How the Chernobyl Disaster Transformed Nuclear Safety and Regulations

Shaoxuan Ma

Senior division

Historical Paper

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Process Paper

For this year's NHD project, I already had the topic of Chernobyl in mind, since it reflected my interests in science, specifically nuclear science. Later on, when the theme came out of "turning points in history," I found that the Chernobyl aftermath embodied it perfectly, displaying a turning point as nuclear energy - a significant part of the energy sector - was revolutionized. Today, more than thirty countries use nuclear power, and post-Chernobyl laws and regulations serve a pivotal role in ensuring the safety of nuclear reactors all around the world.

To start my project, I wanted to find information and give myself solid background information to use. I conducted my research in many ways, finding primary and secondary sources to help support my project. I used many secondary sources, like websites and books. These websites that I found gave me a great deal of information regarding people's feelings and emotions during the disaster, but also factual information regarding the scientific aspects of the incident including, the flawed reactor design. In addition to websites, I also read books about the accident. These allowed me to understand Chernobyl's impact at a local level. In addition to secondary sources, I also utilized primary sources in my project, such as documents from the time, and interviews I conducted. These helped me to understand the perspectives of people during the accident as well as scientists and other professionals' perspectives in the aftermath.

I chose to make my project a paper since it would allow me to explain the information in a descriptive way, with a word count better suited for in-depth explanation. I also picked it because I could convey my ideas more efficiently, since there were nuanced topics that I wanted to discuss. While writing my paper, I created a plan and edited it as I went along, adding details and other points that I wanted to address. In the end, I added explanations and wrote it to flow cohesively.

During this process, critiques and suggestions from family and friends that I showed it to were vital in my writing process as I revised and reworked my paper.

The Chernobyl disaster's aftermath perfectly exemplifies the theme of "Turning Points in History." The creation of regulations and treaties by organizations such as the International Atomic Energy Agency (IAEA) - directly resulting from Chernobyl - demonstrates how much the accident transformed nuclear safety and laws, as well as public health in regards to radiation related illness.

The Chernobyl disaster, at its core, resulted from irresponsibility, poor engineering, and dishonesty. In light of the disaster that these mistakes caused however, the rules, laws, and regulations created prevents another disaster from happening. Chernobyl spread radioactive debris from Ukraine to Scandinavia and caused the death of thousands of people, not to mention birth mutations and abortions. Chernobyl's aftermath turned this around with the work of many scientists, politicians, and even civilians, creating regulations that would become a bulwark in the assurance of nuclear safety for millions.

Introduction

It was 1:30 a.m. on April 26, 1986. The people's homes in Pripyat, Ukraine were illuminated by a bright blue glow.[1] Some people who were awakened headed outside and saw the Chernobyl power plant, just six miles away, become one big cloud of smoke.[2] As people walked towards the bridge that directly faced the reactor, it began to snow – yet, it wasn't snow, it was flakes of radioactive debris blown from the reactor.[3] From that day on, the people on that bridge would die from acute radiation poisoning and cancer.[4] This bridge would be immortalized as the Bridge of Death.

Over the course of the following months and years, thousands of people would lose their lives, contract cancer, and develop other mutations or diseases. Furthermore, there were significant indirect effects, such as more than a million babies aborted due to fear of birth defects.[5] These factors caused a reformation in nuclear safety, regulations, and laws that would ensure that an accident at the scope of Chernobyl would not happen again.[6]

Thesis

The Chernobyl disaster and its aftermath perfectly exemplifies the theme of "Turning Points in History." The Chernobyl disaster, at its core, resulted from irresponsibility, poor engineering, and ignorance.[7] In light of the catastrophe that these mistakes caused however, the

[1] Zhu Liu. What is Cherenkov Radiation? IAEA.
[2] Kim Willsher (interviewing Pasha Kondratiev). Chernobyl 30 years on: former residents remember life in the ghost city of Pripyat, The Guardian, March 7, 2016.
[3] Jessica Kingston. What happened to the people who watched Chernobyl explode on the Bridge of Death. Mamamia.com, June 5, 2019.
[4] Chernobyl Story Members. Bridge of Death in Chernobyl, Chernobyl Story Tours.
[5] World Nuclear Association Members. *Chernobyl Accident 1986*, World Nuclear Association, updated April, 2022.
[6] International Nuclear Safety Advisory Group Members. *INSAG-7 The Chernobyl Accident: Updating of INSAG-1*, IAEA, 1992.
[7] Reference 6, INSAG.

rules, laws, and regulations subsequently enacted have prevented another disaster from happening, keeping us safer today. The creation of regulations and treaties by organizations such as the International Atomic Energy Agency (IAEA)[8], demonstrate how much Chernobyl transformed nuclear safety, as well as public health.[9]

Chernobyl caused extreme hardships in people's lives, such as death, cancer, mutations in children, and the displacement of thousands of people from their homeland.[10] Despite these hardships, the people still championed for change. Numerous protests arose, from the affected areas (such as Belarus) to distant countries like Italy[11], who were left with little radiation damage in comparison. Not only did citizens campaign relentlessly to get their point across, but thousands of scientists and politicians worked as well, striving to implement laws and other regulations that would ensure nuclear safety for the future. These laws are still prevalent today, allowing us to live with less worry of another Chernobyl-scale accident.

Chernobyl Power Plant, Before the Catastrophe

The reactors at Chernobyl faced numerous problems long before the disaster had even occurred. Built in 1978, the Chernobyl reactors were efficient in commercially providing nuclear energy to thousands of people.[12] However, starting in 1982, the plant started encountering problems. At this time, Chernobyl's reactor number one had a partial meltdown as a result of a

[8] International Atomic Energy Agency Members. *The 1986 Chornobyl nuclear power plant accident*, IAEA.
[9] *Public Health and Medical Preparedness for a Nuclear Detonation: The Nuclear Incident Medical Enterprise,* National Library of Medicine.
[10] Reference 5, World Nuclear Association Members.
[11] Marco Giugni. *Social Protest and Policy Change: Ecology, Antinuclear, and Peace Movements in Comparative Perspective*. 2004.
[12] David Langbart. *Chernobyl Before It Was CHERNOBYL! National Archives*, 2022.

failed experiment, due to the graphite rods being wet.[13] This caused them to lose their ability to control the reactivity.[14] The accident's information was disseminated around through the USSR KGB[15], where reports now show them hiding the evidence from the public, "to prevent panic and provocative rumors."[16] In 1983, Chernobyl would be put on watch by the Soviet government for being one of the most dangerous USSR reactors. Later, in 1984, another accident would occur, damaging reactors three and four.[17] Chernobyl being on the "most dangerous" watch list should have entailed closer supervision of the plant – potentially preventing the accident – but it was neglected without any intervention.

In addition to the power plant being unsafe, the design for the reactors themselves had major flaws[18]. The most significant of which is that Chernobyl's reactor, an Reaktor Bolshoy Moshchnosti Kanalniy (or RBMK), had an engineering flaw called a positive void coefficient.[19] Simply put, the water cooling did not work, instead turning to steam. This steam would then heat up the reactor even more, converting even more water to steam[20]. As this process continued, the energy produced would make a dangerous feedback loop. This design flaw had previously been acknowledged by the accident of reactor SL-1 in America.[21] Although independent, this disaster

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[13] Carnegie Corporation of New York (letter written by Gibadulov Nikolai Grigoryevich). *Report of KGB's Governance about the Emergency Stop of Chernobyl Nuclear Power Plant Unit No.1 on 9 September 1982*, Wilson Center Digital Archive
[14] Wison Luangdilok. *Nuclear plant severe accidents: challenges and prevention*, Science Direct
[15] Wilson Center Members translation. *Chair of the Committee of State Security [KGB] of the Ukrainian SSR to the Central Committee of the Communist Party of Ukraine, 'Informational Message for 14 September 1982'*, Wilson Center Digital Archive
[16] Reuters Editors. *Unsealed Soviet archives reveal cover-ups at Chernobyl plant before disaster*, Reuters
[17] (Translated from Russian) Svetlana Golovina. *SBU declassified new documents about the disaster at the Chernobyl nuclear power plant*, Zvezda
[18] World Nuclear Association members. *RBMK Reactors – Appendix to Nuclear Power Reactors,* World Nuclear Association, February 2022.
[19] Reference 6. INSAG.
[20] Reference 5. World Nuclear Association.
[21] Atomic Heritage Foundation members. *Idaho Falls*, Nuclear Museum.

had first exhibited this defect[22], relaying the information worldwide. Responding to this known problem may have prevented the accident, but it was ignored due to RBMKs being easy and cheap to mass produce.[23]

The Chernobyl Disaster

On April 25th, there was a scheduled test to be run - ironically, it would be a safety test.[24] However, this test was delayed due to a scheduled maintenance which disrupted the experiment. Nevertheless, the managers of the plant, Anatoly Dyatlov, Nikolai Fomin, and Viktor Bryukhanov, still pushed for the test to be completed[25], due to pressure from the soviet government. Thus, the test was performed with the less experienced night shift, who were not adequately prepared for it.

They began the procedure, but by 12:30 a.m. the reactor's power had plummeted,[26] so the operators started removing control rods in order to raise the power. This was a major violation of nuclear plant safety guidelines.[27] They had gotten the power high enough to start the test, but the power was still below the preferred levels.[28] At this point, the interior of the reactor started to build up xenon, which caused instability in the core of the reactor.[29] Despite these dangerous conditions, the workers continued to pull out control rods until only six remained. This made it impossible to

[22] Craig S. Webster. *Safety in unpredictable complex systems – a framework for the analysis of safety derived from the nuclear power industry.* JSTOR, June 2016.
[23] Reference 6, INSAG.
[24] Jesse Greenspan, *Chernobyl Timeline: How a Nuclear Accident Escalated to a Historic Disaster*, History.com
[25] Serge Schmemann. *CHERNOBYL CHIEFS OUSTED FOR ERRING DURING ACCIDENT*, New York Times
[26] Reference 5, World Nuclear Association.
[27] Atomic Archive Members. *Chernobyl – Timeline of Events,* AtomicArchive.com
[28] Reference 5, World Nuclear Association.
[29] Natallia Pinchuk. *Chernobyl Timeline*, Whatisnuclear.com

shut down the reactor in an emergency, since there was not enough control.[30] However, the plant managers were unaware.

Continuing under the pressure of Anatoly Dyatlov, the workers continued to raise the power until 1:23 a.m. when the power began to surge[31]. At 1:23:40, Aleksandr Akimov, the reactor operator, called for the AZ-5 (emergency button) to be pressed[32]. This action should have stabilized the reactor by stopping all reactions, but since the reactors had graphite, a highly reactive element, on the tips of the control rods, the reactor became even more unstable[33]. Akimov would never know what happened as he would die of acute radiation syndrome, saying, "I did everything correctly."[34] As the rods were all reinserted by the emergency button, the graphite caused an energy spike that fed into itself due to the positive void coefficient.[35] This energy spike could not be contained, causing the first explosion.[36] However, this explosion was not the last. As the fuel channels ruptured and chemicals began spreading everywhere, hydrogen was produced rapidly, causing a second explosion, at exactly 1:23:45 a.m..[37] This explosion blew up the entire reactor, including the 1,000-ton metal lid covering the reactor core.[38] Within hours, radioactive debris spread all around Europe, resulting in 400 times the amount of radioactive fallout from the Hiroshima bombing being exerted.[39] (See Appendix A)

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[30] Andy Brunning. *30 Years Since Chernobyl – How Nuclear Reactors Work*, Compound Interest, April 26, 2016.
[31] World Nuclear Association Members. *Sequence of Events – Chernobyl Accident Appendix 1*, World Nuclear Association.
[32] Chernobyl Gallery Members. *Chernobyl Disaster Timeline*, Chernobyl Gallery.
[33] Richard Rhodes. *Nuclear Renewal*, 1993.
[34] Kayla Whelehon. *Unsafe Behaviors and Unsafe Conditions: What's the Difference?* Bluefield Process Safety, August 1, 2019.
[35] Reference 6, INSAG
[36] Reference 5, World Nuclear Association.
[37] Reference 32, Chernobyl Gallery Members.
[38] Reference 24, Greenspan.
[39] Timothy A. Mousseau. *Why military action in radioactive Chernobyl could be dangerous for people and the environment*, PBS.org, March 3, 2022.

The Effect of the Disaster

Chernobyl was a race against the clock as hundreds of scientists, politicians, doctors, and even civilians worked to help restore stability at the power plant. In an attempt to fix the problems that arose, people such as the 600,000 liquidators who had come to the highly radioactive zones to decontaminate and evacuate the surrounding areas[40], the 400 coal miners stepping up to dig a tunnel in 122°F heat because of a *chance* that uranium would melt into the black sea[41], and three engineers that worked at Chernobyl volunteering to go on a potential "suicide mission" to prevent an explosion that would have caused much of Europe to be inhabitable for hundreds of years (See Appendix B). [42]

More than a million people in the direct aftermath of the disaster put their lives, families, and health on hold in order to try and help the situation.[43] Vladimir Naumov, a miner at Chernobyl would say, "Who else but us? Me and my fellow workers were brought up that way. Not that we went there to die, we went there to save lives," when asked if he ever questioned the sacrifices he and his fellow miners made.[44] However, as many as 45,000 liquidators would have cancer by 2008[45] and one in four miners would die of radiation-related illness[46]. However, on a positive note,

[40] The Chernobyl Forum (Affiliated with organizations: IAEA, UNSCEAR, WHO, UN-OCHA, UNDP, FAO, UNEP, World Bank Group). *Chernobyl's Legacy: Health, Environmental and Socia-Economic Impacts and Recommendations to the Governments of Belarus, Russian Federation and Ukraine*, The Chernobyl Forum: 2003-2005.
[41] Neela Debnath. *Chernobyl explained: What happened to the Chernobyl miners?* Express, June 27, 2019.
[42] Sky History Members. *THE REAL STORY OF THE CHERNOBYL DIVERS*. Sky History.com.
[43] Reference 39. The Chernobyl Forum.
[44] Diana Magnay. *Chernobyl: The real-life heroes of nuclear disaster watch TV hit*, Sky News, June 4, 2019.
[45] Richard Gray. *The True Toll of the Chernobyl Disaster*, BBC, July 25, 2019.
[46] Reference 41. Debnath.

all three heroic divers would survive, until one, Boris Baranov, passed of a heart attack, unrelated to radiation in 2005, with the other two still alive today.[47]

In addition to these workers' health problems, many civilians in the vicinity of Chernobyl died or got radiation related cancer, and while tolls vary, as many as 150,000 people would end up dying from Chernobyl related illness.[48] Beyond death and cancer, around 200,000 people were relocated and one million babies were aborted out of fear of birth defects.[49]

The disaster was tragic to everyone, even those living in cities far away. I got the opportunity to talk to Dr. Sophia Moskalenko, a woman who grew up in Kiev, Ukraine but was evacuated, and she told me this: "Cancer is cancer no matter what causes it. People overcome (or not) as best they can."[50] Perspectives like hers and other people's experiences underscore the hopelessness of the Chernobyl disaster. One such story would be that of Eduard Korotkov. As a liquidator, he returned home with his old clothes, giving his little son his hat, which the boy wore all the time. Two years later, his son had developed a brain tumor.[51] These accounts and narratives prove the urgency that there was to develop changes in nuclear regulation in order to safeguard the world's future from similar avoidable nuclear accidents.

The Turning Point

As the immediate dangers of Chernobyl began to subside, scientists, politicians, and government officials came together, including at a 1992 meeting in Vienna. Here, the International

[47] Reference 42. Sky History.
[48] Peter Dizikes. *Chernobyl: How bad was it?* MIT News, March 5, 2019
[49] Reference 5. World Nuclear Association.
[50] My own interview with Dr. Moskalenko, September 6, 2023
[51] Svetlana Alexievich. *Voices from Chernobyl*, translated by Keith Gessen.

Nuclear Safety Advisory Group (INSAG) members met to discuss the disaster and what the future of nuclear safety would look like[52]. They met many more times in the following years, producing documents such as *INSAG-7 The Chernobyl Accident: Updating of INSAG-1*[53], which provided first hand material explaining how the disaster happened, which allowed for nuclear scientists to learn what happened, and how to implement changes to prevent further accidents.[54] [55]

First, these efforts would lead to design changes. Chernobyl was caused by many factors and came down to a disastrous series of flaws and specific circumstances. Nevertheless, an accident would have been easily preventable had the engineering behind the reactor been sound.[56] In the International Atomic Energy Agency's (IAEA) *Safety Standards Series No. NS-R-1, Safety of Nuclear Power Plants: Design,* the IAEA touches on many points, two key points being containments and shutdown systems.[57] At Chernobyl, there was no containment due to the cost of construction.[58] That said, if there had been a containment structure, the effects of the blast would have been minimized.[59] On top of containments, Chernobyl was lacking a sufficient shutdown system.[60] The predetermined emergency system, the AZ-5 button's job was to lower every control rod, ceasing energy production.[61] However, it failed at Chernobyl because the AZ-5 button did not

[52] International Nuclear Safety Advisory Group. *The Chernobyl Accident: Updating of INSAG-1,* 1992
[53] Reference 6, INSAG.
[54] Brett Soloman. *Developing a Robust Safety Culture*. American Society of Safety Professionals. August 2015.
[55] U.S. Government Accountability Office. How Chernobyl Jump-Started the Global Nuclear Safety Regime, U.S. GAO, September 12, 2019.
[56] Reference 33. Rhodes.
[57] International Atomic Energy Agency. *Safety Standards Series No. NS-R-1, Safety of Nuclear Power Plants: Design,* IAEA.
[58] Reference 5. World Nuclear Association.
[59] Richard Wilson. *CHERNOBYL: ASSESSING THE ACCIDENT*, Arizona State University, Fall, 1986.
[60] Reference 6. INSAG.
[61] The Chernobyl Gallery Members. *The Cause,* The Chernobyl Gallery.

work in the given circumstances.[62] Had there been a failsafe shutdown system, the disaster might have been minimized, if not averted.

In addition to design changes, the IAEA established many regulations for power plant workers. In the IAEA's *Safety Standards Series No. NS-G-2.14 Conduct of Operations at Nuclear Power Plants*[63]*,* the IAEA detailed certain requirements for each operator to follow, such as training in knowledge of a nuclear plant's control and safety features,[64] simulator training, and familiarity with procedures and guidelines.[65] This would have been pivotal at Chernobyl, since the disaster was largely caused by irresponsibility of the managers. In addition to guidelines for nuclear plant workers, organizations like the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)[66] run routine checks on nuclear plants to ensure they are still stable and safe, while other organizations like the Nuclear Regulatory Commission (NRC) issues licenses and regulates nuclear energy usage.[67] Both organizations are currently active in ensuring the safety of nuclear power plants and nuclear energy.

Beyond protocol at the power plants themselves, safety has also been improved outside of the power plants. The IAEA and other similar agencies are international, sharing information, conducting joint research[68], and implementing treaties for emergency responses with aid[69]. In addition to building international relations, Chernobyl acted as a portent of more nuclear disasters

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[62] IAEA Members. Frequently Asked Chernobyl Questions, IAEA.
[63] International Atomic Energy Agency. *Safety Standards Series No. NS-G-2.14 Conduct of Operations at Nuclear Power Plants,* IAEA
[64] Reference 5. World Nuclear Association.
[65] Reference 62. IAEA.
[66] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Members. About UNSCEAR: With Scientific Authority and Independence of Judgement. United Nations.
[67] Federal Register: Daily Journal of the United States of America. *Nuclear Regulatory Commission (NRC),* National Archives.
[68] IAEA. *Nuclear Research*, IAEA.
[69] IAEA. *Emergency Preparedness and response*, IAEA.

if the same sort of secrecy were to continue. Thus, it prompted transparency in the nuclear industry, [70] [71] caused primarily by the protests of people all around the world.[72]

The Results and Their Importance

To date, there has only been one significant nuclear accident since Chernobyl, the Fukushima disaster. In contrast to Chernobyl however, this was caused by the 2011 Tōhoku earthquake and tsunami.[73] Even though the reactor still had a meltdown, regulations attributed to Chernobyl still had positive impacts with mandatory containment shelters.[74] The blast and impact of the meltdown did spread, but were confined by the containment built around the reactor.[75] Fukushima, however, did still have problems. It showed many more ways to improve reactor designs, such as implementing backup energy systems, as Fukushima had its energy cut off by the tsunami.[76]

In addition to minimizing the impact of nuclear meltdowns, Chernobyl is actively ensuring nuclear safety. Organizations such as the Environmental Protection Agency (EPA) monitor radiation levels daily to ensure citizens' safety.[77] In addition to this, the studies performed by thousands of scientists worldwide regarding radiation exposure and health allow for more understanding of what radiation can do to the body, allowing for healthcare innovations.[78]

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[70] National Nuclear Safety Administration (NNSA), *Nuclear Stockpile Transparency*, NNSA.
[71] IAEA. *The Emergence of Transparency*, IAEA.
[72] Reference 33. Rhodes.
[73] World Nuclear Association Members. *Fukushima Daiichi Accident*, World Nuclear Association, updated August, 2023.
[74] Nuclear Energy Institute Members. *Comparing Fukushima and Chernobyl*, October, 2019.
[75] Reference 72. World Nuclear Association.
[76] Reference 73. World Nuclear Association.
[77] Environmental Protection Agency (EPA). *Nationwide Environmental Radiation Monitoring*, EPA.
[78] Center for Disease Control and Prevention Members. *Health Effects of Radiation*, August 6, 2021.

Finally, scientists, policymakers, nuclear workers, and even citizens have learned valuable lessons as the disaster played out. Nuclear workers and scientists have seen what happens under unstable and unsecure circumstances,[79] and policymakers and citizens have seen why transparency is vital in order to prevent such disasters from happening, especially in a field as significant as nuclear energy and power.[80]

Conclusion

The aftermath of Chernobyl was a turning point in history which led to nuclear regulations. Chernobyl was a horrible disaster that destroyed thousands of people's lives, yet thousands more came together – the liquidators, miners, divers, scientists, doctors, and more – sacrificing themselves to save millions of lives.

In a comparison of today's nuclear regulations and laws to those at the time of Chernobyl, it is evident that there were many changes implemented.[81] Technical improvements in nuclear design, widespread changes in employee conduct, and improved international cooperation – which encouraged transparent and honest discussions[82] – all occurred as a result of the disaster. These efforts have continuously worked to keep us safer, as the work of those almost 40 years ago have ensured nuclear safety for us today.[83]

As we look to the future with uncertainty regarding nuclear bombs or even a nuclear war, we can be assured that in our own country, nuclear safety and regulations have been managed with utmost priority[84], so we don't have to worry about another Chernobyl-like disaster happening again.

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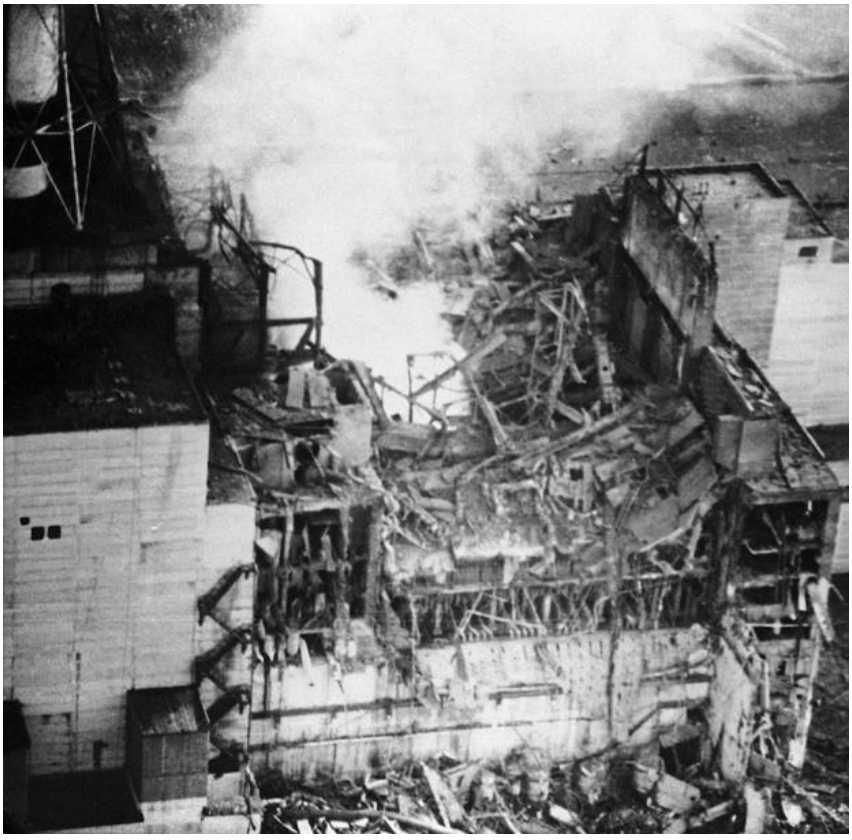
[79] Reference 5. World Nuclear Association.
[80] Reference 71. IAEA.
[81] INSAG. *Strengthening the Global Nuclear Safety Regime, INSAG-21*, Vienna, 2006.
[82] John Carlson. *Chernobyl: the continuing political consequences of a nuclear accident*, The Lowy Institute.
[83] Len Fisher. *Could Chernobyl happen again without human error?* BBC Science Focus.
[84] U.S. EPA. *Radiological Emergency Response*. EPA.

These changes in regulations as a result of Chernobyl will forever be a benefit to humans, eternalizing itself as a turning point for nuclear safety and energy.

Appendix A



Aerial photo of the reactor after burning for 10 days straight.

"Horrifying photos of Chernobyl and its aftermath," CBS News[85]

https://www.cbsnews.com/pictures/horrifying-photos-of-chernobyl-and-its-aftermath/6/

[85] Jessica Learish. *Horrifying photos of Chernobyl and its aftermath*, CBS News, March 11, 2022.

Appendix B

Alexei Ananenko, Valeri Bezpalov and Boris Baranov gearing up to go into the radioactive waters within reactor, in order to prevent a thermal explosion.

"Who Saved Europe? The Three Unsung Heroes of Chernobyl," Chernobyl X[86]
https://chernobylx.com/who-saved-europe-the-three-unsung-heroes-of-chernobyl/

[86] Chernobyl X writers. *The Three Unsung Heroes of Chernobyl*, Chernobyl X

Annotated List of Works Consulted

Primary Sources

Aerial Photo of the Reactor Burning. *CBS News,* www.cbsnews.com/pictures/horrifying-photos-of-chernobyl-and-its-aftermath/6/.

This picture allowed me to see how bad the explosion itself was, as it burned for 10 days straight.

"Conduct of Operations at Nuclear Power Plants." *Safety Series*.

This document was crucial to my writing since it showed exactly how Chernobyl impacted personnel requirements. The document explained how a certain amount of training was necessary to get a job, followed by what that they'd have to go through, such as simulations or team leader training. This would help my points of Chernobyl being pivotal in the changes for nuclear regulations, explaining the changes for employees.

Grigoryevich, Gibadulov Nikolai. Letter. 10 Sept. 1982. *Wilson Center Archive*, digitalarchive.wilsoncenter.org/document/report-kgbs-governance-about-emergency-stop-chernobyl-nuclear-power-plant-unit-no1-9#_edn1.

The letter details an accident at Chernobyl in 1982. This would have been 4 years before the big Chernobyl accident, which helped me to understand that Chernobyl was already unsafe, and could have been easily prevented with more supervision.

International Nuclear Safety Advisory Group. "INSAG-7 the Chernobyl Accident: Updating of INSAG-1." *INSAG Safety Series,* e-book ed., Vienna, International Atomic Energy Agency, 1992, pp. 1-148.

This source was the most vital for me to learn the facts of the disaster. It covered all the points that I needed to know for my paper, such as engineering flaws, and manager irresponsibilities, and it also covered a lot of the aftermath. Overall, it allowed me to read about the accident, how it started, and why it happened. The knowledge that I got from here helped me to understand why Chernobyl was such a big deal and it helped me to make sure I understood the accident before writing about it. Reading through the proceedings I learned a lot about nuclear reactors which also helped me to make sure my paper was historically, and scientifically, correct.

Letter. 14 Sept. 1982. *Wilson Center Archives,* digitalarchive.wilsoncenter.org/document/chair-committee-state-security-kgb-ukrainian-ssr-central-committee-communist-party-ukraine.

This website showed information regarding Chernoby's first meltdown accident. It helped me see how non-transparent the USSR was with their information, even blackmailing people to not see the information. They also used reasons like "preventing provocative rumors" as a way to prevent the spread of information, which highly contrasts today's, as people will immediately know, to help.

Moskalenko, Sophia. E-mail interview with the author. 6 Sept. 2023.

Going into this interview, I only looked at the facts of what happened with Chernobyl. As I interviewed Dr. Moskalenko, however, she allowed me to see how dire the circumstances were for those involved. She had already published pages on her experience, harrowing accounts of oncological disease and evacuation. The thing she told me that stuck with me, however, was "People overcome (or not) as best they can." It showed me that the people who were

affected sometimes had no way of getting better, they just had to live with the problems Chernobyl caused. This entire interview helped me to understand the magnitude of Chernobyl, and it was great to have the opportunity to talk to her.

Safety of Nuclear Power Plants: Design. E-book ed., Vienna, 2012.

This source was very important when I was covering design changes. It touched on multiple elements of the Chernobyl disaster, such as confinements and the positive void coefficient, which were changed to ensure future safety. The file explained why each change happened and why they were necessary which was helpful to me as I learned about the topic.

Schmemann, Serge. "Chernobyl Chiefs Ousted for Erring during Accident." *New York Times,* 16 June 1986, www.nytimes.com/1986/06/16/world/chernobyl-chiefs-ousted-for-erring-during-accident.html.

This website was published at the time of the three managers, Viktor Bruykhanov, Anatoly Dyatlov, and Nikolai Fomin's charges, as they were outed for pushing the disaster until it exploded.

The Three Unsung Heroes of Chernobyl. *Chernobyl X*, chernobylx.com/who-saved-europe-the-three-unsung-heroes-of-chernobyl/.

In my paper, I touched on three divers who would go on a mission, that would ultimately save Europe. However, at the time, it was widely believed that they'd die. This photo shows them gearing up, getting ready to head into the radioactive waters, wearing suits of protective gear. I thought this photo was a good depiction of the aftermath of Chernobyl, since it showed people putting their lives down to help, working hard to undo the problems caused by Chernobyl.

Secondary Sources

"About UNSCEAR." *United Nations Scientific Committee on the Effects of Atomic Radiation*, www.unscear.org/unscear/en/about-us/index.html#:~:text=About%20UNSCEAR&text=Its%20mandate%20in%20the%20United,and%20for%20establishing%20protective%20measures.

This website helped me understand the role that UNSCEAR plays in nuclear safety, such as constantly reviewing and making sure ionizing radiation levels are checked and creating protective measures in case of emergencies.

Aleksievich, Svetlana. *Voices from Chernobyl*. Translated by Keith Gessen.

This book was vital as I used it since it benefitted my background knowledge so much. Reading a variety of people's stories helped me a lot, as I got to see the lasting horrors of the disaster. I read about its impact on the liquidators, soldiers, photographers, everyday citizens, etc. Multiple cases stuck with me, and I used them to express how tragic the disaster was, and how much hardship it had caused. Two of these cases were the stories of Lyudmilla Ignatenko and Eduard Korotkov. Ignatenko's story was about how she had watched her husband, a firefighter who had responded to the accident, suffer through the gruesome health implications caused by the radiation. On the other hand, Korotkov had gone to Chernobyl to help and came home. However, he had given his hat to his son, who wore it every day, until he became ill with a tumor in his brain. Stories like these stuck with me as I wrote my paper since they helped me understand the magnitude of the incident.

"Bridge of Death in Chernobyl." *Chernobyl Story Tours*, chernobylstory.com/blog/bridge-of-death-in-chernobyl/#:~:text=It%20is%20said%20that%20soon,be%20dead%20short%20after%20that.

This page helped me to understand what happened at the Bridge of Death that allowed it to be immortalized with such a name. It showed me why the bridge was so dangerous, and scientifically, what had happened to the people who had gone there. The website also expressed the Bridge of Death's almost perfect location to view Chernobyl, yet it lead to so many tragic deaths.

Brunning, Andy. "30 Years since Chernobyl - How Nuclear Reactors Work." *Compound Interest*, 26 Apr. 2016, www.compoundchem.com/2016/04/26/nuclear-reactors/.

As I did my research, the science of nuclear reactors was the most difficult to grasp, especially as it talked about factors like the positive void coefficient. This source helped me to understand how they worked, and how Chernobyl's didn't work right.

Carlson, John. "Chernobyl: The Continuing Political Consequences of a Nuclear Accident." *The Lowy Institute*, 9 July 2019, www.lowyinstitute.org/the-interpreter/chernobyl-continuing-political-consequences-nuclear-accident#:~:text=As%20a%20consequence%20of%20Chernobyl,impossible%20with%20light%20water%20reactors.

This website talked about all the ways Chernobyl was messed up and all the problems it caused, but it also highlighted the fact that today nuclear plants are

much safer. I found this article early in my writing process so it introduced me to many ideas and points to take into account.

"The Cause." *Chernobyl Gallery,* www.chernobylgallery.com/chernobyl-disaster/cause/.

This source was important for me as it highlighted what happened, but more specifically, it emphasized what was supposed to happen. For example, the website explains what the AZ-5 button was supposed to do, and then explains what happened. It was helpful to me in my research because I understood what was supposed to happen too, so I got more of a grasp on the science element of the disaster.

"The Chernobyl Accident: Updating of INSAG-1." *International Atomic Energy Agency,* 1993, www.iaea.org/publications/3786/the-chernobyl-accident-updating-of-insag-1.

This website described the purpose of INSAG meeting in 1992. It helped me write my paper since it showed them meeting in order to talk about the accident itself, as well as develop ideas for the future of nuclear energy and safety.

The Chernobyl Forum. "Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine." *The Chernobyl Forum,* pp. 1-55.

This document was very helpful to me as it showed the work of multiple organizations, put together into one. The way it helped me most, however, was data. It accessed documents from Belarus, Ukraine, and Russia, getting numbers of the amount of liquidators, miners, etc. This was helpful to me because it allowed me to understand how much aid was needed in the recovery, and allowed

me to write about death rates and the immediate as well as long term health effects of Chernobyl.

"Chernobyl Timeline of Events." *Atomic Archive,* www.atomicarchive.com/science/power/chernobyl-timeline.html.

The website was full of specific times, down to the second, of what happened in Chernobyl. It showed what happened before, as well as after, which helped me develop a solid understanding as to how Chernobyl happened.

Coleman, C. Norman. *Public Health and Medical Preparedness for a Nuclear Detonation: The Nuclear Incident Medical Enterprise*. *National Library of Medicine,* https://doi.org/10.1097/HP.0000000000000249.

This source helped me later on as I learned about specific cases where regulation reform caused an impact. This specific report caught my eye because of the images that helped me to understand emergency responses as far as nuclear power plants go. It helped solidify the point of Chernobyl causing reforms with medical responses, as the USSR's response to Chernobyl was too slow.

"Comparing Fukushima and Chernobyl." *Nuclear Energy Institute,* www.nei.org/resources/fact-sheets/comparing-fukushima-and-chernobyl.

This website helped me see the impact Chernobyl had on the Fukushima disaster. It highlighted how Fukushima had a containment shelter and Chernobyl did not. This meant that the nuclear fallout blast was minimized, allowing this disaster to not have spread as much as Chernobyl did. This was important to me since containment shelters were mandated after the Chernobyl disaster, meaning that

they had solid evidence that Chernobyl's reforms were already bettering the industry and the dangers associated.

Debnath, Neela. "Chernobyl Explained." *Express*, 27 June 2019, www.express.co.uk/showbiz/tv-radio/1141188/Chernobyl-explained-miners-HBO-Sky-Atlantic-series-real-life.

Although much of the article talked about the show Chernobyl, it also emphasized the facts. It explained how many of the miners (1/4) would die of radiation-related illness, as well as the struggles they had, such as working in 122-degree conditions. Overall, this source helped me understand the story of Chernobyl's miners, especially the sacrifices that they made.

Dizikes, Peter. "Chernobyl: How Bad Was It?" *MIT News*. *MIT News*, news.mit.edu/2019/chernobyl-manual-for-survival-book-0306.

This website helped me to understand the effects of Chernobyl. Not only did it talk about the death tolls for specific people, such as the liquidators or miners, but the total, which has been constantly debated. I used the number from this website, 150,000, since it was in the middle of most other estimates I saw, and was derived from reputable sources. Overall, this website helped me understand what Chernobyl did to people.

"The Emergence of Transparency." *International Atomic Energy Agency*, www.iaea.org/resources/nuclear-communicators-toolbox/basics/transparency.

This website helped me in seeing reform concerning governments following Chernobyl as it talked about how the idea of transparency emerged after similar types of nuclear accidents. It adds on, explaining how the legacy of governments

hiding information (just like the USSR did at Chernobyl) can be overturned by being honest, forthrightness, and transparency.

Fisher, Len. "Could Chernobyl Happen Again without Human Error?" *BBC Science Focus,* www.sciencefocus.com/science/could-chernobyl-happen-again-without-human-error.

This website helped my understanding of Chernobyl since it explained how unless humans do something wrong, a nuclear disaster like Chernobyl couldn't happen again.

"Frequently Asked Chernobyl Questions." *International Atomic Energy Agency*, www.iaea.org/newscenter/focus/chernobyl/faqs.

This website helped me understand why Chernobyl exploded. It emphasized how the conditions had gone too far, so at a certain point, there would be no way to safely control the reactor. This helped me in my writing since it allowed me to see how the explosion could've gotten to that point.

"Fukushima Daiichi Accident." *World Nuclear Association*, world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.aspx#:~:text=Following%20a%20major%20earthquake%2C%20a,in%20the%20first%20three%20days.

This website wasn't prevalent as far as Chernobyl is concerned, but it did inform me a lot about what happened at the Fukushima Daiichi Accident, such as explaining why it happened.

Giugni, Marco. *Social Protest and Policy Change: Ecology, Antinuclear, and Peace Movements in Comparative Perspective*. 2004.

This book wasn't too prevalent in my research, but it did help me to understand how people were feeling at the time. Evidence on page 55 that said 150,000 to 200,000 people were marching in Rome to abolish Italy's nuclear system allowed me to see how the accident was affecting people across the world. It caused a sense of unease and even disbelief that an accident like this would be able to happen. Overall this book just allowed me to understand how unreal and unbelievable the accident was, especially then when it was assumed nuclear reactors couldn't meltdown.

Gray, Richard. "The True Toll of the Chernobyl Disaster." *BBC*, 25 July 2019, www.bbc.com/future/article/20190725-will-we-ever-know-chernobyls-true-death-toll.

This source helped me in knowing the effects of Chernobyl, specifically on the workers that went there after, such as liquidators and miners.

"Health Effects of Radiation." *Centers for Disease Control*, www.cdc.gov/nceh/radiation/health.html#:~:text=How%20Radiation%20Affects%20Your%20Body,to%20cancer%20later%20in%20life.

This site goes to show how many scientists and doctors have been researching radiation and its effects on the body, which has been a major point ever since Chernobyl.

History. 15 Aug. 2023, www.history.com/news/chernobyl-disaster-timeline.

This source helped me understand the timeline, especially the before and after, of the Chernobyl disaster. It briefly covered why it happened, and then went in-depth, following second-by-second recounts of what had happened.

History.com. "The Real Story of the Chernobyl Divers." *History.com*, www.history.co.uk/article/the-real-story-of-the-chernobyl-divers#:~:text=On%204%20May%201986%2C%20just,many%20considered%20to%20be%20suicide.

This source was very helpful to me when I was researching and learning about the Chernobyl divers, Alexei Ananenko, Valeri Bespalov, and Boris Baranov. This helped my paper since I highlighted their story as I wrote about the sacrifices made in order for the recovery. This source helped me to understand their importance, as well as what they did in detail. Even beyond the paper, it gave me the background knowledge of how much they sacrificed to do this mission.

"How Chernobyl Jump-Started the Global Safety Regime." *U.S. Government Accountability Office*, www.gao.gov/blog/2019/09/12/how-chernobyl-jump-started-the-global-nuclear-safety-regime.

This website helped me in my research since it developed the idea that Chernobyl kicked off nuclear safety reform. It talked about how it did so, such as the New Safe Confinement as well as what people are doing today. Overall, it just helped in my paper as it showed what Chernobyl did to change nuclear safety.

"Idaho Falls." *Atomic Heritage Foundation*, ahf.nuclearmuseum.org/ahf/location/idaho-falls/.

This website helped me understand the SL-1 accident in America. This accident highlighted a flaw in design that would later be prevalent in the Chernobyl disaster.

International Atomic Energy Association. "The 1986 Chornobyl nuclear power plant accident." *International Atomic Energy Association*, www.iaea.org/topics/chornobyl.

This website helped me understand the accident further. It explained how to IAEA responded to the accident, offering support and aid to the recovery. This also helped me as I researched and learned about new reforms in nuclear safety, as I could compare one to the other, seeing how much emergency response has improved.

Kingston, Jessica. "What Happened to the People Who Watched Chernobyl Explode on the Bridge of Death." *MAMAMIA*, 5 June 2019, www.mamamia.com.au/chernobyl-bridge-of-death/.

When I was writing the introduction, I was trying to find a topic that would grab attention, but not take away from the body of my writing. I found out about how there was a bridge that existed in the neighboring town of Pripyat, where radioactive debris was falling almost snow-like. It was such a tragic story as most people would end up dead because they went outside that day. This website helped me understand what had happened, and it felt like a way to accurately sum up how tragic the disaster was.

Langbart, David. "Chernobyl before It Was CHERNOBYL!" *National Archives*, 26 Apr. 2022, text-message.blogs.archives.gov/2022/04/26/chernobyl-before-it-was-chernobyl/.

Chernobyl is known for being the most fatal nuclear history in history, but it wasn't always like that. This source helped me see that Chernobyl was successful when it was founded, and produced energy for many people's usage. Concerning writing my paper, this website first gave me facts on pre-disaster Chernobyl, but also allowed me to understand that no one saw a disaster like this coming, especially from a seemingly stable plant, albeit, the plant did have its difficulties.

Liu, Zhu. "What Is Cherenkov Radiation?" *International Atomic Energy Agency*, 28 July 2022, www.iaea.org/newscenter/news/what-is-cherenkov-radiation.

This website helped me to learn about Cherenkov radiation - what it is and why it happens. It helped me a lot in my research because many recollections of the night of the disaster recall a bright blue light and I just never understood how it was possible, so this website helped me understand why.

Luandilok, Wison. *Chapter 5 - Nuclear Plant Severe Accidents: Challenges and Prevention*. *Science Direct*, https://doi.org/10.1016/B978-0-12-818256-7.00005-2.

This paper helped me to understand why, scientifically, the first Chernobyl accident, in 1992, happened.

Magnay, Diana. "Chernobyl: The Real Life Disaster Heroes Watch Hit Show." *Sky News*, 4 June 2019, news.sky.com/story/chernobyl-the-real-life-heroes-of-nuclear-disaster-watch-tv-hit-11734773#:~:text=How%20Chernobyl%20quietly%20became%20a%20huge%20TV%20hit&text=Four%20hundred%20miners%20from%20Donbas,try%20and%20cool%20the%20core.

This website helped me because I saw the enthusiasm that the workers had. For example, Vladimir Naumov would say, "Who else but us? Me and my fellow workers were brought up that way. Not that we went there to die, we went there to save lives." This helps develop my idea that the workers at Chernobyl were incredibly hardworking at what they did.

Mousseau, Timothy. "Why military action in radioactive Chernobyl could be dangerous for people and the environment." *PBS.org*, 3 Mar. 2022, www.pbs.org/newshour/world/why-

military-action-in-radioactive-chernobyl-could-be-dangerous-for-people-and-the-environment#:~:text=A%20direct%20hit%20on%20the,environmental%20disaster%20of%20global%20proportions.

This website helped me to understand the magnitude of the disaster. It helped me to see this by explaining how Chernobyl exerted 400x the nuclear fallout that Hiroshima, the atomic bomb did.

"Nuclear Emergency Preparedness and Response." *International Atomic Energy Association*, www.iaea.org/topics/emergency-preparedness-and-response-epr.

This website helped me because it showed how the IAEA has plans in place in the case of an emergency, with its member countries helping each other as well as having safety plans ready too.

"Nuclear Regulatory Commission (NRC)." *Federal Register*, National Archives, www.federalregister.gov/agencies/nuclear-regulatory-commission.

This website helped me see the role of the Nuclear Regulatory Commission as they regulate nuclear usage to protect public health and safety, as well as the environment.

"Nuclear Research." *International Atomic Energy Agency*, www.iaea.org/topics/nuclear-research.

This source helped me because it explained how the IAEA and its member states would work together to research nuclear energy and its impacts. This was helpful to me because it showed joint research between countries, which was a way that the IAEA enforced international cooperation.

"Nuclear Stockpile Transparency." *National Nuclear Security Administration*, www.energy.gov/nnsa/nuclear-stockpile-

transparency#:~:text=Increasing%20the%20transparency%20of%20states,and%20strategic%20and%20non-strategic.

This website helped me because it acknowledged how the United States has been releasing documents regarding nuclear energy to the public, which allows for strength as far as transparency between government and citizens, something that stemmed from activists and protests starting as early at 1986, from Chernobyl.

Rhodes, Richard. *Nuclear Renewal*. 1993.

This book was very helpful to me in my research. It helped me see how many protests there were, especially in places like Italy, where Chernobyl's damage had barely reached. It highlighted the effects of the damage and why the field of nuclear energy needed a revamp, or renewal. The transparency established post-chernobyl with governments and citizens was highlighted here too as people called for the end of nuclear energy.

SBU Declassified New Documents about the Disaster at the Chernobyl Nuclear Power Plant.

This source was helpful to me because it again showed the faults at Chernobyl pre-disaster. It explained the second meltdown in 1984, which again should've entailed Chernobyl to closer monitoring.

"Sequence of Events – Chernobyl Accident Appendix 1." *World Nuclear Association,* www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/appendices/chernobyl-accident-appendix-1-sequence-of-events.aspx.

This website helped a lot as it not only told me what happened when, but it explained why it happened. It helped me to understand how nuclear reactors work and why Chernobyl's failed. It did this in-depth while following a timeline of a

second-by-second replay of the accident. This helped me not only in my paper but in my background knowledge too as I got to understand what was going on.

Soloman, Brett. *Developing a Robust Safety Culture*. American Society of Safety Professionals. *JSTOR*, www.jstor.org/stable/48690844.

This source was important as I researched the idea of Chernobyl reforming safety. It explained how Chernobyl was a wake-up call, showing the necessity for better safety in the nuclear industry, especially from the INSAG-7 Document.

Strengthening the Global Nuclear Safety Regime INSAG-21. E-book ed., Vienna, International Atomic Energy Agency, 2006.

This source encapsulated my points about Chernobyl causing changes to nuclear regulations and safety. This source explained how Chernobyl and other nuclear disasters have impacted these regulations, enhancing the safety principles and allowing for their improvement as time goes on.

"Timeline of the Disaster." *Chernobyl Gallery*.

Instead of only covering the disaster, this website went into a review of the entire Chernobyl power plant's history. It helped me see the problems, such as in 1982 and 1984 and explained what happened then and why. This was also helpful as it went past the disaster, for example, explaining how the managers got arrested and when. It highlighted the problems at Chernobyl and allowed for in-depth reasoning at each step.

United States EPA. "RadNet || US EPA." *United States Environmental Protection Agency*, www.epa.gov/radnet.

As I was researching the impacts of Chernobyl on modern regulations and safety laws, I found this website, which talks about how the U.S. EPA will monitor and watch out for signs of nuclear problems, every second of every day.

U.S. EPA. "Radiological Emergency Response." *United States Environmental Protection Agency*, www.epa.gov/radiation/radiological-emergency-response.

This website allowed me to see the efforts put into nuclear safety following Chernobyl. The site states what steps and protocols would be taken in case of a disaster, and it contrasts that of Chernobyl's, showing the growth in safety since then.

Webster, Craig S. *Safety in unpredictable complex systems – a framework for the analysis of safety derived from the nuclear power industry*. June 2016. *JSTOR*, https://doi.org/10.1080/08109028.2017.1279873.

I found this source in the later stages of writing where I was polishing details on my paper. This specific paper helped me because it showed me how in 1961, 25 years before Chernobyl, the positive void coefficient problem was already found, which could have prevented Chernobyl altogether. This paper was very well written and explained thoroughly how every step happened, again showing how Chernobyl was yet again preventable.

What is Nuclear? whatisnuclear.com/chernobyl-timeline.html.

This website along with a couple of others allowed me to get a very good timeline as to how and when everything at Chernobyl happened. It covered seconds during the accident, describing how the science unfolded, causing the explosion.

Whelehon, Kayla. "Unsafe Behaviors and Unsafe Conditions: What's the Difference?" *Bluefield Security,* 1 Aug. 2019, bluefieldsafety.com/2019/08/unsafe-behaviors-and-unsafe-conditions-whats-the-difference/.

This website helped me in learning Akimov's (the manager during Chernobyl) reaction to the disaster saying, "I did everything right."

Williams, Matthias. "Unsealed Soviet Archives Reveal Cover-ups at Chernobyl Plant before Disaster." Edited by Estelle Shirbon. *Reuters,* 26 Apr. 2021, www.reuters.com/world/unsealed-soviet-archives-reveal-cover-ups-chernobyl-plant-before-disaster-2021-04-26/.

This website developed my ideas as I wrote since it showed me that Chernobyl was dangerous even before it blew up. It gave me another outlook on the disaster and helped to show me the negligence of the Soviet government, as well as how preventable the accident was.

Willsher, Kim. "Chernobyl 30 Years On: Former Residents Remember Life in the Ghost City of Pripyat." *The Guardian,* 7 Mar. 2016, www.theguardian.com/cities/2016/mar/07/chernobyl-30-years-residents-life-ghost-city-pripyat.

In this article, Kim Willsher talked to Pasha Kondratiev, a citizen of Pripyat when Chernobyl occurred, talking about her experience. She expressed stories of the Bridge of Death, and how there were smoke pillars all around. Her story helped me develop my paper as I wrote about the Bridge of Death and its tragic story.

Wilson, Richard. *Chernobyl: Assessing the Accident.* Arizona State University, 1986. *JSTOR,* www.jstor.org/stable/43312732.

This paper covered a lot about what had happened at Chernobyl, but most notably to me, it talked about the containment structure. Wilson talked about how, with a containment structure, the blast and consequently, the nuclear fallout, would've been minimized. This was important, since it pushed for new regulations in the future, leading towards now with a mandate for nuclear confinement buildings.

World Nuclear Association. "Chernobyl Accident 1986." *World Nuclear Association,* world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx#:~:text=The%201986%20Chernobyl%20accident,of%20main%20electrical%20power%20supply.

This was the most important source in my research. It first gave information about the reason why Chernobyl happened, detailing what parts of the reactor were flawed, such as the positive void coefficient factor. It explained the science behind each part of the reactor, which helped my background knowledge as I wrote my paper. Also, this website gave in-depth reviews of how the disaster happened. This, too, I used in my paper, as this site was a culmination of the work of many reliable organizations. Beyond the accident, it also helped me to see the results of the accident. It explained the symptoms of many who were effected and many other indirect effects Chernobyl had, such as abortions throughout Europe. Even more, however, this site also helped explain what came after Chernobyl, as well as what we learned from it. It was beneficial to me to see this because it allowed me to understand how Chernobyl impacted our modern world of nuclear science.

---. "RBMK Reactors – Appendix to Nuclear Power Reactors." *World Nuclear Association,* www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-

reactors/appendices/rbmk-reactors.aspx#:~:text=RBMK%20Reactors%20–%20Appendix%20to%20Nuclear%20Power%20Reactors&text=The%20RBMK%20is%20an%20unusual,the%20RBMK%20reactors%20still%20operating.

This website was very helpful to me as I researched the scientific reasons for Chernobyl, especially the positive void coefficient. It allowed me to understand how an accident like that could've occurred. It also helped me understand why they had their reactors like that since the government also factored in cost and productivity.