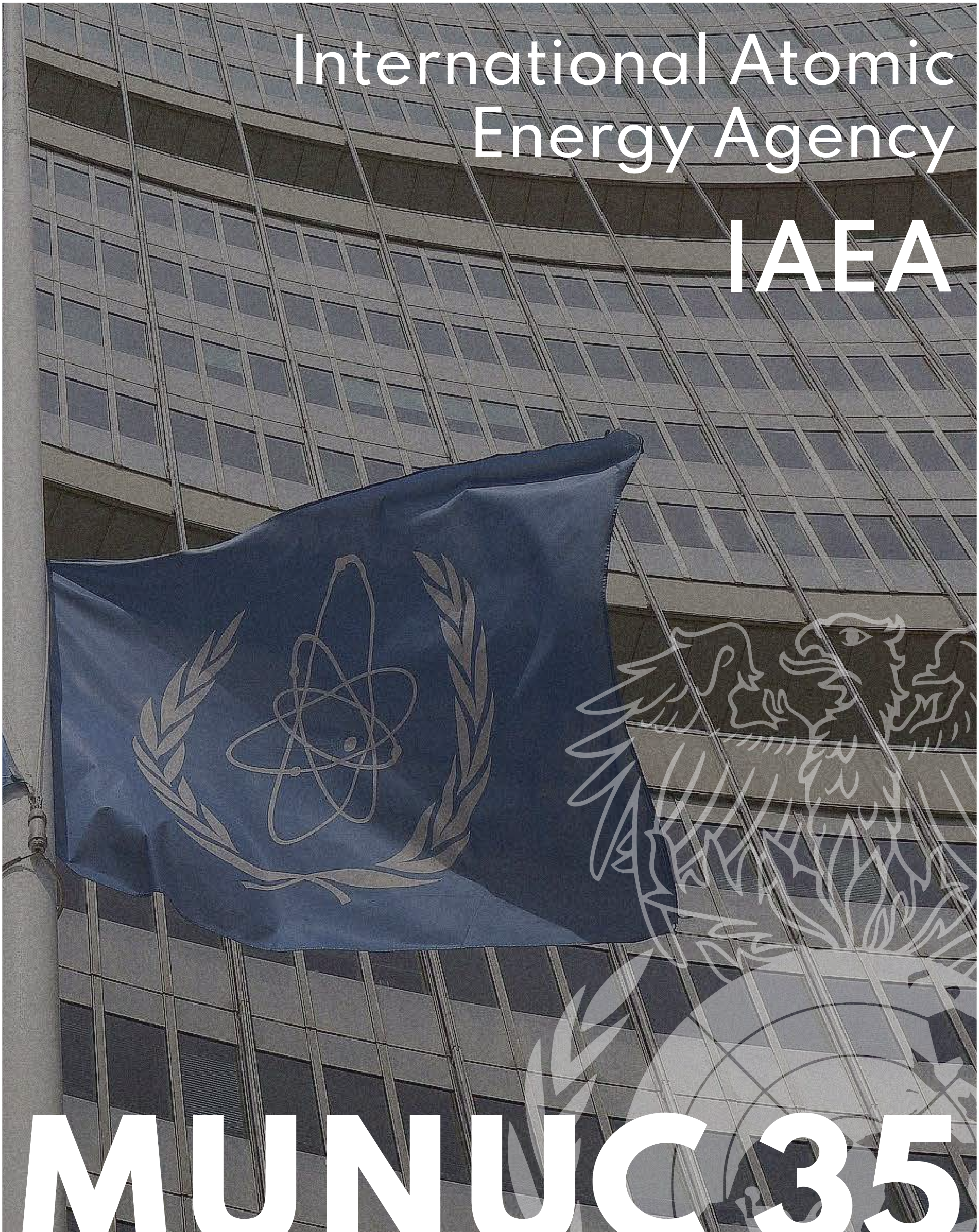
International Atomic Energy Agency

IAEA



MUNUC 35

Model United Nations of the University of Chicago

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CHAIRS LETTER

Hello there!

We are Alan Pham and Sam Huang, and together we will be chairing the International Atomic Energy Agency, or IAEA for short. We are excited to get to know you throughout the conference at MUNUC 35. Before getting into the topics, first a bit about ourselves!

I'm Alan. I am currently a second-year, majoring in Computer Science and Economics. Outside of my academic life, I am a part of MUNUC, as you could probably tell, and the Golf Club at the school. Outside of school, I can sometimes be found in a field of grass hitting a little white ball around with a stick or in a room moving heavy circles, which sometimes happen to be hexagons.

I'm Sam. I am also a second-year, and I major in Cognitive Science and Computer Science. On campus, I am involved in MUNUC, UChicago Game Design, and the Esports Club. Outside of class, I play soccer, like to hang out with friends and nature and listen to Post Malone.

For the committee, the first topic was chosen in response to the rise of nuclear energy and the threats it poses to those working with such hazardous materials. As nuclear energy has become more widespread, the hazards of working in such industries have also become increased. With this being the unfortunate reality, it is important to provide the workers with as much protection as we can, as there are further implications for the safety of our nuclear workers than just their health.

We chose the second topic because we wanted to expose the history of nuclear weapon development, especially the complex social processes involved. Learning about how modern power structures came into being challenges our views of the present, and helps remind us that we should not take our surroundings for granted. That said, we encourage you to think about ways in which historical mistakes can be addressed on national and international levels.

This conference is an event that we look forward to, and we hope to make your experience as wonderful as it should be. Throughout the conference, we hope that you will be able to interact with a multitude of other delegates to work together and hold a respectful debate about the topic at hand. Being able to understand the position of other countries and the nuances of the topic is only one of the goals of the conference, as we aim to help you learn about nuclear energy and testing, and practice your public speaking. We wish you the best of luck and feel free to reach out with any questions or concerns. Until then!

Best,

Alan & Sam

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HISTORY OF THE COMMITTEE

On December 8, 1953, the President of the United States, Dwight D. Eisenhower, delivered a speech during the meeting of the 470th Plenary Meeting of the United Nations General Assembly. This speech, now known as the Atoms for Peace speech, laid the foundation for the organization that is now the International Atomic Energy Agency. The Atoms of Peace speech highlighted the fast-spreading knowledge and testing of various atomic weapons, and the belief that "if a danger exists in the world, it is a danger shared by all; and equally, that if hope exists in the mind of one nation, that hope should be shared by all."[1] The goals expressed in the Atoms of Peace speech soon played a role in shaping the statute of the Atoms for Peace and Development Organization within the United Nations, or the IAEA, with its official ratification on July 29, 1957.

With the headquarters based in Vienna, Austria, its two regional offices in Toronto, Canada, and Tokyo, Japan, and two liaison offices in New York City, United States, and Geneva, Switzerland, the IAEA set out to "harness the power of the atom for the benefit of humankind".[2] Hence, the IAEA is responsible for the control of nuclear technology as a controversial weapon and its practical uses ranging from boosting the food supply to protecting the ecosystem. At the same time, the organization provided its expertise on nuclear security to all member states. Eventually, the organization's work and assistance towards using nuclear science and technology for a better future was recognized in 2005 with the gifting of the Nobel Peace Prize by the Norwegian Nobel Committee.

Today, with its 175 member states, the IAEA has stayed true to its origins, focusing on the use of nuclear science and technology in a safe, secure, and peaceful manner. The IAEA currently has four Active Technical Operations as well as one Active Coordinated Research Project aiming toward better usage and understanding of Nuclear Science. With its belief that nuclear technology is part of

[1] "Atoms for Peace Speech | IAEA." 2014. iaea.org. July 16, 2014. https://www.iaea.org/about/history/atoms-for-peace-speech.
[2] "This Is the IAEA." n.d. www.youtube.com. Accessed September 11, 2022. https://www.youtube.com/watch?v=9TmYGBtmSk4.

the solution to humanity's biggest challenges, the IAEA continues to work towards its goals that are set out in its statute.

TOPIC A: ADDRESSING THE CONSEQUENCES OF NUCLEAR TESTING

Statement of the Problem

The nuclear weapons of today are the products of decades of state-led development programs. Since the United States carried out its first nuclear test in 1945, countries around the world (some no longer existent, like the Soviet Union) have conducted over two thousand nuclear tests in total. Despite their most straightforward product—weaponized nuclear devices—they have also resulted in significant environmental damages and human casualties, among other losses. Moreover, colonial and indigenous territories were disproportionately affected by nuclear testing. This topic will focus on and attempt to both address the consequences of historical testing and prevent future disasters from active nuclear programs.

Despite their experimental nature, the devices detonated in nuclear tests are capable of bringing lethal, large-scale, and sustained damage. The damage dealt by a nuclear test depends largely on its setting. On one hand, there are different types of tests. A nuclear test could be atmospheric, underwater, underground, or exoatmospheric. Each type of test has different hazards, as the yield of the tested nuclear device could vary. If all other conditions are the same, a nuclear weapon's destructiveness increases with its yield.

Early nuclear tests were mostly atmospheric. Nuclear weapons were detonated in settings that were exposed to the atmosphere. The detonations were either on the surface or in mid-air, such as on balloons. Atmospheric tests were rarely designed to contain the radioactive particles they created, meaning they contaminated the surrounding area. In addition to contamination, atmospheric tests can emit radioactive fallout that can follow wind patterns and affect relatively distant locations. Furthermore, once radioactive debris enters the atmosphere, it could potentially spread across the globe through atmospheric activities.[3]

[3] Prăvălie, Remus. 2014. "Nuclear Weapons Tests and Environmental Consequences: A Global Perspective." *AMBIO* 43 (6): 729–44. https://doi.org/10.1007/s13280-014-0491-1.

Atmospheric test conducted in 1952[4]

Instead of being atmospheric, some other early tests were conducted as underwater tests. They concern nuclear devices that were detonated, as the name suggests, in bodies of water, usually oceans. Because the aim of underwater nuclear detonations was usually to test the effectiveness of nuclear weapons on naval fleets, many underwater tests were conducted close to the water surface. As a result, they can emit radioactive steam that enters the atmosphere, though the scale of the fallout is usually much smaller than that created by atmospheric tests. Nevertheless, they were capable of contaminating nearby waters and posed a threat to marine biology and any nearby inhabitants that depended on it.

[4] The Official CTBTO Photostream. 2011. "'Ivy Mike' Atmospheric Nuclear Test - November 1952." Flickr. December 8, 2011. https://www.flickr.com/photos/ctbto/6476282811.

Both atmospheric and underwater tests pose particular threats to ecosystems in general and human health in particular. Once radioactive contamination has affected either soil or water, it could propagate along the food chain and enter the bodies of all kinds of organisms, including humans. Moreover, populations could receive dangerous doses of radiation for a long time before displaying symptoms, after which their health has already been seriously affected.

In the late 20th century, countries began adopting underground nuclear tests. In well-designed underground tests, nuclear fallout should be fully contained, reducing the extent of radioactive contamination to a near-negligible level. The nuclear device is positioned at a sufficient depth underground. Upon initiation, rocks surrounding the device are vaporized and form a cavity that contains the radioactive steam generated by the blast. Usually, this cavity does not collapse until the steam has condensed, thus "burying" the radiation.[5]

There remains, however, the possibility for radiation to escape the cavity and cause contamination of the atmosphere. Such cases are called containment failures. Common reasons for containment failures include insufficient detonation depth, unexpected rock and soil structures, and unexpected yield. They cause the cavity created by nuclear explosions to be exposed to the atmosphere, venting radiation to the outside world. In some cases, the energy of the explosions cracks open top-layer soil and exposes steam to the atmosphere directly, while in other instances radioactive gasses seep out through small gaps slowly.

The yield of a nuclear weapon is the amount of energy released upon detonation. It is usually measured in kilotons (Kt, or thousands of tons of TNT equivalent) or megatons (Mt, or millions of tons of TNT equivalents). Higher yields are usually correlated with increased irradiation capacity. Yet higher yields do not always result in more damage to the environment and human health, because some tests, such as underground tests, are designed to contain nuclear contamination. Containment measures are designed according to the expected yields of test devices. In cases where actual yields are unexpectedly large, designed safeguards might fall short of preventing containment.[6]

[5] *Ibid*.
[6] *Ibid*.

Environmental and Health Issues of Nuclear Testing

The major environmental concern of nuclear testing is its production of radioactive debris. Upon detonation, nuclear devices produce intense direct radiation in their surroundings. The radius of this radiation could range from less than a mile for small bombs to tens of miles for larger ones. Organisms within this radius during detonation could receive lethal doses of radiation, posing an immediate threat to the humans and ecological systems near the test site. However, because test sites are usually selected at remote locations that do not have much human population and animal presence, direct radiation has not provided the most serious consequences of testing, especially when compared to the more enduring effects of the other form of radiation caused by nuclear tests—radioactive fallout.

Irradiated materials do not remain harmful forever. Radioactive substances experience radioactive decay, which gradually reduces radioactivity to a trivial level. The speed of radioactive decay, however, varies. The time it takes for a material's radioactivity to reduce to half its current level is called its half-life. This could range from less than a few seconds to months and even years. When materials with relatively long half-lives are released by nuclear tests and allowed to travel freely in the atmosphere, they could cause serious problems.

The energy produced by nuclear explosions could send irradiated particles into the atmosphere. If those particles enter the stratosphere, they could remain there for a long time. The time it takes for nuclear fallout to reach the ground ranges from hours to years. During this time, radioactive fallout could travel with winds and other weather patterns and cover long distances. The fallout could bring lethal damage to the ecology in areas it passes through, as it leaves radioactive particles behind in water, soil, and organisms. If it covers human settlements, their populations could receive doses of radioactivity that exceed safety limits and develop sicknesses caused by radiation.[7]

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[7] *Ibid*.

Radiation and the Human Body

Small doses of radiation are usually harmless to the human body. In fact, we constantly live with a low level of natural background radiation. High levels of radiation, however, can cause serious and even lethal illnesses. High levels of radiation kill large amounts of human cells, destroy their DNA, and facilitate gene mutations. Because mutations of body cells can be sustained through the offspring of those cells, the health issues that radiation brings can be long-lasting. If the genes of cells involved in reproduction are modified, the effects of high radiation can even be passed on through generations. In other cases, the ability to reproduce might be lost, or the affected individual might not survive at all.

Large doses of radiation can give rise to symptoms including nausea, vomiting, headache, skin burn, and hair loss. If exposed individuals survive the initial acute symptoms caused by radiation, they would face long-term problems such as decreased immunity and increased risk of cancer.[8] In some cases, this would require heightened medical attention throughout the rest of their lifetime.

Clearly, unregulated or poorly regulated nuclear testing presents a problem, and the IAEA must determine solutions to prevent the dangerous effects of nuclear tests moving forward.

[8] "Sources and Effects of Ionizing Radiation." 2008. *Unscear.org*. United Nations Scientific Committee on the Effects of Atomic Radiation. https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2008_Annex-C-CORR.pdf.

History of the Problem

Though the first nuclear tests were carried out in World War II, the largest and most destructive nuclear tests mostly occurred during the Cold War. These tests were a direct result of the Cold War nuclear arms race, in which countries from competing factions, i.e. the western liberal states and countries from the Soviet bloc, strived to acquire the technology required for nuclear weapons.

Among the Cold War tests, the most environmentally disastrous ones were mainly conducted from the end of World War II to 1964. Due to the geopolitical pressure of the Cold War, ignorance of the consequences of nuclear testing, and governmental negligence, this period saw nuclear tests that not only had large yields but also lacked any significant containment measures. Most tests conducted in this period were either atmospheric or underwater. Countries that carried out nuclear tests during this period included the United States, the USSR, the United Kingdom, France, and China.

The number and the average yield of nuclear tests increased rapidly—almost exponentially—since 1950. The largest U.S. testing, codenamed Castle Bravo, happened in 1954 and produced a 15 Mt yield. The largest nuclear weapon ever to be detonated, the Tsar Bomba, was tested by the Soviet Union in 1961 and gave a 50 Mt yield. Despite a short period of testing moratorium (suspension of testing) on both sides around 1959, the global number of nuclear tests reached a peak of almost 200 tests in 1962, while the total yield of nuclear weapons detonated worldwide reached about 170Mt that same year.[9] The high yields of such nuclear tests, coupled with the fact that they were either conducted in open air or underwater and thus produced radioactive particles that could propagate freely, produced disastrous health and environmental consequences.

Some of the most notorious cases of nuclear testing bringing human casualties are the U.S. tests in the Marshall Islands and the French tests in French Polynesia. Test sites are usually selected from remote areas to minimize the impact on the domestic population. In those cases, however, the

[9] Yang, Xiaoping, Robert North, Carl Romney, and Paul Richards. n.d. "Worldwide Nuclear Explosions." https://www.ldeo.columbia.edu/~richards/my_papers/WW_nuclear_tests_IASPEI_HB.pdf.

selected sites are near enough to indigenous settlements to bring substantial and sustained impact to their communities.

The United States detonated 67 nuclear devices in the Marshall Islands between 1946 and 1958. At that time, the Marshall Islands were a U.S. territory. The U.S. government relocated hundreds of inhabitants from the atolls that were to become test sites. However, the impact of nuclear fallout on neighboring atolls was not fully considered. One of the largest and most destructive tests was Castle Bravo, which induced an explosion 1,000 times the force of that of Hiroshima. After it was carried out on the Bikini Atoll, radioactive fallout spread quickly towards neighboring atolls, forcing hundreds of native Marshallese islanders and American servicemen to evacuate.[10] Further nuclear tests were conducted in the following months, resulting in even more radioactive contamination of the atolls. The tests resulted in widespread radiation-related diseases. The proceeding years witnessed more than tenfold increases in the number of miscarriages and stillbirths among the populations on neighboring islands.[11] Also reported were increased cases of cancer and body deformities.

The impact of U.S. nuclear testing in the Marshall Islands is enduring, as radiation has still never returned to pre-testing levels. In 1998, more than 40 years after the tests, a group of scientists led by the IAEA reported that although Bikini Atoll is ready for permanent resettlement, as locally produced foodstuffs could still contain harmful radiation.[12] The recommendation for resettlement is presumed upon the local population eating primarily imported food, which would add an undue financial burden to the island's potential inhabitants. As of 2022, Bikini Atoll remains uninhabited.

[10] Castandea, Ryan. 2018. "The Marshall Islands: U.S. Nuclear Testing of the 1950'S." Large.stanford.edu. Stanford University. April 7, 2018. http://large.stanford.edu/courses/2018/ph241/castandea2/.
[11] "Exposures to the Public from Man-Made Sources of Radiation." 2000. *Unscear.org*. United Nations Scientific Committee on the Effects of Atomic Radiation. https://www.unscear.org/docs/reports/annexc.pdf.
[12] K Lokan, and Peter Stegnar. 1998. *Radiological Conditions at Bikini Atoll : Prospects for Resettlement.* Vienna: International Atomic Energy Agency.

Underwater test conducted in the Bikini Atoll[13]

Between 1966 and 1996, France carried out nearly 200 tests in the South Pacific, specifically on the islands that make up French Polynesia. Among those tests, 41 were atmospheric. Though the military had supposedly put together thorough plans to prevent radioactive contamination from spreading to inhabited areas, other reports claim that more than 110,000 people were affected by nuclear fallout, which amounted to almost the entire population of the archipelago at that time.[14]

French nuclear tests on Moruroa Atoll in July 1966, for example, caused at least 450 inhabitants of neighboring islands to receive significant doses of radioactivity. The inhabited Gambier Islands, located 424 kilometers southeast of the Moruroa test site, were determined to be too far away to be affected by nuclear testing. However, on July 2, winds blowing towards the southeast brought radioactive fallout to the Gambier Islands and its inhabitants. Yet according to declassified reports, weather forecasts hours before the detonation predicted south-east blowing winds.[15] This test is just

[13] "An Atomic Bomb Is Detonated Underwater in the Lagoon of Bikini Atoll, Harry S Truman National Historic Site, 1946. - PICRYL Public Domain Image." n.d. Garystockbridge617.Getarchive.net. Accessed September 12, 2022. https://garystockbridge617.getarchive.net/amp/media/an-atomic-bomb-is-detonated-underwater-in-the-lagoon-of-bikini-atoll-harry-888398.
[14] BBC News. 2021. "French Nuclear Tests Contaminated 110,000 in Pacific, Says Study," March 9, 2021, sec. Europe. https://www.bbc.com/news/world-europe-56340159.
[15] INTERPRT. n.d. "Moruroa Files." Moruroa-Files.org. https://moruroa-files.org/en/investigation/moruroa-files.

one example of many tests that resulted in radioactive contamination due to gross negligence on the part of the government conducting the test. According to a French Ministry of Defence report in 2006, the Gambier Islands alone were impacted by radioactive fallout from French testing on 31 different occasions, resulting in an abnormal frequency of observed thyroid cancers. Even so, it is only ranked third among the most contaminated areas in French Polynesia.

Nuclear tests resulted in an estimated total of 110,000 people receiving radioactive doses higher than 1mSv (millisievert, a unit of radiation), with at least 11,000 of them receiving more than 5mSv, five times the minimum level of radiation received for one to be qualified for compensation by the French government.[16] For many of the tests resulting in contamination of inhabited islands, official records frequently blamed either shifting weather patterns or unexpected explosion magnitudes. Yet a declassified French report on its Polynesian testing program highlighted "the difficult balance between security imperatives and the demands of the calendar."[17] In many tests, weather reports issued warnings beforehand on the high possibility of contamination, but those tests were not aborted. For some, it might seem plausible that certain security measures were not given enough attention due to tight experiment schedules, and thus human lives and the environment were put at risk.

The French government changed its Pacific tests to underground facilities due to international pressure, specifically protests from the New Zealand government. In July 1973, two New Zealand military vessels approached a French Polynesian atoll in protest of the testing program. France later switched to engaging in underground tests on the atolls. Some incidents still occurred during underground testing, however, and led to a tsunami and human casualties.[18] For both the US Marshall Islands tests and the French Polynesian tests, affected populations and local authorities have advocated for compensation by either the US or the French government, respectively.

Though the US government has a relatively comprehensive plan for individual compensation, disputes remain over the responsibility of maintaining nuclear waste containment facilities. US

[16] "France Underestimated Impact of Nuclear Tests in French Polynesia." 2021. Theguardian.com. The Guardian. March 9, 2021. https://www.theguardian.com/world/2021/mar/09/france-has-underestimated-impact-of-nuclear-tests-in-french-polynesia-research-finds.
[17] INTERPRT. n.d. "Moruroa Files." Moruroa-Files.org. https://moruroa-files.org/en/investigation/moruroa-files.
[18] Stanley, David. 2000. South Pacific. Emeryville, Ca: Avalon Travel. https://archive.org/details/bub_gb_w6zguqsU7xoC.

authorities dumped radioactive contaminants in the concrete Rumit Dome in the Marshall Islands. After the Marshall Islands gained independence from the US, the responsibility of this containment facility became contentious. The authorities of the Marshall Islands argued that the US should take care of the consequences of its nuclear tests, while the US argued for the opposite on the grounds that the dome is physically located in the Marshall Islands.[19]

France set up a nuclear victims compensation committee in response to calls for compensation in its South Pacific territory. Yet as of March 2021, it was reported that only 63 Polynesian civilians had received the promised compensation. French Polynesia is still French territory, and it is not within the IAEA's jurisdiction to interfere with a country's internal affairs. Historical French testing, however, has also reportedly affected countries like New Zealand and Peru.[20] This committee would therefore need to consider the international impacts of those historical testing programs.

Between 1962-1964, there was a significant decrease in the number of atmospheric and underwater tests, a lot of them being replaced by underground tests.[21] This resulted from test ban talks mainly between the Soviet Union and the United States, but which also involved the United Kingdom. In 1964, the Partial Test Ban Treaty (PTBT) was signed into effect, which prohibited atmospheric and underwater nuclear tests. The reasons for allowing only underground tests were mainly technical and political, instead of environmental. Though the parties initially intended to reach a comprehensive test ban, i.e. one that bans underground testing as well, further negotiations revealed complexities for banning underground tests. Specifically, underground tests that are carried out under sufficient depth were hard to detect, and they were hard to distinguish from earthquakes. When abnormalities in geological activities were detected, the accused countries could dismiss the readings as caused by earthquakes instead of nuclear tests. As such, countries did not have the means of making sure that others were abiding by any potential bans on underground tests. After stalling negotiations, both the US and the USSR decided that it was best to give up on a

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[19] Rust, Susanne. 2019. "How the U.S. Betrayed the Marshall Islands, Kindling the next Nuclear Disaster." Latimes.com. Los Angeles Times. November 10, 2019. https://www.latimes.com/projects/marshall-islands-nuclear-testing-sea-level-rise/.

[20] Weyler, Rex. 2004. Greenpeace : How a Group of Journalists, Ecologists and Visionaries Changed the World. Emmaus, Pa.: Rodale. https://archive.org/details/greenpeacehowgroooweyl/page/n7/mode/2up.

[21] "Sources and Effects of Ionizing Radiation." 2008. *Unscear.org*. United Nations Scientific Committee on the Effects of Atomic Radiation. https://www.unscear.org/unscear/uploads/documents/publications/UNSCEAR_2008_Annex-C-CORR.pdf.

comprehensive test ban and focus on banning easily detectable types of tests for the moment—atmospheric and underwater tests. The resulting partial test ban coincided with the benefits to the environment but was mainly not motivated by environmental concerns.

More than 100 countries would join the PTBT as signatory states after its initial enactment. Though the PTBT was successful at stopping mass atmospheric testing by the US and the USSR, there remained about 60 non-signatory states which continued to conduct consequential atmospheric tests. Among them are France, China, and North Korea. French atmospheric nuclear testing continued until 1974, and the last Chinese atmospheric test was in 1980. North Korea's testing program continues today.

Past Actions

Test Ban Treaties

After the PTBT, other treaties aimed at curbing nuclear weapons followed. The Non-Proliferation Treaty (NPT) in 1970 prohibited states that had not acquired nuclear weapons before 1967 to test nuclear weapons. In 1974, the Threshold Test Ban Treaty banned underground tests above 150 Kt.

The Comprehensive Test Ban Treaty (CTBT) aspires to realize the original intention of those who pushed for the PTBT. Since the PTBT negotiations, the technology for detecting underground tests has significantly improved. Modern monitoring systems can detect underground tests with yields as small as 1Kt. With new technology to ensure the enforcement of underground test bans, the CTBT aims for the ambitious goal of prohibiting nuclear tests of all forms.

However, the CTBT is not in force yet, because of an additional provision that requires all "Annex 2 States" to sign the treaty before it could enter into effect. Those Annex 2 States are states that could potentially acquire nuclear weapons as assessed at the time the treaty was negotiated due to these countries operating national nuclear energy programs. Among them, however, eight states have yet to ratify the treaty. From that subset, the United States, China, Iran, Israel, and Egypt have signed but not ratified the treaty, while North Korea, India, and Pakistan have yet to even sign it. It would be extremely difficult to persuade those countries to ratify the CTBT, as they are motivated by varying interests.

Many national governments are blamed for viewing the CTBT as an instrument to further their national interests rather than for either nuclear disarmament or environmental protection. Nuclear weapon states, for example, view the CTBT and related test-ban efforts as more of a means to secure their monopoly over weaponized nuclear technology. Their motivations for test-ban treaties involve preventing the proliferation of nuclear weapons to other countries by prohibiting nuclear testing, which is essential to the development of nuclear weapons.

The situation is more complex for countries involved in regional conflicts. Specifically, India and Pakistan, two of the three states that have not yet signed the CTBT, demonstrate particular reserve towards the treaty. This is partly due to the longstanding rivalry between the two countries. India has developed its own nuclear weapons despite its insistent call for comprehensive disarmament, while Pakistan has also developed an arsenal, allegedly through some help from China. Yet the US has also demonstrated considerable tolerance towards India's nuclear undertakings, reflecting its intention to use India's nuclear power to counterbalance the alliance between China and Pakistan. Both India and Pakistan fear that ratification of the CTBT would hinder their nuclear development programs and make them fall behind their opponent.

Compensation for Historical Testing

Since the Marshall Island tests, the US government has reportedly provided a total of more than $600 million in compensation to affected communities and is continuing to provide the atolls with services that cost about $6 million annually.[22] This includes medical services, resettlement funds, rehabilitation costs, etc. However, there are some disagreements between the Marshall Islands and the US over the responsibility of certain nuclear waste containment facilities. The Runit Dome in the Marshall Islands, for example, was built by the US in the last century to store nuclear waste from not only its Marshall Island tests but also its tests in Nevada. As sea levels and water temperatures rise, the Runit Dome requires increased financial input for the maintenance of its aging structures. If it is not properly maintained, there might be leaks that could endanger the marine environment and nearby inhabitants. The US, however, adopts the position that it is the responsibility of the Marshallese, instead of the US, to maintain the structure.[23]

The unwillingness of the US to take responsibility for the Dome is representative of the attitude of several governments that produced nuclear testing disasters. Among other matters, this committee would need to evaluate the measures taken to address the problems left behind by historical nuclear

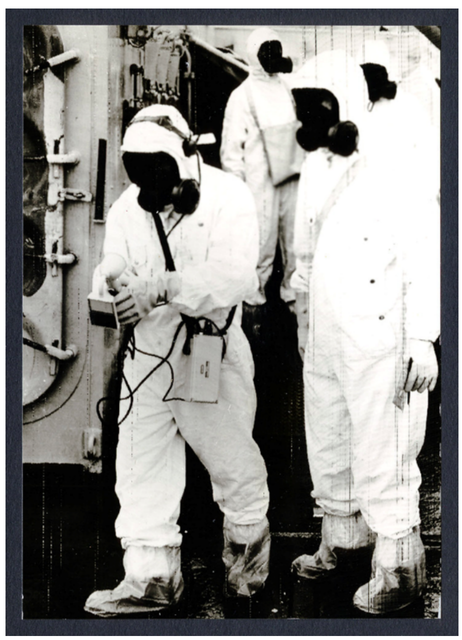
[22] "The Legacy of U.S. Nuclear Testing and Radiation Exposure in the Marshall Islands." 2012. Usembassy.gov. U.S. Embassy in the Republic of the Marshall Islands. September 15, 2012. https://mh.usembassy.gov/the-legacy-of-u-s-nuclear-testing-and-radiation-exposure-in-the-marshall-islands/.

[23] Rust, Susanne. 2019. "How the U.S. Betrayed the Marshall Islands, Kindling the next Nuclear Disaster." Latimes.com. Los Angeles Times. November 10, 2019. https://www.latimes.com/projects/marshall-islands-nuclear-testing-sea-level-rise/.

tests, since they have the potential to affect not only local populations but also the global environment.

Civil Liability for Nuclear Damage

The 1963 Vienna Convention on Civil Liability for Nuclear Damage aims at developing standards for national laws that involve the civil liability of nuclear use.[24] For example, it specified the minimum liability of operators of nuclear power plants in case of any damage caused by them. The Convention only sets minimum liability standards, and individual nations are allowed to include additional liability legislation as long as it meets basic requirements.[25] Though the Convention is only adopted by 44 countries, and its scope is limited to peaceful uses of nuclear technology, it is a good example of how responsibility assignment for nuclear damages can be regulated on an international scale.



Workers inspecting the environment after the Mururoa Nuclear Test[26]

[24] "Vienna Convention on Civil Liability for Nuclear Damage." 2014. Www.iaea.org. International Atomic Energy Agency. August 27, 2014. https://www.iaea.org/topics/nuclear-liability-conventions/vienna-convention-on-civil-liability-for-nuclear-damage#:~:text=The%20Vienna%20Convention%20on%20Civil.
[25] "Civil Liability for Nuclear Damage." 2021. World-Nuclear.org. World Nuclear Association. March 2021. https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/liability-for-nuclear-damage.aspx.
[26] Zealand, Archives New. 2016. "HMNZS Otago at the Mururoa Nuclear Test Zone, 1973." Flickr. December 12, 2016. https://www.flickr.com/photos/archivesnz/32495769801.

Possible Solutions

CTBT

Though the CTBT has effectively lowered atmospheric radiation levels globally, it remains unsigned by 8 Annex 2 States. Those states are China, the U.S., Egypt, Iran, Israel, North Korea, Pakistan, and India. Today, almost all nuclear tests, including those of the non-signatory states, are conducted in controlled underground settings to avoid potential environmental contamination and human casualties. Nonetheless, despite the prevalence of underground tests, the international community would still benefit from the remaining Annex 2 States joining the CTBT and formalizing their commitment to giving up non-underground tests. By gathering these final important signatures for the treaty, this committee could ensure that no more nuclear devices would be detonated in the Earth's atmosphere, at least in experimental settings.

One limitation of the PTBT, as alluded to before, is that accidents in underground tests could still contaminate the environment. Since the signing of the PTBT, its signatory parties have conducted several experiments that resulted in the venting of radioactive debris into the atmosphere. A Soviet test in 1965 created fallout that reached as far as Japan, while a 1970 US test in Nevada released radioactive debris into the air and reportedly irradiated 86 workers. Those problems could be prevented by a comprehensive test ban that prohibits any form of nuclear test. As mentioned before, however, the CTBT is waiting for eight Annex 2 States to ratify it before it could enter into effect, and it could be hard to get those states on board. A draft resolution that contains test-ban-related content would need to address the complex geopolitical factors that have been stalling consensus for the CTBT for decades.

To leverage the CTBT as an effective solution against all future nuclear testing by the remaining Annex 2 States, entrenched geopolitical considerations must be overcome. As pointed out earlier, it will be very difficult for India and Pakistan to agree to the terms of the CTBT given the country's mutual mistrust. Similar political considerations are at play for several of the other Annex 2 States. In order to bring these final signatories under the purview of the treaty, one should consider how transparency can be leveraged to assuage fears which fuel the resistance to the treaty. If countries could engage in meaningful and transparent peer inspections the remaining Annex 2 States could be persuaded to join. However, concerns about national security will persist until a compromise is reached.

International Treaties for Nuclear Disaster Relief

Because nuclear-related issues, almost by nature, involve concerns relating to geopolitics and national security, some countries might consider test-ban advocates as having intentions that go beyond protecting the environment. Even if this is not the case, some countries could find it unacceptable to exchange national security for generalized environmental protection. They would look more favorably toward a solution that aims specifically at preventing nuclear disasters to one that detours from sensitive geopolitical matters where consensus is likely far from reach.

A possible formulation of such a solution is an international treaty for nuclear disaster relief, which would obligate a country to take specific actions to prevent further spread of contamination once a testing accident has happened. This might look like a military version of the Vienna Civil Liability Convention mentioned in the previous section, specifying international liability in cases of problematic nuclear tests. Yet even less radical solutions would involve complexities that might stir further debate. For example, countries might not want to disclose information relating to the incidents due to military secrecy. Furthermore, a disaster relief treaty would bind countries to relief efforts that could be expensive.

Nonetheless, the guiding idea of this line of solution still holds, which is to create solutions that are aimed specifically at environmental protection against nuclear waste. This would require special considerations to avoid sensitive matters surrounding geopolitics and national sovereignty, thereby finding common ground.

Bloc Positions

States with Nuclear Weapon Technologies

As previously mentioned, recognized nuclear weapon states, including the US, the UK, France, Russia, and China, are generally interested in preventing the proliferation of nuclear weapons. Though there are significant disagreements and even hostility between these countries, they generally agree with the principle that it is best to avoid the uncontrolled proliferation of weaponized nuclear technology to other, currently non-nuclear states. This spread of nuclear weapon technology to non-nuclear weapon states is sometimes called horizontal proliferation, as opposed to vertical proliferation, which involves the update of nuclear weapons within states that already have them. Nuclear weapon states approach test-ban treaties as means to enforce horizontal non-proliferation. Nevertheless, they usually prefer that vertical proliferation remains possible. By keeping the option of testing open for themselves, they can make sure they have up-to-date military nuclear technologies and that they can legitimately conduct tests in face of heightened security risks or even wars. In any treaty that involves nuclear testing, they would therefore need to balance the need for controlling horizontal proliferation while allowing for potential vertical proliferation.

The stance against horizontal proliferation is, however, not absolute for nuclear weapon states. Their geopolitical interests are involved in various regional conflicts, and they would allow some proliferation of nuclear weapons if they consider it beneficial. This is exemplified in the situations in India, Pakistan, North Korea, and Iran, all of which are under the influence of powerful nuclear weapon state stakeholders, notably the US, Russia, and China. For example, China's opposition to US-proposed sanctions against North Korea and Iran not only reflects its regional strategic interests in the Pacific and the Middle East, respectively, but is also indicative of the overall hostility between China and the US, along with their respective allies. In any test control treaties, nuclear weapons states need to consider the tension between their general interests in non-proliferation and the specific interest of supporting their regional allies.

Additionally, states that have done damage to ecosystems and communities through historical nuclear tests, notably the US and France, would work to avoid extra costs for compensation efforts.

Though many nuclear weapon states are generally interested in environmental protection, they prefer to view it as a joint responsibility of the international society instead of financial burdens that they should carry alone. They would likely denounce any calls for additional reparations and would tend to render previous wrongdoings as things of the past that have already been properly dealt with, regardless of whether their victims agree or not.

Non-P5 States Possessing Nuclear Weapons

Several countries, including India, Pakistan, North Korea, and Israel, possess or are thought to possess nuclear weapons even though they are not included as recognized nuclear weapon states in the NPT. Similar to the P5, however, they have strong reasons to retain the possibility of nuclear testing, especially considering they are directly involved in regional conflicts that threaten their national security. Their imperative to develop strategic deterrence would render any attempt to weaken their nuclear programs unacceptable, regardless of any reasonable environmental or political costs. Iran, though still in the process of acquiring nuclear weapons, could also be included in this list of countries, since their overall aim of reducing restrictions on testing and non-NPT nuclear programs are the same.

Pacific Island States

These states would be particularly prone to the negative environmental effects of nuclear testing because of their unique locations and ecologies. Many of them are situated near current France and US Pacific territories, some of which had been and could yet again become preferred nuclear test sites. If tests are resumed, those states might be affected by radioactive fallout and tsunamis if things go wrong. Their population depends upon ecosystems that are more fragile than ever in light of rising sea levels and ocean water temperature, and any accidental introduction of nuclear radiation could prove detrimental.

Island states on the Pacific Ocean, in addition to supporting any efforts aimed at test-ban and environmental protection in general, would also push for proper compensation for previous ecological disasters caused by nuclear testing, especially those conducted in the Pacific. These include taking care of radioactive waste facilities whose functioning is challenged by the effects of climate change.

NATO and Allies

These states include not only NATO but also non-NATO states whose defense strategies largely rely on nuclear deterrence provided by the US, including Japan, Australia, etc. Though these states do not and would not attempt to possess weaponized nuclear technology themselves, they would have to follow the US in sensitive nuclear weapon matters because they are protected by its nuclear arsenal. Nevertheless, their overall economic capacity, along with their domestic political landscapes which usually champion sustainability, would make them more ready to commit to well-designed measures oriented towards environmental protection against radiation. Some of them, such as New Zealand, are located in the Pacific. They are home to and rely on unique but fragile ecosystems that could be threatened by nuclear tests. They would therefore need to balance their military security strategies and environmental security concerns.

Advocates for Non-Proliferation

This final bloc includes those who do not have any interest at all in nuclear weapons. They are from around the world and represent the largest bloc on the issue. These states do not have extensive military ties with any of the major nuclear powers. Nuclear weapons pose nothing but a threat and a factor of instability to them, and they are united in their aspiration for a nuclear-free world. These states, though large in number, lack power in the international arena. To achieve their aims, they would need to change the current situation of powerful nuclear states making almost unilateral decisions on nuclear matters.

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Yang, Xiaoping, Robert North, Carl Romney, and Paul Richards. n.d. "Worldwide Nuclear Explosions." https://www.ldeo.columbia.edu/~richards/my_papers/WW_nuclear_tests_IASPEI_HB.pdf.

Zealand, Archives New. 2016. "HMNZS Otago at the Mururoa Nuclear Test Zone, 1973." Flickr. December 12, 2016. https://www.flickr.com/photos/archivesnz/32495769801.

TOPIC B: IMPROVING THE SAFETY OF NUCLEAR WORKERS

Statement of the Problem

In 70 years, the first self-sustaining nuclear reaction turned into, as of July 2022, 440 nuclear power reactors up and running with 55 still under construction. Additionally, 200 commercial, experimental, and/or prototype reactors, and more than 500 reactors have been shut down.[27] Still, the 440 working nuclear reactors provide about 10% of the world's electricity, which, though it may not sound like much, resulted in close to 2553 Terawatt Hours of electricity, enough to sustain the electricity needs of many countries. The nuclear industry is large and fast-growing, so it needs a large workforce to effectively operate. All workers must be protected in such a way that allows them to live healthy lives while continuing to provide for their families. While the atom may be a complex topic that continues to be researched, the dangers of working with such ionizing material should not be left by the wayside, and must be understood to identify the problem to be addressed.

As society continues to progress with the knowledge of the power and possibilities of nuclear energy, it is becoming more clear that the subject itself is growing and becoming vastly detailed. However, the risks that nuclear workers face can be split into four groups. These groups are the actual risk of radiation, the chemical risk of the radioactive products, the conditions of the work area in regards to the danger of the radioactive materials, and other, not necessarily radioactive, hazards in the workplace.[28] While the categories are most certainly applied to nuclear power reactors, these categories apply to other areas of the nuclear industry including the mining of nuclear products and ongoing research.

[27] "Plans for New Nuclear Reactors." World Nuclear Association, July 2022. https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx.
[28] Stello, Victor, and John A Pendergrass. "Memorandum of Understanding between The U.S. Nuclear Regulatory Commission and The Occupational Safety and Health Administration." Worker protection at facilities licensed by the NRC | Occupational Safety and Health Administration. United States Department of Labor, October 21, 1988. https://www.osha.gov/laws-regs/mou/1988-10-21.

Nuclear Plant Workers

Workers at a Chinese nuclear plant[29]

When we think about nuclear workers affected by nuclear incidents, we often think about the workers within nuclear power plants. Bearing in mind the incidents of Chernobyl, Fukushima, and others, a prominent danger of working in a nuclear power plant resides within the risk of radiation, especially from accidents and reactor meltdowns. However, the risk of radiation turns out to be one of the issues that lives lower on the list of importance to workers. The IAEA has set out concrete steps that are used to protect the workers from the ionizing radiation as well as the essential keys to the safe use of such ionizing material, which can be read in the Occupational Radiation Protection written by the IAEA on May 12, 2022.[30] As it turns out, to experience acute symptoms, a worker would need to be exposed to somewhere around 100 microsieverts of radiation. The average

[29] HM Treasury. 2013. "Chancellor Meets Chinese Nuclear Power Plant Workers." Flickr. October 17, 2013. https://www.flickr.com/photos/hmtreasury/10326334786.
[30] "Radiation Protection for Workers." IAEA. IAEA, June 8, 2016. https://www.iaea.org/topics/radiation-protection/workers.

exposure to radiation for a worker at a nuclear power plant is roughly 0.19 microsieverts per worker—significantly less than the 100 microsieverts baseline for acute symptoms. While there may be some correlation between low steady doses of radiation and cancer in workers, it is much less clear and needs to be further researched.[31] Interestingly enough, a person gets exposed to more ionizing radiation during a CT scan or while smoking.[32] However, the main issue lies within the conditions of the workplace as a whole.

Nuclear power plants are complicated, but useful, tools that require constant monitoring. This need for constant monitoring combined with certain business practices creates detrimental effects on both the quality of work and life for the worker. These effects include increasing the probability of an accident, one of the more pressing fears of a power plant worker.[33] While certain cases of fatigue may be a result of the worker's poor choices in how they use their rest time, there are two more urgent causes for worker fatigue that should be addressed. Companies, looking for any possible methods to maximize profit, do so by limiting the number of employees that they hire to operate the power plants. This involves hiring the bare minimum number of employees to cover all shifts of a full 24/7 work cycle.[34] As workers face the difficulties of life and call out sick or are absent from their shift for any reason, it puts stress on the worker who now has to work overtime to cover the shift of the absentee. This can lead to a sick-day snowball effect where a large multitude of workers have been overworked and extremely stressed due to the company's limited employment for better margins.

Aside from the business tactics in strict regard to the profitability of the power plant, there lies an issue with the organizational structure of such companies. Many of the commanding figures within a power plant contain some military background. Hence, the leaders bring the belief that working with little sleep is something to be proud of since they had to complete many tasks while lacking sleep. However, the leaders, in this case, struggle to account for the mistakes that may have occurred while

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[31] Ali, Yasser F, Francis A Cucinotta, Liu Ning-Ang, and Guangming Zhou. "Cancer Risk of Low Dose Ionizing Radiation." Frontiers, August 12, 2020. https://www.frontiersin.org/articles/10.3389/fphy.2020.00234/full.
[32] Muller, Derek. "The Most Radioactive Places on Earth." YouTube. YouTube, December 17, 2014. https://www.youtube.com/watch?v=TRL702kPqwo.
[33] Park, KiJung. "Nuclear Worker Health," February 11, 2017. http://large.stanford.edu/courses/2017/ph241/park-k1/#:~:text=Short%2DTerm%20Health%20effects&text=In%20fact%2C%20many%20of%20the,to%20radiation%20during%20routinely%20work.
[34] "Fatigue Risk Mitigation." Nuclear Engineering International, August 15, 2011. https://www.neimagazine.com/features/featurefatigue-risk-mitigation/.

completing said tasks, possibly because of the decrease in memory due to immense fatigue.[35] In an industry such as nuclear power, where small mistakes can create immense consequences, plant operators must limit their mistakes. Since many studies have shown that "cognitive fatigue is the primary root cause of human errors… in all types of cognitive or knowledge work," these mistakes can be limited by adequately utilizing time to achieve proper rest.[36]

Workers in the Mining Industry

Those who mine the raw materials needed for nuclear activities are often not considered when discussing the rights of workers in the nuclear industry. Miners of uranium and other radioactive materials face risks that are, in a sense, similar to those of the workers within the nuclear power plants, but to a more severe level. The safety regulations for miners, similar to the power plant operators, are based on the idea that small increases of exposure are not immediately harmful but should be minimized wherever possible. With this idea in hand, the World Nuclear Association bases its recommended standards of protection for miner safety on the principles of justification, optimization, and limitation. The Association believes that any practice involving radiation exposure can only be justified by some net benefit to society and/or the workers who get exposed. They try to optimize the health of the workers and the welfare of the companies by keeping radiation doses and risks as low as is reasonably achievable while limiting external contact with workers whose dosage level or radiation risk is deemed unacceptable.[37] These regulations aim to lessen the risk of danger for the miners but have little effect in areas where regulations aren't enforced as tightly as they should be.

Take Rössing uranium mine, the world's largest open-pit uranium mine which has been raising concerns for over 30 years.[38] Workers are regularly exposed to and inhale radon gas and uranium dust as a result of explosives used to access the uranium deep underground, seemingly failing to

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[35] Heerema, Esther. "Causes Memory Loss." Verywell Mind, February 18, 2022. https://www.verywellmind.com/what-causes-memory-loss-4123636.
[36] "Fatigue Risk Mitigation." Nuclear Engineering International, August 15, 2011. https://www.neimagazine.com/features/featurefatigue-risk-mitigation/.
[37] "Occupational Safety in Uranium Mining." World Nuclear Association, March 2020. https://world-nuclear.org/information-library/safety-and-security/radiation-and-health/occupational-safety-in-uranium-mining.aspx.
[38] "Rössing, Namibia." nuclear-risks. Accessed August 5, 2022. https://www.nuclear-risks.org/en/hibakusha-worldwide/roessing.html#:~:text=The%20R%C3%B6ssing%20uranium%20mine%20has,pose%20serious%20public%20health%20problems.

meet the limitation basis of the regulations from the World Nuclear Association. With many other examples of mines failing to satisfy the basis for the recommended regulations, it is increasingly important to hold plants accountable for keeping their workers safe while benefiting their societies.

Mining shovel at the Rössing uranium mine[39]

The practice of Uranium mining leads to the release of radioactive dust which, when inhaled, can affect the body's functions. The danger isn't due to the radioactivity, but more so the fact that uranium dust, a heavy metal, has entered the body. Because uranium decays through alpha particles, the skin can act as a barrier keeping the uranium decay from harming any of the internal organs. Inhaling the uranium dust, however, allows the uranium to bypass the skin barrier and access the major organs, which can lead to lung cancer.[40] As critical as it may sound, because of the slow decay of uranium, lung cancer isn't the dire issue of inhaling uranium dust. The chemical toxicity of

[39] jbdodane. 2014. "Mining Shovel, Rössing Uranium Mine, Namibia." Flickr. June 6, 2014. https://www.flickr.com/photos/jbdodane/14513002415.
[40] "Radioisotope Brief: Uranium." Centers for Disease Control and Prevention. Centers for Disease Control and Prevention, January 21, 2022. https://www.cdc.gov/nceh/radiation/emergencies/isotopes/uranium.htm.

uranium causes damage to the kidneys much quicker than the alpha particles will lead to cancer. It has been found that the effects of radioactive dust are weakly associated with "altered proximal tubules function without a clear threshold."[41] As in, a major site of metabolism within the kidney fails to function and secrete solutes, which can inadvertently affect the function of other organs.[42]

Focusing on the improvements of the safety of the workers does not just end with those directly involved in the nuclear industry. Regulations must go on to protect their families, friends, neighbors, and the rest of humanity. The increased safety for workers leads to increased safety for the general public. One situation to demonstrate the widespread implications of nuclear accidents is that of the Chernobyl nuclear disaster on April 26, 1986. While safety regulations have allowed for a safer workplace, the Chernobyl disaster continues to display the effects of such disasters. Initially, the main concerns were the initial release of radioactive iodine and its effects on human health. However, this proved to be one of the less pressing issues for those affected. The radioactive iodine would go on to affect the agricultural industry in the surrounding communities before the negative effects of the radiation spread to the rest of Europe. Initially, the radioiodine (radioactive iodine) was quickly absorbed into the milk supply causing a significant thyroid dose to those that regularly consumed milk. This effect spread significantly among the children of Belarus, Russia, and Ukraine. Eventually, the fire from the explosion continued to release radioactive deposits which led to the immediate evacuation and establishment of an exclusion zone of 2600 kilometers, or 1000 miles.[43] Thanks to the work of the firefighters, civil workers, and military personnel that helped in reducing the spread of the fire, such as the Chernobyl liquidators, the area of effect was limited. However, the lingering effects of radiation continue to create issues today. As the remaining area remains a ghost town overwrought with plants, vegetation, and trees, there is a constant concern of forest fires during dry seasons. Luckily this issue is under the control of the Bellesrad, an organization responsible for managing radioactive activity in Belarus and mitigating its impact. However, this

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[41] Dewar, Dale, Linda Harvey, and Cathy Vakil. "Uranium Mining and Health." National Library of Medicine. College of Family Physicians of Canada, May 2013. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3653646/#:~:text=Uranium%20mining%20has%20widespread%20effects,nuclear%20power%20and%20nuclear%20weapons.
[42] Curthoys, Norman P, and Orson W Moe. "Proximal Tubule Function and Response to Acidosis." National Library of Medicine. American Society of Nephrology, August 1, 2013. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4152816/.
[43] Steadman, Philip, and Simon Hodgkinson. Nuclear Disasters & the Built Environment: A Report to the Royal Institute of British Architects. London: Butterworth Architecture, 1990.

continues to show how widespread the effects of a nuclear accident can be, and how the health and safety of workers can translate to the well-being of the general public.

Piglet that died during gestation due to mutations from the radiation of Chernobyl fallout[44]

[44] http://www.videgro.net, Vincent de Groot-. 2009. "English: Piglet with Dipygus - Kiev - Ukrainian National Chernobyl Museum. 'Каліцво порося' Visible in the Display's Caption Translates as 'Mutated Piglet'." Wikimedia Commons. November 16, 2009. https://commons.wikimedia.org/wiki/File:Kiev-UkrainianNationalChernobylMuseum_15.jpg.

History of the Problem

The nuclear energy industry has been widely known as an industry providing many people with a stable source of income to support their families. Within the United States alone, roughly 100,000 high-quality jobs are held within the country's nuclear sector.[45] High-quality jobs means that they have "a living wage, basic benefits, career-building opportunities, wealth-building opportunities, and a fair and engaging workplace."[46] This number quickly jumps to around half a million when accounting for the secondary jobs that typically have lower wages and are more temporary positions as the turnover rates are higher than those "high-quality" jobs.[47] Regardless, the nuclear industry has created a vast amount of jobs but the jobs don't come without their downsides, as reality can be unfair. Many nuclear workers are overworked and underpaid in an industry that requires careful monitoring and regulations to keep the workplace functional. The following case studies aim to not only point at the negligent practices of the nuclear industry but also display the potential consequences of failing to keep the workers in conditions that allow them to live and work safely.

The Chernobyl Disaster

During the night on April 25, 1986, a poorly designed experiment on reactor 4 of the Chernobyl nuclear power station would soon become one of the worst nuclear power plant disasters in history. Due to its infamous nature, the Chernobyl disaster may seem like a minor mistake that compounded for the worst. However, behind the scenes, there were undertrained and overworked operators and overseers that played a significant role in the disaster that made the settlement of Pryp'yat, a city made to house workers and their families, completely uninhabitable. Had workers been adequately prepared and given proper rest, the disaster could have been prevented.

Before the disaster, the Chernobyl power plant had been one of the Soviet Union's best-performing nuclear stations. Even the city that housed the workers, Pryp'yat, was a symbol of progress being

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[45] "Jobs." Nuclear Energy Institute. Nuclear Energy Institute. Accessed August 6, 2022. https://www.nei.org/advantages/jobs.
[46] "Section 1: Understanding Job Quality." The Aspen Institute, May 11, 2020. https://www.aspeninstitute.org/longform/job-quality-tools-library/section-1-understanding-job-quality/.
[47] Berkman, Mark, and Dean Murphy. "Report by Brattle Economists Assesses Economic and Carbon Value of Nuclear Plants." Brattle, December 15, 2021. https://www.brattle.com/insights-events/publications/report-by-brattle-economists-assesses-economic-and-carbon-value-of-nuclear-plants/.

made toward a better future.[48] However, behind the bright lights was Viktor Brukhanov who was appointed as the head of the Chernobyl Nuclear Project at 34 years old. Throughout the process of building the Chernobyl nuclear plant, Viktor and his team had been overworked and under-equipped while being asked to meet unrealistic deadlines.[49] As such, the structure of the plant contained numerous design faults which increased the likelihood of accidents. The process of construction also had its share of poor practices which included a coverup of a radiation leak in 1982. As a result, while performing phenomenally regarding energy production, the power plant and its reactors didn't meet any recommended safety standards. Reactor No. 4, the reactor that exploded and caused international outcry about radiation, had been signed off by Viktor despite completely failing a required safety test.

On the day of the accident, Anatoly Dyatlov and Leonid Toptunov were the two figures in charge of overseeing a test on Chernobyl Reactor No. 4, both of whom were well-respected figures. Before the test had even begun, Leonid had missed a step in controlling the reactor that dropped the power output practically to nothing. His initial thought was to shut the reactor down and postpone the testing of the reactor, however the sleep-deprived and irritated Anatoly had ordered Leonid to quickly raise the power levels back up to resume the test. To do this, Leonid pulled out all of the cooling rods in hopes of quickly generating lots of power. In mere seconds, the power levels had risen to levels that were quite literally off the charts, rapidly raising internal temperatures. In an attempt to bring the reactor to a complete halt, the operators pressed the emergency shutdown button to shove all of the cooling rods back in to cool the temperature and decrease the power. Unfortunately, the emergency shutdown system was one of the multiple systems that had been improperly built during the building process.[50] This faulty "emergency shutdown" system led to the explosion beginning the Chernobyl Nuclear disaster and the "emergency shutdown" of the city of Pryp'yat.

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[48] Higginbotham, Adam. "Chernobyl: 7 People Who Played a Crucial Role in the World's Worst Nuclear Disaster." History. A&E Television Networks, April 26, 2019. https://www.history.com/news/chernobyl-nuclear-disaster-7-people-who-played-crucial-role.

[49] Stamper, Peta. "The Man Blamed for Chernobyl: Who Was Viktor Bryukhanov?" History Hit. History Hit, March 18, 2022. https://www.historyhit.com/who-was-viktor-bryukhanov/.

[50] Zubacheva, Ksenia. "The Truth about Anatoly Dyatlov, the Man Blamed for Chernobyl." Russia Beyond, June 17, 2019. https://www.rbth.com/history/330525-anatoly-dyatlov-chernobyl.

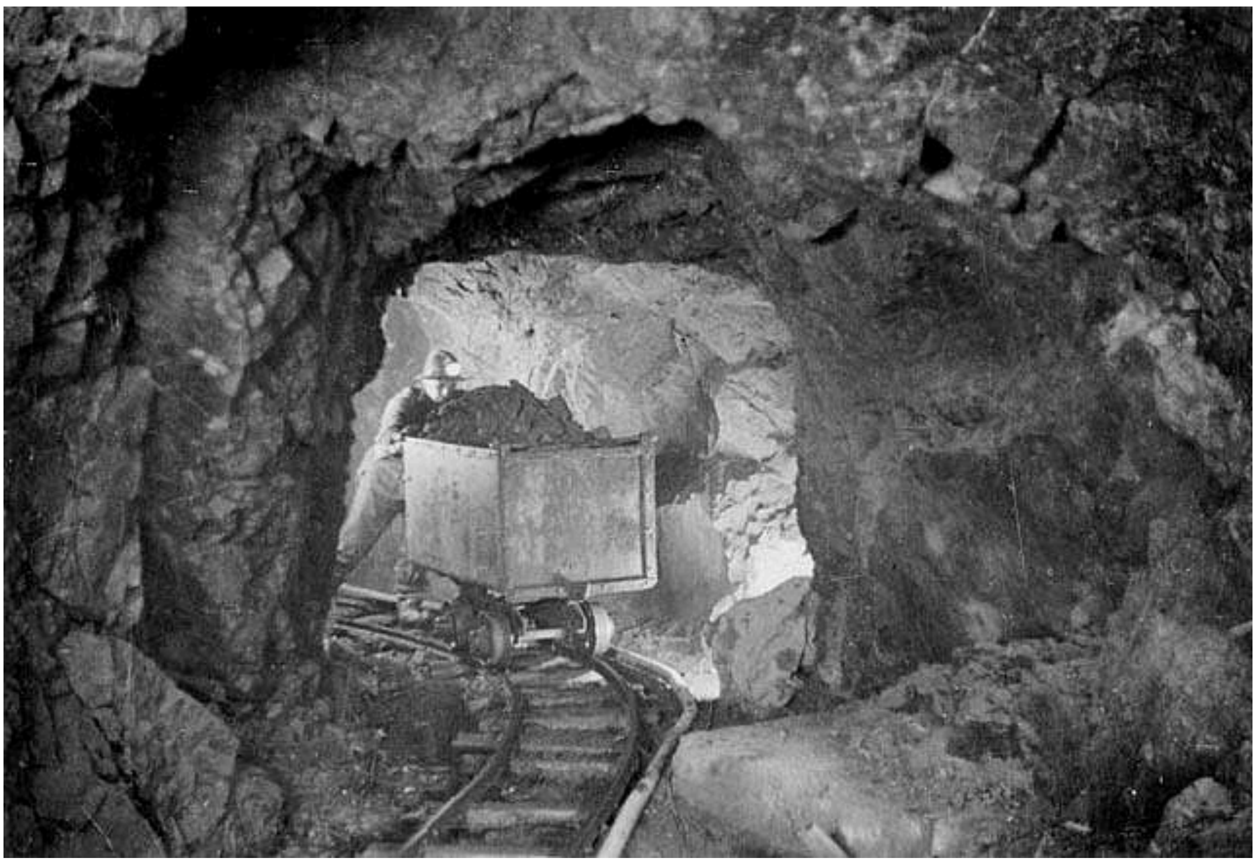
Initially, Anatoly Dyatlov and Leonid Toptunov were both accused of creating the disaster. Surely, Anatoly's sleep deprivation played some role in his decision to continue with the test despite the reactor clearly being in a state unfit for the test. While the disaster would officially be blamed on human error, it was the failures of the emergency system that ultimately led to the explosion. Hence, it was the rushed building process of the nuclear power plant that ultimately led to the disaster with its defective systems. As a result of the explosion, around 384 people were diagnosed with radiation poisoning. The accident serves as a testimony to the results of workers being overworked and inadequately rested. Anatoly's vast knowledge and experience should have allowed him to realize the dangerous state of the reactor. However, it is believed that his lack of sleep played some role in the disaster.[51] Additionally, Viktor had been overworked and pressured by the Soviet government to rush the construction of the power plant and these impossible deadlines resulted in taking shortcuts that would prove disastrous.

Damaged turbine in Chernobyl plant[52]

[51] "The Role of Sleep Deprivation in the World's Worst Disasters." ProNappers. Accessed August 8, 2022. https://pronappers.co.uk/the-role-of-sleep-deprivation-in-the-worlds-worst-disasters/.
[52] IAEA Imagebank. 2013. "Damage Turbine Hall of Chernobyl (02710168)." Flickr. June 4, 2013. https://www.flickr.com/photos/iaea_imagebank/9032364034.

Port Radium Mine

In 1942, located on a peninsula along the eastern shore of Great Bear Lake in the Northwest Territories of Canada, lies a mine that contains uranium ore.[53] This uranium ore gets refined into radium as a result of decay and becomes more radioactive during its decaying process. The company in charge of extracting the uranium ore, Eldorado Gold Mines Ltd, would soon begin the exploitation of its workers and the land belonging to the Dene, an indigenous group that lives in the surrounding area.



Miner with little protection pushing a cart of silver radium ore[54]

[53] "Port Radium." Government of Canada, October 2, 2017. https://www.rcaanc-cirnac.gc.ca/eng/1445630103716/1618401563211.
[54] "A Miner Hauling a Car of Silver Radium Ore, 340 Feet below the Surface, Eldorado Mine of Great Bear Lake." 1930. Wikimedia Commons. January 1, 1930. https://picryl.com/media/a-miner-hauling-a-car-of-silver-radium-ore-340-feet-below-the-surface-eldorado-c1020e.

In the midst of 1942, the United States, having recently entered World War II, began the search for uranium to fulfill the needs of experiments being conducted under the Manhattan Project. With the order of 60 tonnes of Uranium from the United States and the two main supplying countries of uranium, Czechoslovakia and Belgium, busy with Nazi Germany, Eldorado was able to capitalize on this rare opportunity. In turn, the mine began recruiting the local Dene people to assist in mining uranium, the mineral that the Dene people called "the money rock."[55] Having never been informed of the potential dangers of uranium and its mining process, the Dene people assisted in the transportation of the uranium and radium ore to the refinery. Unaware of any potential risks of uranium, the workers treated the mineral as any normal rock. They carried bags of the ore on their backs, slept on the ore, and ate fish from water contaminated by radioactive tailings all of which unnecessarily exposed the Dene workers. From 1942-1960, 14 Dene people died of some lung, colon, and/or kidney cancer—diseases that they had never heard of.[56]

Aside from the health risks that the Dene people faced as a result of the mining and insufficient safety regulations, the mining had indirectly affected the mental health of the workers. Due to the secretive intentions of the uranium going to the United States for the Manhattan project, they were unaware of the horrors that their work would lead to—the atomic bomb. As the miner Elder Alfred Taniton would say, "not only was the mine hard on people's health, it was hard on their hearts."[57] While the Canadian government has never issued an apology to either the Dene or Japan for the use of the uranium they provided, the Dene issued an apology to Japan in 1998 for their role in the destruction of Hiroshima and Nagasaki.

The United States had known of some potential risks of mining for radioactive material. Through the search of declassified documents, it is apparent that the United States chose to withhold this information from the miners in order to move forward with the Manhattan Project. The events that followed present a clear example of the consequences of mining nuclear minerals without any enforced regulations. While this event happened right at the beginning of the nuclear age in 1942,

[55] Nikiforuk, Andrew, and Calgary Herald. "Echoes of the Atomic Age." Canadian Coalition for Nuclear Responsibility, March 14, 1998. http://ccnr.org/deline_deaths.html.
[56] *Ibid*.
[57] Bird, Geoffrey. "Legacy of Canada's Role in Atomic Bomb Is Felt by Northern Indigenous Community." The Conversation, August 9, 2020. https://theconversation.com/legacy-of-canadas-role-in-atomic-bomb-is-felt-by-northern-indigenous-community-143524.

the events that occurred in Port Radium serve to show the consequences of the lack of standard regulations resulting in damage to the physical and mental health of the miners.

Past Actions

Worker safety is a fairly small portion of the overall goals of the IAEA, which typically falls within their Nuclear Safety and Security section. However, worker safety holds many implications since it has been shown that worker safety can affect the safety of the community around them, by making fewer mistakes and thinking more rationally. As noted by the United States Nuclear Regulatory Commission, the overall productivity and safety of the nuclear plants has been improved partially by "recognizing human performance's critical role in plant safety."[58] While the safety of workers in the nuclear industry continues to grow as an issue and become more directly addressed, the plans put forward to increase the safety of the overall plant can improve the safety of the workers as it improves the general work environment. As nuclear plants gradually create safer work environments the following will describe some of the standards and regulations put in place in order to achieve better nuclear practices.

IAEA Action Plan on Nuclear Safety

Following the incident at TEPCO's Fukushima Daiichi Nuclear Power Station, the IAEA led a ministerial conference on nuclear safety in July 2011.[59] The goal of this conference was to learn from the mistakes of the Fukushima Nuclear Disaster to improve nuclear safety, prepare for future emergencies, as well as protect people and the environment with new international protocols. As a result of the deliberations of the conference, the IAEA Action Plan was published and endorsed by the IAEA in 2011.[60] While the responsibility of implementing the action plan falls on the individual member states and their respective facilities, the given action plan reflects the highest standards of nuclear safety based on the working sessions and information available at the time. With such considerations, the IAEA continues to update the action plan as understanding of the accident continues to unravel and present itself.

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[58] "Backgrounder on Improved Plant Safety Performance." U.S.NRC, March 2018. https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-plant-sfty-after-tmi2.html.
[59] "IAEA Action Plan on Nuclear Safety - International Atomic Energy Agency." IAEA, September 2011. https://www.iaea.org/sites/default/files/actionplanns.pdf.
[60] "IAEA Action Plan on Nuclear Safety." IAEA. IAEA. Accessed July 9, 2022. https://www.iaea.org/topics/nuclear-safety-action-plan.

IAEA fact-finding team conducting an inspection[61]

Among the many points of the IAEA Action Plan the strengthening of the peer review system is particularly important. As defined by the IAEA Peer Review and Advisory Services Committee (PRASC) a peer review is defined as a "documented review based on relevant IAEA safety standards and security guidance performed by peers who are independent of the work being reviewed, and the advisory services…conducted by an expert team…to provide advice on the application of relevant IAEA and international instruments and guidance."[62] It is one of the services that the IAEA provides to its member states to review the state and current safety standards of the operating facilities. The action plan focuses on emphasizing certain aspects to be focused on during the peer review process while also increasing the transparency of the reviews by publishing reports detailing each peer review. In doing so, each member state and its respective plants are held to a higher standard. In a

[61] "File:IAEA Fact-Finding Team (02810460).Jpg - Wikimedia Commons." 2011. Wikimedia.org. May 27, 2011. https://commons.wikimedia.org/wiki/File:IAEA_fact-finding_team_%2802810460%29.jpg.
[62] "Supporting Member States: IAEA Peer Reviews and Advisory Services." IAEA. Accessed July 29, 2022. https://www.iaea.org/sites/default/files/20/07/supporting-member-states-iaea-peer-reviews-and-advisory-services.pdf.

sense, this helps keep the workers up to date with the current state of their respective work environments and avoids situations like the Chernobyl disaster where faulty systems led to catastrophic disasters.

The Action Plan additionally addressed the situations within the operating organizations in the hopes of improving nuclear worker safety. Ultimately, the responsibility of abiding by and implementing the action plan falls on each member state. However, this section of the action plan allowed the member state to request help in regards to the overall management of the facility including the safety culture and the scientific and technical capabilities, while also urging the states to host a safety review team and openly exchange any new information regarding safety and/or engineering aspects. The section encourages a safer overall work environment by allowing member states and the respective plants to collaborate with the IAEA and other member states. Operating plants can stay informed and prepared for any incidents to come.

Occupational Radiation Protection Call-For-Action

In 2014, the IAEA along with the International Labour Organization (ILO) and 15 other international organizations came together to host an international conference in Vienna. This conference gave a chance for the member states to come together and discuss any new information that they had obtained to further protect workers from radiation. In doing so, the conference addressed any new advances and challenges that were faced after the previous conference in 2002 and identified areas to improve in the future. As a result of this conference, the Occupational Radiation Protection Call-For-Action was written which provided a summary of the conference as well as the conclusions as a result of the discussion. This call-for-action, which can be found online along with its supplementary materials, focuses on the safety of the nuclear industry's workers regarding their exposure to ionizing radiation.[63]

Of the 12 topical sessions and 5 round table discussions of the international conference, the topics focused on the management of health in regards to the workplace and its records, as well as the

[63] "International Conference on Occupational Radiation Protection: Enhancing the Protection of Workers — Gaps, Challenges and Developments." In Occupational Radiation Protection: Enhancing the Protection of Workers — Gaps, Challenges and Developments. Austria, 2014. https://www-pub.iaea.org/MTCD/Publications/PDF/STIPUB2004web.pdf.

challenges of implementing the results that come from the conference. Much of the resulting plans for actions involved the use of free exchange of information, further detailed information, and more accessible use of assistance from the IAEA.[64] In this sense, the workers are now able to make more informed decisions regarding the plants, allowing them to prevent any unnecessary exposures due to a lack of knowledge. As seen from the discussion of Chernobyl in a previous section, increased education and communication about prior accidents can help to prevent further unnecessary accidents and save the lives of the operators working the plant.

Additionally, the discussions resulted in additional safety guidelines and assistance from the IAEA to meet these safety guidelines in the interest of the workers' health and safety. While the discussions do not address the issue of the overwork and fatigue of the operators, the IAEA ultimately came up with a plan that adequately prepared the member states and the plants.

With the conclusion of the international conference, each member state and its plants were able to have clear guidelines to follow to ensure the safety of the overall plant and its workers. Not only that, but many issues with the management of a nuclear plant arose that helped shine a light on improving worker safety. One of these issues was the proper recording of the occupational radiation exposure dose of the workers, which is as important as other issues, but many countries lack an effective system to manage the exposure dosages. Many turned out to be using systems equivalent to just using Excel to maintain records of radiation exposure.[65] The IAEA, in turn, aimed to create a prototype model of a National Dose Registry which is now up and running in many countries. This issue is only one of the multiple issues that were brought up during the discussions about the difficulties of implementing an occupational radiation protection system and demonstrates methods that the IAEA used to allow countries facing these difficulties to provide their workers with adequate safety measures.

[64] "Occupational Radiation 16-3437 Protection Call-for-Action." IAEA. International Atomic Energy Agency, 2014. https://www-ns.iaea.org/tech-areas/communication-networks/orpnet/documents/16-3437-NSR-IB-ORP-web.pdf.
[65] "International Conference on Occupational Radiation Protection: Enhancing the Protection of Workers — Gaps, Challenges and Developments." In Occupational Radiation Protection: Enhancing the Protection of Workers — Gaps, Challenges and Developments. Austria, 2014. https://www-pub.iaea.org/MTCD/Publications/PDF/STIPUB2004web.pdf.

Nuclear power plant organization and staffing for improved performance: lessons learned

Nuclear power plants are operated and monitored by humans 24 hours a day, 7 days a week. As such, humans are susceptible to error which can inevitably lead to catastrophic disasters, like in the case of Chernobyl. A series of compounded mistakes due to human error came together in an unfortunate sequence of events and blew the top off, quite literally. As Murphy's principle states, anything that can go wrong will go wrong. Ideally, cascades of events won't all break and falter in a single series of events leading to catastrophic explosions, but in the case that it does it is best to learn from the mistakes that were made. Especially in the construction and beginning stages of a nuclear power plant, past experiences can allow for additional safeguards that ultimately keep the workers safer as well as prevent accidents as a result of human error to the best of their ability. Accidents may still occur, but the past events and the lessons learned can aid in diminishing the potential dangers and effects on the operators in the plant and the surrounding communities.

This idea of continual improvement from unfortunate and unforeseen events is the main focus of this document. The given document is by no means an end-all-be-all of safety within nuclear power plants, even stating in the foreword, "it is not expected that any particular utility or NPP manager would consider all of the suggestions provided here to be appropriate."[66] While the document may not be a strict set of guidelines, the document represents the continued growth and development of methods to allow nuclear workers a safe place to work, including methods such as proper delegation of tasks based on known methods, comparison of the methods and practices of multiple nuclear plants, an increase in collaboration both within the plant and internationally, and much more all with the intent to provide nuclear workers a safe working environment.

Occupational Radiation Protection in the Uranium Mining and Processing Industry

So far, much emphasis has been placed on the safety of the workers within a nuclear power plant. However, the protection of the miners is equally important in ensuring the continual development of the nuclear industry. Due to the nature of uranium mining, many of the issues that lie with the plant

[66] Bogomolov, Diaz-Francisco, Haferburg, Hamlin, Jeon, Lipar, Mason, et al. "Nuclear Power Plant Organization and Staffing for Improved Performance: Lessons Learned." IAEA. International Atomic Energy Agency, 1998. https://www-pub.iaea.org/MTCD/Publications/PDF/te_1052_prn.pdf.

operators also show up in the nuclear mining industry, which includes unnecessary overexposure to radiation. Many companies will voluntarily follow the international radiation guidelines, but there are still places that the companies can improve for the miner's safety.

To enhance the safety of the miners, the IAEA released the Information System on Uranium Mining Exposures (UMEX) in 2011. This measure included a global survey to assess the current state of occupational radiation protection, which they would then analyze to identify both good practices and areas for improvement.[67] The presented article uses the results of UMEX as a discussion point to which the IAEA presented actions they would take to assist member nations in optimizing protection as well as information on uranium mining as a whole. As listed in the article, the publication includes discussions about, "uranium mining and processing methods, radiation protection considerations, monitoring, dose assessment, and radiation protection programs for the range of commonly used mining and processing techniques."[68] All of this serves to provide information to workers and other various stakeholders to address the safety issues of the mining sector and the potential methods to address each issue. As the nuclear industry progresses and becomes more prominent in the energy sector, guidelines such as those presented in the Occupational Radiation Protection in the Uranium Mining and Processing Industry help keep the miners protected.

[67]Ashokkumar, Baldry, Brown, Chambers, Guy, Haridasan, Harris, et al. "Occupational Radiation Protection in the Uranium Mining and Processing Industry." IAEA. International Atomic Energy Agency, 2020. https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1890_web.pdf.

[68] Haridasan, P.P., and H.B. Okyar. 2020. Review of *Occupational Radiation Protection in the Uranium Mining and Processing Industry*. *IAEA*. Vienna: International Atomic Energy Agency. https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1890_web.pdf.

Possible Solutions

As the safety and well-being of the workers within the nuclear industry become public concerns, more actions have been taken to improve the overall work environment. Much of the action focuses on the ionizing radiation that employees may be exposed to during the course of the work and understandably so. In nuclear disasters such as Chernobyl, much of the public media seemed to focus on the radioactive fallout that affected the surrounding communities. As there has been a resulting stigma surrounding nuclear power plants focused on radioactive exposure, little has been done to help improve the other poor aspects of the working environment. Ultimately, it is the responsibility of each member state and their respective operating plants to ensure that the workers are given a safe workplace to maximize efficiency. The coming possible solutions to aid in the improvement of the workplace will serve as a starting point to which further ideas and solutions can be built, highlighting some of the existing issues and some possible challenges that could be faced during its implementation.

Fatigue Risk Mitigation Strategies

As previously stated, the responsibility to provide workers with a viable and safe workplace falls on the individual member states and the respective plants. However much the plants may be aiming to provide a clean and, generally, safe form of energy, the nuclear industry is ultimately a business. Just like any other business lies the goal to maximize profits by either reducing spending or cutting costs. One of the ways this happens is by hiring the minimum number of workers to carry out a 24-hour shift weekly. This method of limiting employees inevitably leads to overworked, fatigued, and overly stressed employees.[69] These negative effects are only further compounded when these overworked employees fall victim to their stress and need to call out of work for whatever reason. Of course, a worker's fatigue may be self-induced by inappropriately utilizing the time they have been given to rest. However, it is still the responsibility of the plants to do what they can to reduce any additional sources of fatigue. One such method that could be followed is fatigue risk mitigation strategies.

[69] "Fatigue Risk Mitigation." Nuclear Engineering International, August 15, 2011. https://www.neimagazine.com/features/featurefatigue-risk-mitigation/.

Fatigue Risk Mitigation Strategies have been considered before. In 2008, the United States Nuclear Regulatory Commission (NRC) established a set of guidelines that U.S. licensed reactors would have to follow by October of the following year. This set of guidelines of seven requirements aimed to set a cap on the maximum number of hours an individual could work as well as help the individual manage their fatigue through training and reporting systems. Ultimately, this action resulted in an improved performance in the U.S. nuclear reactor safety performances with fewer reported significant events and a decrease in unplanned reactor shutdowns.[70]

While the United States has seen improved performance, the application across the member states remains a challenge. The guidelines set by the NRC are not a one size fits all scenario. While they may have aimed at the primary cause of fatigue that the management can control, many other factors need to be considered to successfully implement such guidelines. These factors include individual models of work systems at each plant, the physical working environment and the surrounding area, individual assessments of fatigue, and much more that all play a role in how much the workers can utilize their designated time to rest. While such fatigue risk mitigation strategies may pose a challenge to implement worldwide, mitigating the fatigue that workers receive from their workplace can work to improve the safety and overall performance of reactors.

Enhanced Transparency and Communication

Since atomic power can be so destructive and catastrophic it is understandable why the information or new advancements can be kept relatively secret. It may seem beneficial to keep the information private to avoid any unwanted leaks or creating a stigma against the industry. Looking at the Three Mile Island or even Chernobyl, a lack of communication ultimately resulted in negative effects. In the case of the Three Mile Island, lack of proper communication led to an intensely negative stigma surrounding nuclear power within the United States, when in fact the accident had caused relatively few radioactive damages.[71] In Chernobyl, even though the right steps had been taken following the extremely unsafe rise in energy production, the secretive nature of the construction project had led

[70] "Backgrounder on Improved Plant Safety Performance." U.S.NRC, March 2018. https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-plant-sfty-after-tmi2.html.
[71] Hill, Kyle. Three Mile Island - America's Worst Nuclear Accident. YouTube, 2022. https://www.youtube.com/watch?v=cL9PsCLJpAA&t=1883s.

to shortcomings that played a large role in what turned out to be one the worst nuclear accidents to date. By encouraging transparency and communication between member states, free information exchange would allow member nations to stay up to date with relevant information to help create a more efficient and reliable nuclear power plant.

To date, many of the discussions have involved some degree of improving the communication of any new improvements or opportunities to learn. For example, the IAEA Action Plan on Nuclear Safety contains a dedicated section about the spread of information. All the points in the section focus on nuclear safety, both about emergency preparedness and general nuclear safety.[72] The issue that continues to show is the fact that the most the IAEA can do is send representatives to the plants for reviews and encourage the member states to share their information. To avoid any form of tyranny, the IAEA will not force its member states to follow any set of guidelines though they may put some incentive or punishment for the member states to do so.

Ultimately it is the choice of the member states to be open about the information they present at conferences, but it does seem to be in the best interest of all states to be clear and concise with any possible advances. As stated previously, the IAEA does not preside over each member state at all hours of the day to enforce the recommended guidelines. Thus, nothing is keeping the member states from entering a communal group to share information, as long as there is no malicious intent. Since the exchange of information is so valuable in maintaining and developing safer protocols, forming a large, information-sharing group to exchange information quickly can stand as a viable solution. However, this idea runs into the same issues as many other associations without some authoritative figure. There is always the issue of security and purposeful leaks to extort other nations, and many other issues that should be accounted for or at least acknowledged. Of course, the intent of forming a free information exchange platform is in good will to help each other, but paranoia may convince states to abandon these plans.

[72] "IAEA Action Plan on Nuclear Safety - International Atomic Energy Agency." IAEA, September 2011. https://www.iaea.org/sites/default/files/actionplanns.pdf.

Research and Implementation of More Advanced Technology

Current nuclear plants require 24/7 monitoring to keep the plant operational. This necessity for constant monitoring is part of the reason why so many workers tend to be overworked, having to stay attentive to the status of multiple parts of the plant throughout the night. As simple as it may sound, advances in the technology of a nuclear plant would aid in the efforts to improve the safety of the workers. In doing so, not only are the workers able to rest a little more but the plants also become safer environments to be around.

Innovations in technology are hardly a new topic. From the beginning of time, humans have always attempted to find new ways to improve the items and methods that they already have in their possession. Even within the nuclear industry, advances are constantly being made. With the lessons learned from previous accidents and disasters, improvements to safety and construction guidelines were implemented to help prevent such accidents. As many member states continue to communicate the advances that have been made, an example would be the innovations with more advanced reactors and possibly accident-tolerant sources of fuel. An example of advancements in technology would be the innovations within the United States with the new versatile reactor designs. These new reactors are built to have a passive safety cooling system, seemingly to prevent overheating and a reactor core meltdown, allowing the reactors to be walk-away friendly.[73] In the ideal world, the operator would be able to walk away from the reactor without having to worry about any freak accident. That said, it is continually important to understand while any advancements may play a proactive role in improving safety, workers must stay aware and on edge to protect themselves and surrounding communities.

[73] "3 Innovations Transforming the Nuclear Industry." Energy.gov. Office of Nuclear Energy, June 5, 2018. https://www.energy.gov/ne/articles/3-innovations-transforming-nuclear-industry.

Bloc Positions

The improvement of the safety of nuclear workers is itself a fairly non-controversial topic, even if there may be different approaches to doing so. It is generally in the best interests of each member nation within the IAEA to not only improve the safety of their workers but also to provide knowledge and assistance to other nations that need it. Through safer workspaces, nuclear plants tend to see improvements in their performance, which tends to be quite favorable. While the responsibility of implementing safety standards lies with the individual member states, the IAEA and its member nations are all committed to the goal of creating safer nuclear power plants for their workers and communities.

Member States with Active Nuclear Programs

This bloc of member states typically includes nations that have nuclear programs and have been operating nuclear reactors for some amount of time. These nations, having run a nuclear program for some time, are often the most experienced and will tend to have the most to share in terms of experience and lessons. Being one of the more developed nations in terms of nuclear power, these nations tend to abide by the safety standards that have been recommended by the IAEA. However, having the most experience with their nuclear programs, these nations may not always agree with the IAEA's guidelines. In turn, during the implementation process of newly recommended standards, these countries may slightly skew away in favor of regulations that better fit their needs and/or situations. While they might not always agree with the decisions of the IAEA, their desire to uphold a strong level of safety for their workers remains. Ultimately, the nations in this bloc are willing to offer help to nations that have just entered the nuclear industry, being able to provide certain lessons or practical methods to keep the programs up and running. Just as is with the rest of the IAEA, these nations are dedicated to growing the nuclear industry and keeping nuclear power plants safe for all. However, nothing can go without its setbacks. While the nations of this bloc are ready and willing to provide assistance and expertise, nations on the receiving end may have some of their own concerns. This may include budget restrictions to adequately pay the experts that come to help, national security concerns, and much more that may play a role in how the information is shared and communicated between the nations.

Member States with Emerging Nuclear Programs

As of May 2022, there are roughly 30 states who fall under the definition of emerging nuclear countries. According to the World Nuclear Association, an emerging nuclear country is a country that is either considering, planning, or starting some form of a nuclear power program. Ranging from more developed countries with sophisticated economies to continually developing nations, the nations of this bloc all share the goal of reaping the benefits of nuclear power. However, these countries also tend to share an issue that manifests itself in many different situations—a lack of experience.

Since this bloc consists of nations that are relatively new to the nuclear industry, this lack of experience is certainly understandable but poses many problems on the path to becoming a country with a well-developed nuclear program. Oftentimes, nations entering the world of nuclear power face two main problems that will affect the overall structure of the plant. First, since nuclear plants are larger than the fossil fuel plants they replace or supplement, countries are limited regarding the amount of land they can allocate towards nuclear plants. Second, the development of nuclear power involves multiple aspects including construction labor, operating, overseeing, expertise and intellect, any damages, etc.[74] Because of these necessities, emerging nations will face financial issues during the developmental phase of implementing nuclear energy. As a result, these countries may be tempted to take shortcuts during the construction process. However, as seen with Chernobyl, the construction of nuclear power plants is not to be taken lightly. Poor standards will leave its operators with less than desirable outcomes despite good operating intentions. This lack of space is only one of the many examples where the lack of experience becomes an issue, and, knowing such, these nations are more willing to allow the IAEA to develop a standard set of guidelines. While these

[74] "Emerging Nuclear Energy Countries." World Nuclear Association, 2022. https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx#:~:text=About%2030%20countries%20are%20considering,their%20first%20nuclear%20power%20plants.

countries may not be able to share any experiences, they can understand and abide by guidelines to protect their workers during the nation's journey to a developed nuclear program.[75]

Member States with No Plan for Any Nuclear Program

Whether the country is opposed to nuclear power for possibly financial, political, or technical reasons, the nations within this bloc have no active power plants and no plans for any type of nuclear program for the foreseeable future. While these countries may not have to deal with the direct consequences of failing to give workers a proper working space, they are continually cautious of any potential actions that may indirectly yet adversely affect themselves or their citizens. Due to the nature of improved nuclear plant safety and nuclear worker safety, these countries tend to favor intervention and strict guidelines from the IAEA because it relates to their safety. As there is a wide scope of possible reasons as to why these nations fall into this bloc, this bloc is large in number and could potentially be further split into separate blocs. Simply put, this current bloc could be further split into one that is completely opposed to any nuclear power and a separate bloc that is more accepting of the potential of nuclear power. However, in regards to worker safety and guidelines, these nations will tend to have opinions that align in the hopes of keeping their citizens safe.

[75] "IAEA Action Plan on Nuclear Safety - International Atomic Energy Agency." IAEA, September 2011. https://www.iaea.org/sites/default/files/actionplanns.pdf.

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