs and their deaths, would serve as a baseline for establishing nuclear worker and radiation health safety standards. The U.S. Public Health Service (PHS) initiated studies in 1948 on the miners, hundreds of whom were Native Americans, without their knowledge, and they were not warned of any dangers or developing health problems. All practical health information was withheld, including their lung cancers and impending deaths.[464] The findings of the interim study published in 1952 were distributed to "everyone we could think of" testified Dr. Duncan Holaday years later, "but not the

[463] Primary documents of testimony are located in the Pope A. Lawrence Papers, 1924-1983, National Institute of Health, Bethesda MD and the KZ Morgan papers, un-accessioned at the University of Tennessee in Knoxville; See previously cited works, LaDuke, "Uranium Mining, Native Resistance" 2009, Eichstaedt, Brugge et al, Brugge, Kuletz, Hecht, and Pasternak. For many other aspects of uranium mining as a racial and environmental injustice, also see, John Byrne and Steven M. Hoffman. "A 'Necessary Sacrifice:' Industrialization and American Indian Lands" in *Environmental Justice: Discourses in International Political Economy Energy and Environmental Policy Volume 8,* eds., by John Byrne, Leigh Glover, and Cecilia Martinez, (New Brunswick: Transaction Publishers, 2002) 97-118; Cate Gilles, "No One Ever Told Us: Native Americans and the Great Uranium Experiment" in *Governing the Atom: The Politics of Risk* Energy and Environmental Policy Volume 7, eds., John Byrne and Steven M. Hoffman, (New Jersey: Transaction Publishers, 1996), 103-25; L. S., Gottlieb, and L.A. Husen, "Lung Cancer among Navajo Uranium Miners." *Chest* 81:4 (1982), 449-52; Johansen, Bruce E. "The High Cost of Uranium in Navajoland." *Akwesasne Notes,* n.s., 2, no. 2 (Spring 1997): 10-2, accessed April 25, 2014, http://www.ratical.com/radiation/UraniumInNavLand.html; Barbara Rose Johnston, Susan E. Dawson, and Gary E. Madsen, "Uranium Mining and Milling: Navajo Experiences" in *Half-Lives and Half-Truths: Confronting the Radioactive Legacies of the Cold War,* ed, Barbara Rose Johnston (Santa Fe: School for Advanced Research Press, 2007) 97-116; Dorothy Nelkin, "Native Americans and Nuclear Power." *Science, Technology and Human Values* 6, no. 35 (Spring 1981): 2-13. For occupational health treatment of the topic see, Jessica S. Pearson, "Organizational Response to Occupational Injury and Disease: The Case of the Uranium Industry." *Social Forces* 57, no. 1 (September 1978): 23-41; Victor E. Archer, "Health Concerns in Uranium Mining and Milling." *Journal of Occupational Medicine* 23 no.7 (1981): 502-5,

[464] Eichstaedt, *If You Poison Us,* 47-65 and Shelley Smithson, "Radioactive Revival in New Mexico" *The Nation*, June 29, 2009, accessed April 21, 2014, http://www.thenation.com/article/radioactive-revival-new-mexico.

miners." [465] Eventually, the men would die. Contamination from Leetso, (the Diné word for uranium) that was once isolated underground, was deposited by daily practice and by accidents such as the 1979 Churchrock spill on the Navajo landscape.[466] At least 4 to 6 million tons of uranium ore were mined on the Navajo Nation from the 1940s until 1986.[467] All of it was sold to the U.S. government and used to make bombs, although after 1971, utilities also bought uranium for nuclear power plants.[468] Uranium mill operations were also located on the reservation, and when the mining and milling ended in the 1990s, between 450 to 600 of the estimated 5,000 Hopi and Diné miners and millers had died from lung cancer, and 1,500 polluted mining sites were abandoned with the complicity of the tribal trustee, the U.S. government.[469]

The exclusion of consideration for the miners and the southwestern Navajo communities in the circulation of nuclear science involved a mechanism of denial of responsibility. The Atomic Energy Act of 1946 alluded frequently to health and safety, even going so far as to include allowable standards of radiation exposure. However, as Congressional hearings charged in 1987, the AEC was in the position of being "a fox guarding the chicken coop."[470] The fox also had been empowered to control all data it

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[465] "Transcripts of Trial Proceedings" 140-1, File "John N. Begay vs The United States, 1981-3, file 3 of 9", Pope A. Lawrence Papers, 1924-1983, MS C 539, Box 13, History of Medicine Collection, National Library of Medicine Archives, National Institute of Health, Bethesda. The miners were given chest X-rays as part of the study.

[466] See chapter 5 and Richards, "On Poisoned Ground" *Chemical Heritage Magazine* 31, no.1 (Spring 2013) 32-38 and co-authored with Perry H. Charley, "Nuclear Environmental Justice in Arizona and Beyond, Part 2" *Voices from the Sylff Community* (January 2013):10-4: "Nuclear Environmental Justice in Arizona and Beyond" *Voices from the Sylff Community* (October 2011): 7-11.

[467] EPA "Addressing Uranium Contamination on the Navajo Nation," accessed April 25, 2014, http://www.epa.gov/region09/superfund/navajo-nation/; Yazzie-Lewis and Zion, "Leetso," 3.

[468] Walker, *Containing the Atom*, 233-234; Brugge and Goble "Public Health Then and Now,"1413.

[469] Johanson, "The High Cost of Uranium in Navajoland" 10-12; LaDuke, "Uranium Mining, Native Resistance," 2009; Brugge and Goble "Public Health Then and Now," 1417.

[470] U.S. Congress, House, Committee on Energy and Commerce, Subcommittee on Energy and Power, One Hundredth Congress, First Session, (February 10, 1987) Hanford Nuclear Reactor: Safety issues (Serial No.

deemed essential to national security. This conflicted role as both promoter of nuclear technology and enforcer of health and safety may have been real on paper, but the mechanisms and the will to achieve standards for public and worker's health and safety were not always in place.[471] The power differential between the miners and the AEC was profound, but the AEC would have benefited from heeding the warning of the Diné stories.

The Reactors

Should nuclear safety regulation have applied to the miners? Willard Libby's establishment of background radiation as a standard of safety, either by accident or design, inverted the dangers to miners as less dangerous than the exposures were in reality. Mining was left to private industry and states to control. The ability to ignore radiation risks to miners might have been made easier by the conceptualization of radiation, too. Despite the comparisons of artificial radiation to natural background radiation to reassure the public of the safety of fallout, perhaps uranium risks were still seen by AEC scientists as a natural source and therefore as safer than artificial radiation. The lack of ventilation however, magnified the high inhalation radioactivity risks to the miners. Other uranium exposures, for example, from the fine yellow dust coating the miners clothes, may have also been easier to ignore because they were thought of as external, low ionizing natural exposures from natural background radiation. Miners were just men, digging in the dirt and rocks. How dangerous could it be? But because radon with its potent cancer-causing radon daughters was concentrated unnaturally in unventilated and underground man-made mines, the exposures were not at all comparable

100-8) (Washington DC: U.S. Government Printing Office, 1987), 111; Also, see the Atomic Energy Act of 1946, accessed April 25, 2014, http://www.osti.gov/atomicenergyact.pdf.
[471] Walker and Mazuzan. *Controlling the Atom,* 30-1.

to the measures of natural background radioactivity. Some of the Diné miners had cumulative exposures forty-four times higher than the levels at Hiroshima and Nagasaki.[472] The paradigm of using natural background radiation as a threshold would also privilege protections for laboratory personnel exposed to artificial radioactivity. The infrastructure of radiation protection science led to attention to effects within labs: not in the environment, and not for miners. The environment was part of the industrial machine to dilute pollution. Perhaps indigenous people were seen as part of this machine as well.[473]

Those scientists who did speak out for decades to try to intercept the death sentence upon the miners were silenced. For just one example, Wilhelm Hueper (who had found in 1942 serious health risks from mining) was not allowed to travel nor to speak about his findings to prevent publicly about his research findings.[474] Other AEC scientists who became concerned about health and safety, such as John Gofman, Thomas Mancuso and K.Z. Morgan were eventually maligned in some way by the AEC, losing either their positions or their credibility.[475] The same occurred to non-governmental scientists who ventured to question AEC pronouncements of safety such as Alice Stewart and Linus

[472] Pasternak, *Yellow Dirt,* 154.
[473] Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Macmillan, 2011); The results of using the landscape as part of the dilution mechanism for radiation can be seen in the ongoing severe pollution problems at Hanford, see Power, *America's Nuclear Wastelands*.
[474] Brugge and Goble "Public Health Then and Now," 1413. For many more details on the efforts of scientists to prevent this tragedy, see especially Eichstaedt, *If You Poison Us*.
[475] Karl Z Morgan and Ken M. Peterson. *The Angry Genie: One Man's Walk through the Nuclear Age* (Norman, Oklahoma: University of Oklahoma Press, 1999); Iona Semendeferi, "Legitimating a Nuclear Critic: John Gofman, Radiation Safety, and Cancer Risks" *Historical Studies Nat Sci.* 38, no. 2 (2008 Spring;):259-301; Pearce Wright, Obituary "Ralph Lapp: Manhattan Project Physicist Who Went on to Warn the Public about the Dangers of Nuclear Radiation" *The Guardian*, September 16, 2004, accessed April 25, 2014 http://www.theguardian.com/news/2004/sep/16/guardianobituaries.science; Merril Eisenbud, *An Environmental Odyssey.*

Pauling.[476] However, when scientists did ask how radiation contamination could alter genetic material and cells in living and ecological systems, the work was funded by the Atomic Energy Commission (AEC) and wedded to the question of nuclear military victory or defense.[477] A much less obvious influence on the isolation of radiation health safety however, was the role of prestige of those who operated reactors. The circulation of radiation health safety among scientists at a growing university in North Carolina brings into view pragmatic decision making and the inability to enact the precautionary principle, even in a laboratory. Unlike the Native American miners, who were not even provided gloves for protection during this same era, laboratory scientists were the focus of safety standards and protocols. "Rad safety" as it was called, with its clicking Geiger counters, dosimeters, and area monitoring was instituted primarily to protect laboratory scientists. But even with this focus, the lure of experiment was not always tempered.

The work of radiation protection was primarily directed at laboratory or production facilities. Perhaps this narrowing can be seen as a natural aspect of "normal" science that, without conscious malice or intention, limits itself to questions scientists believe are actually answerable.[478] In addition, many of the research questions were tethered to the equipment, not to biology. Research reactors are low power reactors that do not generate electricity but do generate isotopes for experiments and are a teaching tool for reactor operators. These small reactors served even more powerfully than radioisotopes had before, as a "gateway to the nuclear age" to establish civilian nuclear

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[476] Gayle Greene, *The Woman Who Knew Too Much: Alice Stewart and the Secrets of Radiation* (Ann Arbor: University of Michigan Press, 1999) and Thomas Hagar, *Force of Nature.*
[477] Hamblin, *Arming Mother Nature* and *Poison in the Well*.
[478] Hasok Chang, "Complementary Science" *The Philosophers Magazine* 40, no. G, (2008, first quarter) 17-24.

science programs.[479] The machines, however, only expanded the field of who would unwittingly become experimental subjects. A new form of knowledge and expertise would establish who decided what was safe, and it was not necessarily the health physicist.

Health physicists often felt isolated from other nuclear scientists. One scientist remarked he felt he was perceived by nuclear physicists as a cop.[480] In 1962, only between 1-2 % of the AEC nuclear workforce of around 130,000 people were "radiation protection specialists."[481] Health physicists as a group were deeply concerned about safety but also admitted that not enough was known. They seemed initially confident in their ability to control radioactivity: if done correctly, safety, nuclear weapons and power could all coexist.[482] A separation of health physics from other academic disciplines was compounded by the mystique surrounding those associated with the Manhattan Project who operated nuclear equipment. Disciplinary lenses, professionalization, and academic boundaries only continued to elevate a new class of engineers, while dividing the knowledge of radiation effects into separated realms of physics, medicine, chemistry and biology.[483] Particularly biology was alienated from the physical aspects of radiation, and

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[479] "First Temple of the Atom" booklet, File "NE First Temple of the Atom," Departmental to Nuclear Engineering, 1968, NCSU Libraries, Special Collections Department, University Archives, Raleigh, NC. For more on radioisotope history as a gateway, see Angela Creager, *Atomic Life.*

[480] "Transcript of Gordon Little" *How OSU Grew Nuclear Science,* Oral History Collection, SCARC accessed April 25, 2014, http://blogs.oregonstate.edu/nuclearhistory/transcript-of-gordon-little/.

[481] Howard M. Vollmer and Donald L. Mills, "Nuclear Technology and the Professionalization of Labor" *The American Journal of Sociology* 67, no. 6 (May, 1962): 690-6.

[482] The dedication to safety is clear in Dale Trout's Papers at SCARC and the papers of KZ Morgan at Knoxville, Tennessee. In Morgan's case however, he came to distrust the nuclear industry by the end of his career. Kathren and Ziemer, *Health Physics,* 1980 "Dedication to the Memory of E. Dale Trout (1901-1977)" Trout a health physicist at Oregon State University (formerly Oregon Agricultural College) was eulogized as a "scientist, educator, and humanist." See also KZ Morgan, *Angry Genie*, Eisenbud, *An Environmental Odyssey,* and Walker, *Permissible Dose.*

[483] Early "Radioactivitists" however, had been a primarily interdisciplinary group but disciplinary splits become clear by the time of Big Science. These boundaries and tensions between physics and other disciplines appear in the records of IUPAC and the Cain Conferences at the Chemical Heritage Foundation

remote from the operations of shielded reactors. Even Willard Libby during 1957 Congressional hearings on fallout admitted this separation was a shortcoming. Libby said at the hearing, "I am impressed with the disparity in our knowledge of the biological effects as compared to our knowledge of the physical effects" of radiation.[484]

The machines were already running, ahead of the knowledge of their biological effects.[485] The first education research reactor preceded Eisenhower's Atoms for Peace speech by three months. It "went critical" in the center of the North Carolina State University campus on September 5, 1953. The reactor was informally christened the "First Temple of the Atom" by the science editor of the Associated Press, Howard Blakeslee, and the name would stick. The reactor began "breathing with life," fueled by a uranium core given by the military lab at Oak Ridge, Tennessee. It was built with the approval and help from the AEC Oak Ridge staff, and was intended as a training tool for operations of nuclear reactors and multidisciplinary experimentation. In addition, the reactor was to contribute to the ongoing study of how heat could be transferred into energy.

Archives as well as in the RG 326 AEC documents in NARA II records but are established by J. Christopher Jolly, "Linus Pauling and the Scientific Debate Over Fallout Hazards" *Endeavor* 26, no. 4 (2002): 149-153. For much more detail on the disciplinary boundaries, see his dissertation, "Thresholds of Uncertainty: Radiation and Responsibility in the Fallout Controversy" (Ph.D. diss., Oregon State University, 2003); For the professionalization of nuclear labor and noting the new field of radiation protection, see Vollmer and Mills, "Nuclear Technology and the Professionalization of Labor;" Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (New York: Harper & Row, 1989); Samuel J. Walker, *Permissible Dose: A History of Radiation Protection in the Twentieth Century* (Berkeley: University of California Press, 2000). Both Caulfield and Walker give extensive history on the making of radiation safety science.

[484] Walker and Mazuzan, *Controlling the Atom*, 50-52, quotation 52. See also the June 1957 hearings as this biological absence of data is noted thru out that hearing, Congressional Hearing "The Nature of Radioactive Fallout and its Effects on Man" Vol. 1-3 June 4-7, 1957 7.022 LP Peace, SCARC.

[485] And this would not necessarily be corrected. For example, high speed particle accelerators at CERN were already operating before health physicist realized there was no awareness of how different the radiation exposures might be from these newer machines but this requires further research, see documentation of J. Baarlie "Radioactivity Induced in the CERN Accelerators" May 15, 1962 , and "Internal Reports Written by Members of the Health Physics Group 1961-4" in notebook F524 DIRADM HPH/22 File 2 1962/01-1964/04 Health Physics 20318 DIRADM, CERN Archives, Geneva.

The reactor was the cornerstone for the launch for the first nuclear engineering program in the country at NCSU. Dr. Clifford K. Beck was recruited in 1949 from his position at Oak Ridge as Director of Research and Co-director of the Laboratory Division at the Carbide K-25 Gaseous Diffusion Plant to lead the expanding NCSU physics department. NCSU was rich at the time with state legislature funds for expanding facilities and programs. Beck, who had worked on the Manhattan Project and his colleagues at the AEC, felt it was the responsibility of academic institutions to train the workforce for the nuclear age, and create a non-militarized space for learning, although many of the men who applied for the program were in the military. In 1950, the nuclear labor force totaled 70,000 but every major AEC installation was seeking "additional men trained in engineering." Increasingly a new class of expertise was anticipated, as even mine operators would soon become "metallurgical engineers."[486]

The reactor itself was a physical manifestation of the inspirational hopes of peaceful nuclear energy. In proposals and brochures, the "Temple of the Atom" represented the literal public birth of a new "Atomic Age."[487] Beck was poetic in his preface to his Nuclear Engineering proposal: "In the wake of that violently successful birth, visions of blessings to mankind, amazing in scope and almost within grasp, have

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[486] This example of increasing elite expertise commandeered out of newness is an example of Foucault's ideas as interpreted by Hacking, *Historical Ontology,* see especially 76-81;Clifford Beck, "The Undergraduate Nuclear Engineering Curriculum at NCSU" paper presented to the Sectional Meeting for the American Society of Engineering Education, Fontana, NC, August 29, 1950, File "Curriculum in Nuclear Engineering, 1950 n.d." Box College of Engineering, UA 105.16.1 Nuclear Engineering, Series I, General Correspondence Brochures to Seminars, NCSU Libraries, Special Collections Department, University Archives, Raleigh, N.C.; "First Temple of the Atom" booklet File "NE First Temple of the Atom" 1-3, Departmental to Nuclear Engineering, 1968, NCSU Libraries, Special Collections Department, University Archives, Raleigh, N.C.

[487] Clifford Beck, "A Curriculum in Nuclear Engineering" and "First Temple of the Atom" NCSU.

arisen to challenge our generation of engineers and scientists." [488] The NCSU research reactor quickly became an international showcase for Atoms for Peace. The facility was visited by representatives from "Brazil, Belgium, Sweden, India, Spain, Germany, Japan, Turkey, Australia and Argentina" along with twenty American university visitors. The public toured the facility the most: In its first year of operations, 6,000 people came to see the State College Reactor [489] The reactor was the center of Beck's vision of the physics department's expansion into research, with a proposed undergraduate nuclear engineering degree and a doctoral program that became the first in the country in 1950.[490] The reactor also attracted industrial partners for the program.[491] The Newport News Shipbuilding and Dry Dock Company supported a NCSU Professorship in Nuclear Engineering. Their promotional materials focused on the modernity of the world's first college reactor from its structure to its inevitable applications to power ships.[492]

In reality, the technology involved risks. Touted as being able to run for "300 years" without refueling, the first nuclear core of the "Temple of the Atom" met a swift demise, but not before contaminating the NCSU campus.[493] Contamination from radioactivity and the use of radioisotopes already was a challenge for the campus before the reactor started operations. Earlier in April 1953, an escape of polonium had contaminated a laboratory. The event was blamed on the existing radiological safety

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[488] He refers incorrectly to the date of the Trinity explosion as August 5, which I found odd for someone who was a part of the MED, Clifford Beck, "A Curriculum in Nuclear Engineering" NCSU.

[489] "First Temple of the Atom" booklet, NCSU.

[490] "Report to the Governor on Nuclear Energy, 1958" File "General Information, 1955-1963" Box College of Engineering, UA 105.16.1 Nuclear Engineering, Series I, General Correspondence Brochures to Seminars and "First Temple of the Atom" booklet, NCSU.

[491] This PhD program proposal was specifically "Nuclear Engineering and Engineering Physics", "Degree Proposals, 1951" and "Curriculum in Nuclear Engineering, 1950 nd" Box College of Engineering, UA 105.16.1 Nuclear Engineering, Series I, General Correspondence Brochures to Seminars, NCSU.

[492] "The Newport News Shipbuilding and Dry Dock Company Professorship in Nuclear Engineering" brochure File "Brochures, Nuclear Engineering Department, 1955-1988" Box College of Engineering, UA 105.16.1 Nuclear Engineering, Series I, General Correspondence Brochures to Seminars, NCSU.

[493] "First Temple of the Atom" booklet, NCSU.

officer, who was removed from his position. Nine days after the first criticality of the reactor, a new "Committee on Safety and Health for the Nuclear Reactor and Radioisotopes" convened. The committee merged with the former Isotope Committee to centralize and standardize radiation oversight and create policy. It was suggested at the first meeting that the committee operate independent of the reactor operators, but this was not recorded in the formal notes. The new committee, but only in the informal notes, struggled with the requirements for their new expertise and did not want to be seen as "policemen." However, all agreed sufficient monitoring was needed for both health and liability. [494]

These two aspects, potential liabilities and safety, went hand in hand. Blood tests and physical exams were needed before a hire was finalized and after, to rule out any illness that might later be attributed to radiation. Sufficient record keeping would be needed for liability protection as well. Mastery of the proper instrumentation of dosimeters, film badges, and Geiger counter surveys were required to protect against any claims of negligence as much as health. Due to the frustration of not feeling competent, and worries about radiation accidents, the committee suggested that new hires be sought more for their experience with radioactive sources. Present on the Health and Safety committee was James H. Jensen, who had chaired an AEC nuclear waste subcommittee in 1948-9. Jensen alerted the committee to the importance of studying nuclear waste disposal. Beck for his part foreshadowed what was to come, saying the operations of the

[494] Radiation Safety Committee Meeting notes, September 14, 1953, informal handwritten and unsigned, but noticeably different than the official notes "Meeting Minutes, September 14, 1953" submitted and signed by Professor Smallwood; Clifford Beck "An Incident on Polonium Contamination in the Physics Department discovered on April 10, 1953" May 10-22, 1953 File "Contracts, Meeting Minutes, Report Correspondence 1953-4" (1 of 2) Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

unique reactor, for the first time conducted in an unclassified manner, would be "interesting, and their solutions, far reaching." [495]

Soon, the operations of the reactor would be contested. When the newly hired Radiological Safety Officer (RSO) opposed loading more uranium fuel into the "Temple of the Atom," Dr. Beck told him he was not qualified to judge the reactor's resilience. The experiment was temporarily postponed, until further permission was secured from the AEC to proceed.[496] The reactor became a test facility in more ways than one, as the AEC began to analyze how to construct licensing and inspections for future research reactors. A visit from Dr. Hanson Blatz, a radiological physicist who worked in the AEC HASL New York office, resulted in suggestions that all personnel wear film badges, that twenty year records of exposures should be kept on each individual, and that eye examinations be used to detect neutron exposures. [497] Also involved with the "Temple of the Atom" was the Public Health Service, "intimately involved in the Atomic Testing Program" at the same time. PHS Chief of the Radiological Branch, Dr. James G. Terrill, shared with the committee that "over design from the standpoint of safety of reactors was too common."[498] The program, despite struggling with safety as recorded in the Safety

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[495] Jensen served as President of Oregon State from 1961-69 and he presided over the growth from an Agricultural College to a University. His role on the AEC is discussed in Hamblin, *Poison in the Well,* 29, 33-5; Radiation Safety Committee Meeting notes, September 14, 1953, informal handwritten and unsigned, and "Meeting Minutes, September 14, 1953" submitted and signed by Professor Smallwood, File "Contracts, Meeting Minutes, Report Correspondence 1953-4" (1 of 2) Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[496] AP Sanders (R.S.O) to Radiation Safety Committee, November 5, 1953 and C. Beck to Radiation Safety Committee, November 13, 1953, File "Contracts, Meeting Minutes, Report Correspondence 1953-4" (2 of 2) Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[497] Blatz would later serve as an IAEA technical expert (and he is also mentioned in Eisenbud, *Environmental Odyssey* 46, 60) F.P. Pike, Committee on Safety and Health for the Nuclear Reactor and Isotopes, meeting notes, April 3, 1955 File "Correspondence, Meeting Minutes, Reports, July –December 1954 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[498] Terrill is mentioned in Eisenbud, *Environmental Odyssey,* 150. Charles Smallwood, Jr., Committee on Safety and Health for the Nuclear Reactor and Isotopes, Minutes of Meeting, December 15, 1954, File

and Health meeting minutes, was considered such a model that the NCSU staff were invited by Willard Libby to participate in the 1955 Peaceful Uses of Atomic Energy Conference to be held in Geneva.[499]

How to decide when something was dangerous proved to be a subjective matter, and decided more by authority than expertise. There were growing efforts by radiation specialists to articulate more strict safety regulations on campus, but they were overruled as ignorant worries by Beck, the expert in research reactor operations. When a decision was made to operate the "Temple of the Atom" at even higher power levels, after Beck stated he had AEC permission to do so, the former RSO Dr. Newton Underwood was very alarmed. Underwood (who had been blamed for the polonium incident and then removed from the Safety and Health committee) contacted Dr. Pike, the director of the Safety and Health committee to explain he was very concerned about the possibility of a reactor accident or worse.

Underwood, a physicist himself and radiation safety instructor, maintained that the reactor should be thoroughly checked and reviewed in total. His specific concerns were a lack of area and effluent monitoring, classes being conducted in the reactor's Observation room with no dosimeters or film badges for students, and a technical issue of danger due to the possible malfunctioning of the sheathing on the safety rods. Underwood knew he would continue to be maligned and scapegoated for his concerns. Yet, in the winter of 1954, Underwood felt he had no alternative except to speak out. He felt the health and safety of the students and the community should be considered first, above the

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"Correspondence, Meeting Minutes, Reports, July –December 1954 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[499] Charles Smallwood, Jr., Committee on Safety and Health for the Nuclear Reactor and Isotopes, Minutes of Meeting, March 2, 1955, File "Correspondence, Meeting Minutes, Reports, July –December 1954 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

value of any risky experimentation in what he considered an already compromised reactor, located in the heart of campus.[500]

Rather than address the concerns, Beck called into question Underwood's judgment, knowledge and character in his correspondence to the health and safety committee.[501] Yet, Underwood's caution might have been quite well founded. A few incidents had occurred before and after his concerns were voiced: three classrooms became contaminated; an accident melted uranium; unknown radioactive leakage from the reactor occurred several times; repairs were needed on the reactor vacuum system; the off-gas system was found to be inadequate "to hold radioactive gases" and that had to be repaired.[502] But on May 4, 1955, the reactor core lost its vacuum again, with a failure in the off gas system and radioactive leaks. By May 6, the "Temple of the Atom" completely "broke down." [503] By May 13, the reactor room was sealed off to anyone, but it was assumed the leak in the reactor, which could be from something as simple as failed weld, would be eventually easily repaired. [504] Safety and Health Committee members had

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[500] Underwood to Pike, December 17, 1954, File "Correspondence, Meeting Minutes, Reports, July – December 1954 and papers out of sequence Underwood to Pike, December 26, 1954 File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[501] Beck to Pike, December 10, 1954, Underwood to Pike, December 5, 1954, File "Correspondence, Meeting Minutes, Reports, July –December 1954" Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[502] David Lintz, RSO to Safety and Health Committee, undated, "Report on Recombiner and Off-gas System of Raliegh Research Reactor" File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955; David Lintz, RSO to Safety and Health Committee "Investigation of Accidental Uranium Melt" July 30, 1954, RSO to Safety and Health Committee, April 21, 1955, Pike to Deam Lampe, 24 February 1955 (out of sequence in file) File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[503] David Lintz, RSO to Health and Safety Committee, Weekly Report, and David Lintz, RSO to Safety and Health Committee, undated, "Report on Recombiner and Off-gas System of Raleigh Research Reactor" File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955; File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[504] Four days later, Beck was asked to produce the permission from Roth at the AEC to operate the reactor at above 1 KW level but it looks as though he explained this had been a phone call, David Lintz,, RSO to

been assured repeatedly, informally and formally, by Beck that the problem was not serious, just a matter of normal issues in reactor operations.[505]

None of these challenges was to distract from the welcoming of the new nuclear age. The ceremonies to dedicate the "Raleigh Research Reactor" and the building that housed it, dedicated as "Burlington Nuclear Laboratories" occurred as planned on May 23, 1955. The event was undisturbed by the increased radiation from a release of diluted gases twenty- four hours before the ceremony.[506] More diluted releases containing Xenon-133 and Iodine-131 occurred in June over a three day period. The releases were not really worrisome, as the levels were "far below the tolerance level" recommended by the NCRP.[507] However, the committee noted to Beck "this is an operation with a hazard not encountered before."[508]

For Beck, the accident was a learning opportunity, and just another aspect of a discovery, maybe unintended, but above all, an ongoing experiment. To him, it did not so much qualify as an accident. In fact, the reactor incident proved to Beck the resiliency of the "Safety Envelope" incorporated into the design of the reactor to contain what was eventually a uranium fuel leak from the core as well the gas leaks. "It worked precisely as

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Pike May 13, 1955, File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[505] Pike to Beck, May 17, 1955 File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[506] Beck to Health and Safety Committee, June 10, 1955 File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[507] Pike to Beck, June 18, 1955 and RSO to Heath and Safety Committee, Weekly Report, May 23-27, 1955 File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

[508] Pike to Beck, June 18, 1955 File "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

intended." [509] The damaged core itself was providing even more learning opportunities: protocols were invented on how to remove the core. Assistance was provided by Dr. F.W. Gilbert, Manager of Reactor Operations at Chalk River, who had worked on decontamination after the first large scale thermal reactor core was destroyed in 1952. The Chalk River accident built not only expertise, but in Gilbert's case, even cachet.[510] In addition, the core itself would be an object of study, sent to Oak Ridge to be analyzed. Even how the accident was responded to by his colleagues would all inform Beck[511].

By June, the radiation level of the Raleigh reactor was only three times background, and Beck celebrated that the reactor core was removed, placed in a lead shipping container and transported to Oak Ridge for study.[512] It has become a familiar refrain for public relations aspects of nuclear accidents, to focus on what did, in fact, work. And in the end, this is not at all surprising. Beck would go on to present his paper on the Raleigh Research Reactor as a model of modern nuclear education at the Geneva Conference in 1955. But his position at NCSU became untenable as trust in him among his colleagues and the Safety and Health Committee all but evaporated. He resigned his position at NCSU by March of 1956, only to go on to much more influential work

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[509] Beck to Herman M. Roth, (AEC) June 10, 1955 "Evidences of a leak in Gas System of the Raleigh Research Reactor; Plans for Repair" "Correspondence, Meeting Minutes, Reports, Policy Documents" Jan-June 1955 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.
[510] Gilbert's letter to Beck July 12, 1955 after the visit with the findings of how to deal with the reactor meltdown is posted on line at the NCSU Special Collections, accessed April 25, 2014, https://www.lib.ncsu.edu/specialcollections/digital/text/engineering/reactor/DONRleak071255.html. Gilbert was so busy with his social engagements and lectures, that he had trouble meeting with the Safety and Health Committee during his visit to NCSU. July 5, 1955 Safety and Health Meeting Minutes "Correspondence Meeting Minutes, Reports, Jul-Aug 1955" Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006 Box 2, NCSU. For more about the Chalk River incident of 1952, see William G. Cross, "The Chalk River Accident of 1952" Atomic Energy of Canada Limited, accessed April 25, 2014, http://www.nuclearfaq.ca/The_CR_Accident_in_1952_WG_Cross1980.pdf.
[511] See all of File "Correspondence Meeting Minutes, Reports, Jan-March1956" Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006 Box 2, NCSU.
[512]"Safety and Health Committee Meeting" June 3, 1955 File "Contracts, Meeting Minutes, Reports, Correspondence, (1 of 2)" 1953- 54 Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU.

regulating nuclear hazards. He was hired by the AEC and went on to become Chief of the AEC Hazards Evaluation Branch, rising to AEC Deputy Director of Regulation and later acting as an NRC liaison to the EPA.[513]

While it is not unusual for new technologies to initially frustrate and disappoint, as other early reactors did at Atoms for Peace locations, the crucial aspect of this history is the emphasis on the experiment at the expense of radiation contamination concerns. Those scientists who sought to preemptively prevent harm were unable to do so. This story shows the exclusion of concerns of the non-reactor experts, even among scientists. Underwood had initially believed in the "Temple of the Atom" and he wanted only to be reassured of its safety. However, he was not accorded the power to actually protect the public. The emerging reactor expertise invented along with nuclear science also allowed for the AEC to support its own, like Beck.[514] At their wits' end, frustrated by their inability to control the reactor program, the Physics department considered eliminating the reactor and the nuclear program entirely. However, this would have harmed North Carolina's goals for energy independence and their reputation, with their school now so highly enmeshed with the modern reactor. They hesitated. Eventually the committee invited the only man they felt they trusted, Karl Z. Morgan, who grew up in North Carolina, to help. Morgan, as head of the health physics section at Oak Ridge, had a reputation as an honest and reliable health physicist among the faculty. He, with two other consultants, advised that the reactor should be replaced. The new reactor should be

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[513] Safety and Health Meeting Minutes March 29, 1956 and all of File "Correspondence Meeting Minutes, Reports, Jan-March1956" Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006 Box 2 , NCSU; David Okrent, *Nuclear Reactor Safety: On the History of the Regulatory Process,* (Madison: The University of Wisconsin Press, 1981) 14, 118; Walker, *Permissible Dose,* 70; NRC, "A Short History of Nuclear Regulation, 1946-1999," accessed April 25, 2014, http://www.nrc.gov/about-nrc/short-history.html.

[514] This invention of a new class of expertise is explored in a philosophical manner by Hacking, *Historical Ontology*, see especially 76-81.

under the control of one physics professor, working closely with the new reactor manufacturer, Babcock and Wilcox to ensure the safety of the reactor operations. The Nuclear Engineering program should also continue, but with more versatility under a committee of both physics and the Department of Engineering. This would free the Physics Department to return to research and teaching in pure physics. The nuclear program should soldier on. And it did.[515]

The Science

The data of radiation health safety was primarily directed at making standards. . Three approaches evolved to make internal radiation exposure limits: direct, indirect, and computational.[516] The direct approach was accomplished by relying initially on top secret data on humans. Later this data was subsumed into what is called a mixed approach or indirect approach. This meant using results of animal experiments, such as Miriam Finkel's experiments on mice, to collate with human experience, or establishing toxicity ratios by comparing beagles and humans. All of these methods used many assumptions to calculate the most reasonable expectations of exposures, due to the overwhelming complexities of the task. In later years, a computational approach embedded the experimental data in calculated exposure limits for the hundreds of radionuclides and their possible effect on individual organs. [517]

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[515] The program is very successful and still home to a reactor, in the center of campus. See especially K.Z. Morgan, D.J. Zaffarano and D.R. Hamilton "Report of the Nuclear Engineering Consultant Committee on the Visit to the School of Engineering, NCSU" May 3-5, 1956 in File "Correspondence Meeting Minutes, Reports, Jan-March1956" Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006 Box 2, NCSU Libraries; Hamblin, *Poison in the Well,* 15.
[516] Stannard, "Radiation Protection and the Internal Emitter Saga" 14. Numerous studies on beagles and other animals were conducted for these purposes by MED, the AEC and others and the papers are collated in J. Newell Stannard, *Radioactivity and Health: A History* (Springfield, Va: Batelle Memorial Institute, 1988).
[517] Stannard, "Radiation Protection and the Internal Emitter Saga," 14-20. It is important to note the Finkel's mice research was disputed by Linus Pauling who found her study lacking in scientific rigor.

Radiation protection was an indeterminate science, but respected often as fact, by international agency experts who spread radiation standards. The circulation of this science in specific places and times shows the pragmatic judgments involved in the practice of radiation health safety. These scientists influenced the outcomes of radiation protection by their reliance on AEC studies. For just one example, the World Health Organization conducted what looked like an independent assessment of radiation danger in 1959. The committee however, was composed of familiar names from earlier secret AEC studies, such as John Bugher and James V. Neel. Neel, a geneticist who was a part of the Atomic Bomb Casualty Commission, chaired the perceived independent panel of WHO experts from around the world. Not only were these "independent" studies reliant on Project Sunshine studies, but this data was used to bolster foundational arguments and estimates of the original calculation of naturally occurring background radiation.[518] These measurements were not re-evaluated in the light of their inherent bias. They fit the description of "black boxed" facts, obscuring the choices and biases that constructed them.[519] These studies were constructed secretly by Willard Libby and AEC scientists using the unwitting data of uninformed colleagues to military ends and were intended to study fallout. But the independent WHO study simply reproduced the tables, data and conclusions from these earlier studies, whose origins were far from disinterested. These

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[518] First Report of the Expert Committee on Radiation, "Effect of Radiation on Human Heredity: Investigations of Areas of High Natural Radiation" World Health Organization Technical Report Series No. 166, (Geneva: WHO, 1959); Willard Libby, "Radiostrontium Fallout: Project Sunshine" July 1956 (WASH-406 rev. deleted version) Human Studies Project Team, Los Alamos National Laboratory April 29, 1994. This document asserts that "palliative measures may prove effective' against radiation contamination. Libby had been researching how "milk could be purified for radio strontium by a treatment which may well prove to be quite practical and inexpensive." Much more significant information to researchers on the topic of contamination is contained in this study, including the prediction that Sr90 radioactivity from the Castle (it is unclear if this refers to the whole series of the Bravo shot) would peak in the soil in 1970 and that "natural weathering processes" would remove Sr90 from soils so plants would not assimilate it. The use of these AEC studies and how they applied to radiation safety standards construction is problematic.

[519] Latour, and Woolgar, *Laboratory Life*.

AEC studies were partly instigated to convincingly reassure the public about fallout danger. Several charts and facts used in Annex B of the 1959 study to explain the findings on naturally occurring background radiation from cosmic rays and uranium in soils are sourced (footnotes 22, 31, 37, and 13) from Sunshine investigators. Willard Libby is cited twice, including his seminal 1955 paper on background radiation from cosmic rays that is repeatedly used in studies without question or qualification of the potential biases in his work. Merrill Eisenbud's research (Manager of the AEC's New York Operations Office during the Sunshine Project) is also used.[520]

NAS members who investigated health physics and radiation effects included mostly AEC trained and militarily embedded scientists. This leadership, in official and unofficial capacities was dominated by notable Manhattan Project, OSRD and AEC related scientists such as Vannevar Bush, Detlev W. Bronk, James B. Conant with access to classified information. The NAS Biological Effects for Atomic Radiation (BEAR) study, even though not funded by the AEC but by the Rockefeller Foundation, was still manipulated by the agency. The 1956 study was intended to reconcile differing points of view about fallout, but served to hide much of the scientific disagreement on radiation dangers. The AEC maneuvered the parameters of the study, the press, and even the interpretation of the study in ways that hid their involvement. No study would be considered more objective nor have more impact on nuclear policy.[521] Less notable NAS

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[520] First Report of the Expert Committee on Radiation, "Effect of Radiation on Human Heredity: Investigations of Areas of High Natural Radiation" World Health Organization Technical Report Series No. 166, (Geneva: WHO 1959); Libby, "Radiostrontium Fallout: Project Sunshine" July 1956 (WASH-406 rev. deleted version) Human Studies Project Team, Los Alamos National Laboratory, April 29, 1994.

[521] Files Org:NAS "Coms on BEAR: Beginning of Program" 1954-1955, File Org: NAS "Comments & Inquiries" 1955-56, 57, 1959- 1960, and C&B: Coms on BEAR "Pathologic: Subcommittee on Inhalation Hazards," National Academy of Science, Washington DC. For more on the import and history of the NAS BEAR study, and the relationship with the AEC, Hamblin, "'A Dispassionate and Objective Effort:'

health physics scientists also directed committees and refined science according to the US security and national interests.

Merril Eisenbud, of HASL, traveled often to promote Atoms for Peace and to support European and Asian countries developing peaceful nuclear programs. In this capacity, Eisenbud shared methods of collecting fallout data “as well as the public health significance of the data.” Ironically, even in countries concerned about fallout, the AEC scientists charged with promoting nuclear technology were also the ones trusted to explain the meaning and risks of the fallout.[522] Eisenbud traveled in 1950 to Japan as an NAS member to assess whether the long term NAS Atomic Bomb Casualty Commission (ABCC) studies of Hiroshima and Nagasaki victims should continue.[523] Originally funded by the AEC, these studies were investments in the control of radiation health safety science itself. Eisenbud recounted the political reasoning by the Generals Douglas MacArthur and Crawford Sams: if the ABCC studies were terminated “it would create a scientific vacuum into which investigators of uncertain scientific credibility would be drawn.” In addition, the assumption that the present committee was unbiased was unquestioned. Scientists who did not belong to NAS and were not aligned with the AEC “might be so influenced by political factors as to affect their scientific objectivity.”[524]

Another way to spread the AEC’s version of an objective radiation safety science was by sending trained technical experts around the globe. The focus of radiation experts

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Negotiating the First Study on the Biological Effects of Atomic Radiation” *Journal of the History of Biology* 40 (2007): 147-77.

[522] Eisenbud, *An Environmental Odyssey,* 121.

[523] For in depth histories of the ABCC see Susan M. Lindee, *Suffering Made Real*: *American Science and the Survivors at Hiroshima* (Chicago: The University of Chicago Press, 1994) and John Beatty, “Genetics in the Atomic Age: The Atomic Bomb Causality Commission, 1946-1956” in *The Expansion of American Biology*, eds., K. B. Benson, J. Maienschein, and R. Rainger (New Brunswick: Rutgers University Press, 1991): 284-324.

[524] Merril Eisenbud, *An Environmental Odyssey,* 110-3, quotation on 112.

dispersed world wide by the IAEA shows the main concerns of health physicists were to establish AEC safety regimes and practices. These regimes were focused on a laboratory focused role that predominantly measured but did not necessarily prevent contamination. These experts served a promotional public relations purpose that excluded the need for other types of investigations into radiation health safety.

The IAEA's efforts to meet requests for technical experts and to standardize national programs of radiation health safety were slow initially but by the early 60s became much more organized. R.A. Borthwick was among thirty IAEA technical nuclear and raw materials experts sent to twenty countries after 1961, and among six scientists whose expertise was in health physics. These IAEA experts predominantly assisted on a national scale, working through national atomic agencies. Health physics experts were sent from 1961 to 1963 to the United Arab Republic (Egypt), Iraq, Israel, Thailand, Ghana, Iran, Greece and the Philippines.[525]

These radiation safety experts were involved in the problems of inconsistent dosimetry, calibration of instruments, and the crafting of legislation for their host country to standardize regulations for radiation safety.[526] In addition, the experts established programs, monitoring stations and techniques such as a film badge service. They taught laboratory decontamination techniques, began early criteria planning for future reactor sites, and sometimes organized teams of gifted researchers to spark interest in health

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[525] IAEA, "Technical Assistance for Radiation Protection: Work of Some IAEA Experts in Health Physics," 1963, 33-6, accessed May 13, 2014, http://www.iaea.org/Publications/Magazines/Bulletin/Bull053/05305303336.pdf.
[526] Hanson Blatz, "Assignment Report on the Development of Radiological Protection Services in Thailand, April 1963" SEA/Rad/13. 26.6. 63 Restricted Radiation-Thailand D63.1360, 2-7, WHO Archives, Geneva; IAEA, "Technical Assistance for Radiation Protection," 33-6.

physics questions, such as the need for ventilation studies.[527] In sum, they whole heartedly prepared their host country for the new vistas of nuclear energy.[528]

One example of an expert that circulated science is R.A. Borthwick, who had established the radiation health safety program in Thailand in 1963 (mentioned previously in chapter 3). Borthwick also served in the Philippines in 1962 during the construction of the first Philippine research reactor. Originally from New Zealand, he established a nationwide radiation badge service to include hospitals, and he compiled a safety manual. Like other radiation health safety experts, Borthwick helped to craft national legislation. He redefined the terminology in legislation that concerned maximum permissible dose for the Philippines, making the rules less stringent.[529] Borthwick, like many of the experts, served not only one agency but several. He was deeply involved with legislation and regulations of radiation as a WHO expert as well, serving to align radiation safety with western norms in Pakistan and Nigeria.[530] The project of radiation safety legislation relied predominantly on western ideas of safety, measure and evaluation. A bureaucratic network of universities, agencies, technical experts and national commissions, originally facilitated by the US AEC and then the UN AEC, streamlined correspondence with the AEC. The AEC worked through international UN agencies to spread nuclear technical expertise with the help of the IAEA, UNESCO and WHO. This

[527] IAEA, "Technical Assistance for Radiation Protection" 34.
[528] "Technical Expert Reports" AG 8, WHO Archives, Geneva.
[529] Borthwick to Larsson, May 21, 1964 and R. Lowry Dobson to Borthwick, June 27, 1960 A 14/288/2 Jacket 1 "National Legislation for Protection Against Radiations" AG 8 WHO Archives, Geneva NSF grant #1151670 IAEA, "Technical Assistance for Radiation Protection" 35-6; Blatz, "Assignment Report on the Development of Radiological Protection Services in Thailand," 2-7, AG 8 WHO Archives.
[530] Borthwick to Larsson, May 21, 1964 and R. Lowry Dobson to Borthwick, June 27, 1960 A 14/288/2 Jacket 1 "National Legislation for Protection Against Radiations" AG 8 WHO Archives, Geneva.

created an international network that would spread nuclear science and radiation safety through conferences, meetings, training and education.[531]

Conclusion

The spread of nuclear science could not have occurred without a coordinated bureaucracy to support it, or the cheap labor of uranium miners and the use of the landscape as a reservoir. Only one of these contributing factors is, as Hecht asserts, the separation of actual radiation effects from the sociopolitical framing of what is considered nuclear. Radiation exposure disparity was aggravated by the clear isolation of nuclear chain activities such as divisions between industrial processes and laboratory worlds, to allow the disproportionate exposure to nuclear pollution by indigenous people.[532] In retrospect, the real cause may have much more to do with the experimentation that precluded human rights as a whole and how we define a scientific experiment, or even an accident. The operators of the "Temple of the Atom" were proud that during the first year of the reactor operations, they had been in compliance with standards at the time: no one had been exposed to more than 300 millirems a week.[533] Yet, this idea of providing safety obscures so much. The standard by 1959 was lowered to 50 mr per week. [534] The Raleigh Research Reactor was an experiment in and of itself with unwitting students and faculty involved. The destroyed reactor was an opportunity for the

[531] See chapter 1 for information on UNAEC, in AHLP LP Peace, United Nations Atomic Energy Commission, 1945-1956 Box 3.018 Folder 8.6 "The International Atomic Energy Agency, by International Review Service, January, 1957" This requires additional study but is my conclusions from the documents held in multiple archives of the IAEA, WHO, UNESCO, ILO and AEC documents in NARA II.
[532] Gabrielle Hecht, *Being Nuclear.*
[533] F. Phillips Pike to Phillip M. Frazier (AEC) June 16, 1954, File "Contracts, Meeting Minutes, Report Correspondence 1953-4" (2 of 2) Box NCSU, Committees, Radiation Committee Safety Records, UA 022.006, Box 1, NCSU..
[534] Wang to Gleeson, June 23, 1959 RG 62, SCARC.

protagonist, Clifford Beck, to learn more and gain more reactor expertise, to even take it apart. For him, the only crisis at NCSU was the trivial focus on safety.

Even in a laboratory, safety is an arbitrary and subjective matter. Safety has likely never been an isolated scientific question. Who decides? Who has the power? Are not the observations of the Navajoland uranium miners who were studied, experimented on, but not treated nor informed by the PHS, actually correct? What became of those NCSU students, walking to and from class, breathing escaping fission products, between 1953 and 1955? Or of the radium dial painters, their bodies used as test subjects when they believed they were being treated The data from the miners and the other victims of nuclear technology, such as the Hiroshima and Nagasaki survivors are now "black boxed" facts. [535] The basis of the human experimental data was very limited with small sample sizes and funded by the military and later, the AEC.[536] Much of this research was completed under the duress of needing to establish safety limits for the growing nuclear work force during the Manhattan Project and later the Cold War. In 1947 alone, over $5 million was allocated by the AEC for radiation research (and $1.1 million annually for fellowships to do radiation research). With so much funding, three entire hospitals were established under the direction of Shields Warren of the AEC. A profusion of secret

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[535] As Maria Rentetzi asks, were these women not made into experimental objects without consent? Maria Rentetzi "The Women Dail Painters as Experimental Subjects (1920-1990) Or What Counts as Human Experimentation" *N.T.M.* 12, (2004): 233-48.

[536] Walker, *Permissible Dose*; Taylor, *CRC Radiation Protection Standards* (Cleveland, Ohio: Chemical Rubber Company Press, 1971) and Taylor, "Some Non-Scientific Influences on Radiation Protection Standards and Practice" *Health Physics,* 32 (1980): 851-74 and Taylor, *X-Ray Measurements and Protection 1913 – 1964: The Role of the National Bureau of Standards and the National Radiological Organizations*, National Bureau of Standards, Special Publication 625, Library of Congress Catalogue Number 81-600158, US Department of Commerce, December 1981.

experiments took place, enough to later generate a paper trail of 3.3 million documents.[537] However, the ongoing integration of the data from military directed and AEC funded studies into the calculations of safety standards creates not only questions of ethics, but of the quality and utility of using data from such uncertain and tainted science.[538] Yet one can also see the "technical experts" pursuing what they believe will be a bright and healthy future for their host countries.

No matter how far radiation protection travels, one can see the standardization and "black boxed" data, that mark it still as "a typically American story." Looking back at the history of the construction and implementation of radiation safety science, it appears as if the world became an experimental playground, without boundaries, for both radiation and science.[539] How the fundamental right to integrity of one's body has been subsumed to the nuclear project is the recurring question when one looks into the details of this history. In these three examples, the rocks, the reactors and the science one sees the dystopian reality of the circulation of radiation health safety science in specific places and times and the price of exclusion of the precautionary principle. Yet for the sake of the experiment, it was a risk many took, without asking.

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[537] See US Department of Energy, "Spotlight on Human Radiation Experiments" accessed April 25, 2014, https://www.osti.gov/opennet/spotlight.jsp; Welsome, *The Plutonium Files,* 208-9; Stannard, "Radiation Protection and the Internal Emitter Saga."

[538] Welsome, *The Plutonium Files.* The ramifications of using tainted data are discussed in Paul A. Lombardo, "Eugenics, Medical Education, and the Public Health Service: Another Perspective on the Tuskegee Syphilis Experiment," *Bulletin of the History of Medicine* 80 no. 2 (2006): 291-316; Sharon R. Kaufman, "The World War II Plutonium Experiments: Contested Stories and Their Lessons for Medical Research and Informed Consent," *Culture, Medicine and Psychiatry* 21 no. 2 (1997): 161-197; David Bogod, "The Nazi Hypothermia Experiments: Forbidden Data?" *Anaesthesia* 59 (2004): 1155-1159; Jing-Bao Nie, "The United States Cover-up of Japanese Wartime Medical Atrocities: Complicity Committed in the National Interest and Two Proposals for Contemporary Action," *The American Journal of Bioethics* 6 no. 3 (2006): W21-W33.

[539] Hamblin in *Arming Mother Nature* argues that nuclear weapons opened the door to the entirety of the earth being militarized for total war.

Chapter 5 the Deciders: Nuclear Science at Oregon State

"We are constantly being told about 'a permissible amount of radiation.' Who permitted it? Who has any right to permit it?" Dr. Albert Schweitzer[540]

This chapter makes visible some of the academic relationships and infrastructure that gave the Atomic Energy Commission (AEC) decision making power.[541] The power of the AEC allowed nuclear technology and science to infringe on democracy and human rights almost as imperceptibly as radiation exposure itself. Academic science is often taken for granted as objective and independent of the government.[542] How did nuclear science, with all its risks and connections to nuclear weapons, become so embraced by so many academics?

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540 Albert Schweitzer, *Peace or Atomic War?* (New York: HenryHolt and Company, 1958), 14.

541 For an overview of the relationship of the university to science see Roger L. Geiger, "Science, Universities, and National Defense, 1945-1970" in "Science after '40" *Osiris,* 2nd Series, 7 (1992):26-48. The Manhattan Project transferred to the control of the AEC on January 1, 1947. The twelve facilities that made the first nuclear bombs were transferred from the military to civilian control after the war. This effort to create a civilian agency to oversee and non-militarize the benefits of nuclear power was primarily led by former Manhattan Project scientists, see Donald A. Strickland, *Scientists in Politics: The Atomic Scientist Movement, 1945-1946* (Purdue: Purdue University Studies, 1968); Lawrence S. Wittner, *Confronting the Bomb: A Short History of the World Nuclear Disarmament Movement* (Stanford: Stanford University Press, 2009) especially 1-8; Andrew Brown, *Keeper of the Nuclear Conscience: The Life and Work of Joseph Rotblat* (Oxford: Oxford University Press, 2012); Thomas Hagar, *Force of Nature: The Life of Linus Pauling* (New York: Simon and Schuster, 1998); See also "Atomic Energy: Early Legislative History and the Struggle for International Control" in the History of Atomic Energy Collection, 1896-1991, Special Collections and Archives Research Center (SCARC) Corvallis, Oregon, which contains the early efforts of former Manhattan scientists to ban the bomb and have a civilian control of the weapon. For an especially vivid record of this work, see clippings in Box 3.012 Emergency Committee of Atomic Scientists File 12. 5 "Non-Pauling typescript, Newspaper Clippings, Publicity Clippings 1946-1948," LP Peace, Ava Helen Linus Pauling Papers (AHLPP), SCARC; "Angela Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago: University of Chicago Press, 2013) 2. Of the five rotating presidentially appointed AEC commissioners that directed the agency over the years, most were involved with the nuclear industry, or lawyers, agency directors, politicians and physical scientists.

542 To learn more about the infrastructure of the connections during WW II between academia, the military, government, and industry by how it was debated, see Daniel Kevles, "The National Science Foundation and the Debate over Postwar Research Policy 1942-1945: A Political Interpretation of *Science- The Endless Frontier*," in *The Scientific Enterprise in America: Readings from Isis*, eds., Charles Rosenberg and Ronald E. Numbers, (Chicago: The University of Chicago Press, 1996) 297-321; J. E. Hodgetts, *Administering the Atom for Peace* (New York: Atherton Press, 1964); Richard Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953-1961* (Berkeley: University of California Press).

Many books and articles discuss the rapid expansion and funding of nuclear science on college campuses. These often show the importance of infrastructure in the nuclear age, and a case study of a medium sized university campus can tease out the details to answer the question. This chapter shows how the AEC institutionalized such a new, expensive and risky science.[543] Using a localized point of view on the campus of Oregon State College (and after 1961, Oregon State University), one can also see how faculty were recruited and assimilated into the AEC.[544]

Academics rallied nuclear support, locally and globally. The practices of universities, governmental agencies, and industries in their embrace of the benefits of nuclear technology hid many of the consequences of radiation exposure in the midst of the pursuit of shared nuclear utopian hopes. Just as in the first radioactive age, fear and public health failures did not inhibit the robust expansion of nuclear technology.[545] Even on a campus, nuclear expansion continued uninterrupted despite cautionary warnings, even from enthusiastic college faculty scientists. This was partly because of the reassurance of assertive and persuasive scientists armed with AEC designed systems that gave the appearance of control of any risks from radiation. It was also because the applications of nuclear science served as a long term investment into fields as diverse as agriculture and criminology.[546] As the AEC shaped the fields of medicine, biology,

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[543] Creager, *Life Atomic,* 9; Charles V. Kidd, *American Universities and Federal Research* (Cambridge: Belknap Press of Harvard University Press, 1959); Stuart W. Leslie, *The Cold War and American Science: The Military Industrial Academic Complex at MIT and Stanford* (New York: Columbia University Press 1993); Peter J. Westwick, *The National Labs: Science in an American System, 1947-1974* (Cambridge: Harvard University Press, 2003).
[544] Oregon State College became Oregon State University in 1961, the same year James H. Jensen became President of the University.
[545] Lavine, *The First Atomic Age.*
[546] Ironically, an understanding of the earth's processes were also being exposed by radioactive tracers as the public came to appreciate the amount of degradation of the environment, also due to the AEC, see Walker, *Permissible Dose*: *A History of Radiation Protection in the Twentieth Century* (Berkeley:

agriculture, physics and engineering, AEC expertise also cast ideas of how contamination was understood and how it would be surveyed, analyzed, and interpreted for the public.[547]

One specific example of the networks built by the AEC that cultivated the spread of nuclear science is illustrated by Oregon State from 1944 to the 1960s. The AEC connected with individuals like James H. Jensen, who would rise to become college president and then cultivate Oregon State College into a research university. By looking at the genesis and history of a medium sized nuclear program such as what became Oregon State University, one can see that an early relationship with the AEC built careers, expertise and even the university itself. A network of who would be entitled to decide what path was taken to the future, and what rights to accord, developed in the strong relationships between the AEC, government, nuclear industry, military and academia while instituting nuclear programs and research reactors.

In the Heart of the Atomic West

The nuclear history of Oregon State is less visible, but no less influential, than its agricultural contributions as a land grant college. The school was founded as a small private college, but incorporated as a state land grant college in 1868 in Corvallis, Oregon.[548] During the Second World War, the Pacific Northwest was the home of

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University of California Press, 2000); Ronald Doel, "Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA After 1945" *Social Studies of Science* 33 no. 5 (2003): 635-666; Hamblin, *Arming Mother Nature;* Creager, *Atomic Life.*

[547] Creager, *Life Atomic,* 7-8; J. Samuel Walker, "The Atomic Energy Commission and the Politics of Radiation Protection, 1967-1971" *Isis* 85, no. 1 (1994): 57- 76; J. Samuel Walker, *The Road to Yucca Mountain: The Development of Waste Policy in the United States* (Berkeley: University of California Press, 2009); J. Samuel Walker, and George T. Mazuzan. *Controlling the Atom: The Beginnings of Nuclear Regulation 1946-1962* (Berkeley: University of California Press, 1984); Walker, *Containing the Atom: Nuclear Regulation in a Changing Environment* 1963-1971 (Berkeley: University of California Press, 1992); Walker, *Permissible Dose.*

[548] The hope for scientific progress was expressed well by the title of the first commencement speech "The Utility of Science." The school was one of the first in the west to have agricultural courses and soon became thought of as the "West Point of the West" due to the large proportion of military students. A forward thinking physics professor in 1922 built the first fifty watt radio station in Oregon. The school was

plutonium production for nuclear weapons. Oregon, with its vast forests and salmon runs, was nestled downstream from the Hanford Works, in Washington State.[549] Close ties between the making of plutonium and the workforce to produce it linked Hanford and nearby research colleges, including Oregon State. The two facilities shared students, faculty, research projects, and training.[550] Oregon State became an example of a factory "of cerebral America" to train many of the engineers, technicians, and health physicists for nuclear weapons laboratories and commercial nuclear plants worldwide.[551]

Military connections between nuclear science and Oregon State were forged during WW II. In the United States the Office of Scientific Research and Development (OSRD), an alliance between corporations, academia and the military, began to

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forced to lay off many teachers during the depression, but rebounded after WW II because of the influx of veterans with their GI Bills, see Gary L. Beach, Elizabeth Nielson, Larry Landis, eds. Oregon State Special Collections and Archives Research Center "Chronological History of Oregon State University: 1870s, 1880s, 1920s, 1940s" accessed April 10, 2014, http://scarc.library.oregonstate.edu/chronology/chron_head.html. Oregon State University home page, "About" accessed April 25, 2014, http://oregonstate.edu/main/about.

[549] Construction of Hanford's B Reactor began in 1943 and the production of plutonium ended in 1989. This legacy of plutonium production for nuclear weapons resulted in one of the largest environmental cleanups in history. The impacts of Hanford on Oregon include radioactive releases from early operations as well as purposeful experiments that contaminated vast areas of Oregon south to Klamath Falls, as well as radioactive discharges into the Columbia River. A book that summarizes many of the environmental consequences is Max S. Power, *American Nuclear Wastelands* (Seattle: Washington State University Press, 2008). Also see Oregon Department of Energy, *Hanford Clean Up: The First Twenty Years* (Salem: Oregon DOE, 2009), i, accessed April 25, 2014, http://www.oregon.gov/energy/NUCSAF/docs/HanfordFirst20years.pdf.

[550] Chih Wang to Gleeson, July 16, 1962, "Pertinent Information for a Reactor Proposal to the NSF," 3, "Program Relation to Hanford Atomic Energy Works at Richland Wa." and "A Plan for the Coordination of Radiation Research at OSU" College of Engineering Records, 1930-2002, RG 62, Series V. Research 1942-96, Box 8, Series V. Research, File Atomic Energy Projects at OSU (Atomic Energy, General) 1of 3, 1958-1964, Special Collections and Archives Research Center, (SCARC), Corvallis, Oregon.

[551] For the national view, see Robert Seidel, "A Home for Big Science: The Atomic Energy Commission's Laboratory System" in *History Studies in the Physical and Biological Studies* 16:1 (1986):135-175 quotation on 135**;** See "Role of Engineering in Nuclear Energy Development" RG 62 College of Engineering Records 1930-2002, under Series XVIII US Government 1947-1971, Box 21, File Atomic Energy Commission, 1950-1956 and Series II Instruction Box 6 File Nuclear Engineering and Series V Research, 1942-1996 Boxes 8 and 9. Records are scattered throughout of Nuclear Engineering enrollment and job placement records showing the ongoing relationship between Hanford and the university, and records of the large amount of international students trained by OSU. The AEC required reports on enrollments as well, see Gleeson to Registrar's office, January 18, 1960, and Gleeson to Leighton Collins, January 22, 1960 RG 62, Series V. Research, Box 9, Nuclear Engineering Education (AEC) 1955-1958.

coordinate military applications of science from many academic disciplines in 1941 to expedite the building of the atom bomb.[552] This led to almost unlimited resources for scientists, and relationships that endured long after the war.[553] Richard Ray Dempster was hired to teach physics at OSU in 1944.[554] Dempster came to Oregon from the Berkeley Radiation Laboratory to train the physicists needed for the war effort. Dempster as a teacher was so valuable in his role that he "was not replaceable if he was drafted."[555] Another key faculty member, David B. Nicodemus, had been a part of OSRD as a graduate student. He had worked in the "Detector Group" of the Los Alamos scientists' experimental physics division and he helped build the chamber used in the Trinity test, which he witnessed at Alamogordo, New Mexico on July 16, 1945. He arrived at Oregon State five years later in 1950.[556]

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552 Vannevar Bush created OSRD under an executive order from President Roosevelt on June 28, 1941. The order gave Bush an exclusive position to influence military research decisions. Roosevelt trusted and endorsed Bush's conception of how to apply academic scientific research to the war effort. The OSRD incorporated the previous MAUD committee and superseded the National Defense Research Committee which served to consolidate the power of Bush. The authors argue the decision to build the bomb was made by Bush alone in 1941, see Stanley Goldberg "Inventing A Climate of Opinion: Vannevar Bush and the Decision to Build the Bomb" in *The Scientific Enterprise in America: Readings from Isis* eds., Ronald Numbers and Charles Rosenberg (Chicago: The University of Chicago Press, 1996), 273- 7.

553 Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942-1945: A Political Interpretation of Science- the Endless Frontier" in *The Scientific Enterprise in America: Readings from Isis* eds., Ronald Numbers and Charles Rosenberg (Chicago: The University of Chicago Press, 1996), 297-99.

554 Richard Ray Dempster Personnel File, SCARC. Dempster earned his Ph.D in Physics in 1942 at the University of California at Berkeley. He worked from 1943 until 1944 at the Berkeley Radiation Lab. He had earlier worked at the Naval Proving Ground from 1942 until 1943, in the Armor and Projectile Laboratory at Dahlgren, Virginia. Numerous documents refer to his reasons for needing to teach physics to civilian and Army Specialized Training Program Students, including "during wartime a physicist is hard to find." A copy of a Selective Service System Affidavit that was sent to the Oakland California Draft Board, that repeatedly tried to draft him, is in his file, undated.

555 Draft Board Notice, October 24, 1944 and October, 10, 1944 Weniger to Lemon, Selective Service System Affidavit, Dempster Personnel File, SCARC.

556 Nicodemus biographical file (K-P) and Rita Lyn Sanders, "OSU Dean Dies" *Corvallis Gazette Times* Obituary 6/22/99, 2 and "OSU College and the A Bomb" unsourced news article in his file, SCARC. One of the wartime OSRD projects had been coordinated by Hans Straub and 1952 Nobel Prize Laureate Felix Bloch, who employed graduate student David B. Nicodemus from 1942 to 1943 to measure the energy spectrum of uranium fission neutrons. Bloch's prize was based on a research Nicodemus contributed to. Nicodemus went to Los Alamos Lab in 1943 to 1946 and he returned as a consultant to the Los Alamos

The AEC recruited Oregon State faculty and administrators to participate in building a lasting infrastructure for nuclear science. The AEC required facilities to train a large pool of nuclear physicists and other scientists and Oregon State was nurtured by the AEC as a regional center of nuclear education five years before the genesis of the Atoms for Peace program. Shields Warren of the AEC Biology and Medicine Division wrote university President August Strand in early 1948 to invite Oregon State College to an AEC meeting in Washington, DC. The meeting resulted in the college becoming one of four envisioned regional nuclear education centers. The national goal of the AEC was to create at least two colleges in each region to continue the DOD training that had been located only at classified laboratories, and to encourage distribution of information to develop the science of radiation safety. The group working on accepting the AEC proposal decided the best way to proceed would be for Reed College, University of Oregon and Oregon State College to divide among them the expected post bachelor students (of an unknown number) and an initial 15 to 25 students with post graduate fellowships. They accepted the AEC invitation with the understanding that the AEC would provide the teachers if the Oregon institutions needed help.[557] The AEC wanted to train over 500 doctoral candidates and 375 post-doctoral candidates overall in the country. Basic research as well as specific training in radioisotope use was encouraged by

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Lab in 1956-57. Born in Kobe, Japan in 1916, Nicodemus came to Los Alamos from Stanford and went on to become a powerful administrator at Oregon State University. He died in Corvallis in 1999.

[557] Shields Warren AEC to President Strand, 1948, “Brief of Discussion” January 21, 1948, “meeting notes” Queen to Weniger, February 12, 1948, quote is from “Memorandum Meeting with Dr. Queen” January 6, 1948, Stand Presidents File, RG 13, subgroup 11, microfilm reel #156, Folder 209, File AEC, 1948-1969 and “Atomic Program to Include OSC in Research Job: Regional Personnel to Aid in Medical Biological Research.” October 15, 1948, *Barometer,* 1. A small faculty group had met in the library, January 6, 1948 to discuss this and included Butts, Dempster, Huston Logan, Weniger and Spitzer. Spitzer was later fired in 1949 by President Strand during the red scare. For more on Spitzer and the effects of anticommunism campaigns on campus see William Robbins, "The Academy in the Cold War: Oregon State College and the Ralph Spitzer Story," *Pacific Northwest Quarterly* (forthcoming).

generous AEC fellowships that would be offered. The fellowships were intended to train more people in the fields of health physics and biophysics specifically for radiation safety. [558] Radiation safety and nuclear education was understood by the AEC as essential to the civilian expansion of nuclear science.[559]

To nurture the expertise of Oregon State's professors, the AEC provided additional training at Brookhaven, Oak Ridge, Woods Hole and UCLA. [560] As previously stated, by the 1930s the use of radioisotopes as a medical treatment and tracers and research into their use had preceded the development of both nuclear weapons and nuclear reactors for energy.[561] Oak Ridge in particular had a dedicated reactor producing isotopes for the civilian isotope sharing program begun during the Manhattan Project. The radioisotope distribution program encouraged uses of radioisotopes as tracers and therapy in medicine, industry and academic research.[562] Not only tools of research and therapy, but of foreign policy, the program of distribution spread goodwill since 1946 as the peaceful side of the atom before the Atoms for Peace program.[563] Later, to teach about and promote radioisotopes, the AEC invited academics to summer training camps on "radioisotopes in biochemistry and protective measures against overdoses of radiation."[564] OSU Agricultural Chemistry Professor Joseph Butts with Professors Wayne Crews from physics and Lloyd West from chemistry attended the AEC 1948 month long

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[558] "Brief of Discussion," January 21, 1948, Stand President File, RG 13, subgroup 11, microfilm reel #156, Folder 209, File AEC, 1948-1969, SCARC.
[559] This is clear throughout the Office Files of David E. Lilienthal, Subject Files, 1946-1950, Box 1, Shelf IA, RG 326 AEC Records of the Office of the Chairman, NARA II College Park, MD; distribution of radioisotopes began near the one year anniversary of Hiroshima August 2, 1946 and was thought of as a peaceful promoter of nuclear science that used by products of nuclear development by scientists at Clinton Labs at Oak Ridge, see Creager, *Life Atomic,* especially 61, for this history.
[560] "Brief of Discussion" January 21, 1948, Strand Presidents File, SCARC.
[561] Creager, *Life Atomic,* 3 and Lavine, *The First Atomic Age.*
[562] Angela Creager *Life Atomic*, 2, 400-7.
[563] Ibid., 5-8.
[564] "Meeting notes" and Queen to Weniger February 12, 1948, quote is from "Memorandum Meeting with Dr. Queen," January 6, 1948, Strand President File, SCARC.

summer training camp at Oak Ridge, Tennessee, one of the original Manhattan Project atomic laboratories.[565] Crews and Butts also attended a month long training at Brookhaven Lab on Long Island, and W.R. Varner of the physics faculty spent a year's leave at General Electric working on the nuclear plant at Hanford.[566] Butts and Crews developed and arranged a successful OSC application to the AEC in 1948 for Fellowships in applications of biology and medicine that were offered by the AEC.

The AEC was in the business of education. In order to expand nuclear science rapidly and meet the AEC needs, the college reshaped its curricula. The AEC obligated the faculty to use its standardized programs and curriculum and to meet the AEC's goals.[567] Soon, Oregon State was selected as one of thirteen schools nationwide to be a part of the AEC's emerging biology and medical studies. A news article in the student newspaper attributed the success of the college in securing the fellowships to the expertise of faculty and to Oregon State's plans to install a cyclotron beginning in 1948.[568]

Nicodemus and the AEC would help Demptser and the Physics department build the first cyclotron in the state and kick start the early nuclear physics program.[569] The cyclotron was a particle accelerator that could create radioisotopes and a high energy

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565 Joseph S. Butts personnel file, SCARC. G.W. Gleeson to Leighton Collins, October 14, 1958, RG 62, Series V, Box 8, File AEC Summer Institure,1958-1968, shows other faculty, like physics professor Edward Daly in 1958 were trained as well at various AEC Summer Institutes held over the years. Other records also identify a Dr. Fan as trained at Oak Ridge and a Dr. Parks and an unnamed professor trained at Argonne. Research reactor manufacturers trained additional faculty as well.

566 "Cyclotron Arrives for Graduate Study" Beaver Yearbook, 1949, 184, University History, SCARC.

567 This continues into the 1960s the bulk of the letters to and from the AEC in both the Radiation Health and Nuclear Physics are what the AEC expects for regulations, content in the curriculum and curriculum development. E. Dale Trout, a radiation health safety specialist hired by OSU influences even international curriculum. See documents throughout AEC files in Series V. Box 8, RG 62 and in the Dale Trout's boxes, SCARC.

568 "Atomic Program to Include OSC in Research Job: Regional Personnel to Aid in Medical Biological Research," *The Daily Barometer,* October 15, 1948, 1

569 See a photo of the large cyclotron magnet being installed on campus at *How OSU Grew Nuclear Science,* accessed May 15, 2014, http://blogs.oregonstate.edu/nuclearhistory/the-cyclotron/ SCARC.

beam for experiments. It required huge magnets to create the velocities needed and the magnets were donated by the AEC. Made from fifty tons of steel, the magnets for the Oregon State College cyclotron were salvaged from a Manhattan Project magnet with the help of cyclotron inventor, E.O. Lawrence at Livermore Laboratory. The magnets arrived on a train flat car in November of 1948. With faculty, staff and student volunteers and a $5,000 grant from the National Research Council a building was built by 1952 to house the evolving cyclotron. The building had concrete walls thirty to forty eight inches thick to shield from the neutron generated radioactivity. The cyclotrons purpose, according to the 1949 *Beaver* Yearbook, was to fill an urgent need of the AEC for men trained in the nuclear field and to generate isotopes and experiments to understand nuclear physics.[570]

The equipment, AEC training, and enthusiasm gave the Oregon applicants an edge. Some of the experiments conducted at Oregon State College involved the use of radioisotopes as research tools and studies of isotope exchange reactions using radioactive sulfur. Agricultural studies into pesticides were conducted with radioactive "Carbon-14 labeled DDT and 2,4 D" by Professor Butts as well as research that examined the biosynthetic pathways of amino acids by Professor Chih H. Wang while working on his nuclear chemistry Ph.D.[571]

In these years, anti-Communism and loyalty became connected by the AEC to nuclear science. Ninety percent of the $1 billion of funding for all academic scientific

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[570] Larry Landis, "Oregon State Enters the Nuclear Age" (unpublished manuscript draft, SCARC, 2014); "Cyclotron arrives for Graduate Study" *Beaver* Yearbook, 1949, 184. The cyclotron took until 1956 to become operational.

[571] "The Chronological Development of the Radiation Center and Institute of Nuclear Science and Engineering" 1, (undated copy, but it ends in 1967) Memorabilia Collection, Box 135, File Radiation Center, and Chih Wang Personnel File, "Professional Vita," SCARC. Wang received his PHD in Nuclear Chemistry in 1950 and became an assistant professor in 1951, an associate professor at OSU in 1954, Professor in 1958, Director of the Radiation Center in 1962, and Director of the Institute of Nuclear Science and Engineering in 1964.

research and development in the year 1949 -1950 came from the U.S. Department of Defense (DOD) and the AEC.[572] This patronage was complemented by the declassification of once secret nuclear data to enable rapid civilian academic and industrial participation in the nuclear field. But by June of 1949, before it was even known that the Soviets had built a nuclear bomb, there were accusations of loose AEC security controls. This resulted in the demand that all AEC Fellows sign a loyalty oath as well as pass a FBI background security check. By August of 1949 AEC Fellowships were only given to those who could pass the FBI security clearance. This was interpreted by many in the atomic scientist movement who wanted to ban nuclear weapons as an attack on the civilian control of the AEC, especially by the scientists who had pushed for civilian control of nuclear science. The force for the formation of the AEC as a civilian agency had come from some former OSRD and nuclear scientists who also wanted international control of nuclear weapons. The accusations against the AEC included what would later be found to be a manufactured case of missing uranium from Argonne National Laboratory.[573] On campus, in this atmosphere, two Oregon State College professors were fired.[574] Yet, even with the political setbacks, by 1953 an academic (and industrial) research base was in place with the most loyal students.[575]

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[572] Daniel J. Kevles, "Foundations, Universities, and Trends in Support for the Physical and Biological Sciences, 1900-1992" *Daedalus* 121, no. 4, Immobile Democracy? (Fall, 1992), 195-235, statistics on 212-3.

[573] The loyalty oaths signed by Dempster, Nicodemus, Ender and Trout are retained in their Personnel files; "Congress and the Bomb: Attacks on Lilienthal held to show Secrecy is Mistaken for Security" *New York Times* May 26 1949, August 4, 1949 Memo on "O'Mahoney Amendment and Special Presidential Commission" and Federation of American Scientists meeting notes (Higginbotham's Memo to Associations on July 17, 1947) in File "United Nations Atomic Energy Commission, 1945 to 1946" LP Peace, 3.018.1, Ava Helen and Linus Pauling Papers (AHLPP) SCARC. Higginbotham writes in his memo about the AEC discrediting civilian control with the investigations into AEC Fellows, "Looks to be a long siege by the HUAC."

[574] Stand President File, 1949, RG 13, subgroup 11, microfilm reel #156, Folder 209, File AEC, 1948-1969 and personal communication from Donald Wells (a professor on campus at the time) January 2009. The two men were primarily fired for their association with the Progressive Party candidate for President Henry

Nuclear education on campus centered around equipment provided by the AEC. No less important was atomic scientist Nicodemus's ability to use it. In addition to the 37 inch cyclotron and an X-ray facility, by 1955 Oregon State College also offered a Ph.D. in nuclear engineering in cooperation with national military laboratories, working intimately with General Electric's Hanford Works and three other northwest colleges.[576] This offered students much needed experience with research reactors at both Hanford and Los Alamos in addition to the on-campus cyclotron.[577] The hybrid of industrial and academic education featured popular graduate classes taught at Oregon State College by Nicodemus in neutron physics. Also in 1955, Nicodemus's friend, mentor and Nobel Prize winner Felix Bloch became the Director General of CERN.[578] During the one year that Bloch ran the organization, he strongly influenced the development of the global

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Wallace. Wallace favored international control of nuclear weapons. Wallace had campaigned on the OSU campus and been supported by Ralph Spitzer, a former graduate student of Linus Pauling's, see Robbins, "The Academy in the Cold War" (forthcoming).

[575] Monsanto was particularly eager for nuclear information and quite disappointed with the slow pace, see Charles Allen Thomas of Monsanto Corporation to Lilienthal, September 6, 1949 and much of the following correspondence in File "Correspondence- Advisory Committee To Make Technical Information Available to Industry" RG 326 AEC Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1, Shelf IA, NARA II; Hewlett and Holl, *Atoms for Peace and War,* 252-6.

[576] RG 62, Series V. Research 1942-96, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) , 3 of 3, 1958-1964, and Box 9, File Nuclear Engineering Education (AEC) 1955-1958, and Series XII. Engineering Extension Services, 1944-1969, Box 16, Files General Electric and Atomic Energy Commission Graduate Program, 1950-1964, SCARC.

[577] Single purpose military laboratories such as Los Alamos, which until 1956 focused only on nuclear weapons, became available for unclassified and joint academic projects at that time, when the mission broadened to reactor development. "Brief of Discussion" January 21, 1948, Strand Presidents File, SCARC. The OSC PhD program required one year of graduate coursework at the OSC campus followed by graduate training leading to both Masters and PhD degrees at Los Alamos or at the Graduate School of Nuclear Engineering of the General Electric Co. at Richland, also known as the Hanford Works. See also see *How OSU Grew Nuclear Science: Gordon Little*, the on campus cyclotron also experienced operational problems that suggest further research. The cyclotron was eventually discarded in a shed on the outskirts of campus, according to Little was an RSO for the school after the cyclotron was no longer used.

[578] Bloch and his connection to the development of MRI technology and his role in CERN accessed April 10, 2014, http://cerncourier.com/cws/article/cern/28942 and his Nobel speech is "The Principle of Nuclear Induction" April 26, 2014, http://nobelprize.org/nobel_prizes/physics/laureates/1952/bloch-lecture.html. For more about CERN today see April 26, 2014, http://public.web.cern.ch/Public/Welcome.html. More history of CERN can be found in John Krige, ed., et al, *History of CERN: Building and Running the Laboratory* (Amsterdam: North-Holland Publishers, 1990).

Atoms for Peace program.[579] Through Nicodemus, Oregon was a part of an international and growing nuclear science community.

Students interested in nuclear physics were anchored to the armed forces and industry by their training. The most important skill training took place in contractor-operated military facilities. Military labs were the only place to excel in reactor physics. This male dominated culture left little, if any, space for female physicists. A majority of the 25 graduate students enrolled in 1956 who were affiliated with Oregon State College completed work at Hanford.[580] On the national level, that same year, more than 800 research projects were shared between academia, industry and the former and current weapons labs. A total of $100 million was spent by the AEC in 1956 on basic scientific research in metallurgy, physics, chemistry, cancer, medicine and biology.[581] Historians have argued this lavish funding served as a salve for the consciences of the AEC commissioners and military planners and a respite from planning for Armageddon.[582] However, the AEC still had a shortage, not of money, but of a specific type of expertise.

The AEC's needs altered what colleges offered to students. It changed the type of science that would be taught. Physics led to nuclear physics; radioisotopes were to be used in agriculture and environmental studies. This was because the AEC's need for

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[579] Maurice Jacob, *CERN: 25 Years of Physics*, Volume 4 (New York: North-Holland Publishing Company, 1981), 3 has a photograph of Felix Bloch laying the cornerstone for the laboratory site in Meyrin, Switzerland. Bloch did not like being an administrator, and missed time for his own research. Nicodemus had co-authored two papers with Bloch, who received the Nobel Prize for one of the papers. Nicodemus's letter of recommendation for Emeritus status in his personnel file said "His collaboration with Professor Bloch led to one of the classic papers in nuclear physics a precise quantitative determination of the magnetic moment of the free neutron by magnetic resonance."

[580] "The General Electric School of Nuclear Engineering in cooperation with Oregon State College, the College of Washington, University of Idaho, and the University of Washington" and "1956 College Programs in Nuclear Engineering," RG 62, Series Box 9, File Nuclear Engineering Education (AEC) 1955-1958. The 1956 curriculum guide sponsored by the American Institute of Chemical Engineers advertised the OSU program as regional. See also RG 62, Series XII. Engineering Extension Services, 1944-1969, Box 16, Files General Electric and Atomic Energy Commission Graduate Program. 1950-1964.

[581] Hewlett and Holl, *Atoms for Peace and War,* 253-256.

[582] Ibid., 252-3.

personnel trained "in nuclear science and engineering together with the life sciences" far exceeded the supply. Grants for fellowships, faculty training and equipment were the solution, so much so that by 1958, the two AEC grant programs (one specifically for reactors, the other for Biology and Medicine) had dispersed $7.5 million to 96 different institutions. The AEC believed grants for seventeen research reactors made graduate programs possible. The AEC money also secured further local and state funding for nuclear programs.[583] Such official sanction and optimistic encouragement indeed made nuclear appear to be a secure investment for the future.

The AEC's standards and values permeated more than the Oregon State College campus. The AEC garnered support by amplifying its triangular relationship with industry, politicians and academic programs to advertise a nuclear bright future. Oregon State College faculty and administrators wanted to be a part of it, and so did industrialists. A few miles outside Corvallis, a plant that had produced zirconium metal at the former Albany Bureau of Mines restarted production. Zirconium made possible the development of nuclear reactors, as the metal can withstand the heat and radiation inside atomic reactors.[584] Zirconium was rare and essential. It was produced at only two other locations in the world, Japan and New York. The southern beaches of Oregon provided a source of zircon for the zirconium that was made by mixing zircon with baddeleyite ore from Brazil.[585] The demand for zirconium was expected to increase dramatically with the expansion of nuclear science by Atoms for Peace, as plans for commercial nuclear power

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[583] AEC Meeting Minutes 267/48 May 26, 1958 "Report to the General Manager by the Director of Reactor Development and Director of Biology and Medicine" File "Reactor Technology, vol. 3 21" Box 115, RG 326 Records of the AEC, General Correspondence 1951-8, NN3-326-93-010 HM 1993, NARA II.
[584] AEC official letter head, signed by Lewis Strauss, his statement at the plant dedication ceremony to be read by his friend, Neuberger was composed on April 12, 1957. It is also important to know the location of this production becomes a Superfund cleanup site, Box 8, File 37, Richard Neuberger Papers (RNP), University of Oregon Special Collections, Eugene, Oregon.
[585] Undated Wah Chang History for pamphlet, 2, Box 14, Wah Chang 8 File, RNP.

plants were realized. The Albany location would also dramatically reduce shipping costs of the metal in the Northwest region.[586] This unique nearby industry gave Oregon State even more reasons to recognize the important role they had to train a workforce in service of the nuclear nation.

The hopes for Wah Chang Corporation and its zirconium production were linked tothe new nuclear future. The opening ceremony on April 22, 1957 showed the web of relationships connecting the college via the AEC to the power of the state and the nearby zirconium plant. The ceremony included a prayer by the Pastor of the First Presbyterian Church Reverend Morton L. Booth, and a speech by Oregon Governor Robert D. Holmes.[587] US Senator Richard L. Neuberger read a statement from AEC chair Lewis Strauss, to express congratulations to Wah Chang Corporation (the name translates as "Great Development") whose owners had come forward to meet this "immediate national need."[588] Faculty in the College of Engineering were honored guests at the ceremony.[589] The links between industry, Oregon State's nuclear engineering program and government aims were nourished by the AEC to promote the work at Oregon State College as essential to national success and security.

Nuclear science was not a normal academic endeavor. It is not often that advocates for educational departments are US Senators, but in the case of Oregon State's

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586 Untitled notes Box 14, Wah Chang 8 File, RNP.

587 "Official Opening Ceremony Wah Chang Corporation, Zirconium Plant, April 22, 1957 Albany Oregon" It is significant to note that after the needed zirconium was produced, the AEC found it did not need to continue the contract by 1958, and Neuberger played a central role in advocating for the plant to remain open for national security as well as the Oregon economy, see Box 14, Wah Chang 8 File, RNP.

588 Strauss said that the former plant in Albany had produced the zirconium fuel used to make the reactor in the Nautilus submarine that had been launched in 1955. This statement was later investigated and found to be untrue, but it is often repeated throughout the Wah Chang files, and had been a part of a poetic speech that caused some negative press attention later for Strauss. Strauss speech, Box 8, File 37, his statement was read at the plant dedication ceremony by Neuberger on April 12, 1957, RNP.

589 "Official Opening Ceremony" Box 14, Wah Chang 8 File, RNP.

nuclear programs, they had a champion in Senator Neuberger, who had close ties with AEC chair Lewis Strauss. Neuberger worked to encourage generous financial support of Oregon State's nuclear education programs. Strauss sent a congratulatory letter to the Senator when Oregon State was awarded a $165,900 AEC grant.[590] Oregon State was awarded the grant along with six other colleges and universities around the country for "small training reactors" that totaled $3.5 million as part of a third round of grants by the AEC approved in 1956.[591] The grant paid for the first reactor to be installed in the state and for additional nuclear equipment by 1958.[592] The Oregon State College Director of Purchasing received a letter from Nucleonic Corporation of America, "gratified to learn from the Atomic Energy Commission that your institution was recently awarded a grant" and eager to assist by providing the highest quality nuclear equipment.[593] The AEC facilitated relationships among industry, academia, and the state fashioned the resiliency of the community coalescing around nuclear science and technology.

Nuclear Determination, 1958 to 1964

It was imperative for the AEC to attract faculty and students to the field. On the Oregon State College campus, the total enrollment of students taking nuclear courses grew by 61 percent in just two years.[594] The grant for the low level "atomic reactor" as it

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[590] Lewis Strauss to Neuberger, February 28, 1958, and "Official Press Release" sent by Neuberger to major press outlets in Oregon to announce the grant on March 5, 1958, Box 8, File 37, RNP. They refer often to each other as close friends in the correspondence.

[591] C. Goodman to Durham, January 31, 1956, File "Reactor Technology, vol. 3 21" Box 115, RG 326 Records of the AEC, General Correspondence 1951-8, NN3-326-93-010 HM 1993, NARA II.

[592] RG 62, Series V. Research 1942-96, Box 9 File Radiation Center, 2, and 3 of 3 and File Nuclear Engineering Education (Atomic Engineering Commission). 1955-1958. and Box 8 File Atomic Energy Projects, File 2 of 3: "History" and "OSU College and the A Bomb." A single photocopy page of the article was in Nicodemus's Biography File, SCARC.

[593] Marvin Felder, Manager, Sales Promotion Nucleonic Corp of America, to Director of Purchasing, April 20, 1959, RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

[594] Gleeson to Registrar's Office January 18, 1960, and Gleeson to Leighton Collins, January 22, 1960 RG 62 Series V. Box 9, Nuclear Engineering Education (AEC), SCARC. In 1956 158 students were enrolled

was called in the student newspaper, *the Daily Barometer,* was soon targeted to prepare students "for operation of larger nuclear reactors or nuclear power plants." [595] The initial AEC goal of teaching and researching radiation safety in the first grants and fellowships of the late 1940s, was overshadowed by the need for reactor operators. Programs coalesced around equipment and directed students' research questions, leading research away from the original stated radiation safety and health protection goals of the Oregon State College program.[596] Safety became more detached and relegated to health physics eventually as a Public Health Service Fellowship program, distinct in trajectory from the glamour of nuclear physics.[597]

Safety appeared to be entirely assured by the AEC's authority and its nuclear experts. A *Barometer* article announcing the grant reassured readers that the reactor, to be installed in the basement of Dearborn Hall in the heart of campus, was "licensed by AEC

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and by 1959 there were 257 enrollments in the 9 nuclear courses, none of which had a specific focus on radiation safety. The AEC required reports on enrollments in specific AEC approved courses.

[595] "Atomic Reactor Purchase Set," February 8, 1958, *The Daily Barometer.*

[596] R.C. Ernst, "Present Status of Nuclear Engineering Education" (1952) and "Report to the Secretary of the ASEE Committee on Atomic Energy Education on the Committee Program at the Dartmouth Program of ASEE in June 1952" RG 62, Series X. Engineering Organizations - Educational. 1944-1969, Box 14. File Reports - Miscellaneous. 1945-1953. The AEC representative Dr. T. Keith Glennan present at the meeting explained that the number one focus for the AEC is atomic weapons, and that research reactors were a viable investment for educators to make. Also see RG 62, Series V. Research. 1942-1996, Box 8, AEC file 1958-1964, see also lists of general research projects conducted in the first reactor in Series V. Research. 1942-1996, Box 9, Radiation Center, 1959-1962 File 2 of 3, The Nucleonics AGN-201 manual in File Radiation Center 1942-96, 3 of 3, and Nuclear Engineering Education (AEC) in box 9. This element of the technology leading the inquiry is discussed in detail by Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: The University of Chicago Press, 1997).

[597] This divide led to the development of health physics as its own discipline but isolated it from nuclear physics in the main. One course or two would be offered in health physics for nuclear science students, and students interested in radiation health safety (after E. Dale Trout established the AEC/PHS curriculum in Radiation Safety) would then stay within their discipline to the point that health physicists recalled being seen as outsiders or cops. See curriculum guides and PHS materials in E. Dale Trout Papers and RG 62, Series II Instruction, 1944-1991, Mechanical Engineering. 1944-1981, Box 6 File Nuclear Engineering. 1968-1977 and *How OSU Grew Nuclear Science: Gordon Little* SCARC.

as completely safe."[598] Serious research reactor accidents had occurred in the past including at Chalk River, Canada in 1952, but no additional reassurance of safety was made except that a certified and licensed instructor would be in the reactor control area at all times. Only AEC trained faculty were allowed to operate the reactor and had to be present if anyone unlicensed such as students were operating the reactor. Seven faculty in 1959 were qualified for this. They were physically examined, trained, tested, and licensed as reactor operators by the AEC.[599]A campus Radiation Safety Committee (RSC) formed that same year, as each university was responsible for monitoring its own compliance with AEC exposure limits. The level of bodily, lab area, and outside surveillance required in terms of AEC paperwork was frustrating, confusing, and time consuming. The RSC compiled the numbers of exposures off film badges and pocket dosimeters. Periodic medical exams including daily urinalysis before and after conduct of experiments could be ordered for students, staff and faculty.[600] More significantly, the Committee expressed their struggles to adequately monitor exposure in many different labs spread across campus utilizing radioisotopes and other radioactive materials.[601]

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[598] "Atomic Reactor Purchase Set," Feb. 8, 1958 *The Daily Barometer* and "OSU Gets Special Nuclear Reactor for Classroom Use" January 26, 1959, OSU News Bureau Press Release, RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU, (Atomic Energy, General) 1958-1962, SCARC.
[599] Gleeson to Strand, May 4, 1959, the seven named faculty were C.H. Wang, D.B. Nicodemus, L. Schecter. E.A. Daly, T.H. Norris, C.E. Wicks, and J.G. Knudsen, RG 62 Series V. Research. 1942-1996 RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.
[600] RG 62, Series XV Committees, 1942-1983, Box 19, File Radiation Health Safety Committee 1958-1962, SCARC.
[601] RG 62, Series XV Committees, 1942-1983, Box 19, Radiation Safety Committee, 1958-1962, meeting notes, SCARC. In these years the AEC did have site visits, see Gleeson to Popovich, September 19, 1960 RG 62, Series V. Research. 1942-1996 Box 8 File Atomic Energy Projects at OSU, (Atomic Energy, General) 2 of 3, 1958-1962 which recorded a surprise visit on September 15 by AEC staff, R.H. Engelekin and G.R. Yesterberger. The school had no citations with four recommendations. The inspection wrote Gleeson, "paid us a complement to the effect that we were one of the very few institutions in the country where adherence to regulations and rules appeared to be complete"…and the only school "he had inspected which had not received a citation of some violation."

Unanticipated problems plagued the low level AGN-201 Aerojet General Nucleonics training research reactor. Established systems for liability and safety on campus did not quite fit the dangers of the new research reactor. A misunderstanding about insurance almost caused the order of the reactor to be canceled, but the reactor manufacturer helped by recommending a temporary insurance arrangement. [602] This was followed by Congress resolving the long term insurance issue later in the summer, with the merging of several bills that required the AEC "to indemnify and hold harmless" all nonprofit educational institutions up to $5 million.[603] This insurance, lobbied for by Senator Neuberger and the AEC, allowed the reactor project to move forward.[604] Oregon State soon operated one of fifty such research reactors in the country and was one of forty-two AEC-approved nuclear engineering graduate programs to remedy the government's forecasted shortage of trained atomic workers.

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[602] Morris Robertson, OSU Business Manager, to Neuberger, July 11, 1958, and Charles Fowler Sales manager of Aerojet-General Nucleonics of San Ramon, California, May 13, 1958 in Box 8, file 37 "Atomic Energy Commission" RNP, University of Oregon Special Collections. The correspondence referred to "attachments enclosed" of testimony on the need for acceptable insurance costs and immunity for colleges with reactors that was given by a Mr. Peterson at the Joint Committee on Atomic Energy and the AEC. The testimony was no longer attached, but the correspondence confirms the problems.

[603] G. Morris Robertson to Neuberger, July 11, 1958 and July 14, 1958 Neuberger to Robertson, Box 8, file 37 "Atomic Energy Commission" RNP. After ordering the reactor, it had been discovered that OSU was expected to provide its own insurance, and a hold was put on the original order for the reactor by the OSU Business Manager, G. Morris Robertson in May, see Fowler to Gleeson, May 7, 1958 and Robertson to Fowler, May 13, 1958, RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 1958-1962 .The issue was complicated because after the grant had been awarded and the purchase for the AGN-201 begun, a hearing on regulations for the AEC was held and proposed new regulations attempted to waive all state immunity in Title 10 of the Federal Register. Insurance had also played a significant role in the establishment of civilian nuclear power utilities.

[604] Dean Gleeson to Mr. John Prince, December 4, 1961 (Prince was Radiation Health Officer at Dearborn Hall) and Dean Popovich to Dean of Engineering Gleeson, "Equipment Grant form the AEC," December 16, 1959, RG 62, Series V, Box 8, File Atomic Energy Projects at OSU, (General) file 2 of 3, 1958-1962. The reactor was licensed by the AEC to operate on November 13, 1958. On January 27, 1959, the reactor "went critical" and sustained a continuous reaction in the 3.13 pound uranium-235 core to produce energy. The core, loaned by the AEC for the life of the reactor had a value of $10,500, which was the financial responsibility of Oregon State. The reactor was six and a half feet in diameter and nine feet high, weighing over 22,000 pounds with 7,500 pounds of lead shielding. The reactor was decommissioned in 1974.

Disappointingly, the small reactor never did perform well. Interest in the AGN-201 nearly doubled the number of students enrolled in the nuclear engineering courses, but the AGN-201 turned out to be a lemon and described as "so safe it hardly ran." It would automatically shut itself down when students tried to operate it.[605] In addition, the Slow Neutron Monitor, type N578 from Atomic Accessories malfunctioned. It had a strontium 90 calibration source inside it that leaked radioactivity for a year before it was discovered.[606] Perhaps much more seriously, the cyclotron was discovered to be emitting levels of radioactivity too high for minors to be exposed to, but the college family housing abutted the facility. The high cost of installing shielding was prohibitive so a fence labeled "restricted area" was installed around the cyclotron lab to protect children.[607] It was difficult even for experts like Nicodemus to keep up with regulations as well as the safety guidelines and to understand the foibles of new equipment.[608]

The AEC's need for security and classified research dominated the culture of nuclear research at the college. This included the AEC's relationship with other agencies

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[605] The quote is from "Radiation Center History: 40th Anniversary: Stories from Chih Wang" 1, Nuclear Engineering and Radiation Health Safety Department, OSU. For the scramming and problems caused by the AGN 201 see handwritten Gleeson note "To Whom It May Concern" and Aerojet General Nucleonics Richard L. Newacheck (Manager, Technical Services Division) to Gleeson, October 30, 1959, RG 62, Series V. Research, Box 8, Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962. From my review of the material in RG 62 and Trout's papers, the papers are dominated by inquiries to manufacturers about problems with equipment and questions about regulations. The quote is from "Radiation Center History: 40th Anniversary: Stories from Chih Wang" 1, Nuclear Engineering and Radiation Health Safety Department, OSU.

[606] Edward A. Daly to Gleeson, October 8, 1959, Nicodemus to Gleeson, July 16, 1959, Nicodemus to Gleeson, u.d., handwritten notes signed by Nicodemus concerned about the situation and Gleeson to Those Concerned u.d., Gleeson to Aero-jet General Nucleonics, October 26, 1959, RG 62, Series V., Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3 folders, 1958-1962, SCARC.

[607] It is mentioned that due to the experimental nature of the cyclotron, when it was built they were unsure of how much shielding to provide and it was very expensive to add, E.A. Yunker (Physics Dept.) to Strand, July 13, 1959 Wang to Siegel and E.A. Yunker, November 1, 1960, RG 62, Series V., Box 19, File Radiation Health Safety Committee, 1958-1962, SCARC.

[608] For just one of many examples in this file, see Edward Daly to the AEC, October 23, 1959 as Daly is unsure of if the Slow Neutron Monitor equipment with the leaking strontium could be given to the AEC as it is in a locked and marked enclosure, RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

that had jurisdiction for health and safety. By 1958 a division of Radiological Health was established by the Public Health Service with their manuals, teaching materials and focus aligned with the work of the AEC.[609] Dr. Jensen had served in the early 1949 discussions of how to implement joint questions of radiological safety between the AEC and PHS regarding stream and environmental health.[610] The rapid nuclear expansion increased confusion over questions of local, state and federal jurisdiction and enforcement for health and safety, despite a few states, like Oregon, that adopted their own regulations for clarity.[611] During this same era on an international level, a push by the AEC and international agencies to coordinate and standardize international regulations for reactors and peaceful applications of radiation occasionally magnified confusion over areas of responsibility for science education and public health. This was particularly clear between WHO and the newly forming IAEA. The IAEA, instigated by Eisenhower's Atoms for Peace program, was aligned with the philosophy of safety of the AEC. [612] That philosophy was that there was a threshold to danger, and if established AEC protocols were strictly adhered to, nuclear science could fuel society for thousands of years.[613]

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[609] Albert Harris, Jr., "State Regulation of Hazards Growing Out of the Use of Atomic Energy" *California Law Review* 46 no. 1 (March 1958): 84-97. For an outline of the relationship between the PHS and the AEC see "Attachment 5: Excerpts From a Collection of PHS Materials" for an outline of the relationship between the PHS and the AEC see NSA Archives at George Washington University NSA Archives, George Washington University, accessed May 15, 2014, http://www2.gwu.edu/~nsarchiv/radiation/dir/mstreet/commeet/meet8/brief8/tab_j/br8j1e.txt; E. Dale Trout Collection, SCARC. The materials in Trout's boxes about PHS Fellows were dominated by materials from the AEC. "A Summer Advanced Training Course in Engineering Aspects of Radiological Health for Public Health Officials July 11-September 16, 1960" and Marshall S. Little to OSC June 23, 1960, RG 62, Series V., Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.
[610] Surgeon General to Carroll Wilson November 15, 1949, in "Attachment 5: Excerpts from a Collection of PHS Materials" NSA Archives.
[611] Harris, Jr., "State Regulation of Hazards."
[612] See File "WHO 1963-4 0/320-2" Correspondence with WHO, DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives, Vienna, Austria. See also Hamblin*, Arming Mother Nature,* 105-7.
[613] Alvin M. Weinberg *The First Nuclear Era: The Life and Times of a Technological Fixer* (New York: American Institute of Physics, 1994). Also see File "WHO 1963-4 0/320-2" Correspondence with WHO,

The legal and regulatory role of the AEC to reach this aim was unlimited. They were not constrained, even at the highest levels of government. This was due to the extent of the powers granted to the agency in the Atomic Energy Acts. On a practical level, they had the ability to amplify their knowledge with experts when needed in the national press and at trainings, meetings, conferences, and events.[614] This only served to expand the AEC's horizontal control to other agencies and government entities while expanding their interpretations of radiation safety.[615] Instead of publicly acknowledging safety concerns, which erupted during the fallout controversy, the AEC responded by accelerating research and appearance of providing a tough regulatory role. The reality was much more experimental. The rapid expansion of research from the former military national labs to universities and to civilian corporations had the result that both research and development were conducted simultaneously "without the usual lag time" between "pure research, its experimental application in prototypes and its ultimate commercial application." This was evident in the construction of the cyclotron.[616] The crisis over the dangers of fallout in 1959 caused a "full scale radiation scare" and a crisis of trust in the AEC and the government. In 1955, only seventeen percent of Americans even knew what fallout was,

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DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives.

[614] This press access as well as social and traveling aspect of the AEC is very clear in the meeting minutes of the AEC and throughout RG 362, NARA II.

[615] For example, the AEC surveyed what was being organized and often invited itself (if by some odd occurrence, it was not already invited or the organizer itself) to meetings on nuclear safety, see RG 326 for multiple examples throughout the collection, especially the correspondence and AEC meeting minutes in the 1950s and 60s, NARA II; For details of state struggles to gain control of public health after the introduction of the AEC's expertise, see Harris, "State Regulation of Hazards;" For the legal power and primacy of the AEC see E. Blythe Stason, Samuel D. Estep, and William J. Pierce, *Atoms and the Law* (Ann Arbor: The University of Michigan Law School, 1959).

[616] The national trends are carefully explained in Hodgetts *Administering Atoms for Peace,* 84-87, 119- 132, quotation on 85.The files on the AEC with various correspondences on rules and equipment dominate the correspondence, see in RG 62, Series V. Research. 1942-1996, Box 9, File Nuclear Engineering Education (Atomic Engineering Commission), 1955-1958 and File Radiation Center, 1956-1965, 3 folders and Box 8 File Atomic Energy Projects at OSU (Atomic Energy, General) 1958-1964, 3 folders.

but two years later, fifty two percent felt fallout was dangerous.[617] This change in attitudes influenced radiation safety standards on campus.

Radiation safety had not been as seriously mandated as one might assume for such a risky technology on a public college campus. Up until 1959 the National Committee on Radiation Protection (NCRP) composed of some AEC affiliated academics and industry scientists, (including both Jensen[618] and E. Dale Trout, while he was at GE labs) made only recommendations for radiation safety standards, with no enforcement mechanism, beyond the AECs oversight through grant and licensing procedures. However, each group that worked with atomic materials was expected to establish its own criteria to meet the guidelines for what was believed to be a safe level of exposure.[619] This was to allow flexibility for each industry, college, or government user of radioisotopes or nuclear technologies to integrate the standards in ways that did not inhibit the embrace of the science. For this purpose, Oregon State had created its Radiation Safety Committee.

Providing radiation safety exceeded the containment ability of systems thus far constructed. By 1957, questions about the safety of fallout led to the release of formerly classified data held by the AEC to assuage what they felt were irrational fears. The AEC data, however, also showed rising background levels of radiation and integration of radioisotopes like Sr-90 into human bones from nuclear weapons testing. There was no

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[617] Hacker, *Elements of Controversy,* quotation on 198, and Walker, *Permissible Dose,* 22-3.
[618] Hamblin, *Poison in the Well,* 29. Jensen was at NCSU at this time and chair of the NCRP subcommittee on waste disposal and decontamination.
[619] Walker, "Politics" 59; RG 62, Series XV. Committees 1942- 1983, Box 19, File Radiation Safety Committee 1958-1962, meeting minutes, SCARC; Dale E. Trout, "The History of Radiation Protection in the Untied States" *Hospital Progress*, 41 no. 8 and 9 (1960). Trout also served on the ICRP. Very well respected, he had begun his career with General Electric and had used radiography to test the bolts and integrity of ships and airplanes during WWII. He founded the Radiation Safety program at OSU, see Ronald L. Kathren and Paul L. Ziemer eds., *Health Physics: A Backward Glance, Thirteen Original Papers on the History of Radiation Protection* (New York: Pergamon Press, 1980) dedicated to Trout.

denying that the testing had already increased everyone's overall exposure to radiation. The AEC scientists felt their data supported the reliability and safety cushion of their standards, but the standards were based on a lower level of background radiation than now existed. All types of radiation exposures believed previously to be safe now became suspect in the public eye. A national radiological crisis occurred as the fallout believed to be safely ensconced in the stratosphere was instead drifting down to earth and raising radiation levels. A temporary committee assigned by the president, the Radiation Safety Council, lowered the acceptable doses as newly recommended by the ICRP and NCRP. Within a few months, President Eisenhower, on the advice of the Radiation Safety Council, created a new agency, the Federal Radiation Council, for the "collation, analysis and interpretation of environmental radiation."[620]

This public admission of the lack of AEC credibility, however, did not really change the status quo on campus. The AEC, while it no longer issued the actual radiation limits of exposure, still maintained ultimate oversight of its campus- affiliated and other laboratories, and this oversight was obtained through the many grant agreements and licensing procedures. In sum, for the public, the "safe" doses were likely to have more severe risks than previously determined by the NCRP or AEC. The record on fallout did lead to changes on campus, including smaller allowable radiation doses for the laboratory students and workers.[621] The implementation of stricter standards for dose and exposures,

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[620] Arthur Flemming, Secretary of Health, Education and Welfare, "The Federal Radiation Council" August 26, 1959, accessed April 26, 2014, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1929357/pdf/pubhealthreporig00132-0075.pdf

[621] Hacker, *Elements of Controversy*, 198-9 and Walker, *Permissible Dose,* 22-23. This is also my conclusion from seeing documents after 1959 in the IAEA archives and AEC RG 326 at NARA II. This new standard was issued by the Radiation Safety Council in June of 1959. This advisory group also recommended the formation of a new agency, the Federal Radiation Council or FRC. The FRC became responsible for radiation safety standards and this role was taken from the AEC by Presidential order to salvage trust in the nuclear project.

as the AEC had feared, raised questions for the Oregon State College president. The new 1959 standards lowered the allowable exposure levels by one third from 75 millirems a week to 50.[622]

Seeing the new criteria made President Strand curious to know what actual doses staff and students were receiving. The data from the dosimeters, film badges, gummed papers, Geiger counters, scintillators and alarm systems that stood at the ready to warn of radiation, however, were not public information. According to Dr. Chih Wang, chair of the Radiation Safety Committee and a force behind nuclear science on campus, Strand's request even to know how much radiation people were being exposed to created a "delicate situation." The simple request of more radiation information than the AEC required was in fact, according to Wang, an AEC violation. The issue was not delicate because it involved the radiation exposure for faculty, staff and students, who themselves were not informed of their exposures. The situation was "delicate" because the inquiry alone was a possible transgression against the AEC. The college was only allowed to release information if the doses received exceeded the legal limit.[623] The ultimate power to decide the safety of the allowed doses rested with the AEC and no other party was even privy to the data. Not even the President of the college could trump the power of the AEC. Even after the humiliation of the AEC's record on radiation safety with the

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[622] Wang to Gleeson, June 23, 1959 RG 62, Series V., Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

[623] Wang to Gleeson, June 23, 1959 RG 62, Series V. Research, Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC and Gleeson to Strand, May 21, 1959, Wang to Gleeson, June 8, 1959, Gleeson to Wang June 9, 1959, RG 62, Series XV Committees, 1942-82, Box 19, File Radiation Safety Committee, 1958-1963, SCARC. Gleeson wrote "any students who are exposed to any ionizing radiation" should have dose records on file at the University. These dose records, he said, were requested by private companies.

establishment by the FRC, there was still no oversight of how much radiation people were being exposed to by AEC-instigated nuclear science technology and programs.[624]

The AEC acted to assert even more control after the grant for the first Oregon reactor was secured, but before it was installed. In the aftermath of the fallout controversy, the AEC acted to reassure the public and campus of their expertise in safety by issuing more regulations to grantees and nuclear technology license holders. The regulatory demands of the AEC soon exceeded the ability of the campus to attend to safety. Safety itself was complicated by the difficulty of understanding the increasing number of AEC regulations, much less how to interpret the complicated rules and successfully comply with them.[625] It became clear that the campus needed help to meet the requirements of the AEC regulations, which also expected equipment to be in a specified working order or face penalty,

Strand was not allowed to know the actual doses received by students, staff and faculty, but he still wanted to protect the campus. When Strand told Dr. Chih Wang he felt that a better system of standardization and reporting of radioactive materials on campus was urgently needed, he was told it was already being addressed. Wang, chair of the Radiation Committee and a force for nuclear expansion on campus, assured the President that the Radiation Committee was working on this already: "in view of the rapid expansion of programs of this type, the committee, anticipating a sharp increase in radiation levels in various installations, has been undertaking… unified regulations and

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[624] The FRC is in chapter 3 and was created by Eisenhower (to salvage the public trust so the nuclear power industry could continue to expand) by Executive Order the Federal Radiation Council EO 10831 on August 14, 1959. The powers of the FRC for oversight of public radiation standards were transferred to the EPA when it was created in 1970, see EPA website "The President Shapes the Program" accessed April 26, 2014, http://www.epa.gov/radiation/laws/eo_pdd.html.

[625] Hodgetts, *Administering Atoms for Peace;* RG 62, Series XV Committees, 1942-1983, Box 19, Radiation Safety Committee, 1958-1962 Meeting Notes, SCARC.

procedures."[626] This alone, however, was not easy to accomplish for a volunteer committee composed of already stretched faculty and staff. Wang proposed the hiring of a radiation expert. He suggested a full time health physicist aid the Radiation Committee in assuring campus safety. This hire would be someone with "an M.S. degree in one of the AEC sponsored training programs" to "permit future expansion in the field of radiation research."[627] The focus remained on the growth of the science, and the chance to reassess or broaden safety oversight was deferred to another AEC connected and trained individual. There would be no ability for anyone outside of the AEC to assess independently the health of the individuals who were monitored, and who might have been exposed to amounts that were now considered one third too high. As Libby had explained it, radiation was a part of life.

There was never a question of a retreat from Oregon State College's nuclear expansion. This was despite the dangers, complications, malfunctions, uncertainties and AEC sudden demands. The faculty and staff expressed concern about their ability to interpret and implement increasingly lengthy and complex regulations, wondering if they were in or out of compliance with AEC paperwork and expectations. In the midst of these worries, Wang spearheaded an even larger irreversible nuclear commitment. Frustration with the AGN-201 sparked a campus wide effort for a more powerful reactor that could

[626] Wang to Gleeson, June 23, 1959 RG 62, Series V., Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC. Wang had worked on projects for the Navy in the late 1940s. He became a member of two nuclear task forces for the state of Oregon, one in the 60s and again in the 70s and he published several text books. For much more on Wang and his efforts to build the Radiation Center, see Jindan Chen, "Society Shaping Science: Chih Wang and the Making of a Radiation Center in Cold War America" (Master's Thesis, Oregon State University, June 10, 2013).

[627] Wang to Dean Lemon, February 25, 1959 RG 62. Series V. Box 8, Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

be used by multiple disciplines.[628] Wang thought Oregon could create a cutting edge Radiation Center that would house a future TRIGA (Training Research Isotope General Atomics) reactor for multidisciplinary research across five schools on campus. Hoping to unite radiation research in one laboratory, the stated vision for the Oregon State program was to coordinate closely with AEC and national labs as well as with industry. Locally the college hoped to dispatch radioisotopes to nearby industries and to agricultural and forestry operations. They wanted to coordinate with AEC installations, including Hanford, the Arco Idaho Reactor Testing Station, and the Radiation Laboratory at Lawrence, California as well as with the Oregon State Board of Health, and Civil Defense groups.[629]

Those planning the new Radiation Center orchestrated a cross campus effort that tempered what was told to the public. Wang, Dean of Engineering George Gleeson and Milosh Popovich, Dean of Administration, were aware of the importance of perception. It was not an actual reactor they had in mind, but a center for study. One center would eliminate some of the safety problems caused by the use of radioisotopes spread all over campus in different departments and labs. The announced goal of the center was to "introduce the potentiality of nuclear power and the use of ionizing radiation as a research tool" to students and teachers from even the primary grades.[630] As early as April 1960 the college Deans agreed it was important to take into consideration "the public relations aspect of any expanded nuclear program."[631]

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[628] Strand to Gleeson, April 30, 1959, Strand to Gilfillan, April 30, 1959, Henderson to Strand, May 7, 1959, "Use of dangerous isotopes," RG 62, Box 8, Series V., File Atomic Energy Projects at OSU (Atomic Energy, General), 2 of 3, 1958-1962.
[629] "A Plan for the Coordination of Radiation Research at OSU" undated, but most likely this document was composed before 1963, RG 62, Series V. Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 1 of 3, 1958-1964, SCARC.
[630] Ibid.
[631] Dean Gleeson to Dean Popovich of the President's Office, April 7, 1960, RG 62, Series V., Box 8, File Atomic Energy Projects at OSU (Atomic Energy, General) 1 of 3, 1958-1964, SCARC.

No public announcement of the intention to build the reactor was made until after the grant funds for the Radiation Center were secured. When the plans for the new reactor became public, the press reiterated safety as absolute. This was how the press releases of the first, but troublesome, AGN-201 had also been handled, which had reassured readers in 1958 that the reactor was "completely safe." [632] Not relatively safe, but entirely. For the new TRIGA purchase that was planned, this tack was more misleading. The fact that this reactor could "power up" for nanoseconds to do experiments with the same capacity as a much more dangerous 1000 to 2000 MW commercial reactor was not mentioned in public references to the reactor. Instead, press releases and promotional materials stated that because of its careful design, the planned reactor posed no risks to the environment or health.[633]

After the grant was awarded, the state of Oregon was warned of the ramifications if the state failed to provide required matching funds for the Radiation Center. Only a small window of time was left to request the required matching funds from the state of Oregon, since the project had been kept so long under wraps. The legislature was no longer in session. Professor Chih Wang, in his official request for $395,000 in state funds from the emergency board (which meets to deal with crisis allotments needed when the legislature is not in session), stated: "If matching funds from the state budget cannot be arranged at this time, the University has been requested previously by the respective agencies to submit formal withdrawal of the original applications. Such an action will

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[632] "Atomic Reactor Purchase Set," Feb. 8, 1958 *The Barometer*.
[633] "Building Plans Given Approval" July 24, 1962 Gazette Times, Corvallis, 2; "New OSU Radiation Center to Start Operating June 1" *The Daily Barometer,* May 2, 1964, 4.The article stated that the radiation Center is its first of its kind but even though the grant had been tied with the TRIGA reactor, no mention of the incoming powerful reactor is made. See also Memorabilia Collection, Box 135, Radiation Center and Wang to Gleeson, May 28, 1962 RG 62 Series V. Research, Box 8, Atomic Energy Projects at OSU (Atomic Energy, General) 1 of 3, 1958-64, SCARC.

jeopardize the outlook of future fund requests in the years to come.”[634] Not only was prestige of the state entwined in the request, but freedom itself. The role of anticommunism and the Soviet break with the weapons testing moratorium with the huge “Czar Bomba” test October 30, 1961 created a dramatic opportunity to secure funding. The new OSU President Jensen accompanied Wang to lobby the Oregon legislature. Jensen passionately said to the chair of the Oregon State Emergency Board at the State Capital in Salem: “Sir, then you have noted that the USSR exploded the largest nuclear bomb with a yield of 58 mega tons yesterday. This concerns the whole world; don’t you think that is an emergency situation? Sir, this country needs a great number of scientists and engineers specializing in the nuclear area to manage our nuclear program. In order to do so, we need good facilities for nuclear education.” This was a national security issue. Nuclear education was needed not just for peaceful purposes but for military ones as well, like supremacy in nuclear weapons. The funds were released with no more discussion.[635]

Jensen’s plea came at a moment of ambition at the institution, just at the name changed from Oregon State College to Oregon State University. The Radiation Center was part of Jensen’s effort to turn Oregon’s land grant college into a world-class research university. It showed the cross-campus and statewide investment in a nuclear future. Wang’s cross campus and political marshalling of supporters eventually culminated in

[634] “A Statement with Regard to the Request of Fund for the Construction of a Radiation Center at OSC University”, 4. The cover letter was directed to Dean Gleeson, Wang to Gleeson, dated August 22, 1961, RG 62, Series V. Research, Box 8, Atomic Energy Projects at OSU (Atomic Energy, General) 2 of 3, 1958-1962, SCARC.

[635] Chen, “Society Shaping Science” 2013. Quotation from page 10, original source Chih H.Wang, “Radiation Center 40th Anniversary: Stories from Chih Wang,” Non-dated, (circa Fall 1967), document from the archive of Nuclear Engineering & Radiation Health Physics Department at Oregon State University, quotation page 3.

the $2 million Radiation Center, which was built in two phases.[636] The first phase of the modern laboratory building was completed in 1964. The second phase was the addition of the Oregon State University TRIGA Mark II Reactor (OSTR) to the building in 1967. The ceremonial opening of the TRIGA included an address by the AEC Commissioner Wilfrid E. Johnson. Johnson, an alumnus of Oregon State College, shared the stage with Governor Thomas McCall, remembered in popular culture as the most environmentally progressive governor of the state.[637] Johnson spoke of the need to study nature and to aid the less fortunate by the gift of nuclear power; even “deserts will be irrigated and produce food… in the longer run, food, clothing and shelter should be abundant everywhere.” Celebrating both the independence of Oregon State and fifteen AEC operating contracts, Johnson implied the AEC’s average of 600,000 research dollars awarded to Oregon State per year was unbiased economic support for development of basic science. One billion dollars had been spent by an American public willing to invest in nuclear education and promise by 1967. In return, scientists should be capable of explaining the benefits of nuclear research to sustain public support.[638]

The gift of nuclear education needed to be returned by scientists accepting responsibility for public advocacy of all things nuclear. It was assumed, perhaps, that the public was ignorant of the benefits and only focused on the risks during the fallout risk. The experimental nature of nuclear science caused not pause in the pace. Instead, there

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[636] The event was on October 26, 1967, also see “The 1965-1971 Capital Construction Program of the Department of Higher Education,” 39-40, quotation on 39**,** Institutional Records 1965-1971, RG 193, Facilities Services, SCARC.
[637] For more on Oregon political and environmental history, see Charles K. Johnson, *Standing at the Water’s Edge: Bob Straub’s Battle for the Soul of Oregon* (Corvallis: OSU Press, 2012). Despite this popular lauding of McCall, Johnson argues Governor Straub was in reality, the inspiration for Oregon’s environmental protections.
[638] “Program” and AEC press release, October 26, 1967, “Remarks by Wilfrid E. Johnson, Commissioner U. S. Atomic Energy Commission at the Dedication of the Radiation Center Oregon State University Corvallis, Oregon, October 26, 1967,” Memorabilia Collection, Box 135, File Radiation Center, SCARC.

was increasing determination for more research, regulations, and AEC oversight. It was a new frontier and the sacrifice of living in uncertainty was needed to create the future. The establishment of nuclear science demanded a large investment of faculty commitment, AEC funds, and effort across the entire campus from the late forties, fifties and early sixties. The AEC fostered the success of the program with not only grants but the appearance of control and security. After completion, the center influenced disciplines across campus and became a source of nuclear workers for the AEC and around the world.

Oregon Atomic Trailblazers

The AEC developed and nurtured personal relationships. They grew these as well as expertise and opportunities among scientists who would become, in the main, lifelong supporters who promoted progress through nuclear technology and energy. A glimpse at Oregon State faculty shows the central role of the military and the AEC in the life and fate of the college. Several OSU faculty were connected with the AEC, beyond physics faculty Nicodemus and Dempster, including radiation safety expert Dr. Earl Dale Trout, chemist Dr. Robert Elder, President James H. Jensen and the most international, Agricultural Professor Dr. Joseph S. Butts. A study of these men underscores how personal relationships with the AEC built nuclear science on campus and beyond.

One example of the scientists who created the first radiation health standards is Dr. E. Dale Trout. A physicist trained at Franklin College, Indiana, Trout belonged to the Health Physics Society. He was an influential member of the International Commission on Radiological Protection (ICRP). Trout had worked with General Electric on the

Manhattan Project developing industrial x-rays.[639] He also invented a portable radiation safety meter that was easy for workers to read, with large print, so it encouraged them to monitor their exposures during their work day. Retiring from a lifetime of work with General Electric and x-ray and radiation research, OSU hired him in 1962, where he filled the position of Health Physicist suggested by Wang. [640]

Trout's position at Oregon State was also the result of planning by the AEC-related arm of the Public Health Service (PHS). According to Gordon Little, a former student, it was the PHS that insisted that when Trout retired, he "settle down some place near a university" to run a program for the PHS in radiation safety. Trout apparently had just wanted to fish in retirement. Instead he established the OSU Radiation Health Physics program. Trout's main concern, however, was never genetics or delayed effects, but how to shield properly to prevent the acute painful effects from radiation that could be seen and immediately felt, such as burns from exposures during dental exams or medical procedures.[641]

With Trout came the institutionalization of fellowships for his students. PHS provided generous stipends and fellowships for students to learn the AEC curriculum on radiation health safety. Trout traveled much while at Oregon State. Little recollected, "There was one thing wrong with Dale Trout as far as I was concerned. The darn guy was never here. You want to ask him something and he's in Sweden or he's in Germany or he's in Atlanta or he's you know, you name it anywhere far enough away that you

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[639] E. Dale Trout Personnel File, SCARC. Much of Trout's salary was paid by "outside grants" but the source is not clearly identified in his Personnel File. Documents from 1965 concerning Elders in his personnel file state "He was never on the payroll of OSU' as his salary was referred to as a courtesy appointment that was paid entirely by the Public Health Service.

[640] E. Dale Trout Papers, and his personnel file, SCARC.

[641] SCARC, *How OSU Grew Nuclear Science: Transcript of Gordon Little*, accessed April 26, 2014, http://blogs.oregonstate.edu/nuclearhistory/transcript-of-gordon-little/ and Trout Papers, SCARC.

couldn't get to him." [642] A typical student of Trout's, Little was a former military man who had worked at Hanford for ten years before coming to Oregon State, as a Public Health Service Fellow.[643]

As the PHS radiation safety program grew it deepened relationships with the military and AEC. Faculty were needed with radiation expertise and ability to monitor safety and use nuclear technology. AEC veteran Dr. Robert Elder was hired in 1965 for the OSU Radiation Health graduate program. A former Lt. Commander of the U.S. Public Health Service, he worked specifically from 1958 to 1961 at the Nuclear Weapons Test Program in Las Vegas, Nevada. He worked at weapons tests at Eniwetok and the Marshall Islands.[644]

There were strong links between the AEC and personal and institutional success. Jensen himself, now the university president, had helped create the first radiation standards with the NCRP, worked with the AEC, and helped instigate the North Carolina Temple of the Atom. When he presided over the 1967 Radiation Center opening, he brought his perspectives on the primacy of nuclear power. Serving as president from 1961 to 1969, Jensen oversaw the expansion of nuclear science with the Radiation Center, the installation of the TRIGA reactor, and the evolution of Oregon State from a state agricultural college to a science research university. Jensen had worked on laboratory

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[642] *How OSU Grew Nuclear Science: Transcript of Gordon Little,* accessed April 26, 2014, http://blogs.oregonstate.edu/nuclearhistory/transcript-of-gordon-little/.

[643] Gordon Little served for three years in the military in the late 1950s and later, he worked at Hanford before becoming a student of Trouts. After retiring from work at Berkeley, many years later, Little returned to work as the Radiation Safety Officer or RSO at OSU in the 1980s. SCARC, *How OSU Grew Nuclear Science.*

[644] He had received his B.S in Civil Engineering from OSU in 1958 after being a Research Fellow at the OSU Engineering Experiment Station from 1955 to 1958. In 1958 he became an officer in the Public Health Service. His Masters thesis showed his environmental concerns: "Treatment of Textile Wastes" and he received his doctorate from John Hopkins University in 1964 in radiological science and biochemistry Robert L. Elder's Personnel File, SCARC.

safety and nuclear waste disposal when he directed the Biology Branch of the AEC Division of Biology and Medicine in the late 40s, and he may have first met Dr. Joseph Butts while he served in this capacity.[645]

Joseph Butts had a less meteoric rise than Jensen, but shows how embedded the AEC could become in a person's life. The AEC built long term relationships with faculty like Butts that expanded nuclear education on multiple scales, from local to global.[646] Butts, born in 1903, was hired as a professor of Biochemistry at Oregon State College in 1939. He had worked previously at the University of California since 1929. [647] During WW II Butts served the Surgeon General's Office and the Army Air Force.[648] He returned to OSC immediately after discharge. He was given a raise because his war service had earned him other more lucrative job offers and because "his leadership in the chemical field has gained for him national recognition."[649] He became chair of the Agricultural Chemistry department at OSC in 1946. He used radioisotopes to study animal ketosis and physiology and the specific workings of amino acids, carbohydrates

[645] Jensen's role on the AEC is discussed in Hamblin, *Poison in the Well,* 29, 33-5. How unusual or common it was for the AEC to have such connections with administrators is for future research. However in 1969 it was announced by the press that Jensen had been appointed by President Johnson to the AEC Commission. The appointment, however, did not materialize and Jensen resigned from OSU to work for the Rockefeller Foundation. See Fred Shideler Papers, Series VIII, James H. Jensen, Box 4, Folder "Resignation, 1969" SCARC.
[646] "Dr. Joseph S Butts" SCARC on line photo collection, accessed May 15, 2014, http://oregondigital.org/cdm4/item_viewer.php?CISOROOT=/archives&CISOPTR=3243&CISOBOX=1&REC=4.
[647] "Butts, Joseph S" Job Application July 25, 1939 "Butts, Joseph S" Personnel Records, 1 of 3, SCARC.
[648] "Changes in Budget" November 9, 1945 "Butts, Joseph S" Personnel Records 1 of 3, and Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts" "Butts, Joseph S" Personnel Records 2 of 3, SCARC. Butts was a Major in the Surgeon General's Office and he volunteered to serve overseas as a Nutritional Officer for the Eighth Air Force during the war. He returned to work in Washington DC to advise and act as a "trouble shooter" throughout the United States for research and development programs, serving from 1942 until 1946. Staying as a reserve officer and becoming in his lifetime one of the few reservist Colonels in the Medical Service Corps and he served as a member of the Surgeon General's Advisory Committee on Nutrition throughout his life.
[649] R.S. Beese? (name illegible) and Gilfillian to Strand, November 9, 1945 "Butts, Joseph S" Personnel Records, 1 of 3.

and lipids. His science was well respected, but it was his early association with the AEC that shaped both his career and life opportunities.[650]

Butts became involved with the AEC early and would be a trusted ally. He attended the very first meeting to contemplate educational coordination with the AEC at Oregon State in 1948. This was soon followed by his attendance at one of the first trainings in nuclear science held that same summer in Brookhaven, Long Island and Tennessee at the AEC's Oak Ridge laboratory.[651] Butts's grey research notebook gives a snapshot of the nature of the camaraderie built at the training. His notebook begins with a photo of seven smiling men, five of them sitting close on a porch banister, including him and fellow Oregon State chemist Dr. Lloyd West at the "Rutherford Hotel." Two men stand behind the others and one, cigarette dangling, pulls the other's ear. They are caught by the camera in a photo that exudes unity of purpose and friendship. The actual hotel was a military barracks. Butts recorded each man's name in his notebook and the date of the training, August of 1948, when Jensen also worked at Oak Ridge, in charge of the Biology Branch of the AEC Division of Biology and Medicine.[652]

Butts's notebook shows how much radiation dangers may have been underestimated in labs in the early years of radiobiology. After the Oak Ridge photo, the next page of his lab notebook had taped to it the operating instructions for a Geiger Muller radiation counter. It then records experiments he began in Oregon, with isotopes sent on planes from Tennessee. Butts studied cabbage and corn exposed to C-14, as well as flies, rats, grasses and wheat. Butts's experiments also involved growing

[650] American Institute of Nutrition, "Resolved" April 13, 1961, "Butts, Joseph S" Personnel Records 2 of 3 SCARC.
[651] Robert G. Swan to Norblad, May 15, 1961 "Butts, Joseph S" Personnel Records 2 of 3.
[652] Joseph S. Butts Papers, Box 1, Research Notebooks, SCARC.

e. coli, protozoa and bacteria in a phosphorus-32 medium. He studied bean plants, with P32 added to the soil and pollen immersed in P32 solutions. One sample gave off readings of 4437 cpm (counts per minute, about 26 cpm was then average for background) and required shielding to protect the scientist taking the count.[653] During the experiments, some contamination of the lab occurred and this was counteracted by washing the area with soap and water and then heating the rack of the sample chamber in a 110 degree oven for an hour.[654] Radiological contamination as a new problem was often handled by trial and error.

Some of Butts's research projects may have been driven by the AEC and Libby's classified Sunshine Project. Butts collected samples of vegetation from many areas in Oregon and as far north as British Columbia and east to Montana. He measured the amount of phosphorus and other elements for example in animal feed, wheat, alfalfa, clover, grasses, hay, peas, and cane molasses. Some of his research was classified. This work by 1952 earned him notice at the highest echelons of the AEC. [655] Shields Warren of the AEC Division of Biology and Medicine wrote Oregon State President A.L Strand specifically to recruit Professor Butts for a temporary staff two year position with the AEC.[656]

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[653] Grey unlabeled notebook, quotation page 27 dated Oct 10, 1949.This book starts with the label the "Experiments on Radio Isotopes" and on page 2 "Oak Ridge Tennessee July 1- August 1948" followed by data and dated entries of various experiments, Joseph S. Butts Papers Accession 93:033 SR 3/6/1/60 Box 1, SCARC.

[654] Grey unlabeled notebook "Oak Ridge Tennessee July 1- August 1948" 82, Joseph S. Butts Papers, Box 1.

[655] Butts papers do not include any classified information among the ten small files of the actual measurements he collected starting in 1948 and continuing until 1955 but he has two files of "Unclassified Trace Elements No. s," Joseph S. Butts Papers Accession 93:033 SR 3/6/1/60 Box 1. It also looks as if he was collecting measurements on "experimental calves" but I am uncertain of this by just looking at the documents. Also he has a research notebook from June to July 1938 that looks like he was doing some type of tissue sampling or tumor research on mental health patients at Cardiff City Mental Hospital in California.

[656] Warren to Strand, June 10, 1952 Strand to Warren June 17, 1952, "Butts, Joseph S" Personnel Records, 1 of 3, SCARC.

The AEC wanted the best faculty to spread nuclear science on campuses: someone like Butts. Shields wrote “we are cognizant of the desirability of bringing into the program the most able scientists and of concurrently making available to the colleges and universities the skills and facilities of the program of the Commission.” Butts “would bring to the Commission a background of experience and knowledge” of particular value to the AEC. Strand scribbled at the bottom of the page ‘in releasing him, we would want his continued counsel on tracer element work.”[657] This shows the value of Butt’s growing expertise with radioisotope research. Strand responded to Warren that the college had no stated policy on such types of leave, and the leave of two years was rather long, but Strand wanted to “do everything possible to further the professional welfare of our men.” Several letters were exchanged. Paul Person, Chief of the Biology Branch of the Division of Biology and Medicine reiterated Butts was needed for “his experience in guiding our research program in the field of biochemistry.” Not only that, Pearson wanted President Strand to understand that thus far, all the two year AEC temporary staff hired from colleges had returned to their faculty positions and “we feel it is rather essential that these men be encouraged to return to their institutions” to make is possible to bring “outstanding men from colleges and universities” into the work of the AEC.[658] This design of temporary service allowed Butts and others to increase their AEC experience, credentials and prestige, without losing any perceived academic independence.

Butts’s life trajectory would be changed by the prestigious two year position. He went from college professor to Assistant Chief of the Biology Branch with the Biology and Medicine Division of the AEC. He believed the position would enhance his career.

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[657] Ibid.
[658] Pearson to Strand, June 24, 1952 “Butts, Joseph S” Personnel Records, 1 of 3.

He would have the opportunity to visit "all of the laboratories of the institutions which hold AEC contracts" with the division of Biology and Medicine.[659] His hunch was correct. His position with the AEC allowed him to travel and work worldwide. [660] He also was given access to classified information. As a key AEC staff member, he became a participant in the secret Sunshine Project studies and often represented the AEC abroad.[661] In 1954 Butts explained to participating researchers that the AEC's interest in strontium had increased and assays were being made by contractors of bones, milk, plants and soils. [662] However, unexpected and wide variations of measures of strontium found in bones among various labs demanded some sort of alignment of the variant results. For example, one lab found consistent amounts of strontium across a large sample of human bones, while another found wide variations from one individual to another. Different methods of analysis had been used. [663] As a solution, Butts coordinated "interlaboratory comparisons" of samples of bone ash, powdered milk and soil extracts of strontium among some of the laboratories participating in the Sunshine studies. This was to clarify if the differences in findings were due to geography or some other unexplained factor.[664]

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[659] Butts to Price and Gilfillan August 22, 1952 "Butts, Joseph S" Personnel Records 1 of 3, and Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts" "Butts, Joseph S." Personnel Records 2 of 3, SCARC.
[660] Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts," "Butts, Joseph S., Personnel Records 2 of 3.
[661] "Rand Sunshine Project" 3, this page lists all participants in the Washington DC Sunshine Meeting January 9 and 10, 1954, including Butts, File "US Atomic Energy Commission, Project Sunshine Reports Folder #1" MP 1997-0004 Miscellaneous Physics, American Institute of Physics, College Park, MD.
[662] Butts (AEC Division of Biology and Medicine) to H.H. Mitchell May 24, 1954, "Comparison of Analyses for Elemental Strontium" NNSA/NSO Nuclear Testing Archive, Accession Number NV0721133, DOE OPenNet.
[663] Butts to N.S. MacDonald, May 24, 1954, " Letter to N S MacDonald Letter to N.S. MacDonald "Interlaboratory Comparison of Analyses for Elemental Strontium" NNSA/NSO Nuclear Testing Archive Accession Number NV0721134.
[664] Butts (AEC Division of Biology and Medicine) to H.H. Mitchell May 24, 1954, "Comparison of Analyses for Elemental Strontium," NNSA/NSO Nuclear Testing Archive, Accession Number NV0721133, DOE OPenNet.

His expertise at managing research grew with his work to promote nuclear science on a global scale.

Personal relationships were instrumental to the success of the AEC. Butts was lauded as an outstanding right hand man to Pearson because of his ability to create successful relationships. Pearson wrote an emotional thank you to President Strand for having enabled leave for Butts: “there was a void that I knew would not be filled” after Butts departure to return to Oregon State College. Butts’s central location served to connect the AEC to the Department of the Army and the State Department. Pearson asked Butts to remain as a contracted consultant to the AEC, which Butts did until the end of his life. [665] Butt’s work with the AEC exposed him to current research and built him and the AEC a broad base of researcher and contacts. These kinds of networks enhance prestige and careers. For example, Butts, due in particular to his role with the AEC and his own research into aspects of the respiration of radioactivity by plants, was invited to visit the Radiation Laboratory in Berkeley for a few months if he had so desired before returning to Corvallis from his position with the AEC.[666]

Butts work with the Commission made him irreplaceable to Oregon State College. The techniques of radioisotope research were becoming, according to President Strand, “almost universal in all the research fields.” [667] The special relationship he had with the AEC kept him traveling and working on their behalf for his entire life. His personnel file in the university archives is mostly composed of AEC letterhead requests for long leaves

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[665] Pearson to Butts, August 16, 1954, “Butts, Joseph S.” Personnel Records 1 of 3.
[666] Melivin Calivin (University of California Radiation Laboratory) to Joseph S. Butts, October 26, 1953, "Possibility OF Proponic Acid Activation to Lactic and Pyruvic" NNSA/NSO Nuclear Testing Archive, Accession Number NV0702054.
[667] Paul B. Pearson (Biology Branch Chief of AEC) to Strand, August 17, 1954 and Stand to Pearson, August 20, 1954, “Butts, Joseph S” Personnel Records 1 of 3, SCARC.

for Butts to promote atomic energy. He also worked with the Department of Defense, including traveling in the Middle East with Dr. Frank Berry, Assistant Secretary of Defense.[668] Many of the requests were specific to the spread of Atoms for Peace. He took part in an AEC exhibit in Berlin in 1954 on the peaceful applications of nuclear energy. Three years later Butts served as an ambassador for the Atoms for Peace Program in Paris for one year.[669]

Butts's work shows the meshing of the AEC with global politics and trade. As an Atoms for Peace ambassador, Butts established research programs "using atomic energy or the byproducts of atomic energy."[670] He traveled to 19 countries in Europe and the Middle East.[671] Butts worked closely with 11 western European nations on development of research and education programs. Specifically, while serving the Atoms for Peace program in Europe, he was dual assigned as United States Consultant to the Organization of European Economic Cooperation. The EEC coordinated the application of nuclear science to agriculture and helped "by breaking down trade barriers." Butts encouraged atomic information sharing among the nineteen countries he visited that included Iceland,

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[668] R.W. Henderson to Strand, January 20, 1956, Butts to Henderson, April 10, 1956, Frank B. Berry (Asst. Secretary of Defense) to Strand, October 4, 1955, "Butts, Joseph S" Personnel Records 1 of 3, SCARC. He served as Director of a five man nutritional survey team in Iran in 1956, American Institute of Nutrition "Resolved" April 13, 1961, and Butts to Price and Gilfillian, October 16, 1956, and F.A. Gilfillian to Dean E.B. Lemon, October 24, 1956 in "Butts, Joseph S" Personnel Records 2 of 3.The stated purpose of the trip was "to stimulate interest in nutritional status, particularly of the Armed Forces, although the civilian population is also considered." He was again granted leave in 1956 for three months while he served on the Interdepartmental Committee on Nutrition for National Defense for the Department of Defense. When he explained his research it sounded untried and experimental: "we will attempt to correlate clinical results with biochemical findings which we hope can be related to dietary intake." His risk taking research benefited from his exposure to research being done around the country and internationally.

[669]Henderson to Strand, September 20, 1954 "Butts, Joseph S." Personnel Records 1 of 3; Harold E. Howland (Specialist Division, International Education Exchange Service) to Strand, July 19, 1954, Personnel Records 1 of 3; F.E. Price to A.L. Strand, September 16, 1957 and Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts" "Butts, Joseph S" Personnel Records 2 of 3.

[670] "Dr. Joseph Butts Dies of Dysentery in India" GJ, source unknown, April 11, 1964 "Butts, Joseph S" Personnel Records 3 of 3.

[671] Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts" "Butts, Joseph S" Personnel Records 2 of 3.

Iran, Portugal and "even Communist controlled Yugoslavia." Seventeen of the nineteen countries Butts visited were building reactors at the time. In many countries the reactors were supported by the US. At this time, most countries had an atomic agency modeled after the US AEC.[672] The ease of working with well-organized and like-minded institutions built the nuclear community across cultures and countries in a way that would make modernity simply inseparable from nuclear science.

Butts became an articulate promoter of the work of the AEC. He published for the AEC a 1956 paper called "Isotopes in Agriculture." His article extols the peaceful work of the Atomic Energy Commission, because as he wrote, "too many people think of the Commission only in terms of bombs and instruments of war, quite overlooking" the benefits to mankind of atomic energy. The AEC was "the single most important force in applying nuclear energy and its products to biological and agricultural problems." His article gives an overview of the extent of the reach of AEC research into the university by 1956. One hundred and ninety-five research projects by colleges and institutions were funded by "the Biology Branch alone."[673]

Butts served the vision of nuclear expansion even in his death. He died from amoebic dysentery in 1961 at the age of 57 while reportedly working with an Indian school milk program for children as part of a joint project by FAO, UNICEF and

[672] "OSC Staffer Comes Back" *Oregonian* September 8, 1958, "Butts, Joseph S" Personnel Records 3 of 3, SCARC.

[673] In the article, Butts described one of the most exciting areas of research as the "Gamma Field," which had a large fenced plot being exposed to a cobalt 60 radiation source in the center of the plot. This work by Dr. Ralph Singleton at Brookhaven National Laboratory exposed various plants like corn to study the induction of positive mutations for plant breeding, thus speeding up the improvement of species from 100 years to one. This research was applied to forest studies on trees, shrubs and vines as well. At North Carolina State College, there was exciting research on peanuts and at Brookhaven, oats. Another area dominated by the AEC was fertilizers. Animals were studied as well, see Joseph S. Butts "Isotopes in Agriculture" 1-4, *The Industrial Atom* (Washington DC: Division of Information Services, March 1956) "Butts, Joseph S" Personnel Records, 1 of 3, SCARC.

WHO.[674] He was eulogized by President Strand as someone who died in the line of duty to create a better world for "the undernourished, the sick, the economically depressed and most of all, those who had grasped a new vision for a better life." As a land grant college, the duty of Oregon State College to help "the less fortunate of the world," a duty which increased after World War II, was fulfilled by Butts, who was "following the American university tradition of attempting to help others."[675] The contracts Butts procured from the AEC had totaled "well over a half a million dollars."[676] Butts was an example of the "many 'little men of science' who daily contribute so much to our world, doing so with little or no fanfare. I hope you will agree with me that Dr. Butts, in part, is one of hundreds of 'Dr. Butts' on the staffs of the colleges of foreign lands as well as the colleges and universities of the United States." [677]

When requesting government recognition for Butts, President Strand described him "as an example of selfless devotion to fellow man through a lifetime of service to student, government, and foreign nations through the little known, but highly important field of biochemistry."[678] According to an article in *Barometer,* he died "serving…the cause of international peace and research groups." Strand felt Butts "as an individual did more than an army of thousands in furthering our aims of democracy and in working towards world peace." [679]

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[674] Morris Greene, Regional Administrative Officer FAO to Strand, July 26, 1960, Robert G. Swan to Norblad, May 15, 1961, "Butts, Joseph S" Personnel Records, 2 of 3, SCARC.
[675] "Memorial Service for Dr. Joseph S. Butts," April 18, 1961, "Butts, Joseph S" 2 of 3.
[676] Eulogy by either Paul Weswig or Strand, "In Memory of Joseph Shirley Butts," "Butts, Joseph S" 2 of 3 SCARC.
[677] Robert G. Swan (on Richfield Oil Corporation stationary) to A. L. Strand May 15, 1962, "Butts, Joseph S" Personnel File, 2 of 3.
[678] Robert G. Swan to Norblad, May 15, 1961, "Butts, Joseph S," Personnel Records, 2 of 3.
[679] Ibid.

Conclusion

Oregon State College was part of an emerging system of military and AEC influenced patronage at American universities.[680] There is little doubt among historians that funding in post war America shaped science itself.[681] Science became tailored to national security goals, dominated by threats of nuclear war and militarizing even studies as innocuous as the earth's geochemical systems and weather.[682] From 1944, with the first hire to teach nuclear physics, to the 1960s, radiation safety was established, promoted, and taught by the AEC. This required academics to offer up their bodies and their work areas for a new type of intrusion, for both security and safety, as oaths were sworn, Geiger counters clicked and an occasional urine sample was ordered. What started on campus rapidly became a worldwide modern and normal system of surveillance of bodies and the environment.[683]

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680 OSU can be compared with other college histories, such as Darlene A. Croteau, "Atoms for Peace: A History of the Nuclear Radiation Center at Washington State University" *Columbia* (Summer 2003)11-16 and Robert H. March, "Physics at the University of Wisconsin: A History" Physics in Perspective 5 (2003) 130-149 and Ralph Bray, Solomon Gartenhaus, Arnold Tubis and David Cassidy "A History of Physics at Purdue: The Post-War Years (1945-1958) Department of Physics" "About Us" "History" accessed May 17, 2014, https://www.physics.purdue.edu/about_us/history/post_war.shtml.

681 This is a consensus among many historians, see Seidel "A Home for Big Science, 135-175; Robert W. Seidel, ed., *Historical Studies in the Physical and Biological Sciences, Vol. 18, Pt. 1* (Berkeley: University of California Office for History of Science and Technology and University of California Press, 1988); For the impacts of one man on the organization and identity of scientists during this patronage, see Karen A. Rader, "Alexander Hollaender's Postwar Vision for Biology: Oak Ridge and Beyond" *Journal of the History of Biology* 39, no. 4, Radiobiology in the Atomic Age: Changing Research Practices and Policies in Comparative Perspective (Winter, 2006): 685-706; There are extensive high quality studies of the relationships between the governments, military, corporations, popular culture and academia, that address the larger academic and military labs. How academic science was influenced by the Cold War is well explained in Leslie, *The Cold War and American Science,* Westwick, *The National Labs.* Historian of science Mary Jo Nye examines the foundations of these intersections from the year 1800 to 1940 in her book *Before Big Science.* She explains the links marking the development of "Big Science" that existed prior to World War II and the Manhattan Project, Mary Jo Nye, *Before Big Science: The Pursuit of Modern Chemistry and Physics, 1800-1940* (New York: Twayne Publishers, 1996).

682 For a thorough discussion of how even the earth itself was thought of as a potential weapon by British and American scientists after the use of nuclear weapons opened the gates to total war using nuclear, chemical and biological warfare planning that would utilizing the earths' systems as weapons, see Hamblin, *Arming Mother Nature.*

683 This was even though originally, AEC control had been resisted and suspected as totalitarian and non-democratic, see Hamblin, *Poison in the Well*, 30-31. To understand the details of how AEC regulation was

However, the AEC was as ambivalent about securing safety on campus as in the world.[684] One can see on campus the misleading sense that things were under the control of the AEC, even after it had been discredited and its regulatory functions for radiation health replaced by the FRC. This expansion of nuclear science for peace and war was accomplished by the AEC through its original secretive military genesis and an AEC-cultivated web of academia, industry and international experts and agencies.[685] While the agency demanded compliance, there was little to no oversight on the Oregon campus other than an occasional friendly AEC visit or self-policing of dosimeter and laboratory monitor readings. Safety oversight was an afterthought and was seen as an additional role for AEC trained scientists like Wang, Elder, and Trout, and the novice Radiation Committee. All aligned with the AEC philosophy of a safe threshold for exposure and the hope that radiation dangers could be controlled by a fence, as in the case of the cyclotron, shielding, and dilution.

A bureaucratic network of universities, agencies, technical experts and national commissions grew to tackle the enormously complicated system of monitoring nuclear pollution while at the same time, simplifying for the public the interpretation of radiation contamination. This contamination was a small price to pay for the assumed benefits of modernity. But the nuclear world was built as well by the will of the scientists involved who were respected and rewarded for their expertise and loyalty to the AEC. The AEC relationship allowed them to be “experts” and trailblazers in a time when it was thought their work would create a nuclear age of plenty for all. They also could serve the AEC in

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established, see Walker, *Permissible Dose.* Creager connects this security and surveillance with the start of radioisotope distribution by the AEC, Creager, *Life Atomic,* 400.
[684] Creager, *Life Atomic,* see especially 400-407.
[685] Creager, *Life Atomic,* 407.

international and local venues, building trust with their own conception of nuclear science as the key to a bright future. The infrastructure forged on a college campus expanded to international diplomacy for those who had a new kind of capital because they were skilled in nuclear technology.

The success of the Oregon State College (and later, University) program can be seen in comments by a former Los Alamos Laboratory Test Director. Charles F. Costa was in charge of nuclear detonations for decades and he worked on the Amchitka tests as well. Costa said "The health physics program at OSU with Dale Trout was one of our best, absolute top notch."[686] Not only did these relationships provide easy communication and connections among experts but the AEC and cooperating scientists, educators, and politicians portrayed the nuclear project as inseparable from modernity and cast it as a human rights endeavor.[687] This is a cautionary tale that should not be lost in its banality. The next chapter turns to the very mundane aspects of the AEC management that also led to human rights infractions. Like the early radium craze at the turn of the early 20th century, with no patron to represent the concerned public, the question of "is it safe?" was not asked. For those in a position to decide, there was no question that radiation's benefits could and should be maximized. It was only a matter of how nuclear exposure could be made less dangerous. But that was not a very glamorous question to ask. Most did not want to know if they had guessed wrong.

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[686] Trout's papers show the name of each graduate from his program and their placement. The quote is from a visit to the Las Vegas Atomic Testing Museum on August 22, 2008, and grant applications and press releases refer to the Radiation Center as one of the most powerful research facilities in the nation.

[687] See chapter 1 for information on UNAEC, United Nations Atomic Energy Commission, 1945-1956, Box 3.018 File 8.6 "The International Atomic Energy Agency, by International Review Service, January, 1957" in LP Peace, AHLPP, SCARC. This requires additional study but is my conclusions from the documents held in multiple archives of the IAEA, WHO, UNESCO, ILO and AEC documents in NARA II.

Chapter 6 In the Mundane

Accordingly, it is hereby declared to the policy of the people of the United States that, subject at all times to the paramount objective assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace. Atomic Energy Act, 1946[688]

This chapter will show how an institution like the Atomic Energy Commission that was founded and entrusted to advance the human rights of peace and prosperity, could simultaneously cause such large scale radioactive contamination with future genetic and somatic risks.[689] Human rights can be defined as Linus Pauling and Marshallese Islanders did in the fallout cases, as inalienable rights to "life, liberty and the pursuit of happiness." In addition, both the AEC and UN agencies were defined by a directive to protect and promote human rights and welfare. The rights to health and human rights were specifically accorded in founding documents of UN agencies in pursuit of the goals of world peace. However, even as a right to health and human rights is disputed as a subjective effort to define contested universals, the reality is these health and human rights aims justified the very existence of the UN Charter and the AEC alike. However, without any mechanism for legal enforcement, or precedent of radiation contamination as a violation of health and human rights in either the United States, or the Court of Justice, these rights were still asserted by plaintiffs as preexisting, inalienable rights in legal suits, including the failed fallout cases from 1958-1964.

[688] "An Act for the Development and Control of Atomic Energy" Public Law 585- 79th Congress Chapter 724-2nd Session (S. 1717) accessed April 26, 2014, http://science.energy.gov/~/media/bes/pdf/atomic_energy_act_of_1946.pdf.
[689] Much literature outlines the institutional history of the AEC by official government and non-government historians, to give many overviews of an agency that had few limits to power and include many previously cited, but for radiation history specifically see especially Walker, *Permissible Dose.*

Despite the US influence and eventual signature on the Universal Declaration of Human Rights, (adopted in 1976 by UN members as binding law as part of the International Law of Human Rights) the right to health and human rights remains unrecognized for its role as nuclear arbiter. There is agreement among antinuclear groups, exposed communities, academics, Congressional investigations and legal suits that nuclear technology has, in fact, impinged on Constitutional, as well as heath and human rights.[690] In particular, a 1994 investigation of AEC human radiation experiments found health impacts and ethical violations that included the victims of the errant Castle Bravo shot, uranium miners, Pueblo Indians located near Los Alamos, patients that underwent unknowingly thousands of human medical experiments, atomic soldiers, and populations exposed to purposeful radiation releases.[691] In retrospect, the lack of definition of these "unethical acts" as health and human rights violations by the 1994 investigation makes them no less so.

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[690] Joseph J. Mangano, *Low-Level Radiation and Immune System Damage* (New York: Lewis Publishers, 1999), Howard L. Rosenberg, *Atomic Soldiers: American Victims of Nuclear Experiments* (Boston: Beacon Press, 1980), Rodger S. Clark and Madeleine Sann, eds., *The Case Against the Bomb: Marshall Islands, Samoa and Solomon Islands before the International Court of Justice in Advisory Proceedings on the Legality of the Threat or Use of Nuclear Weapons* (Camden, NJ: Rutgers University School of Law , 1996), Harvey Wasserman and Norman Solomon, *Killing Our Own: The Disaster of America's Experience with Atomic Radiation* (New York: A Delta Book, 1982), Howard Ball, *Justice Downwind: America's Atomic Testing Program in the 1950s* (New York: Oxford University Press, 1986), Ernest Sternglass, *Secret Fallout: Low Level Radiation from Hiroshima to Three Mile Island* (New York: McGraw Hill Book Company, 1981); Eileen Welsome, *The Plutonium Files: America's Secret Medical Experiments in the Cold War* (New York: The Dial Press, 1999); Howard L. Rosenberg, *Atomic Soldiers : American Victims of Nuclear Experiments* (Boston: Beacon Press, 1980); Masco, *Nuclear Borderlands;* Valerie L. Kuletz, *The Tainted Desert: Environmental Ruin in the American West* (New York: Rutledge, 1998); Jay M. Gould and Benjamin A. Goldman, *Deadly Deceit: Low-level Radiation, High-level Cover-up* (New York: Four Walls Eight Windows, 1993), Pasternak, *Yellow Dirt: An American Story for a Poisoned Land and A People Betrayed* (New York: Free Press, 2010); Michael D'Antonio, *Atomic Harvest: Hanford and the Lethal Toll of America's Nuclear Arsenal* (New York: Crown Publishers, 1993) and previously cited works by Hamblin, Hacker, Walker, Brugge, Caufield, Makhijani, Udall, Van Wyck, Gofman, Lifton and Pauling.

[691] See chapter 1 for a more extensive description of health and human rights as embedded in the mission of the UN and UN agencies; See previously cited, "Advisory Committee on Human Radiation Experiments: Executive Summary and Final Report" (1994) Department of Energy, accessed May 9, 2014, https://www.osti.gov/opennet/spotlight.jsp and "Advisory Committee on Human Radiation Experiments Final Report" see "Findings: Biomedical Experiments 1944-1974" Chapter 17, 789-95.

The expansion of nuclear technology shows the privileging of some rights over others created health and human rights abuses. Mundane organizational and daily conduct of operations emboldened the trajectory of the AEC, and other agencies such as the International Atomic Energy Agency (IAEA). How could protection of nations, with weapons and power, result in the weakening of bodies and the environment with pollution? This history can be explained as "national security trumped individual rights" but such an explanation can be parsed further. Historians and philosophers like Hannah Arendt argue that violations of human rights can be partially explained by the mundane role of organization and bureaucracy.[692]

How can it be that the AEC, an organization founded on peace and welfare would be responsible for worldwide contamination with long-lived radioactivity? Looking back, it is well understood that radiation itself, since the discovery of X-rays in 1895, was at best hard to fathom, much less control.[693] Unseen risks became delayed harm, or even death. The idea persisted however, that below a certain threshold, radiation was safe. The thought that radiation might even be good for one's vitality would continue long after evidence accumulated that this notion was rife with uncertainty.[694] Later, the Manhattan Project operated under crisis conditions of secrecy and fear. This ensured even less rigorous protection with increasingly dangerous experimentation with atomic weapons

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[692] Robert Jay Lifton and Eric Markuse, *The Genocidal Mentality: The Nazi Holocaust and Nuclear Threat* (New York: Basic Books, Inc., 1990); David Kauzlarich and Ronald C. Kramer *Crimes of the American Nuclear State: Home and Abroad* (Boston: Northeastern University Press,1998), 143-161; Hannah Arendt, *Eichmann in Jerusalem: A Report on the Banality of Evil* (1963) (Rev. ed. New York: Viking, 1968)
[693] Lavine, *The First Atomic Age.* Much is explained by the legacy of the first radiation age, where the radium industry persisted despite harm and deaths. See also Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942- 1946,* (Berkeley: University of California Press, 1987) and Samuel Walker "The Atomic Energy Commission and the Politics of Radiation Protection, 1967-1971" *Isis* 85, (1994): 57-78.
[694] Walker, *Permissible Dose*. Hormesis is an idea that still finds some support in studies, see Edward J. Calabrese, "Hormesis: From Marginalization to Mainstream" *Toxicology and Applied Pharmacology* 197 no. 2 (2004).: 125–36, accessed April 17, 2014, http://www.sciencedirect.com/science/article/pii/S0041008X04001292

and fission.[695] During this time, the mining of uranium by Native American workers without concern for their welfare, human radiation experiments, and the lack of evacuations or health warnings at the first Trinity atomic weapons test, set the stage for future human rights abuses.[696] The infringements and violations of human rights only grew more ubiquitous in the conduct of the AEC.[697]

The influence, power and reach of the AEC and the nuclear industry largely shaped global nuclear politics and policy since its inception in 1946. The agency had dual responsibility for safety and promotion of nuclear technology and ignored and even suppressed information on health effects from radiation.[698] The culture of the AEC encouraged secrecy, and required compartmentalized thinking. Many forgot that science requires doubt as well as confidence. The scientists shared in common an elite knowledge, hidden from others. This would have impacts on how they approached their work long after the declassification of some of the data needed for the expansion of commercial

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[695] Lavine, *The First Atomic Age;* Howard Ball, *Cancer Factories: America's Tragic Quest for Uranium Self Sufficiency* (London: Greenwood Press, 1993).

[696] Doug, Brugge, Timothy Benally, and Esther Yazzie Lewis, eds. *The Navajo People and Uranium Mining* (Albuquerque: University of New Mexico Press, 2006); Masco, *Nuclear Borderlands*; Dennis J. Carroll, "Downwinders Welcome Study of Trinity Impacts" *Santa Fe New Mexican* January 25, 2014, accessed April 17, 2014, http://www.santafenewmexican.com/news/local_news/downwinders-welcome-study-of-trinity-blast-s-impacts/article_830c1f00-7630-5e63-8d57-a07311978140.html

[697] Examples include the ongoing use of people and soldiers as subjects in human radiation experiments and the exposure without consent of the public and earth at large during nuclear weapons tests and nuclear plant accidents. For information on the admitted and pervasive extent of nuclear pollution from weapons testing, mining and nuclear accidents, see B.G. Bennett, "Worldwide Panorama of Radioactive Residues in the Environment" in *Restoration of Environment with Radioactive Residues Papers and Discussions Proceedings of an International Symposium in Arlington Virginia USA 29 November to 3 December 1999* (Vienna: International Atomic Energy Agency, 2000).

[698] To explore the conflict of the dual promotional and regulatory roles of the AEC in nuclear power production, see George T. Mazuzan, "Atomic Power Safety: The Case of the Power Reactor Development Company Fast Breeder 1955-1956" *Technology and Culture* 23, no. 3 (Jul., 1982): 341-71; Walker, *Permissible Dose*; Barton Hacker, *Elements of Controversy* and *The Dragon's Tail*. For international regulation history see Soraya Boudia, "Global Regulation: Controlling and Accepting Radioactivity Risks" *History and Technology* 23, no.4 (2007): 389-406. For a careful political history, that shows the overlaps between the success of individual GAC members in their careers due to their association with the AEC, see Richard T. Sylves, *The Nuclear Oracles: A Political History of the General Advisory Committee of the Atomic Energy Commission, 1947-1977* (Ames, IA: Iowa State University Press, 1987).

nuclear power by the Atomic Energy Act amendments of 1954. Those working for the AEC and in the nuclear industry also shared an anticommunist identity, believing themselves as objective as possible, with a common wish to deny harm and hope for the best.[699] This denial of harm was compounded and encouraged by the daily conduct of the organization of the AEC itself and the institutions the AEC influenced.

The bonds between the agency and scientists left little room for boundaries or doubt. Most all American and non-American scientists involved in nuclear science were in relationship with the AEC, other national atomic energy agencies, and the IAEA. Individual scientists and non-scientists such as industrial and military men worked collectively to serve the daily work and operations of agencies and industries that had crisp, compelling visions for the world's nuclear future but few, if any limits, to their power.[700] This would create a science with a reach to contaminate unlike any other before.

For Welfare and Peace

At the heart of the founding of the AEC was the hope for disarmament. The proposal of the AEC began for some as a venture for peace. It was intended as an agency to promote nuclear technology for economic equality coupled with disarmament to *save* the world from the scourge of nuclear weapons. And perhaps, for some of the atomic scientists who wanted to salvage meaning from their war work, even to end war itself.

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[699] This is the overall impression I have of particularly of health physicists from archival documents, oral histories, autobiographies, and primary sources and secondary literature include Sean F. Johnston, *The Neutron's Children, Nuclear Engineers and The Shaping of Identity* (Oxford: Oxford University Press, 2012), Walker, *Permissible Dose*, Hacker, *Elements of Controversy* and *The Dragon's Tail*. For more explanation of the anticommunist fervor of the era and fear of nuclear scientists, see Lawrence Badash, "Science and McCarthyism" *Minerva* 38 (2000):53-80.

[700] A representative list of titles that discusses this culture include Johnston, *The Neutron's Children*, Paul Loeb *Nuclear Culture: Living and Working in the Largest Atomic Complex* (New York: Coward McCann & Geoghegan, Inc, 1982), Daniel Ford, *The Cult of the Atom: The Secret Papers of the Atomic Energy Commission* (New York: Simon and Schuster, 1982) and from an AEC participant, Ralph E. Lapp, *The New Force: The Story of Atoms and People* (New York: Harper & Brothers Publishers, 1953).

Establishing the AEC itself was a hard fought victory for former Manhattan Project scientists. Many of the scientists who had built the first atomic weapons organized as the Federation of Atomic Scientists (FAS) to work for international and civilian control of atomic weapons. The scientists, despite no previous political experience, prevailed to defeat what was General Groves' attempt to solidify military control of atomic weapons. This resulted in the creation of a civilian Atomic Energy Commission, with a non-military administrator to act as manager and five Commissioners to be appointed by the President.[701] A Joint Committee would provide Congressional oversight with a Military Liaison committee and a nine- member all-civilian Advisory Board to oversee operations. The founding documents of the AEC, the Atomic Energy Act (the McMahon Act or the AEA, 1946) explain that the government agency would be responsible for minimizing

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[701] The Manhattan Project transferred to the control of the AEC on January 1, 1947 the twelve facilities that made the first nuclear bombs were transferred to AEC civilian control. The effort to create a civilian agency to oversee and non-militarize the benefits of nuclear power was primarily led by former Manhattan Project scientists, see LP and the International Peace Movement "Statement of the Federation of Atomic Scientists" accessed April 26, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/peace/papers/peace4.012.7-statement.html. See AHLPP LP Peace section "Atomic Energy: Early Legislative History and the Struggle for International Control" which contains the early efforts of former Manhattan scientists. For an especially vivid record of this work, see clippings in 3.012 Emergency Committee of Atomic Scientists file 12. 5 "Non-Pauling typescript, Newspaper Clippings, Publicity Clippings 1946-1948" and Correspondence, "Telegram from George Pepper to Linus Pauling, November 25, 1945", accessed April 26, 2014, http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/peace/corr/peace4.012.7-pepper-lp-19451125.html and previously cited Strickland, Hager, Wittner, and Brown. The AEC Commissioners chose four Directors who were to be in charge of four divisions: Research, Production, Engineering and Military Applications. The director of the Military Applications research was to be in the Military. Two advisory bodies, the General Advisory Committee of nine civilians appointed by the President and the Military Liaison committee were also appointed by the President. The Commission was empowered to make any contracts to fulfill research goals, but none of these research goals were ever explicitly listed as either health or safety for the public see "An Act for the Development and Control of Atomic Energy" Public Law 585- 79th Congress Chapter 724-2nd Session (S. 1717). Of the five rotating presidentially appointed AEC commissioners that directed the agency over the years, most were involved with the nuclear industry, or lawyers, agency directors, politicians and physical scientists, Angela Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago: University of Chicago Press, 2013) 2.

hazards to public health and safety.[702] On paper, the organization would serve the welfare of all. But making real an idea can be precarious.

The victory by the former atomic scientists was a mirage. The new agency for peace became indelibly a military weapons venture. The military nuclear labs, despite academic ties, retained their personnel and core defense focus.[703] Civilian control proved elusive. Soon McCarthyism and a genuine fear of the Soviet threat would consume the nation to undermine the project of nuclear disarmament. This would paint those who supported weapons control as communists, or worse.[704] According to Hans Bethe, the AEC was conceived as a group charged with the mission to dismantle atomic weapons, but was quickly co-opted by proponents of these weapons, despite their civilian status.[705]

Three years into the AEC's operations, the author of the Atomic Energy Act, Senator Brien McMahon

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[702] Five men would be appointed by the President, and approved by the Senate to compose the AEC, with the chair chosen by the President. Salaries of $15,000 and $17,500 for the chair are in the 1946 act. The Manager of the AEC was paid $15,000 the same as the other 4 Commissioners. The Joint Committee was composed of nine Senators, and nine Representatives, each group appointed by the President of the Senate and the President of the House. No more than 5 members could be of the same party. The Military Liaison number of persons would be determined by the Secretaries of War and the Navy "as they see fit" see "Atomic Energy Act of 1946, Public Law 858, 79th Congress" 4, http://science.energy.gov/~/media/bes/pdf/atomic_energy_act_of_1946.pdf "Draft Principle Assumptions of the Atomic Energy Act" 2, 3 File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II, College Park, MD.

[703] For a much more nuanced analysis of the National Lab system in detail, see Westwick, *The National Labs.*

[704] An excellent presentation of the effect of McCarthyism on science as a whole is in Lawrence Badash, "Science and McCarthyism" *Minerva* 38 (2000): 53-80 and the struggle of civilian control during these years is in Sylves, *The Nuclear Oracles.*

[705]The despair at this cooption came across in a video of Hans Bethe called "The Founding of the FAS" which has now been removed from their webpages, April 26, 2014 http://www.fas.org/press/tools/_video/bethe_fasfounding.html but he shares his disappointment in Hans A. Bethe, *The Road to Los Alamos* (New York: Simon & Schuster, 1991) 25-6. Also, see a history using primary documents of the struggle for civilian and international control by SCARC, "Linus Pauling and the International Peace Movement" accessed April 26, 2014 http://scarc.library.oregonstate.edu/coll/pauling/peace/narrative/page1.html For more on the history and current nuclear weapons free efforts of FAS see http://www.fas.org/.

wrote privately to the President, despondent. He wrote, "it remains an open question whether or not this new force can be wholly integrated in the fabric of free institutions."[706]

Totalitarian control from communists was feared as the power of the AEC grew at home.[707] McMahon and Carl Durham, both members of the Joint Committee of the AEC (that was designed for Congressional oversight of the AEC) said they felt they were violating their duty as Congressmen because their oversight was in fact, limited. [708] Since much of the AEC work was secret, the public was supposed to be represented by the JCAE as their Congressmen and Senators. But the AEC had unlimited ability to make contracts, loans and agreements.[709] McMahon spelled out his objections, saying the AEC "plans a reactor development program that will costs more than a half a billion dollars." Suppose if the JCAE did not agree with those plans? McMahon, of course, he said, did agree-- but just to illustrate the problem, he asked the President to imagine what would happen if the JCAE had an important objection? What if that objection were grave, like "the possibility of a radiation accident would endanger the lives of millions of people

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[706] Brien McMahon and Carl Durham to "Dear Mr. President (Draft)" u.d. but three years after the AEA was passed, so likely 1949, quotation on 1 and "Atomic Energy, Hearings before the Committee of Military Affairs, House of Representatives, Seventy ninth Congress First Session on H.R. 4280 An Act for the Development and Control of Atomic Energy" File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II. The early proponents of the AEC wanted the organization to be civilian precisely because the totalitarian nature of atomic energy threatened democracy, as did the unlimited appropriation of funds that had been intended to be temporary, until disarmament were concluded by the UN AEC and nuclear reactors became viable.

[707] A 42 page Princeton study found government is ruled not by voters but by economic elites, see JC Sevcik "The US is Not a Democracy but an Oligarchy, Study Concludes" *UPI* April 16, 2014, accessed April 19, 2014 http://www.upi.com/Top_News/US/2014/04/16/The-US-is-not-a-democracy-but-an-oligarchy-study-concludes/2761397680051/.

[708] "Atomic Energy Act of 1946, Public Law 858, 79th Congress" 19-20, accessed April 26, 2014, http://science.energy.gov/~/media/bes/pdf/atomic_energy_act_of_1946.pdf

[709] "An Act for the Development and Control of Atomic Energy" Public Law 585- 79th Congress Chapter 724-2nd Session (S. 1717).

living near the area selected as a site?"[710] For McMahon even this strong of an objection could not interfere with the AEC plans.

Congress had already fully funded the AEC due to the emergency appropriations put in the original Atomic Energy Act. McMahon explained to the President that this was out of the normal democratic practice; even the military, vital for the country's defense, must gain approval of projects with specific budgets. Furthermore, McMahon felt "our fellow Congressmen are tempted to think of the Commission as a kind of specially privileged bureau whose actions are 'above the law.'"[711] He described the AEC as having "a well-nigh gargantuan powers" that the JCAE had wanted to limit as early as a year into their operations.[712] For the AEC, not even the sky would be a limit. In later years, weapons tests would take place in outer space, but this mastery of technology could not be applied to an antidote or remedy for radiation's negative effects.

How the AEC was structured contributed to some of the ignorance of radiation's dangers. This was especially of true of long term and low-level exposure. The AEC bureaucratic organization delineated subject areas that did not include explicit consideration of radiation's effects on human health.[713] The Commission was empowered to make any contracts to fulfill four primary research goals, including "the protection of health during research or production activities." The AEC was directed by the Atomic Energy Act to establish standards

[710] McMahon and Durham to "Dear Mr. President (Draft)" quotation on 3. File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1, Entry 1A, RG 326, NARA II.
[711] McMahon and Durham to "Dear Mr. President (Draft)" quotation on 6.
[712] Ibid., quotation on 12. Enclosed in this file that belonged to Lilienthal is a draft copy of how parts of the 1946 bill could be struck out to amend it. By the 1954 update, I am unclear if what changes are adopted.
[713] The proponents of the AEC wanted the organization to be civilian precisely because the totalitarian nature of atomic energy threatened democracy. This is clear throughout the file and especially in the transcripts of the hearings, see "Atomic Energy, Hearings before the Committee of Military Affairs, House of Representatives, Seventy ninth Congress First Session on H.R. 4280 An Act for the Development and Control of Atomic Energy" File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II.

to protect health and minimize dangers, "as deemed necessary." Radiation dangers, however, were not explicitly mentioned and interest in health did not extend beyond workers' safety. The AEC had no research project directed towards the public. There were no prescribed mechanisms or protocols for health and safety enforcement beyond licensing powers.[714] This lack of investment in health and safety was common in other elements of the design of the agency.

Volunteer panels of experts, from newspaper editors to industrial tycoons to doctors, advised the AEC. The goal of these early advisory committees was to establish best practices for the success of the AEC as a decentralized agency. The AEC was struggling with how to maintain secrecy for national security while creating a fair and open capitalistic market for raw uranium materials and nuclear technology.[715] This management structure, however, created long lasting advising areas for the AEC that included extensive nuclear science research but no primary advising focus on health and safety for either personnel or the public. The Personnel Committee, responsible for the workforce and labor relations, had no explicit mention of health or safety for workers in their directives in the AEC's outline of their responsibilities.[716]

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[714] "An Act for the Development and Control of Atomic Energy" Public Law 585- 79th Congress Chapter 724-2nd Session (S. 1717). 4, 7-9, 11, 18. The word health is mentioned three times, and safety two.
[715] All the files in this box refer to this process of committee establishment and advisory responsibilities, see Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II.
[716] "Notes on the First Meeting of the AEC Advisory Committee on Personnel Management" September 8, 1948 File "Advisory Committee on Personnel Management- Correspondence," Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II. The four areas are explained on page 2 of the notes as "1) Production of fissionable materials, 2) Research, Development, Production, Testing of Weapons 3) Development of Reactors and all materials closely related thereto 4) Research in the field of Physical Sciences and research in the field of Biology and Medicine." Later documents including the flow chart of the US Atomic Energy Commission US AEC, "Letter from the Chairman and Members of the AEC, Third Semi-Annual Report to the Congress by the US AEC " February 2, 1948 (Washington: US Printing Office, 1948) 2-3, 16-19 41, File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950 Box 1 Entry 1A RG 326 Records of the Atomic Energy Commission, NARA II. The report had thirteen main subject areas from the Division of Raw Materials to a Division of Biology and Medicine, but not one division dedicated to health and safety despite its mention as one of four main areas of focus in the 1946 AEA document.

AEC research focused on refining nuclear technology for offensive, defensive, and commercial applications. Overall, the expertise of health protection lagged far behind the AEC's ability to produce and test nuclear weapons, use radioisotopes, and build reactors. [717] Or as Eugene Wigner had described this consuming interest during the last year of the war, "everyone could play the game of designing new nuclear piles…we were like children in a toy factory." [718] Years later health physicist Ralph E. Lapp explained, "technology had become dictator of its use."[719] There are many other reasons for this, beyond wartime urgency, including the impetus of profit by industrial investment and physicists' love of technology.[720] But health physics would have none of the glamour of nuclear physics experiments with equipment like cyclotrons, accelerators, and reactors. Research did not include health and safety as a topic at all in early organizational documents, other than the improvement of measuring devices such as Geiger and alpha counters and ionization chambers.[721] Disciplinary boundaries also limited studies to fields of physics, chemistry and biology, with a laboratory focus, while radiation crossed academic lines to enter the environment.[722]

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[717] US AEC, "Letter from the Chairman and Members of the AEC, Second Semi-Annual Report to the Congress by the US AEC" July 23-24, 1947 3, US AEC, "Letter from the Chairman and Members of the AEC, Third Semi-Annual Report to the Congress by the US AEC " February 2, 1948 (Washington: US Printing Office, 1948) 2-3, 16-19 41, File "Atomic Energy Act of 1946" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950, Box 1, Entry 1A, RG 326 Records of the Atomic Energy Commission, NARA II.

[718] Johnston, *The Neutron's Children,* 109.

[719] Ralph E. Lapp, *My Life with Radiation: Hiroshima Plus Fifty Years* (Madison, Wi:Cogito Books, 1995) 120.

[720] An important history of the seductive nature of technology and machines in physics is in Galison's *Image and Logic.*

[721] "Organization of Subject Research" 1-6 undated but a part of November 5, 1949 meeting notes File "Area Manager's Meetings" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950, Box 1, Entry 1A, RG 326 Records of the Atomic Energy Commission, NARA II.

[722] Early "Radioactivitists" however, had been primarily interdisciplinary scientists but the splits become clear by the time of Big Science. These boundaries and tensions between physics and other disciplines appear in the records of IUPAC and the Cain Conferences at the Chemical Heritage Foundation Archives as well as NARA II records but are established by Jolly, "Linus Pauling and the Scientific Debate Over Fallout Hazards." *Endeavor* 26, no. 4 (2002): 149-153. For much more detail on the disciplinary boundaries,

Geneticist Hermann J. Muller used his prize notoriety to speak about the dangers of radiation, but to little avail. In his 1946 Nobel lecture he concluded by warning "the problem will become very important of insuring that the human germ plasm - the all-important material of which we are the temporary custodians - is effectively protected from this additional and potent source of permanent contamination."[723] This genetics-based opposition to weapons and power was soon to be considered a product of the communist Russians, who had been leaders in genetics when Muller researched in Russia.[724] Some scientists felt Muller's case was far too difficult to prove: the effects he had seen in the *Drosophila* fruit fly were dismissed as not comparable to human genetics. Despite Muller's opposition, the first radiation standards for the general public did not take genetic risks into account. These radiation safety standards were on the whole determined in meetings at Chalk River in 1949 (but not released to the public until 1954) by a small committee of mostly former Manhattan Project and AEC scientists. Even though the group included Muller, he was isolated as a geneticist. The only consensus on genetics was the need for further research.[725]

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see his dissertation, "Thresholds of Uncertainty: Radiation and Responsibility in the Fallout Controversy." (Ph.D. diss., Oregon State University, 2003); For the professionalization of nuclear labor and noting the new field of radiation protection, see Howard M. Vollmer and Donald L. Mills, "Nuclear Technology and the Professionalization of Labor" *The American Journal of Sociology* 67, no. 6 (May, 1962): 690-696; Both Caulfield and Walker *Permissible Dose* give extensive history on the making of radiation safety science and the challenges of the science itself.

[723] The prize is listed as for medicine or physiology, Muller Lecture, "The Production of Mutation" Nobelprize.org, accessed April 26, 2014, http://nobelprize.org/nobel_prizes/medicine/laureates/1946/muller-lecture.html. The work of Muller is summarized well in the Presentation Speech, accessed May 18, 2014, http://nobelprize.org/nobel_prizes/medicine/laureates/1946/press.html.

[724] Jolly, *Thresholds of Uncertainty;* "Hermann J. Muller Biographical" Nobelprize.org, accessed May 18, 2014, http://www.nobelprize.org/nobel_prizes/medicine/laureates/1946/muller-bio.html. Muller, an American, had spent 3 1/2 years as Senior Geneticist at the Institute of Genetics of the Academy of Sciences of the U.S.S.R., in Leningrad later then in Moscow (1934-1937) until the rise of Lysenko-ism, when he moved to the Institute of Animal Genetics, University of Edinburgh.

[725] US Department of Commerce, *Permissible Doses from External Sources of Ionizing Radiation* Box 7.001 File 1.4 "Booklet: Permissible Doses from External Sources of Ionizing Radiation U.S. Department of Commerce, September 24, 1954" LP Peace AHLPP. For much more on this history and the isolation of

Part of controlling consensus comes from making the agenda. The AEC learned this when pushed too far towards safety concerns by industry and their own advisors. The AEC by 1955 found it necessary to develop policies for control of industrial and AEC Advisory Board meetings.[726] **As o**ne directive underscored, it is the responsibility of the AEC employee attending advisory board meetings to ensure that the "meetings are conducted within the agenda established by the government."[727] The AEC would provide Advisory groups with their agendas.[728] From meeting agendas to even small scientific conferences, AEC scientists dominated the agendas of nuclear- focused scientific meetings. This can be seen in even in the annual Gordon Cain Conferences. These conferences served to isolate priorities for fields and set an agenda for research. From the late 1940s to the mid 1960s, two decades of radiation and nuclear chemistry conferences, radiation health and nuclear pollution was rarely addressed, easily lost and dismissed. It was most often the AEC experts, most of whom worked with technology in military labs, that chose the papers to be presented. They had been taught not to fear; radiation was part of life. An equipment and laboratory focus consistently limited inquiry by the selection

genetics see Jolly, *Thresholds of Uncertainty*. To learn about the history of biology, genetics and fly research, see Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994).

[726] "AEC Technical Assistance Meetings for the Civilian Applications of Atomic Energy, Report to the General Manager from the Director, Division of Organization and Personnel" undated but the report concerns a meeting held in Pittsburgh by the division of Reactor Development in December of 1955 and the discussions held in May of 1956 on this topic of control of meetings, File "Organization and Management-7 Committees and Boards" Box 66 NN3-93-010 1993 Office of the Secretary, General Correspondence 1951-1958 from Organization and Management 6- thru Organization and Management 7, RG 326 Records of the AEC, NARA II.

[727] Lee Hydman Division of the General Counsel, Ed Falker Division of Organization & Personnel "10 CFR 7-Recommendation to Amend" December 4, 1956 File "Organization and Management-7 Committees and Boards" Box 66 NN3-93-010 1993 Office of the Secretary, General Correspondence 1951-1958 from Organization and Management 6- thru Organization and Management 7, RG 326 Records of the AEC, NARA II.

[728] R.W. Cook, Acting General Manager to Senator Anderson, November 2, 1958, Organization and Management-7 Committees and Boards" Box 66 NN3-93-010 1993 Office of the Secretary, General Correspondence 1951-1958 from Organization and Management 6- thru Organization and Management 7, RG 326 Records of the AEC, NARA II.

first of the chair, a position frequently given to AEC connected scientists. For example, Glen Seaborg served as the chair of the Gordon Cain nuclear chemistry committee.[729] The chair would choose which topics were worthy of study, and select which scientists' work and abstracts were worthy of their attention.[730] Additionally, the AEC often invited itself to meetings by writing the organizers and commenting on the exciting work the AEC was doing in the field.[731]

Often studies contained AEC experts invisible under the umbrella of another group, appearing as if studies were independent. For example radioactive and other concerns about the weather were addressed by the NAS BEAR committee in 1956. But the study was instigated by the AEC Biology and Medicine Division, and then became a joint investigation later under the NAS BEAR name.[732] Self policing and editing was the norm for meetings, as in the unclassified Conference on Possible Effects of Nuclear

[729] Coryell to George W. Parks (Director, Gordon Cain Research Conferences) July 23, 1953, Coryell writes to thank Parks for the landmark in nuclear chemistry meeting that has been led by Seaborg just after receiving his Nobel Prize File 25.265a Series III "Nuclear Chemistry, Records of the Gordon Conferences" see also File 33.9 "The AAAS Schedules Gordon Research Conference for 1952" which ran in *Chemical Engineering News*, vol. 30, April 7, 1952, page 1438 in Series V. Programs Box #87 (Programs, 1947-1952), Othmer Library, Chemical Heritage Foundation, Philadelphia.

[730] This was clear in conference and correspondence notes from the IAEA, UNESCO and WHO archives as well as at the AEC files at NARA II and in the Gordon Cain collection at CHF.

[731] Many examples of this are in multiple archives, from the IAEA to RG 326 to the Gordon Cain Conferences at CHF. Just one example is a June 4, 1954 letter from Charles R. Horner (Division of Reactor Development, AEC) to George Parks of the National Research Council (NRC). Horner writes "I feel the Gordon Research Conference would offer an excellent opportunity for Dr. Schuman [from the Naval Research Laboratory] to make known the details of his investigation. At the same time, I should think that a paper on this subject [dosimetry of high intensity gamma radiations] would be most interesting to those people who are concerned with the problems of radiation damage, dosimetry, or even in the broader phases of solid state physics. Will you kindly consider the possible presentation of such a paper and accordingly advise me? " "Records of the Gordon Conferences" CHF.

[732] The meeting notes reflected nonchalantly on this usual overlap: "We thought it would be very worthwhile to combine the meetings. Essentially the same people will be involved. However, the NAS group shall meet on its own, although anyone who wishes to attend that meeting is welcome." "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather, February 27, 1956, National Academy of Science Building, DC" 1, in File "ORG: NAS Coms on BEAR 1956 Metrologic Meetings Transcript" National Academy of Science Archives, Washington, DC. While the NAS BEAR was funded by the Rockefeller Foundation, these studies were never independent as projected by the AEC in public, see Hamblin, "'A Dispassionate and Objective Effort:' Negotiating the First Study on the Biological Effects of Atomic Radiation." *Journal of the History of Biology* 40 (2007): 147-77.

Explosions on the Weather. Participants were instructed that "We would appreciate it if no account of this gets to outsiders, especially journalists."[733] One reason for this is that at the end of such meetings, a consensus report was usually designed to be released to the press. [734] The AEC had long term cultivated relationships with select newspaper editors, science writers and reporters.[735] This obscured for the newspaper reader the actual amount of disagreement among scientists. For example, at this same meeting on the weather, which discussed errors in Libby's calculations of how long radiation would stay in the stratosphere, the scientists also discussed concerns that atomic bomb testing might decrease the amount of ozone (the protective layer around the earth), or change the albedo of the earth (the amount of radiation reflected by the planet) due to the debris from tests in the stratosphere.[736]

Other findings suspected the tests had disturbed the climate due to the continental testing at the Nevada Test Site. Scientist Brendan Vonnegut shared his findings that radiation from nuclear weapons tests should cause "significant changes in the distribution of conductivity." [737] This change could create droughts downwind of the test site. Precipitation since the beginning of testing had notably decreased. The number of

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[733] "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather, February 27, 1956, National Academy of Science Building, DC" 1, in File "ORG: NAS Coms on BEAR 1956 Metrologic Meetings Transcript" National Academy of Science Archives, Washington, DC.

[734] "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather, February 27, 1956, National Academy of Science Building, DC" 143, 156-60, in File "ORG: NAS Coms on BEAR 1956 Metrologic Meetings Transcript" National Academy of Science Archives.

[735] This was also true of scientists, politicians and college administers, see Carroll L. Wilson, February 3, 1949, File "Correspondence: Advisory Committee to Make Technical Information Available to American Industry" Records of the Office of the Chairman, Office Files of David E. Lilienthal, Subject Files, 1946-1950, Box 1, Entry 1A, RG 326 Records of the Atomic Energy Commission, NARA II, College Park, MD.

[736] "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather," 143, 156-60, NAS Archives.

[737] Vonnegut was the brother of Kurt Vonnegut. While the AEC representatives Dunning and Claus were polite, they disagreed with each point, discrediting his work, and only agreed more studies needed to be made. "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather" 39, NAS Archives.

tornadoes had increased four times. While Vonnegut noted nothing could be certain, he said he feared the same mistakes that had been made with biological systems in the first radiation age could conceivably be happening now with the interrelationship of radiation, climate and weather.[738]

That there had been a change in the weather was not disputed, only if it was atomic bombs that had caused it. Military and RAND representatives in the group denied testing had any effect on weather. For example, Colonel B.G. Holzman of HQ Air Research and Development Command felt that the whole meeting has been ludicrous: "What I have heard today is a lot like a man on Enewetok" throwing a bucket of water into the sea and "expecting a tidal wave on Honolulu." The disparate group worked to smooth out the differences for their final report. Libby helped. He requested privately in three and half hours of meetings with the chair that a more positive spin be put on the usefulness of the Sunshine Project data used by the group.[739] Lester Machta, as temporary chair, discussed with Libby the differences in stratospheric wait times for Sr-90 and a new study that suggested gummed papers were only thirty percent accurate at detecting fallout radiation levels.[740] The draft summary report gave credit to the work of Libby and explained atomic explosions have been helpful for the study of the atmosphere and encouraged meteorologists to design experiments using radioactive tracers. Dr. Claus of the AEC presented in his final summary of the meeting none of the distressing

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[738] "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather, 39-46, in NAS Archives.

[739] This was in the era of thermonuclear bombs, thousands of times more powerful than atomic bombs but oddly, the term atomic bomb is used throughout the meeting. Lester Machta to Members of the NAS Study Group on the Meteorological Aspects of the Effects of Atomic Radiation and copies were sent to Merril Eisenbud at the AEC although he was not present at the meeting, May 28, 1956 "ORG: NAS Coms on BEAR 1956 Meterologic Meetings Transcript" NAS Archives.

[740] Lester Machta to Members of the NAS Study Group on Meteorological Aspects of the Effects of Atomic Radiation, May 28, 1956, 2, File "ORG: NAS Coms on BEAR 1956 Meteorologic Summary Reports: Drafts" NAS Archives.

particulars.[741] To mask this disparity between the content of the meeting and the needs of the AEC, each NAS BEAR committee would submit three reports, but only the summaries would be given to the press. The longer detailed reports would be just "available for reference for the press." Only these reference materials would include criticism of Libby's miscalculations of how long Sr-90 would stay in the stratosphere, and written in a "superficial fashion."[742] The final conclusion of the meteorology committee was intended for the public—"No evidence has been found which indicates the climate had been in any way altered by past atomic and thermonuclear explosions."[743]

Actually, the entire NAS BEAR report had been massaged by the AEC to make radiation less of a known hazard.[744] A meeting of the chairs of the different BEAR committees decided that the sections of the larger BEAR study group on radiation dangers as a whole would be deleted from the public report. This was because "it was decided not to go into great detail concerning the weapons effects of fallout, since a number of the committee did not interpret this as one of their initial obligations."[745] This limited the understanding of the actual detailed findings, as the significant concerns could

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[741] Instead, Claus restated the questions Vonnegut had posed in his talk, none of his cautions or findings, which Claus later interrogated by asking other scientists at first to explain. However, the AEC wanted participants to "dream up what type of thing you think the AEC ought to do to be absolutely certain what the effect of atomic bombs is on the weather." The AEC was also looking for small research projects they could support. "Proceedings: Conference on Possible Effects of Nuclear Explosions on the Weather" 117-9, 160-1 quotation on 160, NAS Archives.

[742] Libby of the AEC met with Lester Machta, the chair (Rapportaur) of the of the Meteorological study group for three and half hours to review the meteorology section's draft. Pages 24-29 were to be eliminated. Lester Machta to Members of the NAS Study Group, May 28, 1956, File "ORG: NAS Coms on BEAR 1956 Meteorologic Summary Reports: Drafts" NAS Archives. For more discussion of Libby's errors see the 1959 May Congressional fallout hearings, where this was a focus throughout the meeting and resulted in his findings being discredited. He left the AEC that same summer.

[743] "Preliminary Report of the Study Group on Meteorological Aspects of the Effects of Atomic Radiation" in "ORG: NAS Coms on BEAR 1956 Meterologic Summary Reports: Drafts" May 1956 1-51 quotation on 50, NAS Archives.

[744] For a detailed look at BEAR, its political uses and the NAS genetics panel, see Hamblin, "A Dispassionate and Objective Effort."

[745] Lester Machta to Members of the NAS Study Group, May 28, 1956, NAS Archives.

be glossed over in final summaries and press releases. The report was used to bolster the safety of radiation by the AEC and Eisenhower administration and established methodologies and data that were used in the future without critical analysis.[746] The AEC was organized to take into account the power of such appearances.

AEC employees often played a dual role to influence scientific bodies. In 1957 a study was conducted to create a long term policy to encourage this. The study found that often, an employee from the AEC was officially assigned by AEC to be "in technical and professional organizations." This was accomplished by an official letter originating from the AEC to the group recommending as much, or more informal means. However, a more coordinated policy was needed to get AEC employees assigned to key working groups and committees of these non governmental bodies "whose determinations may affect developments in the regulatory field." Especially of interest were groups like the NCRP, the American Bar Association and the American Society for Engineering Education that "are engaged in the development of standards, codes or guides in areas of industrial operation affecting atomic energy, which are or may become the subject of AEC regulations."[747] The AEC did not underestimate the power of their influence.

The same managerial style that contributed towards minimizing harm occurred around the hazards of radiation poisoning from nuclear power plants. As with the fallout

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[746] Hamblin, "A Dispassionate and Objective Effort."

[747] This directed all AEC offices to provide documentation of what committees AEC employees already served on. The committees that the AEC wanted representation included American Standards Association, National Committee on Radiation Protection, American Society for Mechanical Engineers, American Society of Professional Engineers, American Institute of Architects, Engineers Joint Council, American Society for Engineering Education, Science Service, American Nuclear Society, American Society for Testing Materials and the American Bar Association. Oscar S. Smith, Director Division of Organization and Personnel, to Heads of Division and Offices HQ September 9, 1957 File "Organization and Management-7" Box 66 NN3-93-010 1993 declassification number NND 947010 Office of the Secretary, General Correspondence 1951-1958 from Organization and Management 6- thru Organization and Management 7, RG 326 Records of the AEC, NARA II.

controversy, reactor safety calculations did not take into account the lack of consent by those who could be harmed. Clifford Beck of the AEC worked on regulatory regimes since leaving North Carolina State University in 1955. Beck was responsible for much of the philosophy that would guide nuclear power plant siting for many years. In the 1960s working at the AEC's Hazards Evaluation Branch, Beck shaped reactor safety in particular, as a balance between anticipating for the most "maximum credible accident" and the cost of safeguards.[748] Beck continued to view reactor development as he had with the "Temple of the Atom" in North Carolina, as a method of trial and error and a chance to continue to refine and improve reactor safety as reactors operated. New reactor designs would require such experimentation to be improved.

This philosophy excluded from study the most serious potential radiological accidents. This was because they were assumed unlikely to occur.[749] In 1964 Beck was in charge of what became a secret study on the safety risks of new large reactors. The report would update the less optimistic findings of the 1957 WASH report to reassure the public on the cusp of the approval of many new power reactors. However, Beck's own preliminary work by 1966 could only conclude that the deaths estimated in 1957 (3,400 possible fatalities) had underestimated the dangers from the higher power plants now being planned. The WASH-740 report had considered accidents for plants operating at 185 Megawatts of power. New designs being approved were in the 1000 MW size. The assumption was that the newer plants would be safer, but Beck's new findings pointed to the indeterminate means thus far of calculating the likelihood of catastrophic failures. He found the likely result of a core melt accident from loss of coolant was an escape of the

[748] David O'Krent, *Nuclear Reactor Safety: On the History of the Regulatory Process* (Madison: The University of Wisconsin Press, 1981) 14, 33-32.
[749] Ibid., 78, 101-2.

assumed foolproof containment. A 3,200 MW reactor core melt could even melt through the reactor vessel, then through the concrete flooring, to bore into the earth "all the way to China." This worst case scenario soon came to be called a "China Syndrome."[750] If such a severe accident did occur, there was a shocking potential loss of life of 45,000 people. Beck met with the AEC Joint Commission and the Atomic Industry Forum, with members like Babcock and Wilcox and GE, and explained the problems with the report. As a result, the entire report was suppressed. None of the findings about such catastrophic accidents, which could involve the death of half of a city's residents, were considered in the approval at the time of five plant applications. AEC chair Glen Seaborg and none of the many people involved admitted dangers in public that were known at the time of catastrophic nuclear power accidents.[751] They knew the news would have dampened enthusiasm for nuclear power just as development of reactors reached its nadir.

The ability to limit unwanted oversight provided the AEC with the managerial power to keep these secrets. The Advisory Committee on Reactor Safeguards (ACRS) to the AEC, privy to this knowledge, became concerned about the loss of coolant and China Syndrome risks. ACRS arranged to meet with British nuclear safety specialists to gather more information. Instead, Beck met with the AEC commissioners. [752] He argued that the ACRS was heading toward its own independent role over the AEC staff and against AEC policy, including getting information from differing consultant sources, creating a lack of

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[750] Ibid.

[751] Daniel Ford *The Cult of the Atom: The Secret Papers of the Atomic Energy Commission* (New York: Simon and Shuster, 1982) 63-81. For an insiders view of this history see O'Krent, *Nuclear Reactor Safety* and sections specific to this revised but unreleased WASH-740 are on pages 98-102, 107-119.

[752] The name China Syndrome was a fanciful play on words for a very serious potential accident. If an emergency occurred so there was no water to cool the uranium fuel rods, then the reactor interior could become so hot as to melt the rods. The melting mass would not be contained by the exterior containment and would travel down into the earth but never in reality"all the way to China." ACRS began in June 1947 as an advisory committee for safety to the AEC, O'Krent, *Nuclear Reactor Safety,* 122-3.

understanding of technical issues between staff and ACRS. Of more concern, ACRS was becoming too involved in "design details, operations, inspection and compliance." Beck's meeting with the Commission effectively restricted the powers of the ACRS to prevent any increase in their regulatory role or in their ability to review staff findings.[753] In 1969 Beck spoke at an Oregon forum on "Man's Environment." He was quoted in the Corvallis Gazette newspaper as saying that AEC regulations required "liquid emissions" from power plants to be "virtually as pure as drinking water." People living next to a power plant will be exposed to no more radiation than if the plant had never been built.[754] There would be no oversight, no matter how well intentioned or scientific, that did not meet the needs of nuclear expansion.

Nuclear Reach

The AEC had the power to limit public information by keeping it secret, as "classified" within the US and on an international scale. The AEC controlled how radiation would be studied immediately after the first use of the bomb. Human autopsies were used as a way to harvest radiation effects for American research. Even the dead belonged to the victor.[755] The Americans, when they arrived days after the bombing, chose to study rather than treat the survivors. No scientific studies of the A-bomb effects could be even undertaken by Japanese scientists without permission from the US General Headquarters during the occupation. No scientific findings pertaining to the A-Bomb

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[753] O'Krent, *Nuclear Reactor Safety,* 122-3.

[754] "N Plant Pollution Claimed Negligible" *Corvallis Gazette,* October 8, 1969. The event was held at Salishan Lodge along the Oregon coast.

[755] Susan Lindee, "The Repatriation of Atomic Bomb Victim Body Parts to Japan: Natural Objects and Diplomacy" in "Beyond Joseph Needham: Science Technology and Medicine in East and Southeast Asia," *Osiris* 2nd Series, 13, (1998): 376-409.

could be published without permission.[756] These orders to cooperate with the US were announced at a November 30, 1945 conference where Japanese scientists and doctors were struggling to understand the implications for A-bomb radiation exposure treatment. There were protests. M. Tsuzuki warned that the withholding of information about radiation injury would create a lack of treatment "unforgivable from a humanitarian standpoint."[757] A year later, President Truman created the Atomic Bomb Casualty Commission (ABCC) and ordered Japanese health agencies to continue to cooperate with American research.

The research took advantage of these survivors to advance the AEC interpretation of radiation dangers and promote nuclear power. [758] The AEC also used the ABCC research facility as a base of operations to expand nuclear science to Japan. The ABCC staff, under AEC direction, introduced and trained Japanese scientists in the use of radioisotopes, nuclear medicine and research reactors starting in 1955.[759] The AEC and ABCC findings that followed have to be understood in context with their investment in minimizing both future risks and the past harm of Hiroshima and Nagasaki in order to promote nuclear technology.

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[756] Eisei Isikawa and David L. Swain, *Hiroshima and Nagasaki, the Physical, Medical, and Social Effects of the Atomic Bombings* (New York: Basic Books, Inc, 1981) 5.

[757] The meeting was of the Science Council of Japan's Special Committee on Atomic Radiation. In the end, all the research up to that point on radiation damage was compiled by the occupation headquarters and classified as top secret. The research was returned to the Japan in 1967. Hidenori and Fusami Sgimine, eds., transl., *Doctors Testimonies of Hiroshima: A Report of the Medical Investigation into the Victims of the Atomic Bombing* (Kyoto: Kyoto Physician's Association Appealing the Prevention of Nuclear War and the Abolition of Nuclear Weapons, 1998 third edition) quotation on 109.

[758] For much more on the history of the ABCC, and the ethical and scientific issues raised by their research, see Susan Lindee, *Suffering Made Real: American Science and Survivors of Hiroshima* (University of Chicago, 1994).

[759] Detlev Bronk to Strauss, March 14, 1955 Strauss to Bronk (President of NAS) September 29, 1955, File "Organization and Management-7 Atomic Bomb Casualty Commission" Box 66 NN3-93-010 1993 declassification number NND 947010 Office of the Secretary, General Correspondence 1951-1958 from Organization and Management 6- thru Organization and Management 7, RG 326 Records of the AEC, NARA II.

Not only Japanese affairs concerned the AEC. The State Department provided the AEC with almost unlimited diplomatic access. They could participate fully on a global scale. Because their actions were directly pertinent to national security, it was relatively easy for AEC Commissioners, staff and connected scientists to meet with Presidents and governments all around the world. For just one example, after aerial exploration, Peru agreed to make their uranium resources available to the United States. But Peruvian President Odria also wanted "extreme discretion" about this agreement.[760] In addition the AEC was assisted by US agencies with intimate contacts abroad such as the Mutual Security Agency that pledged to assist the AEC with locating international uranium resources and asked for information in return for development prospects.[761] The AEC worked closely with other governments and uranium companies such as Eldorado mining to ensure exploration and control of world supplies and pricing.[762] Research reactors spread by academics around the world with the Atoms for Peace program also secured areas for uranium mining. Outside of the US, massive assistance had been provided for uranium prospecting around the world, initially under military control but later by the AEC. Internationally, sometimes grants for research reactors were tethered to access for uranium prospecting.[763]

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[760] "Raw Materials Progress Report" page 2 File "Materials, World Wide Supply Uranium" (FRC 78) Box 159 NN3-326-93-010 HM 1993 RG 326 Records of the AEC, Office of the Secretary, Formerly Top Secret General Correspondence, 1951-1958. NARA II.
[761] William M. Rand to Gordon Dean (Chair of the AEC) March 31,1953, File "Materials, World Wide Supply Uranium" (FRC 78) Box 159, NN3-326-93-010 HM 1993 RG 326 Records of the AEC, Office of the Secretary, Formerly Top Secret General Correspondence, 1951-1958 NARA II.
[762] Roy B. Snap to Jesse C. Johnson (Director of Raw Materials) May 29, 1953 and "Raw Materials Progress Report" and contents of entire File "Materials, World Wide Supply Uranium" (FRC 78) Box 159 NN3-326-93-010 HM 1993 RG 326 Records of the AEC, Office of the Secretary, Formerly Top Secret General Correspondence, 1951-1958, NARA II.
[763] Uranium prospecting and securing raw resources dominated the first years of the agency and can be seen in the AEC meeting notes and records of these early years in RG 326. Just a few representative documents of the exchange of technology for raw materials of the many that are throughout the NARA II RG 326 collections, include Argentina that requests technology transfers in exchange for their help in providing raw

The tenacity of the AEC can be seen in their work in Brazil. Brazil provided uranium for the Manhattan Project after nationalizing all mining activities in 1942. After 1953 Brazil passed laws, in opposition to US intentions, prohibiting extraction of their minerals and ores by foreign entities. Brazilian President Getulio Vargas wanted instead to cooperate with other foreign countries to acquire all phases of nuclear energy production. He was excited to build power plants and train nuclear scientists. This plan resulted in reciprocal policies that encouraged nuclear technology transfers in exchange for uranium and raw materials. Brazil eventually made agreements with West Germany, France and England.[764]

However, this vision for diversified Brazilian nuclear growth ended with the alleged suicide of President Vargas in 1954. His death was followed by the forced resignation of Alvaro Alberto, from the Brazilian National Research Council (CNPq). Alberto was responsible for the strategy to be free from American nuclear control. Soon the President's replacement, former vice president and pro-American General Café Filho, re-established close nuclear cooperation with only the US and its Atoms for Peace program.[765] By 1955 the AEC was successful in creating a "joint uranium mineral exploration program" with Brazil. This program was designed as a result of an explicit

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uranium supplies, K.E. Fields (AEC General Manager) to Alexander Smith (of the US Senate) July 27, 1955 in File "Research & Development 1, Argentine" and "Press Comments on Belgium Uranium Agreement and Construction of a Reactor in Belgium" September 29, 1959 "Foreign Service Dispatch, From Brussels, Belgium to the Department of State" December 15, 1954 AEC meeting minutes File "Research & Development 1, Belgium" Box 128 Office of the Secretary, General Correspondence, 1951-1958, Research & Development, NN3-93-010 HM 1993 RG 326, Records of the AEC, NARA II.

[764] To learn much more about the nuclear history of Brazil see Carlo Patti, "Origins and Evolution of the Brazilian Nuclear Program (1947-2011)" accessed April 26, 2014, http://www.wilsoncenter.org/publication/origins-and-evolution-the-brazilian-nuclear-program-1947-2011; see also "Mining in Brazil" *CountryMine* accessed May 18, 2014, http://www.infomine.com/countries/SOIR/brazil/welcome.asp

[765] Carlo Patti, "Origins and Evolution of the Brazilian Nuclear Program (1947-2011)" accessed April 26, 2014, http://www.wilsoncenter.org/publication/origins-and-evolution-the-brazilian-nuclear-program-1947-2011

AEC goal to procure uranium from Brazil. AEC selected mining ore experts to visit Brazil even before they had been officially invited. Working backwards, the AEC then had the US State Department "arrange for the group to be invited by Brazil."[766] However, because of national unrest, the program became temporarily inactive in 1956. The AEC reported this was due to "ultra Nationalist publicity coupled with communist inspired demonstrations in Brazil."[767] The protests forced the cancelation of procurement of mineral contracts, but the less public AEC exploration program quietly restarted. The program was supported not just by the AEC but by the US Department of State and the Division of International Affairs. The exploration for uranium complemented the negotiation of a power agreement, and the eventual construction of an Atoms for Peace research reactor at Sao Paulo.[768] The building of the nuclear age had diplomatic influences far beyond the obvious.

[766] Memo, "Brazilian Negotiations- see Minutes of Meeting 1092, AEC 1094th Meeting 6-29-55 S" File "Materials, Uranium, Brazil" Box 40 Correspondence 1951-1958, NN3-324-93-010HM 1993, Office of the Secretary, RG 326 Records of the AEC, NARA II.

[767] This was a reference to protests a month before in Brazil and the US Embassy in Brazil's concern that "the political structure and psychological climate … could set in motion a sequence of political developments basically contrary to the interests of the US." The embassy recommended the US continue to build investment in Brazil with military and political support to offset the economic problems of inflation and unrest. Wallner, Telegram From the Chargé in Brazil (Wallner) to the Department of Foreign Relations of the United States, 1955–1957 Rio de Janeiro, October 4, 1957—3 p.m. Document 367 Volume VII, American Republics: Central and South America http://history.state.gov/historicaldocuments/frus1955-57v07/d367. In addition two submarines had just been delivered to the Brazilians in 1956, Letter From the Assistant Secretary of Defense for International Security Affairs (Gray) to the Deputy Under Secretary of State (Murphy) Washington, February 4, 1957, Foreign Relations of the United States, 1955–1957 Volume VII, American Republics: Central and South America, Document 360, accessed May 18, 2014, http://history.state.gov/historicaldocuments/frus1955-57v07/d360; "Memorandum for the General Manager through Assistant General Manager for International Activities, Continuation of the Arrangement for a Joint Cooperative Program for the Reconnaissance and investigation for Uranium Resource in Brazil" January 20, 1956, File "Materials, Uranium, Brazil" Box 40 Correspondence 1951-1958, NN3-324-93-010HM 1993 Office of the Secretary, RG 326 Records of the AEC, NARA II.

[768] The document read, "and furthered the objectives of the Atoms for Peace Program in Brazil." "Memorandum for the General Manager through Assistant General Manager for International Activities, Continuation of the Arrangement for a Joint Cooperative Program for the Reconnaissance and investigation for Uranium Resource in Brazil" January 20, 1956 File "Materials, Uranium, Brazil" Box 40 Correspondence, 1951-1958 NN3-324-93-010HM 1993 Office of the Secretary, RG 326 Records of the AEC, NARA II.

In Japan, the AEC often mixed diplomacy with radiological expertise. During the occupation of Japan, the press code and banned news of radiation and research inhibited science and medical care of the injured for six years. After the occupation ended, the United States continued to control Japanese scientists investigating radiation. With the crisis caused by the contamination of the Japanese fisherman on the Lucky Dragon, Merril Eisenbud of the AEC's Health and Safety Laboratory (HASL) analyzed the urine of two of the men. He reassured Dr. Rokuzo Kobayashi that the levels were too low to be of concern. Five other samples had just arrived and he offered to test the urine of the remaining sixteen patients who were still being treated at Daiichi Hospital, if they could be sent to his laboratory in New York.[769] Eisenbud did not account for the time elapsed between the contamination and the results. His radiation counts did not occur until several days past the incident, which would have diminished the radioactivity even more with transport of the samples.

Rejecting what seemed to be empty reassurances, the Japanese appeared to the AEC and the State Department as ignorant and hysterical. In the eyes of the US Ambassador to Japan, John M. Allison, "a period of uncontrolled masochism ensued, as the nation aided by an unscrupulous press, seemed to revel in fancied martyrdom...the government in Japan ceased to govern."[770] This breakdown, the Ambassador felt, was

[769] See Lapp, *Voyage of the Lucky Dragon* for many more details on the incident. The actual counts of radioactivity found by Eisenbud were for Sanjiro Masuda, 720 disintegrations per liter and Tadashi Yamato, 510 disintegrations per liter. The samples of urine had to be sent to the US and back, and Eisenbud offered to test all 23 victims' urine in this manner. Eisenbud to Dr. Rokuzo Kobayashi. April 6, 1954, File "Medicine, Health & Safety, Radiation vol. 1" declassification number NND943092 Box 163, Materials 5 Thru Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958, Office of the Secretary, RG 326 NARA II.

[770] Ambassador Allison's assessment of the effect on Japanese-US relations notes that the timing of the accident could not have been worse, as the first appropriations had just been made in Japan for atomic research. This created in fighting in Japan over who should be entitled to the research funds and lay claim to the fishing vessel for study. American Ambassador John Allison to Japan to Department of State May 20,

caused by a small group of Japanese scientists and doctors who resented the occupation's previous ban on atomic research and earlier purges of their ranks by the US. They were "fuzzy headed leftists, pacifists, neutralists" and feminists who refused to cooperate with the ABCC and the AEC. These Japanese managed to prevent compliance with Embassy requests for AEC scientists to visit the fishing vessel or the patients, and also refused to surrender the *Lucky Dragon* to the US Navy for decontamination and study. Most importantly, the Japanese had "intense gullibility in atomic matters." What was needed, according to Allison, was recovery of the Japanese people "from a postwar psychosis." [771]

Attempts to repair the relationship came from the Japanese, but accepted only on AEC terms. The US military and the AEC refused requests for thermonuclear testing to stop, or at least be moved, or at minimum, simply be announced with fair warning to the Japanese to guard public health.[772] In the summer of 1954 after the March *Lucky Dragon* incident, the AEC was invited by the Japanese to participate in a scientific expedition on the *Sinkatsu Maru.* The goal was to collect samples of the radioactivity in the ocean from

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1954, quotation on 2, enclosed in "Impact of the Fukaryu Maru on US-Japanese Relations" AEC Meeting 730/2, May 26, 1954, File "Medicine, Health & Safety, Radiation vol. 1" declassification number NND943092 Box 163, Materials 5 Thru Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958, Office of the Secretary, RG 326, NARA. Allison's biographical sketch at the Truman Library (where his papers are held) indicates that in 1941 he was interred by the Japanese before being returned to the US by 1942, Truman Library, John M. Allison Papers, Biographical Sketch, accessed April 18, 2014, http://www.trumanlibrary.org/hstpaper/allison.htm.

[771] His vitriolic analysis did not stop there but included feminists as well and that these Japanese had riled the public up for about three weeks, until US order could be restored. He blamed the events squarely on the weak Japanese government and the sensationalizing press. American Ambassador to Japan to Department of State May 20, 1954, quotation 2, 4, 5 respectively, enclosed in "Impact of the Fukaryu Maru on US-Japanese Relations" AEC Meeting 730/2, May 26, 1954, File "Medicine, Health & Safety, Radiation vol. 1" declassification number NND943092 Box 163, Materials 5 Thru Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958, Office of the Secretary, RG 326, NARA II.

[772] John A. Hall to Col. Vincent Huston, November 9, 1954, WN McCool, "AEC: Exchange of Notes with Japan Concerning Possible Future Thermonuclear Experiments," November 12, 1954, page 1, and Katsuo Okazaki to John Allison, October 5, 1954 Box 163, Materials 5, Medicine Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958 Office of the Secretary, RG 326, NARA II. Note the use of the word "experiment" to describe the nuclear weapons tests.

the errant Bravo thermonuclear test. On behalf of the AEC, Dr. Boss of the AEC's Division of Biology and Medicine and Professor R. Donaldson of the University of Washington accepted the invitation to be on the research vessel. However, "for practical and diplomatic reasons" the two men did not sail.[773] Instead, Boss and Donaldson inspected tuna on the mainland. Later Boss attended a joint five day meeting on land with fifteen Japanese scientists, at the invitation of the Japanese Science Council.

At this scientific meeting the AEC engaged with the Japanese scientists by focusing on the AEC's command of radioisotopes and radiation safety science. The meeting was accepted by the AEC as a way to "combat anti-American sentiment in Japan by establishing friendly and effective scientific relationships."[774] The AEC sent a seven member delegation, including Boss, to help the Japanese, "who were very much in need of scientific assistance in the whole field of radiobiology."[775] The American group included key AEC scientists, including Merril Eisenbud of AEC's Health and Safety Laboratory (HASL), Paul Pearson, Chief of the AEC Biology Branch, and Walter Claus, Chief of the AEC Biophysics Branch. While the conference was instigated by the Japanese, it is unclear how much control, if any, the Japanese eventually had over the agenda.[776] Much attention on the part of the AEC went into how to promote the meeting

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[773] Hamblin, *Arming Mother Nature*, 96;The first invitation had come in June, 1954, KD Nichols to Sterling Cole (Joint Committee on Atomic Energy) November 9, 1954, Box 163, Materials 5, Medicine Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958, Office of the Secretary, RG 326, NARA II.
[774] KD Nichols to Sterling Cole, November 9, 1954, quotation on 2, RG 326, NARA II.
[775] Ibid, quotation on 1.
[776] File "Medicine, Health & Safety, Radiation vol. 1" declassification number NND943092 Box 163, Materials 5 Thru Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958, Office of the Secretary, RG 326, NARA II.

to repair public relations with the Japanese public and the Japanese scientists.[777] The US scientists taught standardization and alignment of radiation measuring and how to use radioisotopes in research. They also instructed the Japanese scientists on how to determine maximum exposure.[778] Thus, the Japanese were taught "the right way" of how to perceive radiation as the AEC did, defining other ways of thinking as non-expert.

The AEC intervention, however, failed to assuage the concerns of the Japanese. Japanese scientists organized several other symposia in response to the *Lucky Dragon* incident. They eventually published 1,817 pages of reports and studies about harms from radiation. The studies included effects from the atom bombs in Hiroshima and Nagasaki, the intensity of the Bravo fallout and the effects of radiation on genetics, weather, agriculture, the ocean and even economics. The interdisciplinary Japanese scientists, organized by the Japan Society for the Promotion of Science, felt due to the unease of the Japanese public, they could shed light on radioactivity and its dangers "contrary to the situation in certain countries which possess nuclear weapons." In those weapons-holding countries "certain facts are well done, but some of the findings were under national control hidden from the public eye."[779] The paper of the leading scientist of the

[777] Salisbury to Strauss, "Formalization of AEC and State Department Position on Public Relations Aspects of Radiation Conference" November 2, 1954, Box 163, Materials 5, Medicine Health and Safety 14, Formerly Top Secret General Correspondence 1951-1958 Office of the Secretary, RG 326, NARA II.
[778] The American delegation also included Dr. John H. Harley, Chief of the Analytical Brach of HASL and Morse Salisbury, Director of Information Services. The meeting was recorded in the proceedings published by the Japan Society for the Promotion of Science as "The so-called American-Japan Radioactivity Conference." Committee for the Compilation of Report on Research in the Effects of Radioactivity, *Research in the Effect and Influences of the Nuclear Bomb Test Explosions I* (Ueno, Tokyo: Japan Society for the Promotion of Science, 1956), 12-3, 15-6. The conference in Japanese documents say it occurred from January 15 to the 19th, in 1955 and included scientist Yasuo Miyake according to this report but according to the AEC documents, the event occurred on November 15- 19, 1954 with the same participants and agenda, so perhaps this is a translation error.
[779] The Japanese, however, felt they were more able and free than the Americans to openly discuss these issues. Committee for the Compilation of Report on Research, *Research in the Effect and Influences,* quotation on 2. These studies, volume I and II, also give a very detailed and primary source description of

Sinkatsu Maru expedition, ocean chemist Yasuo Miyake, was the first in the bound collection. His paper, "Effect of Atomic Explosions on the Atmosphere and the Sea" measured effects in the ocean.[780] The measurements at sea were definitive of the high radiation that had traveled a thousand miles since the nuclear blast. The highest recorded contamination was of fish livers west of the Bikini Atoll at 48,000 counts per minute (cpm) per gram of weight.[781] Cpm are measures of ionizing events per minute relative to the radiation detection instrument to give an estimate of radiation. Miyake's work was a significant threat to how AEC studied radioactivity, and included the effects to the sea itself. He did not limit his view as the AEC expertise did, to think only in terms of the risk to man.[782]

The AEC responded by finding subtle, and not so subtle, ways of discrediting such problematic research. They planned a "follow up" study to retrace the work of the *Sinkatsu Maru*. This was intended to ensure a voice for an AEC interpretation of findings. Another scientist included in the Japan Society's volume, Yasushi Nishiwaki, had completed many studies and found high radioactivity in rain, fallout and tuna. He questioned the very efficacy of gummed papers to capture accurate readings. Gummed papers were used in a worldwide network to collect and monitor fallout by the AEC. Nishiwaki damningly found radioactivity had increased ten to a hundred times more in Japanese people's bones in the two years since Bravo. Nishiwaki was disparaged by the AEC's Charles Dunham and Eisenbud as a communist. Anticommunist propaganda and

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the Fukuru-maru No. 5 incident and the response in Japan to it. See also Hamblin, *Poison in the Well,* 82-87.

780 Hamblin, *Arming Mother Nature*, 96;The Committee for the Compilation of Report on Research, *Research in the Effect and Influences,* 1-6.

781 Hamblin, *Poison in the Well,* 83-84. The Japanese spell this ships name as "Shunkotsu-maru" in . Committee for the Compilation of Report on Research, *Research in the Effect and Influences,* 11.

782 Hamblin, *Arming Mother Nature*, 96; Committee for the Compilation of Report on Research, *Research in the Effect and Influences.*

rhetoric served a dual purpose to discredit efforts to end weapons testing or silence those concerned about safety.

The Japanese scientists, with their much more comprehensive approach to radiation danger, did pose a threat to the AEC. Yet, science was not completely on their side. No matter how much scientists tried to honestly appraise fallout, uncertainty played a role to favor the AEC interpretation of fallout as safe. One thing that would always privilege the argument that radioactivity was "safe" was due to an irresolvable uncertainty: there was simply no existing baseline data for natural background radiation before weapons testing.[783] What was known about background radiation rested primarily on the "black boxed" research of AEC scientist Willard Libby. In addition, the conception of dose rested on assumptions by an X-ray manufacturing employee Arthur Mutscheller in 1924 that were not based on experimental evidence but on small sample sizes of observable visible harm.[784] With the basis and norms of radiation protection built by those invested in radiation's benefits, such as first the ICRP and then the AEC, few scientists or detractors had the capacity to challenge the AEC. However, not to be

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[783] Hamblin, *Poison in the Well,* 82-87, 108-9. Much of the surveillance was accomplished as part of the IGY and manipulated other nations into collecting ecosystem data that served US national security interests.
[784] Lauriston Taylor, considered the father of radiation standards, said this early work was still the basis for radiation protection standards in 1989. Overall, the science that was used to establish the first recommendation of dose by the ICRP in 1928 relied on too few sample sizes with inconsistent units of measurement and used untested assumptions. Working with the little understood mechanisms and effects of irradiation, the origins of radiation health standards involved guesswork and imprecision. Mutsheller, a physicist who worked for an X-ray machine manufacturer, did not use any experimental research program. Instead, he interviewed doctors and technicians at no more than six hospitals to determine that without any visible signs of health effect, the doses received must have been tolerable. He then estimated the assumed safe doses received by measuring the intensity of rays that would have reached the person where they stood relative to the source. He multiplied the electrical current of the X-ray machine in use by the length of time of exposure. Then he divided the result by the square of the distance between the machine and the place where the person stood. A random number, 36.8 was chosen by Mutscheller to then translate the findings into a measure of a dose, called the erythema dose, or the amount of dose that would result in hair loss. Mutscheller took into consideration that with the lead shielding already in use, a person could safely be exposed to 0.01 of the erythema dose per month. The numbers were eventually institutionalized by the ICRP without conducting experiments or creating a research project beyond collecting disparate concurring studies. For much more on this history, see Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (New York: Harper &Row, 1989) 17-22.

undaunted, a proposal for an international conference on radiation harms to be held in 1955 was made by the President of the Science Council of Japan at the annual General Conference UNESCO meeting in Montevideo. The conference would bring together "experts in the medical and biological aspects of physical injuries and harm caused by radioactivity" and develop an international organization for conducting studies. This proposal was eventually replaced by the 1955 Peaceful Uses of Atomic Energy conference, which had neither such focus nor plans for a long term radiation safety study group. [785] The AEC would prove much more influential in the mid- 1950s than its less powerful detractors in determining the global reach and character of radiation studies.

Embedded

As nuclear work expanded, radiation expertise and oversight contracted to even fewer international organizations. For example, the International Labor Organization (ILO) had previously regulated radiation risks, such as radium exposure. Notes from the late 1940s show the ILO Committee of Experts on Dangerous Radiation was prevented by its own Governing Body from addressing maximum permissible doses with regard to only one specific source: uranium. Even mentioning fission products from uranium with regard to maximum permissible doses was not allowed. The members of the committee in their meeting notes, "expressed regret, in view of the expanding use of uranium and its salts in industry, not to have those included under the scope of the Committee's Work." [786] This may have further created a vacuum for health and safety protection for uranium workers.

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[785] Committee for the Compilation of Report on Research, *Research in the Effect and Influences,* 16-7.
[786] "International Labor Office, Committee of Experts on Dangerous Radiation" undated but inclusive of 1948-9 documents File No. SA 1007, International Labor Organization (ILO) Archives, Geneva.

Worldwide systems of shared technical expertise served to reinforce the AEC's initial control of the development of radiation health safety, which never did focus on uranium risks. Technical assistance programs had been a part of the colonialist enterprise, and included nations, industrial companies and foundations in the early 20th century, previous to the organization of the UN with its mission to advance the equality of developing countries to modernize.[787] The US in a once- secret 1950 policy statement to the United Nations stated that its primary influence on developing countries no longer would be through political or colonial rule. Control would be provided through economic and technical assistance. This would also serve as a bulwark against communism. Former colonial powers were encouraged to continue to influence their past colonial holdings by requesting technical assistance projects on their behalf.[788] The primary known objective was to help underdeveloped countries gain "economic and political independence." In exchange, those countries receiving assistance would "give full and prompt consideration to the technical advice they receive." Some of that technical advice translated as profits for established companies.

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[787] Just a few examples of this precursor aid included investment in the Congo from the profits of uranium by Belgium; involvement of Standard Oil in agriculture around the world using petroleum based fertilizers; US Steel and Westinghouse General Electric assisting in Brazil's industrial growth; and American mining company establishment of schools in South America and the Middle East. Walter R. Sharp*, International Technical Assistance* (Chicago: Public Administration Service, 1952) 1-21. For a valuable example of the relationship between colonialism and science, see Michael Osborne, *Nature, the Exotic, and the Science of French Colonialism* (Indiana University Press, 1994).

[788] "United States Policy Toward Dependent Territories" April 26, 1950 Foreign Relations of the United States, 1952–1954 Volume III, United Nations Affairs, Document 778 Department of State Committee files, lot 54 D 5, "Working Group on Colonial Problems" Paper Prepared by the Colonial Policy Review Sub-Committee of the Committee on Problems of Dependent Areas, accessed May 18, 2014, http://history.state.gov/historicaldocuments/frus1952-54v03/d778; Sharp*, International Technical Assistance*, 25-48. A proposal to organize technical assistance in general was initiated by UN specialized agencies four years before Atoms for Peace and about six weeks before the announcement by President Truman of the US technical assistance program, the Point Four proposal. The Point Four program was designed to work together with, and through the UN specialized agencies, wherever possible, and to shield from communist criticism of undue control of trusteeships and former colonial holdings. US leadership and funding made technical assistance a priority in the UN. By 1949, a scaled down version of Truman's original proposal was endorsed by the UN.

Voluntary pledges for technical assistance to UN member states sometimes made their way back into the benevolent nation's industries. The US dominated the contributions. The funding for uranium technical assistance was spent on compiling a data base of large land areas of geological and geochemical maps, while training nationals and establishing "the nucleus of a national geology-mining-metallurgy agency" with labs and technicians. If a new profitable resource were found, the rights to the deposit, after five years of its exclusive use as an UN study area, would revert to the nation state. The nation could then "retain it as a national asset or lease it in whole or in part to the national or foreign private sector." However, whatever percentage a donating nation gave to UN technical aid (that became a profitable venture) would revert to the donating country with the "same proportion of all equipment and supply purchased required for the program."[789] In other words, the Atoms for Peace project was designed to maximize this UN agency apparatus to spread nuclear science around the world and American nuclear industry could also profit.

This appearance of altruism was matched by the AEC's orchestration of agencies and conferences that would view radiation and nuclear technology as a global cure for illness and poverty. The IAEA may have appeared to have been an international effort,

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[789] Franc R. Joubin and D. McCormack Smyth, *Not for Gold Alone: the Memoirs of a Prospector* (Toronto, Canada: Deljay Publications, 1986) 394-5, quotation on 395. Efforts to avoid duplication may have led to more influence for the AEC and industry in safety standards. To coordinate this assistance worldwide, two new groups, a Technical Assistance Board (TAB) and Technical Assistance Administration (TAA) were created to facilitate technical assistance programs. The TAB was composed of the director of each involved specialized agency. This was necessary to coordinate what could easily be redundant or overlapping activities, as each specialize agency had shared fields of action. The TAA was an entire administrative apparatus at the UN level. In 1966 these groups merged to become the United Nations Development Fund, UN Archives, accessed May 18, 2014, http://atom.archives.unesco.org/united-nations-extended-programme-of-technical-assistance;isaar. Previously large scale coordination among UN specialized agencies had been managed by the Administrative Committee on Coordination (ACC) which worked closely with the AEC but the ACC could not also coordinate large scale technical assistance. By 1951, twenty million dollars was provided by 50 nations for technical assistance projects undertaken by the UN, UNESCO, the Food and Agricultural Organization (FAO), WHO, International Labor Organization (ILO) and the International Civil Aviation Organization, see Sharp, *International Technical Assistance*, 59-65.

but had it been suggested by President Eisenhower in his Atoms for Peace Speech; the UN Peaceful Uses Conference and the Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) were also American instigated ventures.[790] The optimism and technological awe of the 1955 International Conference on the Peaceful Uses of Atomic Energy, held at UN headquarters in Geneva at the Palais des Nations, far outweighed any of the earlier concerns expressed by the Japan Society or Enrico Fermi in 1944 about the massive radioactivity and proliferation risks of global nuclear energy development.[791] The AEC used the Peaceful Uses conference to build the relationships that would connect nuclear technology with modernity and accept their brand of humanitarian hopes for the future.

The Peaceful Uses conference deflected Japanese concerns. The Japanese wanted to study harm, radiation exposure and contamination to humans and biological and ecological systems. It resembled nothing of what had been suggested initially by the Japan Society proposal to UNESCO. In fact, geneticist Muller was not allowed by the AEC (which approved presenters) to present his paper on human responses to radiation

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[790] The UN expressed their satisfaction with the 1955 Conference on the Peaceful Uses on the same day the UN General Assembly passed a resolution for the United Nation's first independent study of radiation, US Ambassador to the UN, Henry Cabot Lodge presented the proposal for UNSCEAR to the UN, and several people, including Lewis Strauss claim to be originators of the Peaceful Uses Conference as well, General Assembly, Tenth Session, 912 (X) Peaceful Uses of Atomic Energy I,II and 913 (X) Effects of Atomic Radiation December 3, 1955 4,5 accessed May 18, 2014, http://www.worldlii.org/int/other/UNGARsn/1955/37.pdf. There are different dates recorded for the first meeting to discuss UNSCEAR. as Merril Eisenbud records the first UNSCEAR meeting as held in New York in December of 1955 but in other sources it is March of 1956, see Hamblin, *Poison in the Well,* 107; Merril Eisenbud, *An Environmental Odyssey: People, Pollution and Politics in the Life of a Scientist,* (Seattle: University of Washington Press, 1990), 118-9.

[791] Report of the United Sates Delegation to the International Conference on the Peaceful Uses of Atomic Energy held by the United Nations, *International Conference on the Peaceful Uses of Atomic Energy* Geneva, Switzerland August 8-20, 1955 Vol I and Vol II. This book included the brochure distributed on the model research reactor that was displayed and much of the discussion of the papers as well; Johnston, *The Neutron's Children,* 163-4. To learn more about the 1955 conference John Krige, "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence," *Osiris* 21 (2006): 161-81, and Hamblin, *Poison in the Well,* 60-63.

exposure at the conference because he used the word "Hiroshima" in it.[792] The majority of the conference papers were optimistically centered on areas of future study for the technology and a parade of equipment and techniques needed for research.

The highlight of the conference was the actual installation of a working research reactor.[793] The idea for an operating reactor came from the Union Minière du Haut-Katanga company that mined uranium in the Congo. The Belgian corporation offered to provide free uranium fuel for the reactor and felt it would be "good propaganda for the U.S. Government and good publicity" for firms working on atomic reactors.[794] Over 63,373 people came to see the reactor from July 18 to August 21. The public waited in long lines for hours to hang their heads looking directly down into the reactor vessel pool glowing blue. One of the most important visitors was President Eisenhower, accompanied by a crowd of "one hundred and fifty news reporters and photographers." On August 6th, the ten year anniversary of the bombing of Hiroshima, AEC Chair Lewis Strauss sent personal invitations to all 73 nations and 8 UN specialized agencies delegations and invited them to a special showing of the reactor where they could actually operate it.[795] The reactor was more than a prototype just for show: twenty four countries had made agreements with the US to secure such reactors, and students from

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[792] Lawrence Badash, "Science and McCarthyism" *Minerva* 38 (2000): 67.

[793] Report of the United Sates Delegation to the International Conference on the Peaceful Uses of Atomic Energy held by the United Nations, *International Conference on the Peaceful Uses of Atomic Energy* Geneva, Switzerland August 8-20, 1955 Vol I and Vol II, 314.

[794] H. Robliart to L. Strauss, April 6, 1955, File "Research and Development 1, Belgium" Box 128 Office of the Secretary, General Correspondence, 1951-1958, Research & Development, NN3-93-010 HM 1993 RG 326, NARA II.

[795] Report of the United Sates Delegation, *International Conference on the Peaceful Uses,* 335, 314- 5, quotation from 314.

nineteen countries were already in the US for education and training. Students in thirty two countries were learning about radioisotopes.[796]

The AEC cultivated what would be long-term relationships at the extensive and lavish conference. Proceedings of 600 papers (450 of which were presented at the conference) filled sixteen volumes of 500 pages each. It was also an important means to spread standardized laboratory and production procedures.[797] Eisenbud's AEC Health and Safety Laboratory (HASL) put together a display of all the measuring equipment for studying radioactivity, such as Geiger and scintillation counters, film badges and protective laboratory gear such as gloves. Their display stressed that "respect, not fear was the key to working safely with radiation."[798] Merril Eisenbud also presented his paper, "Industrial Hygiene of Uranium Processing." While his paper was the result of seven years of work by the AEC's Health and Safety Laboratory and the first published paper on the subject, little would be done to increase safety for miners and millers based on his work. This was despite the ability of the AEC to have instituted protections based on what was known of uranium risks at the time.[799] The Atomic Energy Act of 1945 allowed the AEC to institute any regulation necessary to carry out stipulations for health and safety in the act. But ignoring uranium risks kept the price dirt cheap, allowing for the technological expenses of the nuclear chain.

The AEC arranged the low price of uranium to allow for the other expenses required by nuclear technology. This pricing was a significant part of the long term

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[796] Ibid., 314.
[797] Ibid., 865.
[798] Ibid.,322-3.
[799] National protections would not be instituted until 1969 after many deaths. See chapter 5 and works previously cited, Eisenbud, *An Environmental Odyssey,* Eichstaedt *If You Poison Us*, Brugge, *The Navajo People and Uranium Mining,* also Victor E. Archer, "Health Concerns in Uranium Mining and Milling" *Journal of Occupational Medicine* 23 no.7 (1981): 502-5.

growth of nuclear science. Much of the AEC's early years focused on procuring uranium and then setting and controlling the price. This was discussed in secret AEC meetings: "since there is no world market price for uranium, prices have been established for each source which are calculated as sufficient to stimulate the highest rate of production." This referred to the uranium needed to meet production goals for both peaceful atomic uses as well as weapons.[800] In retrospect, the cost of uranium was kept low by excluding proper health and safety protections. This caused the contamination of workers and landscapes, sacrificing some to make the expensive nuclear technology possible. The countries that were providing the cheap raw uranium fuel, however, occasionally called in their chips to ask for support to build research reactors. The AEC happily complied, arranging purchases and agreements and paying for at least half the costs of research reactors.[801]

The 1955 Geneva Peaceful Uses conference solidified the AEC as the experts in radiation protection. Relationships forged at the conference were important to the spread of radiation health safety norms and dosimetry. For example, Eisenbud made international contacts among the 3,600 scientists who attended. He later often hosted foreign visitors, ranging from Queen Fredrika of Greece to the brutal "Papa Doc"

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[800] While there are entire boxes at NARA II on this topic, a representative documents include "AEC Chronology of Actions and Statements Concerning Ore Procurement" quotation on 14, March 24, 1952, AEC meeting minutes and 359/9 and Thomas E. Murray, AEC Commissioner to "Memorandum for Chairman Gordon Dean," May 21, 1953 File "Uranium World Wide Supply Vol. 1" Box 159 and entire File "Industrial Research and Application 1-3, Pricing Policy for Materials Vol. 2" in Box 159 declassification number NND947017 Office of the Secretary, Formerly Top Secret General Correspondence, 1951-1958 From Info and Publications 1 thru Materials, NN3-93-010 HM 1993 RG 326, NARA II. See much more about uranium in the same records group, Box 129, with files from China to Belgium.

[801] Just two representative documents of many for several countries, include Argentina that requests technology transfers in exchange for their help in providing raw uranium supplies, K.E. Fields (AEC General Manager) to Alexander Smith (of the US Senate) July 27, 1955 in File "Research & Development 1, Argentine" but for Belgium in particular see "Press Comments on Belgium Uranium Agreement and Construction of a Reactor in Belgium" September 29, 1959 "Foreign Service Dispatch, From Brussels, Belgium to the Department of State" December 15, 1954 AEC meeting minutes File "Research & Development 1, Belgium" Box 128 Office of the Secretary, General Correspondence, 1951-1958, Research & Development, NN3-93-010 HM 1993 RG 326, NARA II.

Duvalier of Haiti. These visits allowed the spread of AEC and HASL laboratory techniques and instruments used to measure fallout levels to other countries.[802] These international connections enabled the first ever international training in health physics was held in 1955 and jointly sponsored by the AEC, the World Health Organization (WHO) and Sweden.[803] The AEC affiliated scientists traveled worldwide in the late 1950s, from investigating the Windscale accident in England to an Atoms for Peace delegation to New Zealand. [804] Eisenbud's relationship building was a good investment on an international scale. It also narrowed the ways that fallout pollution and impacts might have been imagined or considered in alternative ways.

Nonetheless, expanding international and industrial AEC diplomatic ties did not necessarily muzzle fallout concerns. The Japanese and other non -AEC scientists continued to study the issue in different ways than the AEC.[805] Lewis Strauss as chair of the AEC sent a top secret memo to the Secretary of State for the eyes of the President to warn about the United Nation's "intensification of the propaganda from the Russians and the Indians" to end weapons tests. He lamented "a number of our own people are falling for this bait."[806] Part of the bait was, in fact, a genuine worldwide concern about the safety of fallout from the tests.

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[802] Eisenbud, *An Environmental Odyssey,* 116-118.
[803] *The Work of WHO, 1955* Official Records of the WHO No. 67, Annual Report of the Director General to the World Health Assembly and to the United Nations, (Geneva: WHO , March 1956) 37, WHO Archives.
[804] Untitled, undated list of technical cooperation visits by the AEC ranging from 1955 to 1958, File "Research and Development 1 Technical Cooperation-Index vol.2 " AEC Box 127 General Correspondence 1951-8, Research & Development, NN3-326-93-010 HM 1993, RG 326, NARA II.
[805] This is clear through out the files of the AHLP LP Peace "The Debate over Fallout and Nuclear Contamination" as study after study begin to be generated and sent to Linus Pauling. By 1959 it is a torrent, see studies in boxes 7.001- 7.025.
[806] Lewis L. Strauss to Col. Goodpastor, December 14, 1955, File "Research and Development 1 Vol. 4 International Control of Atomic Energy" Box 115, General Correspondence 1951-8, NN3-326-93-010 HM 1993, RG 326, NARA II. See also Hamblin, *Poison in the Well,* 107-116.

Growing fallout angst required an international AEC strategy. Meetings between Eisenbud's Health and Safety Laboratory and Sterling Cole were held to brainstorm how to approach this public relations quandary. Cole was not only good friends with Lewis Strauss but Chairman of the Joint Congressional Committee on Atomic Energy. Cole would also soon become the Secretary General of the IAEA. [807] They felt the "sensitive issue" of fallout safety would "inevitably be raised in the UN by other states" and sought to avoid looking authoritarian. The UNSCEAR was their proposal and it also conveniently deflected an independent study that was being considered at the time by the less than cooperative International Council of Scientific Unions (ICSU), just as the Peaceful Uses meeting had eliminated the Japan Society's UNESCO study. The US State Department and the AEC had confidence that the UN as a trusted authority would aim above all to calm fallout fears.[808] These fears had been already equated by social scientists at UNESCO as an irrational rejection of automation and modernity.[809]

The extent of the discourse on the UNSCEAR proposal at the UN shows widespread concern that the group's structure would influence its results. Efforts to include China and nonmember states of the UN were rebuffed by the US, but not before the discussion questioned the UNSCEAR's commitment to objective facts. If the project were actually scientific, argued V.K. Krishna Menon, it would be universal. UNSCEAR

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[807] As previously noted, there are different dates recorded for the first meeting, as Merril Eisenbud records the first UNSCEAR meeting as held in New York in December of 1955 but in other sources it is March of 1956, see Hamblin, *Poison in the Well,* 107; Eisenbud, *An Environmental Odyssey,* 118-9.
[808] The AEC thought scientists of the ICSU would have been impossible for the AEC to control, many of whom were against nuclear weapons testing. In order to not duplicate work, and luckily for the AEC, the ICSU deferred to the UN. As previously noted, for many more details on UNSCEAR and how this study was manipulated by the AEC, see Hamblin, *Poison in the Well,* 107-117; General Assembly, Tenth Session, 913 (X) Effects of Atomic Radiation, December 3, 1955, 5, accessed May 18, 2014, http://www.worldlii.org/int/other/UNGARsn/1955/37.pdf.
[809] Hamblin, "Exorcising Ghosts in the Age of Automation: United Nations Experts and Atoms for Peace," *Technology and Culture* 47 (2006): 734–56, see also Hamblin, *Poison in the Well,* and *Arming Mother Nature.*

ought to include data from non-member states, such as a large land mass like China. Menon, the dynamic Indian representative to the UN, explained this was needed because "radioactive fallout did not stop at the boundaries of states which had not signed the charter of the UN." The US retorted indignantly (and ironically) that the planned committee was not going to pander to such blatant political issues "inconsistent with the spirit and traditions of science." [810] India was also concerned about the lack of depth to the study; using the terms "human health and safety" seemed incommensurate with the genetics and "long range biological effects and contamination of plant life, water resources, etc."[811]

The discussion also became too focused on disarmament for the comfort of the AEC. An amendment introduced by Syria and Indonesia that called for a cessation of tests until the study was completed was also rejected with the other non- American proposals.[812] In the end, however, the AEC prevailed to create the study parameters to its liking. Many key AEC members served, including Merril Eisenbud, while working for the AEC's Health and Safety Laboratory in the New York office located near the UN. He was one of two alternates for Shields Warren, the chief US delegate.[813] Only those scientists selected by their governments would serve on the committees. As suggested by Shields Warren (of the AEC and UNSCEAR delegate) at the first meeting, only

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[810] Francis O Wilcox, "Analysis of Voting in the 10th General Assembly Consideration of Atomic Radiation" 2, File "Research and Development 1 Vol. 4 International Control of Atomic Energy" AEC Box 115, General Correspondence 1951-8, NN3-326-93-010 HM 1993, RG 326, NARA II.
[811] Lodge, Confidential Telegram to Secretary of State, October 14, 1955 (declassification NND947017) quotations from p. 1, 2 and see also Wilcox, "Analysis of Voting" 3, RG 326, NARA II.
[812] Wilcox, "Analysis of Voting" 2, 3, RG 326, NARA II; See James Paul Wesley to Pauling, November 4, 1959 and James Paul Wesley, "Background Radiation as the Cause of Fatal Congenital Malformation" Box 7.0012, File 12.14 "Correspondence, Offprint: Background Radiation as the Cause of Fatal Congenital Malformation" James Paul Wesley, 1959 LP Peace, AHLPP. Wesley went on to found a new discipline called ecophyisics.
[813] Eisenbud, *An Environmental Odyssey,* 116-123.

governmental studies of reports or research already completed were to be reviewed by the panel composed of only UN member states. No recommendations would be made. Indeed, as was the tradition since the founding of the ICRP, the study was limited to assembling and evaluating known information, without any enforcement or regulatory mechanism to provide for the protection of the pubic. Most of the data and previous studies were provided by the AEC.[814] Much of this information had appeared in the earlier NAS BEAR study. For example, the data of worldwide kilotons of nuclear weapons tests was essential and this same data was provided by the US for the BEAR update of 1959.[815] UNSCEAR was not necessarily a task of free and open scientific inquiry as it was perceived.

The IAEA conducted itself similarly to the AEC, maneuvering other agencies with their expertise. Trying to anticipate the possible strife over the founding of the International Atomic Energy Agency (IAEA) led Dag Hammarskjold, UN Secretary General, to instruct Luther Evans, Director General of UNESCO, that each agency in the UN would need to "have on the table" their present and planned future atomic activities to coordinate the research and the relationships.[816] Not only did this adjust areas of overlap and redundancy but allowed for scientific disagreements to be minimized, and unanimity presented to a confused public during the fallout controversy.[817] There was however, resistance in bequeathing UNESCO's and WHO's roles in health entirely to the

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[814] Eisenbud, *An Environmental Odyssey,* 119; Hamblin, *Poison in the Well,* 107-117; General Assembly, Tenth Session, 913 (X) Effects of Atomic Radiation December 3, 1955 5, accessed May 18, 2014, http://www.worldlii.org/int/other/UNGARsn/1955/37.pdf.
[815] John A. McCone, chair of the AEC to Detlev W. Bronk, May 5, 1959, File "US Atomic Energy Commission" Box B H717 U.N. – WHO 1974 1461 ms, Alexander Hollaender Papers, American Philosophical Society, Philadelphia.
[816] Dag Hammarskjold to Dr. Evans, August 28, 1955, UNESCO AG 8 Secretariat Records, 1946- File 620.992 : 3 A 06 (44) "58" Expert Meeting on the Social and Moral Implications of the Peaceful Uses of Atomic Energy, France 1958 Part 1 up to 30/6/ UNESCO Archives, Paris.
[817] Hamblin, "Exorcising Ghosts."

IAEA.[818] For one example, tensions between WHO and IAEA erupted in 1959 and 1964.[819]

WHO had been founded as a global health organization by the UN to address the human right of public health. Health as a human right is articulated in the 1948 WHO Constitution: "The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition."[820] WHO embraced the peaceful uses of nuclear technology as a way to treat diseases and enhance equal access to nuclear medicine, another mandate of the Constitution: "The extension to all peoples of the benefits of medical, psychological and related knowledge is essential to the fullest attainment of health. Informed opinion and active co-operation on the part of the public are of the utmost importance in the improvement of the health of the people."[821] WHO joined in an official relationship in 1956 with the ICRP to coordinate radiation safety recommendations. WHO also provided fellowships for the study of health physics and

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[818] S.V. Arnaldo to Director General, November 1, 1955, 3 and Director General to S.V. Arnaldo November 2, 1955, file 620.992:539 .16 "Atomic Radiations (includes UN Scientific CT on the Effects of Atomic Radiation)" Part 1 up to 31.XII.56 AG 8 UNESCO Archives, Paris.

[819] Both WHO and IAEA files during the 50s and early 60s concerning the other show these ongoing tensions at the WHO Archives in Geneva and the IAEA Archives in Vienna.

[820] "About WHO: History of WHO" accessed May 18, 2014, http://www.who.int/about/history/en/ and "WHO Constitution," 1948, accessed May 18, 2014, http://apps.who.int/gb/bd/PDF/bd47/EN/constitution-en.pdf?ua=1. The Constitution states: "Parties to this Constitution declare, in conformity with the Charter of the United Nations, that the following principles are basic to the happiness, harmonious relations and security of all peoples: Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition. The health of all peoples is fundamental to the attainment of peace and security and is dependent upon the fullest co-operation of individuals and States."

[821] *The Work of WHO, 1955* Official Records of the WHO No. 67, Annual Report of the Director General to the World Health Assembly and to the United Nations, (Geneva: WHO , March 1956) 35-7 WHO Archives, Geneva; "WHO Constitution," 1948.

radiation protection to prepare for the coming nuclear expansion.[822] This occurred just at about the time that the IAEA was acquiring most radiation health responsibilities. The rivalry between the two organizations was inevitable.

Eventually, WHO agreed to study only radiation protection in terms of medical uses and consumer protection. This was determined after much angst with a Memorandum of Understanding with the IAEA agencies in 1959. Even though the IAEA limited WHO's area of expertise, the IAEA remained bitter. WHO seemed to still creep into IAEA terrain and did not consult or inform the IAEA. When the IAEA did involve WHO in joint planning: "WHO tries to jump on our bandwagon and then to apply the brakes."[823] The IAEA privately assessed that WHO had "done practically nothing" in the area of technical assistance by the early 60s, and therefore, had no standing as nuclear experts.[824] These problems were resolved with more communication and liaisons, but this only served to consolidate IAEA's control and resulted in more limitation of WHO's role in radiation protection.

However, these differences seemed bridged by a similar methodological approach to radiological problems. Even WHO-designed studies repeatedly framed their research questions following the AEC model of assessing and quantifying numerical abstractions to support standards to determine "safe" doses.[825] The scientific infrastructure of the AEC and the US Public Health Service were long-lasting in terms of *how* things were to be

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[822] "The Radiation Health Work of WHO (a brief summary)" EB 33/46 File "WHO 1963-4 0/320-2" Correspondence with WHO, DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives, Vienna, Austria.
[823] "Comments on WHO Document EB 33/46 "Coordination with IAEA" File "WHO 1963-4 0/320-2" Correspondence with WHO, DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives.
[824] Ibid.
[825] See studies that are described throughout the file "WHO 1963-4 0/320-2" Correspondence with WHO, DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives.

studied. For example, when studies of radiation-induced diseases were discussed, the ILO, WHO and IAEA developed the same United States AEC and Public Health Service approach to data that had been previously collected on uranium miners. This was done without questioning the validity of the design of the approach or that the data may be biased as it was collected during what is retrospectively classified as unethical human radiation experiments. In the AEC and PHS health studies, the miners were told they were being provided “check ups” and they were misled about the condition of their health. They served as unknowing study objects so that radiation exposure could be correlated with lung cancer and death. The miners were monitored but not told that their exposures from the mines were a danger. The medical findings of their lung cancers, diseases and even their impending deaths was withheld from them.[826] A meeting of experts, many connected directly to the AEC, would collate such existing AEC/PHS epidemiological information and use it to make an “assessment of dose to the lungs of exposed persons.”[827]

Examples of the infusion of the AEC perspectives into the various international agencies abound in the documents of the AEC, the IAEA, UNESCO and WHO. For example, the third report of the Expert Committee on Radiation formed by WHO was titled “Radiation Hazards in Perspective.” The group organizer was Austin Brues, Director of the Division of Biological and Medical Research at the US military laboratory

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[826] See previously cited works by Brugge, Pasternak, Eichstaedt and “Advisory Committee on Human Radiation Experiments: Executive Summary and Final Report” (1994) Department of Energy, accessed May 9, 2014, https://www.osti.gov/opennet/spotlight.jsp and “Advisory Committee on Human Radiation Experiments Final Report” see “Findings: Biomedical Experiments 1944-1974” Chapter 17, 789-95.
[827] “WHO/ILO/IAEA Program Consultations, March 23, 24, 1964” quotation on 5, File “WHO 1963-4 0/320-2” Correspondence with WHO, DDG.R1 39.036 143, Records and Communication Section, Box 04204 Location: A0470-39-18, IAEA Archives.

at Argonne, Illinois.[828] Although the committee was an international group, the AEC perspective was clear, with such pronouncements as “Radiation has received a great deal of attention in recent years from a number of points of view and this made it sometimes difficult to view it in perspective against other hazards.” These perspectives included understanding that while a decreased life span and accelerated aging had been found in animals exposed to radiation, this must be weighed against the increase in life span due to nuclear medicine.[829] The results of the six- day meeting in October of 1961 recommended that “public anxiety and mysticism” around radiation hazards be dispelled by proper public health education. This education would put radiation hazards in perspective with other dangers, such as toxins and smoking. The committee concluded that the attention on radiation had caused the neglect of the study of these other dangerous chemical pollutants, which instead should be studied.[830] A future course was set.

Conclusion

The management of the AEC and its management of personnel and scientific discourse minimized doubt. Repeatedly, it was understood by AEC scientists as a fact and promoted as a fact that below natural background levels radiation would not be dangerous. The AEC’s perception of radiation was ensured by its very structural and bureaucratic design that limited oversight and did not focus on contamination. The AEC’s reach worldwide was enabled by the IAEA and access to enormous financial resources. Cheap uranium and access to governments, the press, and scientists embedded

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[828] WHO Technical Report Series No. 248 *Radiation Hazards in Perspective: Third Report of the Expert Committee on Radiation* quotation on 1 (Geneva: WHO 1962) WHO Archives, Geneva.
[829] Ibid., 34-5.
[830] Ibid., 38.

the nuclear age in modern life. The AEC's success was also due to its willingness to use scientists to influence other organizations.

The AEC managed perceptions and consensus on small and large scales. Other scientists, like Pauling and Gofman charged the AEC glossed over harm and the lack of consent. The AEC and the IAEA could intimidate, encourage and manipulate the outcome of scientific inquiry in the mundane planning before a meeting even started. They did this in the everyday humdrum activities of a bureaucracy: restricting oversight with policy; planning meetings; building foreign relationships; arranging for public relations; selecting and placing AEC experts at the helm of meetings and organizations; all the while co-opting or excluding the work of detractors. However, this control and surveillance culture of the AEC caused the AEC's own insulation. AEC scientists were isolated from other facts and possible modes of understanding and action to investigate and prevent radiation dangers. Looking back, one finds their very success and expertise precipitated a vast failure to protect human health and rights.

Conclusion

"The crisis may be quiet, but it is urgent." John F. Kennedy, 1963[831]

Pollution from nuclear technology caused an unknown number of birth defects, cancers, even child-hood leukemia.[832] Sources of exposure have included mining, milling, fallout from nuclear testing, and storage. According to some estimates, fallout from US nuclear weapons tests between 1945 and 1963 may be responsible for 70,000 to 800,000 deaths due to cancer.[833] In terms of the world's population, perhaps this number is small. However, President Kennedy spoke about the death of just one child as an unacceptable price for nuclear weapons testing when he announced the Partial Test Ban Treaty in the summer of 1963 on national television:

> …The number of children and grandchildren with cancer in their bones, with leukemia in their blood, or with poison in their lungs might seem statistically small to some, in comparison with natural health hazards. But this is not a natural health hazard--and it is not a statistical issue. The loss of even one human life, or the malformation of even one baby--who may be born long after we are gone--should be of concern to us all. Our children and grandchildren are not merely statistics toward which we can be indifferent.[834]

Kennedy also wrote of his concern, shared with Pauling, that pollution from modern technology had exceeded the systems designed to control it. New technology, he wrote,

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[831] John F. Kennedy, Foreword, Stewart Udall, *Quite Crisis and the Next Generation* (Salt Lake City: Peregrine Smith Books, 1988) xii.

[832] Dennis J. Carroll, "Downwinders Welcome Study of Trinity Impacts" *Santa Fe New Mexican* January, 2014, accessed April 28, 2014, s/local_news/downwinders-welcome-study-of-trinity-blast-s-impacts/article_830c1f00-7630-5e63-8d57-a07311978140.html.

[833] Arjun Makhijani and Stephen I. Schwartz "Victims of the Bomb' in Schwartz, *Atomic Audit*, 395.

[834] He goes on to say "Nor does this affect the nuclear powers alone. These tests befoul the air of all men and all nations, the committed and the uncommitted alike, without their knowledge and without their consent. That is why the continuation of atmospheric testing causes so many countries to regard all nuclear powers as equally evil; and we can hope that its prevention will enable those countries to see the world more clearly, while enabling all the world to breathe more easily." John F. Kennedy Presidential Library, "Radio and Television Address to the American People on the Nuclear Test Ban Treaty, July 26, 1963" accessed April 29, 2014, http://www.jfklibrary.org/Research/Ready-Reference/JFK-Speeches/Radio-and-Television-Address-to-the-American-People-on-the-Nuclear-Test-Ban-Treaty-July-26-1963.aspx.

"contaminate water and air, imperil wildlife and man and endanger the balance of life itself." This pollution he warned, served to "not only degrade the quality of the national life but to weaken the foundations of national power." Kennedy felt that to meet this challenge, "we must expand the concept of conservation." Society needs "new instruments of foresight and protection and nurture in order to recover the relationship between man and nature" to solve the problems caused by unjustified acts of power for future generations.[835]

Nuclear science can be told as a tale of prolonged, and in some cases, random violence disconnected from the many people and scientists who meant well. If you are a parent of a child with leukemia, you will likely never know what caused the illness: radiation leaves no fingerprints. But the historical evidence accumulates in other ways. The effects of radiation can be seen in many examples, including the deaths of American Indian miners, the contamination of the Navajo Nation and the Marshallese, forever exiled from their homes. The construction of radiation safety became one way of seeing the nuclear age in terms of risks and benefits. Those who disagreed did not have access to a political system for consent, nor recognition of their rights to bodily sovereignty. They had no way to enforce inalienable rights to "life, liberty and the pursuit of happiness" and to protect themselves. A human rights frame for nuclear history reveals that this dystopian outcome was connected to the dream of building a better world through technology. Scientists, institutions and agencies embraced a philosophy of modernity with nuclear technology at the center, as a way to create a better world. Their confidence in this vision led to a distorted view of contamination and how it would be experienced

[835] John F. Kennedy, Foreword, *Quite Crisis,* xi-xiii.

by those exposed. The state, based on such persuasive nuclear expertise, claimed the power to pollute and harm.

A way to begin to untangle this dystopian tale is to remember its very utopian roots. The health impacts of the first radiation age were minimized due to the enthusiasm for the actual benefits of seeing inside the body with X-rays and the possible uses and cures of radiation. The deaths were accumulating, in plain sight, but often not with indisputable connection to radiation as the cause. This delay and denial of harm also occurred later as radiation exposure from fallout and reactors was deemed an acceptable dose by the AEC experts. Many of these AEC scientists believed peace was not just a rhetorical device, but an imperative, maintained only by nuclear weapons testing. Also, they shared Frederick Soddy's hopes: peace and human rights could finally be possible if nuclear power plant and medical technology were shared with the world. The utopian dream of building a better world, with economic, educational and heath equality for all, with a faith in their own science, is what primarily caused the reality of nuclear pollution. Most scientists and agencies had a distorted sense of the human rights violations they were responsible for because radiation "below background" was of no concern compared to other dangers, from cosmic rays, or from a Soviet arsenal.

These scientists and academics had their eyes on one sort of prize, based on Cold War fears of nuclear annihilation. Their vision, however, outpaced the reality of their daily actions. Almost imperceptibly nuclear scientists, educators, and agencies expanded the power of the state to allow and condone contamination. Even on college campuses, scientists (and even a university President) could not prevent those with nuclear expertise from endangering students' health. Reactor accidents were cast as experiments and learning opportunities.

Outside the United States, the AEC also influenced norms in international bodies. When human rights were discussed, they were interpreted as the right of access to nuclear science for economic development, science education, and medicine. These agencies, first in the UN's Atomic Energy Commission and later the International Atomic Energy Agency, cast themselves as defenders of human rights and peace. The AEC built lasting relationships with students, faculty, institutions, industry and these international agencies. They did this with training, grants, curricula, research reactors and personal relationships that cultivated life long nuclear science advocates and experts. In daily operations, the AEC inserted its philosophy into scientific meetings, other countries' legislative radiation safety codes, education, and public ceremonies to dedicate research reactors and nuclear industrial plants. The spread of these norms left few obvious avenues of protest.

Historians have argued that contamination itself is not 'proof of damage."[836] However, human rights protocols since 1945 demanded morality of scientists and the state, requiring consent to human experiments. Consent at the time in practice (as it still can be) was ambiguous and contested.[837] Yet rules to protect human rights were in place, and the AEC, at least on paper, even required consent protocols to be followed.[838] These protocols included the Nuremburg Code (1947), the Universal Declaration of Human

[836] Barton Hacker, *Elements of Controversy,* 277.
[837] Guerrini, *Experimenting with Humans and Animals,* see especially 151.
[838] For a much more in-depth discussion of ethics and the AEC, see "Advisory Committee on Human Radiation Experiments: Executive Summary and Final Report" (1994) Department of Energy, accessed May 9, 2014, https://www.osti.gov/opennet/spotlight.jsp and "Advisory Committee on Human Radiation Experiments Final Report" see Chapter 17, "Findings: Biomedical Experiments 1944-1974" 789-95.

Rights (1949) among other international agreements.[839] Nuclear power and testing both were referred to by scientists many times openly in the AEC records as experiments. As the infrastructure for nuclear science as a human right was being established, there were opposite human rights claims being made against nuclear contamination. They were not typically successful. Beginning with the indiscriminate killing of noncombatants in Hiroshima and Nagasaki, human rights claims against nuclear threats and contamination came from those who argued that governments had no right to contaminate human bodies or the earth's ecology. In 1959 Nagendra Singh, a judge of the International Court of Justice, stated that nuclear weapons were not only incompatible with human rights but irreconcilable with recognized laws. [840] However, the norms established already by the United States, through the AEC, were not weakened by protests. There was no effective format to articulate and protect what many felt were fundamental rights to health and the integrity of one's body and future offspring.

The notion that one's right to remain uncontaminated was rooted in existing values—embodied in U.S. Constitution and amendments, Universal Declaration of Human Rights, and international law— is critical to understanding the nuclear age. The failure to protect, or often to acknowledge, the fundamental right to one's bodily integrity shows the paradoxes of law and the limits of scientific expertise. These values were easily dismissed by scientific experts with an alternative notion of what rights they were protecting. The fallout suits are just one example of a lost claim both in court and in

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[839] "The Belmont Report" Health and Human Services webpage, accessed April 30, 2014, http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html. For much more about consent in general, see Franklin G. Miller and Alan Wertheimer, eds., *The Ethics of Consent: Theory and Practice* (Oxford: Oxford University Press, 2010).

[840] Fifty first Session Item 71 of the Provisional Agenda "General and Complete Disarmament Advisory Opinion of the International Court of Justice on the Legality of the Threat or Use of Nuclear Weapons" October 15, 1996 235-8, A 51/210 United Nations Archives, Geneva.

history. It and the many other cases need to be recovered for a full understanding of both nuclear and human rights history. These claims belong in the stories we tell as we recount the crucial moments of the nuclear age. Academics, health and human rights advocates, and UN agencies alike need to address these forgotten but significant claims, and see them for what they were: clear violations against human rights.

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