'ATOMS FOR PEACE' TO THREE MILE ISLAND: THE CONSEQUENCES OF ANTI-NUCLEARISM IN THE POST-WAR U.S.

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Introduction

When American physicists first began to harness the power of the atom in the early 1940s, their innovations coincided with the escalating U.S. involvement in World War II. Fears that Germany had secretly developed atomic weapons along with the mounting conflict in the Pacific Theater meant that the U.S. government overlooked nuclear fission's potential as an unlimited, clean energy source in favor of accelerating its weaponization. Thus, the creation of the Manhattan Project in 1942 aimed to end World War II and defend the U.S. against foreign nuclear threats. The project succeeded, and on August 6 and 9 of 1945, the U.S. dropped atomic bombs on Hiroshima and Nagasaki, revealing the devastating potential of nuclear fission to the American public.

The initial, destructive use of nuclear energy set up its reputation as a powerful weapon. Its role in ending World War II

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and avenging Pearl Harbor was celebrated by many Americans. However, attitudes shifted dramatically when faced with the prospect of nuclear power in proximity to their homes.[1] For citizens, it was hard to see nuclear energy as a tool for powering their cities when it had just ended the lives of thousands. According to K.R. Smith, "[N]uclear energy was conceived in secrecy, born in war, and first revealed to the world in horror. No matter how many proponents try to separate the peaceful from the weapons atom, the connection is firmly embedded in the minds of the public."[2] The legacy of Hiroshima and Nagasaki and the recurring association of the atomic bomb with nuclear energy would mark the ideological origin point of anti-nuclearism.

Eight years later, nuclear energy entered the U.S. through President Dwight D. Eisenhower's "Atoms for Peace" speech in 1953. Eisenhower provided transparency into the "fearful atomic dilemma" and advocated for the peaceful development of civilian nuclear energy.[3] His vision was well-received by civilians, sending a message for a resourceful future. However, the public's confidence in nuclear energy could not hold up to the conflict of the Cold War. The U.S.' continuous development of nuclear weapons for national security ran counter to Eisenhower's "Atoms for Peace" ideology and gave rise to a nuclear alarmism movement that strongly opposed nuclear weaponization.[4] The beliefs of nuclear alarmists laid the groundwork for anti-nuclearists, who opposed nuclear energy based on the recurring link between nuclear weaponry and energy.

Environmental movements had also grown to prominence in opposition to World War II-era industrialization, but quickly adopted anti-nuclear sentiments as well. These movements agreed with anti-nuclearists on issues such as uranium mining, atmospheric testing, and nuclear waste. For both groups, such problems made it difficult to accept nuclear energy as Eisenhower's constructive technological force,[5] or as a renewable energy source. As environmental movements mobilized against nuclear energy, anti-nuclearism grew significantly throughout the 1970s.[6]

Finally, in 1979, at the height of public nuclear fears, a meltdown at Three Mile Island (TMI) pushed anti-nuclear activity over the edge. The incident resulted in a severely ineffective regulatory overhaul of power plant construction, incited mass protests, and led to extreme anti-nuclear activities at plant sites. The government gradually cancelled all ongoing U.S. nuclear projects, ending eighteen in 1983 alone.[7] The decline has persisted until the present, and the American nuclear energy industry largely exists in a state of regulatory limbo and stagnation. The immediate and long-term impacts of TMI place it as the climax in the dramatic downfall of American nuclear energy.

This paper argues that the key dynamics which caused U.S. nuclear energy to fail were less in response to technical drawbacks and were mainly consequences of anti-nuclearism that had pervaded the public and grown immensely since Hiroshima and Nagasaki. The U.S.' large scientific manpower equipped it with all the tools necessary to solve the key issues—waste disposal, radiation containment, and cost—that so disturbed environmentalists and anti-nuclearists. Instead, however, these faculties were expended on weaponization in the face of an ever-wary public. Political motives such as the motif of 'controlling the atom' and solving the energy crisis were prioritized over reliable progress and further complicated the implementation process. Ultimately, the events surrounding Eisenhower's "Atoms for Peace"—nuclear weaponization, environmental movements, and Three Mile Island— illustrate the ways in which anti-nuclearism became the primary downfall of nuclear energy development and production in the post-war United States.

Atoms for Peace and the Emergence of Power Plants

President Eisenhower's "Atoms for Peace" speech and consequently, the U.S. nuclear energy industry, were initially formulated with public relations tools to influence and inform the American public. By 1953, the U.S. was steadily losing its monopoly on nuclear power as the UK and the Soviet Union engaged in the rapid construction of their nuclear arsenals,[8] a development

which frightened American citizens.[9] As more countries began to nuclearize, the world edged closer to a perpetual nuclear stalemate. Eisenhower's goal of nuclear containment aimed to defuse the ominous threat of nuclear proliferation. To serve this agenda, Eisenhower and his administration decided that an informed public would more readily give their support to the U.S. government.[10] Eisenhower's "Atoms for Peace" speech thus delivered comprehensive information on the capabilities of the U.S.' nuclear arsenal, which countries possessed knowledge of nuclear technology, and the status of ongoing negotiations between said countries.[11] Eisenhower's logic of nurturing an informed public established a trend of government transparency on nuclear weapons, and Americans would continue to be well-informed and aware of the actions of their government.

More implicitly, however, Eisenhower also intended to reassert the U.S.' position as the world leader in nuclear power to the international community. The decision to give his "Atoms for Peace" speech at the UN general assembly was no mistake; Eisenhower's objective required a global audience. In his speech, he began by addressing the U.S.' actions in Hiroshima and Nagasaki: "It is with the book of history, and not with isolated pages, that the United States will ever wish to be identified,"[12] he stated, portraying the U.S. as a peaceful and benevolent country that intended to distance itself from the controversial bombings. With peaceful intent established, Eisenhower went on to characterize the atom as a force for economic growth and even to reverse the destructive trend of nuclear proliferation.[13] This encouraged countries who had little knowledge of the atom to adopt nuclear energy, opening the door for the scientifically superior U.S. to play a guiding role in shaping their programs. Thus, the "Atoms for Peace" speech gave the U.S. a renewed opportunity to lead the world in nuclear energy, but the fruition of Eisenhower's dream balanced on the U.S.' ability to retain its technological superiority.

To establish its status as a cultivator of nuclear energy abroad, the U.S. immediately took steps to build its first power plant. Eisenhower signed the Atomic Energy Act of 1954, which

laid the groundwork for a 'civilian' nuclear power industry. The act also brought changes to the Atomic Energy Commission (AEC), approving the release of technical knowledge to private companies. The AEC then called for energy companies to take on the task of building the Shippingport Atomic Energy Station, which would be the U.S.' first 'civilian' power plant. Rather than design a new reactor from scratch, officials opted to reuse the well-tested Mark I nuclear submarine reactor design with slight modifications to expedite the construction process.[14] Hyman G. Rickover, a U.S. navy admiral who specialized in naval reactors, was selected to oversee its construction. But after groundbreaking began on September 6, 1954, the unprecedented nature of the project soon posed problems. Construction required over 25,000 welds; furthermore, it was imperative that the station's piping be completely leak-proof, or else disastrous issues such as radioactive water leaks and coolant loss would occur.[15] The reactor pressure vessel also weighed 153 tons and had to be inserted in one piece.[16] Such engineering challenges delayed construction from March 1957 to December 1957. The project eventually ran $18 million over budget, meaning that Shippingport's cost-to-kilowatt ratio was around ten times more than that of conventional coal power plants. Shippingport's expenses and low-level output rendered it useless for large-scale commercial generation, but its completion was an achievement nonetheless.

The difficulties of Shippingport's construction were likely due to an unrealistic deadline and scientists and engineers' lack of prior experience with building civilian reactors. When the Soviet Union detonated its first atomic bomb on August 29, 1949, it displayed faster progress in developing the atom than anyone had expected. The loss of the U.S.' nuclear monopoly, added to the lack of scientific breakthroughs since World War II, alarmed Congress. It immediately expanded the AEC's funding to build more nuclear weapons and to keep up with the Soviet Union's scientific advancement. But by 1951, Canada was running a nuclear power plant and Britain would soon begin operating its first plant as well. These developments finally turned Congress' attention

toward developing reactors, but the U.S. was already far behind in the race for the 'peaceful atom.' Scientists and engineers had accumulated almost no experience or research in building civilian nuclear reactors. In 1949, a mere 0.3% of AEC funds ($1.8 million) was invested into a reactor development program, while over $400 million went into producing fissionable material and developing weapons.[17] And even within the reactor program, most researchers were focused on the defensive applications of reactors such as nuclear submarines and plutonium production plants. Evidently, military considerations during World War II and the Cold War had heavily shifted the AEC's focus away from reactor technology and toward developing nuclear weapons. The U.S. was simply not prepared to take on the challenge of commercial nuclear generation. With such factors taken into consideration, the Shippingport project required that engineers with no experience build America's first full-scale nuclear reactor in less than three years.

Moreover, while most American citizens enthusiastically supported the entry of nuclear power into the U.S., the act initially drew little support from industry experts and scientists. Following the first demonstration of the atom in Hiroshima and Nagasaki, the media erupted in excitement over the new technology. Magazines and newspapers filled the public with expectations of the "age of the atom," characterizing nuclear energy as the key to all aspects of life; nuclear energy would revolutionize transportation, electricity, and well-being.[18] But in reality, energy within the U.S. was abundant and coal was relatively cheap with no foreseeable shortage. Electrical power companies saw little reason to invest in nuclear energy and were instead cautious of it, hoping that it would not exact drastic changes on the electricity market. The scientists who had worked on the Manhattan Project also agreed that nuclear energy was not yet viable due to the scarcity of fissile material, which was almost exclusively used for constructing warheads.[19] While the AEC took care to manage the public's expectations,[20] people were nonetheless disappointed to learn that nuclear energy would not be implemented as ubiquitously

as Eisenhower had hoped. In this way, nuclear energy was thrust into a largely unprepared nation with the political motive of 'commanding' the atom.

Cold War Ideology and Nuclear Alarmism

The bombings of Hiroshima and Nagasaki brought with them the imagery of a "nuclear holocaust"[21] and the government's subsequent attempts to suppress it. Following the conclusion of World War II, the global public began to condemn the destructive use of the atom.[22] When surveys examining the remains of Hiroshima and Nagasaki discovered harmful radiation among the debris and surrounding area, the U.S. government effectively downplayed the negative effects of the bombings. Meticulously written government reports translated over to the media; one 1945 headline in the *New York Times* claimed, "No Radioactivity in Hiroshima Ruin."[23] The government's "nuclear denial" of Hiroshima and Nagasaki and support of nuclear weapon development gave rise to military movements during the Cold War that aimed to reimagine Eisenhower's "Atoms for Peace" and garner public support for atomic weapons.[24]

The public's views on nuclearization were complicated when the ideological and political rivalry between the U.S. and the Soviet Union ignited the Cold War in 1947. As the aim of the Cold War was to "deter" war rather than engage in direct conflict, extreme nuclear armament played an ironic role in maintaining—rather than destroying—international peace. In the early years of the Cold War, the U.S. possessed an advantage in nuclear weaponry both in quantity and the knowledge to harness it. However, as the Soviet Union rapidly caught up by developing its first nuclear weapons in 1951, both the U.S. and the Soviet Union armed themselves with mounting stockpiles of weapons. The widespread utilization of nuclear power as a strong-arm tactic within U.S.-Soviet Union relations heightened public awareness of the sheer scale of the nuclear weapons program.

The Cold War panic also led to the rise of nuclear alarmists who worked to frame the atom as an uncontainable force

for destruction. Nuclear alarmists believed that the number of atomic weapons had become far too great and too deadly, and that nuclear proliferation was the greatest threat to both domestic and international security.[25] This ideology directly opposed the U.S. government's "weapons as politics" strategy, which leveraged nuclear armament to keep international peace.

Alarmist scientists played a central role in the fight against nuclear weapons. Linus Pauling, a chemist and peace activist, advocated strongly against atmospheric nuclear testing and worked to inform the public of its dangers to their health and safety. Pauling warned that "every [nuclear] test kills" and that genetic defects could occur from nuclear testing, rousing public concern.[26] In 1957, Pauling and dozens of other alarmist scientists drafted "An Appeal by American Scientists to the Governments and People of the World," petitioning against above-ground nuclear bomb testing. The appeal, leveraging scientific knowledge to make its claims more credible, urged the public as well as world governments to ban the testing of nuclear weapons.[27] Pauling's work and growing public pressure prompted President John F. Kennedy to sign the Partial Test Ban Treaty in 1963, which led Pauling to win a Nobel Peace Prize. Alarmists had successfully altered government policy to resist nuclear weapons.

However, in addition to warning the public of the dangers of nuclear bombs, Pauling's and the alarmists' work had the unintended effect of fueling anti-nuclear energy sentiments. Like Eisenhower, Pauling saw the atom's energy potential as a global resource for well-being, but his work's impact reversed this ideology for the public. The preexisting lack of distinction between the radiation emitted from the widely publicized testing of nuclear weapons and that of a nuclear reactor caused some to turn against nuclear energy for the first time. While public support for the general implementation of nuclear energy was high, opinions on local construction were low and would continue to decrease.[28] Furthermore, alarmists' success at stopping atmospheric testing had set a precedent for local opposition and scientific evidence as being effective tools for government change. Therefore, when

the U.S. built its first power plants in the late 1950s, the alarmists' concerns of nuclear weapons fed into the public's fear of atomic energy. The construction of a test reactor at the Enrico Fermi Nuclear Generating Station faced opposition from the United Auto Workers Union in 1957. Following this, protestors successfully resisted a nuclear power plant at Bodega Bay in 1958, effectively marking the start of the anti-nuclear movement.[29] In this way, nuclear alarmists were the precursors to anti-nuclearism and planted the first seeds of doubt into American discourse regarding the possibility of peaceful atomic energy.

Environmentalists Alongside Anti-Nuclear Movements

In the early 1960s, the anti-nuclear movement began to grow in response to a sustained government effort to build more power plants. The explosion of a military test reactor in 1961 and the partial meltdown of the Enrico Fermi Nuclear Generating Station in 1966 were harmless to the public but showcased the risks nuclear power plants held. Anti-nuclear discourse emphasizing the paramount importance of nuclear safety illuminated a variety of other potential risks. One was called the "China Syndrome," a scenario in which coolant loss would cause a reactor's core components to heat up immensely and burn through the Earth all the way to China.[30] On its journey, the melted components would breach groundwater, expelling radioactive steam into the atmosphere and poisoning thousands. While these events never actually occurred, the nightmare scenario of a reactor meltdown expelling radioactive gas into the atmosphere incited fears surrounding nuclear energy.

It is difficult to pinpoint why exactly anti-nuclear fear grew so swiftly and irrationally in the 1960s, but a likely theory has to do with the social and cultural consciousness surrounding the concept of the atom and radiation; namely, the concept of 'transmutation.' Transmutation, as it relates to radiation, is linked to Ernest Rutherford and Frederick Soddy's 1901 experiments on radioactive decay. When the pair first observed thorium decaying into radium, Soddy reportedly exclaimed, "Rutherford, this is

transmutation!" Rutherford told Soddy to caution himself, fearing that the community would label their research as alchemy.[31] However, in the following years, Soddy would extensively publish his and Rutherford's findings in radioactive decay, referring to the process as 'transmutation' on numerous occasions. Soddy deliberately alluded to alchemy in his writings, hinting at powers of evolution, cycles of creation and rebirth, and unlimited energy.[32] By the early 1910s, much of the scientific community had started referring to radioactive decay as 'transmutation,' leading the public to affiliate nuclear fission with alchemy.

Soddy also emphasized the power of the atom, stating that one pint of uranium could power a ship from London to Sydney and back.[33] The atom's theorized potential for unlimited energy along with alchemy's connotations of cosmic power portrayed nuclear scientists as powerful and mysterious entities who held power over life and death. In one lecture in 1903, Soddy stated that the Earth was "a storehouse stuffed with explosives, inconceivably more powerful than any we know of, and possibly only awaiting a suitable detonator to cause the earth to revert to chaos."[34] Similarly, Rutherford jokingly remarked that "an explosive wave of atomic disintegration might be started through all matter which would transmute the whole mass of the globe."[35] Despite Rutherford himself dismissing the feasibility of such a scenario, the visage of an atomic doomsday crept into the public consciousness.

The motif of a mad scientist destroying the world was not new; the concept had already gained prominence in literature and society through 19th-century authors such as Mary Shelley in *The Last Man* or Jules Verne's science fiction scenarios.[36] Because the public maintained a highly limited understanding of nuclear fission, this image not only persisted but was enhanced: the atom was a cosmic force beyond comprehension. Its invisibility closely complemented this, serving to increase the nuclear fear factor. Radiation was perceived as a kind of fear separate and above earthquakes and tsunamis, as the damage it left was on a scale impossible to perceive until it was too late.[37] Therefore, the alchemical

'transmutation' of the human body and genome terrified the public before nuclear power was even invented.

At the same time as anti-nuclear movements, the early 1960s saw a rigorous discourse on environmentalism beginning to take hold in the American public. Post-World War II industrialization and urbanization had accelerated environmental exploitation, giving rise to concerned citizens who sought to stall such activities.[38] In 1963, a local group successfully resisted the construction of a hydropower dam on Storm King Mountain by taking the issue to court. Three judges unanimously ruled that the project be denied due to its "effect on the scenic, historical and recreational values of the area," a precedent that would be heavily leveraged by environmentalist groups to come.[39] As the environmental movement grew, its members' opinions on nuclear energy were relatively balanced, with some praising its superior energy efficiency as an alternative to coal, while others remained skeptical.[40]

However, uranium mining would cause the balance in nuclear discourse among environmental activists to shift towards anti-nuclearism in the late 1960s. In the early years of the Cold War, the U.S. started uranium mining programs in the Southwest to sustain its development of nuclear weapons. Much of the areas containing uranium, however, overlapped with the Navajo and Laguna Native American Reservations.[41] Under the Atomic Energy Act of 1946, the Atomic Energy Commission (AEC) had the authority to "explore, condemn, and obtain all lands that contain[ed] the existence of uranium," and it contracted with Kerr-McGee Oil and Anaconda Jackpile for their operations.[42] The two companies soon opened mines in 1953, with the reservations consenting to the mining in hopes of improving their economic conditions. The mines served as a primary income source for many Native Americans who were employed as miners, but the long-term effects would be disastrous.

More contentiously, the mines posed extensive health risks and hazards not only to workers but to the surrounding communities. The use of explosives to loosen the ore from rocks filled the air with suffocating dust; insufficient ventilation then worsened

the risks of respiratory illnesses.[43] Miners were also rarely informed of safety measures to protect themselves, such as the importance of wearing masks and helmets. But radiation and the radon gas emitted by the uranium had the most significant impacts on workers' health. Numerous miners developed lung sicknesses, partially lost their vision, or experienced strange sensations in their extremities.[44] The mines also drew on water from the already arid reservations, leaving water supplies drained and contaminated. Even long after the mines closed, polluted dust released into the air caused an uptick in cancer cases among surrounding populations.[45] For the environmental movement, this was an egregious violation of human rights and drew environmentalists' attention to the downsides of nuclear technology.

The issue of nuclear waste disposal presented another point of contention to the environmental movement. Heading into the 1960s, the government had yet to secure a central system of waste disposal. Although the Oakland Ridge Reservation had been in operation storing nuclear waste since World War II, concerns about the radioactive contamination of groundwater persisted. Many alternatives were brought up in the scientific community. Dumping waste canisters at the bottom of the sea was an option that had already been used, but this was discontinued as experts emphasized the importance of monitoring waste.[46] Other ideas such as burial at the South Pole and launching waste into orbit were rejected due to cost and safety concerns. Scientists also brought up the idea of burying waste in dry, secure salt domes, to which the public voiced their considerable support. But when the Atomic Energy Commission built a demonstration salt dome in Kansas, the experimental dome showed radiation's degrading effects on salt, invalidating the solution as well.[47] Thus, nuclear waste disposal went without a viable solution into the 1970s.

Reprocessing, however, emerged as one of the most promising solutions to the nuclear waste dilemma. Reprocessing involved dissolving nuclear fuel rods and using the leftover plutonium and uranium to create new fuel rods. Enticed by its high return on investment, commercial reprocessing plants opened in

1966. However, these plants did not make a profit and were built on the assumption that the price of fissionable material would rise significantly. Instead, uranium would remain abundant, and plants started closing. It was estimated that the price of uranium would have to rise tenfold for reprocessing to be profitable.[48] So, by 1975, all private reprocessing ventures ended. Furthermore, the government feared that terrorists could use reprocessing to obtain fissionable material, leading President Jimmy Carter to ban the construction of reprocessing facilities in 1977. Once again, America's lingering nuclear fears caused the failure of a promising innovation in nuclear energy.

The government's failures in waste disposal again brought environmentalists' attention to the anti-nuclear cause. A lack of waste disposal and the effects of uranium mining almost completely undermined nuclear energy's environmental merits: a technology originally thought to be clean and renewable actually needed a labor-intensive mining process, while its extremely harmful byproducts had nowhere to go. In this light, nuclear energy fell to the same level as coal—or even lower—in the eyes of environmentalists. Soon after, a push to establish the EPA in the early 1970s resulted in the creation of several national environmental groups such as Friends of the Earth, the Natural Resources Defense Council, and Greenpeace.[49] In this period, local advocacy for environmentalism transitioned into national, organized efforts. This culminated on April 22, 1970, when the first Earth Day occurred. With over 20 million participants, Earth Day was by far the largest environmental protest in U.S. history. Through meticulous preparation and organization, its message of conservation reached nearly everyone in the U.S. Environmental movements thereafter grew exponentially, and opposition to nuclear power also gained credibility. The environmental movement's litigative and organizational prowess served as an inspiration for the agendas of anti-nuclearists. The two groups would again cross paths during the Cold War on other issues such as atmospheric testing and radiation contamination.[50] The frequent intersections of their beliefs resulted in the formation of the environmental anti-nuclear movement, which gave

anti-nuclearists a far wider platform to express their concerns and enact their agendas.

The 1973 oil crisis pushed the government to expand its nuclear energy program, further antagonizing anti-nuclearists. In 1973, angered by the U.S.' support of Israel in the Yom Kippur War, the Organization of Arab Petroleum Exporting Countries (OAPEC) imposed an oil embargo on the nation. Oil prices drastically rose, and the U.S. entered an economic recession. In response, the government attempted to diversify the energy industry and reduce its dependence on oil by pursuing renewable energies, including nuclear power.[51] However, President Nixon's Watergate scandal simultaneously came to light, limiting the government's political capacity to efficiently expand alternative energy. Policymaking during the oil crisis, especially regarding nuclear energy, was largely dominated by 'crisis-mentality thinking,' in which the speed of implementation was valued over effectiveness and feasibility.[52] The government hastily commissioned dozens of nuclear power plants, but cost overruns ensured that few of them were finished. For example, an enormous Kansas nuclear power unit was commissioned in 1973 and was projected to cost $525 million. Ten years later, its final cost turned out to be $3 billion.[53] The obvious shortcomings of the nuclear energy program and the industry's expansion despite fervent opposition intensified anti-nuclear sentiments.

The environmental anti-nuclear movement sought to leverage the crisis and the government's response to raise fears of nuclear energy and promote other 'clean' energies. Two national environmental movements, the Sierra Club and the Union of Concerned Scientists, mobilized this agenda through large-scale legal negotiations with the government. It took notice of their opposition and made a few procedural concessions but continued to pursue nuclear energy. It also issued a sweeping safety report, which the two organizations immediately criticized.[54] In 1974, several anti-nuclear environmentalist groups collaborated through "Critical Mass," a national anti-nuclear conference.[55] Its overall goals were conservation, slowing energy growth, environmental

regulation, supporting renewable energy, and a moratorium on nuclear power development.[56] By emphasizing the dual importance of safety and environmental consciousness in America's energy industry, "Critical Mass" gave the public a sense of urgency regarding the evolving energy crisis and the use of nuclear energy as a solution. By influencing government proceedings and critiquing U.S. energy policies, the national environmental organizations linked public fears of nuclear energy to the possibility of imminent environmental damage.

Heading into the 1970s, the AEC began to fall under intense public criticism. People were dissatisfied with its use of funding, as many of its projects had regularly encountered cost overruns and construction failures. Furthermore, many believed that it was endowed with excessive power through its dual function of regulation and development. The AEC had sought to ensure public safety while minimizing regulation that would inhibit the growth of the industry, but anti-nuclearists felt that this balance had leaned heavily towards the latter.[57] Finally, in 1974, immense distrust of the AEC led Congress to pass the Energy Reorganization Act of 1974. The act divided the AEC into the Nuclear Regulatory Commission (NRC) and the Energy Research and Development Administration, emphasizing a separation between destructive nuclear power and clean nuclear energy.

The new NRC began making regulatory changes to radiation emission and control. In 1975, it coined the term "as low as is reasonably achievable" (ALARA),[58] stating that radiation was a high-level threat and had to be kept below unsafe levels, but without taking unreasonably costly measures to eradicate it completely. The International Commission on Radiological Protection (ICRP) adopted ALARA in its 1977 regulations,[59] with one of its objectives being that "all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account."[60] To this day, ALARA remains the most widely used definition of acceptable radiation limits; evidently, the NRC set the level for minimal, low-radiation approaches to nuclear power that acknowledged its socioeconomic risks. But by viewing radiation

exposure as high-risk, the NRC heightened anti-nuclear concerns. With public opinion centering around the need for safety within nuclear energy use, the new NRC served as a reminder of the risks of nuclear energy accidents or misuse.

Three Mile Island Disaster and Public Fallout

On March 28, 1979, an operator error at the Three Mile Island Nuclear Generating Station set off a series of equipment failures that resulted in a partial meltdown of the station's Unit 2 module. The incident triggered a national distrust of nuclear energy and brought the "nuclear holocaust"[61] imagery from World War II into the domestic sphere. As the public turned hostile towards the government and scientific community, a widespread tendency of people to attribute any health issue to radiation surfaced.[62] In many ways, Three Mile Island (TMI) embodied the culmination of nuclear fears that had built up over the past decades. The threats of radioactive transmutation and invisible damage had occurred within proximity of domestic life and would wreak havoc on nuclear energy's reputation.

Not a single person fell ill or died as a result of TMI, but the incident carried immense shock, nonetheless. In addition to validating century-long fears of radiation, TMI had high 'signal value,' the information an event reveals on the likelihood of another occurrence.[63] As a nuclear accident, TMI's 'signal value' was high because the system that caused it was so poorly understood, leading people to believe that it was prone to future malfunctions. On the contrary, many experts believed that nuclear technology was incredibly safe and that the events that caused TMI were a highly erratic anomaly.[64] The incident, in fact, showcased the power plant's safety: radiation had failed to breach the thick outer containment wall, and there was no evidence to show it ever reached the public. Nevertheless, the nature of technologies with high 'signal value' are that negative events demonstrate extreme risk factors, while successful safety measures do little to convince people otherwise.[65] The positives were thus ignored in favor of advancing the anti-nuclear narrative.

TMI was a tipping point for Americans who held moderate views on nuclear power and drove many to hold anti-nuclear beliefs. A surge in the influence of anti-nuclear movements followed TMI, with their membership increasing drastically. In 1981, students opposing nuclear power formed a total of fifty groups on their respective campuses. By 1986, these groups consolidated into the United Campuses Against Nuclear War, with student opposition forming on over 600 campuses. Another prominent anti-nuclear group, the National Committee for a Sane Nuclear Policy (SANE), doubled its membership from 100,000 to 200,000 after merging with the Nuclear Freeze Campaign.[66] Even former nuclear scientists rallied toward anti-nuclear movements, and some industry experts believed that the U.S. needed to change its approach to nuclear energy. TMI thus resulted in a spike in the credibility of anti-nuclearism.

The anti-nuclear movements triggered a series of protests and initiatives designed to pose difficulties for nuclear implementation. Residents living near TMI marched to set rigorous safety standards for the cleanup of Unit 2 and cancel plans to restart Unit 1.[67] In 1979, an anti-nuclear protest in Washington, D.C. drew over 65,000 people.[68] Meanwhile, organized groups such as SANE took wider approaches and had goals of re-calibrating U.S. policy through anti-nuclear, anti-war policy changes. SANE's unique agenda represented a transition from isolated protests to organized resistance on a political and legal level. Still, demonstrations remained the most popular outlet for expressing anti-nuclear sentiment. The climax in anti-nuclear protests came when a demonstration occurred in New York City's central park on June 12, 1982. With a million people in attendance, it stands as the largest political protest in U.S. history.

Additionally, as protest behaviors became more and more frequent throughout the 1980s, the U.S. saw the emergence of extreme anti-nuclearists. Extreme anti-nuclear protests had grown more prevalent due to their effectiveness at slowing nuclear activity. In the 1987 Nevada Test Site protest, organized in part by SANE, several protestors were arrested for violent demonstrations,[69] rep-

resenting the growing discontent surrounding the U.S.' nuclear power developments. The accident at TMI made extreme protests appear as a necessary course of anti-nuclear activity. However, these extreme anti-nuclearists were strictly against "nuclear terrorism," and prevented any acts of misusing nuclear facilities and technology, a doctrine that upheld their reputation.[70] As the government continued to endorse nuclear activities, extreme anti-nuclearism gained further momentum as the primary method of impeding the U.S. nuclear energy program.

Public outrage over TMI also revived discourse around the issue of nuclear waste storage. Congress passed the National Waste Policy Act in 1982, which required the Department of Energy to examine potential locations for waste repositories.[71] However, the search for a waste repository was riddled with political impediments, mainly because no state wanted one built on their land. The DOE was originally to designate one site in the East and one in the West, but the Eastern states leveraged their larger political influence to prevent a repository from being built in the East. The DOE moved forward and designated three sites in Washington, Texas, and Nevada, but the Western states demanded that the list of top candidate sites be revised twice. In this period, there were also nineteen lawsuits filed against the nuclear waste program, primarily by Western state governments.[72] Throughout the process, environmental and anti-nuclear groups also called for a moratorium on nuclear power, hoping to prevent a repository from being built at all. Nevertheless, the DOE began exploring Yucca Mountain in Nevada as the chief site for permanently burying radioactive waste.[73] The site, located just 100 miles northwest of a nuclear testing range, was stable, dry, and remote. There was already information on Yucca Mountain, and most had determined it to be the best location; additionally, Nevada's small congressional delegation meant it was unable to prevent the construction.[74] Therefore, the federal government settled on Yucca Mountain as the designated site for a permanent nuclear waste repository.

However, political disagreements would make the process of building a repository in Yucca Mountain long, arduous, and un-

productive. The state of Nevada itself strongly opposed construction and made every possible effort to impede the DOE's development of the site. In 1989, Nevada passed a bill that made it illegal to store radioactive waste and withheld the environmental permits needed to conduct a study of Yucca Mountain. The federal government reversed these blockades, but Nevada scientists brought up endless technical issues with the site as reasons to prevent its construction. While most were dismissed, some concerns such as volcanism and seismic activity posed a serious threat to the site's security and had to be addressed. The DOE appointed a review panel that found the earthquake threat to be unfounded, but the issue of volcanism remained. Scientists estimated at the time that an eruption had occurred 20,000 years ago, but a DOE study stated that the last eruption had occurred 80,000 years ago.[75] The DOE also asked ten experts, and their average estimates yielded around a one in a thousand chance of an eruption in the next 10,000 years, a probability which went on to become the DOE's arbitrary benchmark for waste repository construction. Still, the state was not convinced and continued to list high humidity, rock formations, and transportation issues in its fight against the repository.[76] With studies, lawsuits, and legislature that opposed the repository, little time was devoted to resolving the actual technical issues of the site. Yucca Mountain was indefinitely put on hold, and the ongoing problem of where to place nuclear waste with as little damage—or public knowledge—as possible continued in addition to the lasting outrage over TMI.

These additional failures brought about by political disagreement and the extreme initiatives against nuclear power that formed after TMI were catastrophic for the nuclear power industry. The resulting public outcry over health and safety concerns forced an unprecedented decline in atomic power plants. Until TMI, the number of reactors in the U.S. had increased nearly every year. But from 1980 to 1998, nuclear power plants were consistently decommissioned and all plans for new power plants were canceled within that period. Furthermore, the regulations that followed TMI were crippling. Construction costs for the average full-scale plant rose

to an estimated $400 million[77] due to new design requirements that were intended to increase safety but made plant designs more convoluted. The consequences and fallout from TMI effectively dismantled the U.S. nuclear power industry.

Conclusion

The future of clean nuclear energy in the U.S. remains heavily defined by the consequences, both political and social, of anti-nuclearism. The events triggered by anti-nuclearists and environmentalists have thrust nuclear energy into the media spotlight, where the public has formed a principally negative opinion of it. According to public energy specialist M. Granger Morgan:

> Those who oppose nuclear power do so because, at least in the rough qualitative way, they have balanced the risks and benefits as they understand them and have concluded that nuclear power is a bad deal. Proponents of nuclear power argue that, with much re-education and a bit of fine-tuning of organizations and technology, the public can be persuaded to rebalance the equation and welcome back nuclear power.[78]

As Morgan suggests, America's decision to reject nuclear energy has been a product of simple risk analysis and self-preservation. The average citizen cannot be held at fault for opposing nuclear energy when the industry and government have given myriad reasons to believe it is an unequivocally dangerous technology. For a vision that depended so closely on positive public opinion to succeed, the government's neglect and failure to address anti-nuclearism dealt a catastrophic blow to nuclear energy.

The state of the U.S. nuclear power industry today is largely overshadowed by the atom's destruction. However, America faces a turning point in its nuclear history at a time when fossil fuels are falling increasingly out of favor and technology is advancing rapidly. The nation holds a renewed opportunity to change the opinion on nuclear energy among the younger generation. And if we are to pursue a cleaner, eco-conscious world fueled by nuclear energy, we must begin by understanding where nuclear power in the U.S. went wrong. When examining the history of anti-nucle-

arism, the legacy of repelling nuclearized nations combined with the growing necessity of re-developing the U.S.' energy sources places nuclear energy in a vulnerable state, both shaped by and still transitioning from its past. As it has in the past, its future will depend on the changing trajectory of public opinion.

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