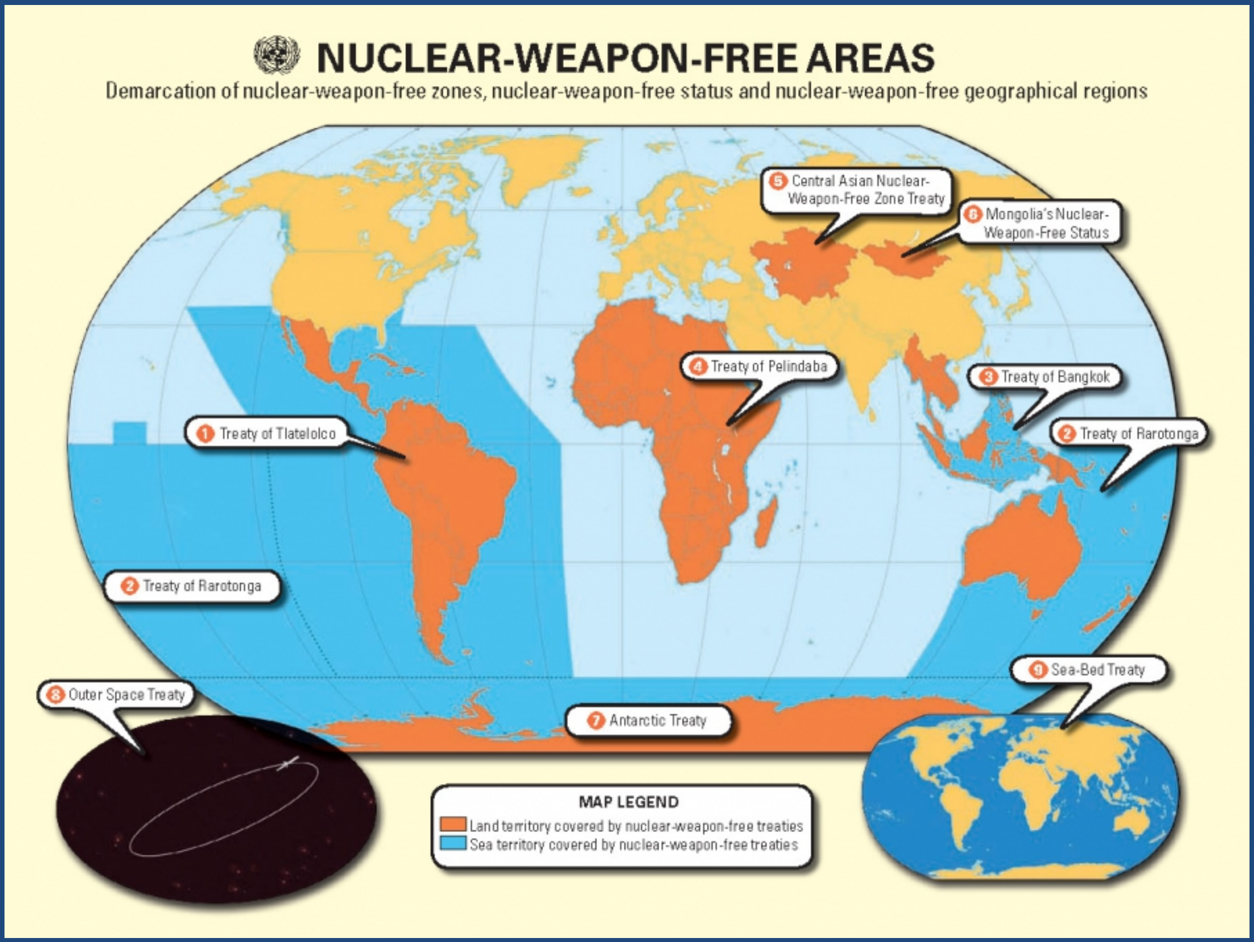

International Atomic Energy Agency (IAEA)

MUNUC 34

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CHAIR LETTER

Hi there!

My name is Marcos Lopez II and I will serve as your Chair for the IAEA. Before introducing the committee and my expectations, I'll introduce myself. I'm a second-year in the College studying Biological Chemistry and Chemistry who hails from the distant western suburbs of Chicago. Outside of academics I am involved in MUNUC, ChoMUN, and compete on our travelling team. I am also a member of Phi Alpha Delta, our school's pre-law co-ed fraternity and work in a molecular engineering lab on campus where I assist in researching vaccine adjuvants. Outside of school I make weekly runs to the local comic shop near campus, hang out with friends, and listen to way too much Daft Punk.

I want to bring all the excitement that comes from participating in a GA while providing a learning experience for both new and experienced delegates alike. To that end, I will be looking for delegates in committee that throw themselves into the committee and try to take an active, but not domineering, role over the course of the weekend. Specifically, I value delegates who bring unique solutions, are looking to speak often, and who collaborate well with the other delegates in the committee. More broadly, inappropriate behavior like bullying, harassment, or just generally being mean will not be tolerated and will be dealt with accordingly. I intend to treat all of you as the mature and responsible students that I know you are; however, offensive or charged language will not be tolerated in committee, regardless of whether it is "in service" of your country's national policy.

I selected Topic A because it is an issue in the realm of nuclear policy that is not discussed enough. As you will see, we will have to store the radioactive waste used in the generating of today's electricity for hundreds of years. There is an incredibly dangerous possibility of a whiplash effect if proper mechanisms and handling techniques are not developed in time to adequately address the hundreds of reactors which will be going offline in subsequent years. I encourage you to not get bogged down in the technical aspects of nuclear decommissioning but think of how the process as a whole can be improved. As you will see, there are many ways for the international community to work together to tackle this complex problem that has been thought of as a domestic issue for far too long. While

Topic B may seem like an issue that only involves the nuclear weapons states, recent developments demonstrate that the international community has an important role to play in this issue. I encourage you to view the issue more broadly as one which requires every nation to play a critical role in maintaining the global nonproliferation regime.

This committee is special to me because MUNUC's IAEA was the first committee I participated in when I attended my first high school Model UN conference. I have selected two topics that are pretty nuanced, and I want to encourage you to dive into these nuances highlighted in the background guide. I have attempted to provide a concise overview of both issues to the best of my abilities which should serve as a helpful touchstone for beginning your research. However, I recognize that I have selected two difficult topics and encourage you to reach out to marcoslopezii@uchicago.edu with any questions you have about the content included in the background guide or difficulties you may encounter while researching. I look forward to seeing you all in February, but until then, best of luck!

Best,

Marcos Lopez II

HISTORY OF THE COMMITTEE

The IAEA was formed in 1957 to provide an international platform for discussing pressing issues related to the "diverse uses of nuclear technology."[1] The idea behind the IAEA, however, was first proposed in 1953 during U.S. President Dwight D. Eisenhower's infamous address to the General Assembly now known as "Atoms for Peace." The goals and vision outlined in President Eisenhower's were the basis of the IAEA Statute that was unanimously approved by the 81 nations in the U.N. in 1956. The mission of the organization was to work with Member States and international partners to promote the safe use of peaceful nuclear technologies.

Still in its infancy, the IAEA offered 'technical assistance' programs to assist in the development of facilities and institutions with the basic capacities to launch a Member States' nuclear program. As revenue towards the Technical Cooperation Fund increased from the 1970s through the mid-1990s, the IAEA was able to expand its operations. Many nations reaped the benefits from the IAEA and the agency is credited with starting many of the world's foremost nuclear programs. The work of the IAEA's technical programs continues today with a multitude of regional facilities and other means used to facilitate the exchange of knowledge critical to the development of peaceful nuclear technologies.

At present, 173 Member States are a part of the IAEA, which means that most U.N. members are Member States of the IAEA. The IAEA is also waiting on five states to deposit the necessary legal instruments to become Member States. Every year the IAEA hosts the General Conference in which all Member States meet to approve proposals from the Board of Governors and debate current issues and policies confronting the organization. The Board of Governors has a fluid membership number but consists of 22 member states elected by the General Conference. These states serve for two-year terms. The outgoing Board then selects ten members who are the most advanced in nuclear technology. Additional slots may be selected by the outgoing Board if there is no country

[1] "History." *IAEA*, IAEA, 8 June 2016, www.iaea.org/about/overview/history.

from a particular region. In that case, the outgoing Board would select the most advanced among that region.

TOPIC A: IMPROVING THE DECOMMISSIONING PROCESS FOR NUCLEAR PLANTS

Statement of the Problem

As the global community continues to increase its reliance on renewable energy sources, nuclear energy output will increase. The amount of energy generated from nuclear power has increased globally since 2012.[2] Additionally, all power plants have a finite lifetime. Early nuclear power plants were designed for a lifespan of about 30 years. While modern projects are likely to last between 40-60 years, these facilities will eventually be taken down.[3] With this in mind, the decommissioning process is arguably a more difficult and dangerous task than the construction of nuclear power plants.

There are currently 443 nuclear reactors operating in 32 countries around the world.[4] In addition there are approximately 50 reactors in various states of construction in 16 countries. Furthermore, 100 reactors are in the planning stages while over 300 power reactors are being proposed to various governments. The majority of these reactors are planned for fast-growing economies that are fueling a rapidly-rising demand for electricity, particularly Asia. Put simply, the number of countries with nuclear power programs could double in the next few decades.[5] While most of these plans will fail to reach the construction phase, the growing demand for nuclear energy cannot be understated. As mentioned previously, these nuclear reactors cannot operate in perpetuity and eventually. It is incumbent upon the IAEA, the global community's pre-eminent forum on nuclear policy, to implement frameworks that will ensure the well-being of workers, community members, and the environment throughout the decommissioning process.

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[2] "Nuclear Power in the World Today." *Nuclear Power Today | Nuclear Energy - World Nuclear Association*, World Nuclear Association, Mar. 2021, www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx.
[3] "Decommissioning Nuclear Facilities." *Nuclear Decommissioning: Decommission Nuclear Facilities - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx.
[4] Wong, Samantha. "Nuclear Power Plants by Country 2021." *Statista*, World Nuclear Association, 20 May 2021, www.statista.com/statistics/267158/number-of-nuclear-reactors-in-operation-by-country/.
[5] *Ibid*.

Even though only some countries may reap the benefits of nuclear energy, the risks of radiation impact the global community. To provide an illustrative example of this danger, one need to look no further than the Fukushima Daiichi nuclear incident. Scientists identified kelp off the coast of southern California containing up to 250 times the normal concentration of short-lived radioactive isotopes (**radioisotopes**) one month after the accident. Luckily the radioactivity from these radioisotopes had little to no effects on the kelp or local marine life. However, the radiation not only traveled over 8,500 miles to the coast of California, but also was present in extremely high concentrations at least a month after the accident.[6] Off the coast of Canada, longer-living radioisotopes from the Fukushima disaster were detected off the shore of Vancouver, British Columbia.[7] While these levels were still safe for drinking by international standards, it nonetheless demonstrates how radioactive materials can travel long distances. Scientists at the University of Washington, Seattle detected radioactive fallout in air filters at their labs one week after the incident.[8] While wind conditions pushed radioactive material westward over the Pacific Ocean—who's large basin of water effectively dissipated much of the radiation that fell on its waves—the effects may have been devastating if the fallout had travelled eastward, effectively spreading across the entirety of Asia. While the cause of the accident was unrelated to the decommissioning process, it illustrates the dangers that radioactive materials present to people and the environment.

Returning to the topic at hand, the IAEA has three, internationally-recognized options for decommissioning nuclear reactors. While delegates are not required to know these processes in detail, it is helpful to be familiar with these decommissioning options. The first option is known as 'Immediate Dismantling' (or Early Site Release) in which a facility is removed from regulatory control soon after shutdown of activities. These plants are often small and have radioactive materials that can be easily contained and removed. Oftentimes the dismantling and decontamination of these

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[6] Cone, Marla. "Radioactive Iodine from Fukushima Found in California Kelp." *Environmental Health News*, Environmental Health Sciences, 30 Mar. 2012, www.scientificamerican.com/article/radioactive-iodine-from-from-fukushima-found-in-california-kelp/.
Article originally re-published in Scientific American.

[7] Oskin, Becky. "Radioactive Isotopes from Fukushima Meltdown Detected near Vancouver." *Scientific American*, Scientific American, 25 Feb. 2014, www.scientificamerican.com/article/radioactive-isotopes-from-fukushima-meltdown-detected-near-vancouver/.

[8] Leon, J. Diaz, et al. "Arrival Time and Magnitude of Airborne Fission Products from the Fukushima, Japan, Reactor Incident as Measured in Seattle, WA, USA." *Journal of Environmental Radioactivity*, Elsevier, 29 June 2011, www.sciencedirect.com/science/article/abs/pii/S0265931X11001366?via%3Dihub.

facilities can begin within a few months of shutdown and the site will reach **greenfield status** (or, in other words, will be safe for human use) within a decade.[9]

The next option for containing is known as 'deferred dismantling' (or SAFSTOR) in which a facility is kept in a safe storage condition for a period of time, oftentimes decades, until decontamination and dismantling can begin. Oftentimes, sites will decide to use this method in order to allow for residual radioactivity to decrease making the decommissioning and decontamination process safer. This makes the handling and transportation of nuclear waste much safer for workers. However, under this plan, new regulations could unpredictably increase the costs of decommissioning.[10] During the period of safe storage, many facilities are required, by national law, to reduce and isolate sources of radioactive waste.

The final method of decommissioning is known as 'entombment' which involves permanently housing radioactive material on-site. Parts of the facility which contain radioactive material are encased in a long-standing structure made of concrete. Oftentimes, the concrete used to cover the facility is especially thick in order to minimize the amount of **gamma radiation** which is emitted by the radioactive waste. Since the old facility is effectively being used as long-term storage for the radioactive material, the areas on or near the nuclear plant will remain unlivable for centuries. Consequently, the focus is on reducing the size of the area where radioactive material is located in order to minimize costs for the construction of the permanent housing structures.[11] A method similar to entombment was used to cover Chernobyl's Reactor 4.[12] While the problem of decommissioning is substantial, it can largely be broken down into three broad issues. Those issues are temporal, funding, and safety.

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9 "Decommissioning Nuclear Facilities." *Nuclear Decommissioning: Decommission Nuclear Facilities - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx.
10 International Atomic Energy Agency, 2005, *IAEA*, www-pub.iaea.org/MTCD/publications/PDF/TE_1478_web.pdf.
11 *Ibid*.
12 Crook, Lawrence. "30 Years Later, We're Still Trying to Contain Chernobyl." *CNN*, Cable News Network, 25 Apr. 2016, www.cnn.com/2016/04/25/world/containing-chernobyl-dome-anniversary-radiation/index.html.

Temporal Problems

Perhaps the greatest problem associated with the decommissioning of nuclear power plants are the temporal problems associated with radioactive materials. All radioisotopes have a **half-life**, which is the time it takes for half the radioactive materials to decay into its neutral products. While some radioisotopes have half-lives of a couple seconds or minutes, many radioisotopes—especially those produced as waste from nuclear plants—have half-lives of decades or even thousands of years.[13] Waiting for these decay processes is part of the reason why deferred dismantling is often used in the decommissioning process. Waiting several decades gives time for radioactive material to decay into less radioactive products which makes it safer for workers to handle. However, even after waiting a period of 30 or 40 years, there are still many other radioactive products that remain which need to be stored safely as their half-lives are so incredibly long it will take centuries for them to be safe to handle.

Nuclear waste is often identified as belonging to one of three categories: low-level, intermediate-level, or high-level waste (LLW, ILW, and HLW, respectively). These categorizations are useful in identifying the best strategies for storing radioactive materials and returning nuclear sites to greenfield status.[14] Nuclear waste must be stored so that it poses no risk to humans and minimizes the harm done to the environment. Unfortunately, the second goal is often difficult to achieve as will be seen in later discussions.

Approximately 90% of all nuclear waste, by volume, is classified as low-level waste.[15] There are many different types of waste that can be classified as LLW, including, but not limited to shoe covers and clothing, equipment and tools, and tissues from laboratory animals.[16] Luckily, safe disposal means have been developed around the world to store LLW. LLW is packaged for long-term management

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[13] "Backgrounder on Radioactive Waste." *U.S.NRC*, United States Nuclear Regulatory Commission, 23 July 2019, www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.html.
[14] "Storage and Disposal of Radioactive Waste." *Storage and Disposal Options for Radioactive Waste - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx.
[15] *Ibid*.
[16] "Low-Level Radioactive Waste (LLW)." *U.S.NRC*, United States Nuclear Regulatory Commission, 9 Mar. 2021, www.nrc.gov/reading-rm/basic-ref/glossary/low-level-radioactive-waste-llw.html.

before being sent to land-based disposal sites.[17] These sites are often below ground, but not particularly deep as there is not much in the way of radioactive material in these items.

High-level waste (HLW) is the radioactive waste category that requires the greatest planning for storage due to the dangers it presents to human health.[18] HLW must be stored to allow for the decay of radioactive elements, oftentimes with long half-lives. HLW is primarily composed of spent fuel from reactors. One current storage method consists of holding materials in Spent Fuel Pools (SFP) or "pools," which are deep pools which hold spent fuel from nuclear reactors by cooling the rods which continue to generate heat from radioactive decay and then dissipating the radiation emitted from the decay of radioisotopes in the water.[19] Unfortunately many pools have reached capacity, necessitating the implementation of dry cask storage in order to increase storage capacity for spent fuel rods. Dry casks allow fuel rods which have been cooled in SFPs for at least one year to be stored in steel cylinders which are welded or bolted shut to provide a leak-tight confinement. The casks are then further surrounded by materials such as steel or concrete to shield workers from exposure to radiation.[20] However, the best storage solution for HLW is deep geological disposal which requires digging deep into mountains or below ground to store materials far away from where they can pose threats to humans.[21] However, many countries struggle with finding where and how to construct such facilities. Currently, the United States is the only country in the world to have a deep geological disposal facility at its Waste Isolation Pilot Plant in New Mexico. This pilot deep geological storage facility is currently for defense-related nuclear waste. However, Finland's Onkalo repository, planned to begin operation in 2023, will be the first deep geological repository for the disposal of HLW produced by civil reactors.[22]

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[17] "Storage and Disposal of Radioactive Waste." *Storage and Disposal Options for Radioactive Waste - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx.
[18] *Ibid*.
[19] "Spent Fuel Storage in Pools and Dry Casks: Key Points and Questions & Answers." *U.S.NRC*, United States Nuclear Regulatory Commission, 14 July 2020, www.nrc.gov/waste/spent-fuel-storage/faqs.html.
[20] "Dry Cask Storage." *U.S.NRC*, United States Nuclear Regulatory Commission, 3 May 2021, www.nrc.gov/waste/spent-fuel-storage/dry-cask-storage.html.
[21] "Storage and Disposal of Radioactive Waste." *Storage and Disposal Options for Radioactive Waste - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste.aspx.
[22] *Ibid*.

Intermediate-level waste (ILW) primarily consists of long-lived radioisotopes and is typically stored in geological repositories. ILW is a new term that is coming into use and is not clearly defined. As such, some items classified as ILW can be disposed of with LLW, while other ILW, due to its activity, needs to be stored with HLW. While storage for LLW is very easy for many countries, most countries are in the early stages of disposal options for ILW and HLW.[23]

Nations with nuclear energy plants must provide guidance on the decommissioning process, including the storage of ILW and HLW. Presently, some national governments have given this task to their existing departments, while other countries have created new national agencies to provide safe places to store nuclear waste.[24] Meanwhile, some nations have advocated for working together to store and deposit their waste. For instance, the Slovakian government is actively considering the creation of a shared international repository project.[25] Additionally, a 2016 report from a high-level commission in South Australia recommended the establishment of an international repository in South Australia.[26] However, no solid plans for an international repository currently exist.

Safety Problems

Nuclear waste presents serious dangers to human health. While the storage of nuclear materials, especially HLW, intends to keep dangerous radioactive materials as far away from humans as possible, some people will inevitably interact with nuclear materials. Particularly during the decommissioning process, workers can come into proximity with dangerous nuclear materials if accidents occur or proper safety precautions are not taken. The greatest risk to the people working on the decommissioning of nuclear power plants occurs as a result of accidents.[27] Accidents are an unavoidable part of the decommissioning process, so the key issue is limiting the risk to workers when accidents do occur. It is of paramount importance that safety measures are put into place not

[23] *Ibid*.
[24] "What Other Countries Are Doing." *The Nuclear Waste Management Organization (NWMO)*, www.nwmo.ca/en/Canadas-Plan/What-Other-Countries-Are-Doing.
[25] *Ibid*.
[26] "International Nuclear Waste Disposal Concepts." *World Nuclear Association*, World Nuclear Association, Apr. 2020, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/international-nuclear-waste-disposal-concepts.aspx.
[27] Kim, Hyungjun, et al. "Safety Assessment Framework for Nuclear Power Plant Decommissioning Workers." *IEEEAccess*, 25 June 2019, ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8678392.

only to keep nuclear materials away from humans, but to protect workers against occupational radiation exposure.

Currently, legislation for the protection of workers is left up to individual nations. While some nuclear energy nations have laws in place to protect workers, no international framework or declaration exists to advocate for safety standards and protection of nuclear energy workers, especially those who must engage in the dangerous task of decommissioning nuclear plants. Instead, most national governments leave enforcement of any laws up to regulatory agencies. While this has worked in the past, as nuclear energy programs expand to a greater number of countries, it is imperative that the high standards of safety remain in effect.

In addition to the physical protection of workers, decommissioning equipment must also be guarded from the unique dangers of radiation. For instance, cranes are often used in the decommissioning process for licensed nuclear sites.[28] However, due to the presence of radiation in items that need to be moved by the crane, cranes are often controlled remotely. One component of the crane is known as a transducer. Thanks to advances in technology, there are two types of transducers: Type A which is completely analogue and Type B which has some digital components. While Type A transducers use older technology, the digital technology in Type B transducers can be quickly degraded by radiation.[29] Many crane designers are unaware of such limitations which can present problems during the decommissioning process; if cranes do not work effectively, workers may be forced to enter dangerous conditions in order to repair these electronics. Additionally, since nuclear cranes must rely on old technology, fewer manufacturers make the necessary parts, shrinking the market and driving prices up, only adding to the costs of decommissioning.

The IAEA has published international regulations for the safe transportation of radioactive material since 1961, with the most recent report released in 2018.[30] Radioactive materials can be transported with trucks, trains, and boats. Similar to protecting workers, the main safety concern when

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[28] "Going Nuclear." *Http://Www.hoistmagazine.com*, Progressive Media International Limited, 10 May 2019, www.hoistmagazine.com/features/going-nuclear-100519-7199431/.
[29] *Ibid*.
[30] "Transport of Radioactive Materials." *Transport of Radioactive Materials - World Nuclear Association*, World Nuclear Association, Apr. 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/transport-of-nuclear-materials/transport-of-radioactive-materials.aspx.

transporting radioactive material is protecting people and the environment from any negative effects of radiation. Radioactive materials are packaged and contained very effectively during the transport process. The main problem with transportation of radioactive material comes from over-regulation. A 2015 Euratom Supply Agency study found that the lack of international harmonization presents the greatest disincentive to the international transportation of radioactive material.[31] This trend likely has contributed to the lack of movement on the creation of an international repository for nuclear waste.

Ultimately, safety in the decommissioning process requires minimizing every chance of exposure. In order to do so, nations must consider backup plans and comprehensive safety codes. For instance, redundant components can be used in the event that its counterpart fails and needs to be replaced. Additionally, by building in safety factors into the decommissioning process, the likelihood of failure becomes less probable.

Funding Problems

The final problem confronting the decommissioning of nuclear power plants is funding. Decommissioning is expensive, especially considering the timescales involved. In fact, the long time frames for the construction and decommissioning of a nuclear power plant seem less like a commercial industrial project and more like a public infrastructure project. As a result, the total financing of nuclear power plants is an incredibly expensive undertaking. This is especially true considering that in most countries, the operator or owner of a facility is responsible for the costs of decommissioning.[32]

There are a variety of financing methods employed in different countries. The first method is called 'prepayment.' Through this method, money is deposited in an independent decommissioning account prior to the plant beginning operation. The account is strictly earmarked for decommissioning and typically funds cannot be withdrawn other than for decommissioning

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[31] *Ibid*.
[32] "Decommissioning Nuclear Facilities." *Nuclear Decommissioning: Decommission Nuclear Facilities - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx.

purposes. This method allows for facility owners to know how much money they have saved for decommissioning, helping set a budget when the time to decommission the nuclear power plant finally arrives. However, if money is not continuously added over time, the limited budget may worsen the scope and effectiveness of the decommissioning process. The second mechanism used to fund the costs of decommissioning is called an 'external sinking fund.' Essentially, companies will allocate a certain percentage of the electricity rates that they charge to customers to go towards a fund that is built up over the years of operation of a plant. Similar to prepayment, the money generated through this method is often placed in a fund separate from the plant's control. Again, the funds are earmarked specifically for decommissioning purposes. This method provides a continuous stream of savings for the plant owner. However, in the event of an accident of early closure, there may not be enough funds to cover the costs of decommissioning. The final option that plants will use to finance their operations is through the purchasing of surety funds, letters or credit, or insurance. The three funding mechanisms guarantee coverage of decommissioning costs, even if the facility defaults or an accident happens. While a reliable and quick source of funds, power plants could find themselves in debt for many years as they work to repay what they were credited.[33]

The cost of decommissioning is dependent upon several factors, including the type, size, and condition of the facility. What is more important to the work of this committee, however, are the decisions about the timing of decommissioning. For instance, placing a reactor in SAFSTOR allows for operators to time the process of decommissioning when it may be more favorable to them. However, waiting to begin the decommissioning process is a gamble and regulatory changes could drastically impact the decommissioning estimate cost. In fact, estimated costs for decommissioning vary vastly in their accuracy; some American plants decommission under budget while other plants, such as the Brennilis plant in France, can run over twenty times the forecasted budget.[34] [35] Put simply, it is difficult to estimate the costs for decommissioning and the likelihood of accidents which will present unforeseen additional costs make the process all the more challenging. As such, better practices for estimating decommissioning costs need to be put into place so operators have a greater

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[33] *Ibid*.
[34] "What Other Countries Are Doing." *The Nuclear Waste Management Organization (NWMO)*, www.nwmo.ca/en/Canadas-Plan/What-Other-Countries-Are-Doing.
[35] "Decommissioning Costs - The Global State of Nuclear Decommissioning: Costs Rising, Funds Shrinking, and Industry Looks to Escape Liability by Decades of Delay." *Beyond Nuclear*, 27 Apr. 2016, www.beyondnuclear.org/nuclear-decommissioning-costs/2016/4/27/the-global-state-of-nuclear-decommissioning-costs-rising-fun.html.

sense of the true cost of decommissioning prior to making decisions on the methods they plan to use to decommission their facilities.

History of the Problem

As of the time of this writing, over 180 commercial, experimental, or prototype nuclear reactors have suspended operations and been retired.[36] Yet, as of 2016, only 17 reactors had been fully decommissioned and reached greenfield status according to the provisions set forth by their respective national governments.[37] The decommissioning process is a long and expensive ordeal, and the global community is slowly coming together to share information that has been gathered from various decommissioning experiences. This information-sharing will be critical to future success, especially as the number of facilities undergoing decommissioning grows over the coming decade. Rather than an exhaustive overview of the history and lessons learned from the decommissioning process, what follows is a series of case studies. These case studies serve to not only provide context to the problem of decommissioning nuclear facilities, but also provide more concrete examples of the problems decommissioning efforts can encounter.

The United States' Yankee Rowe

The Yankee Nuclear Power Station, also known as Yankee Rowe, was shut down in 1991 due to "regulatory uncertainties associated with the integrity of the Reactor Vessel."[38] The reactor had been operating commercially for 30 years before it was shut down.[39] The plant was also the world's oldest commercial nuclear plant.[40] The decommissioning process was completed in 2007 after the United States' Nuclear Regulatory Commission (NRC) certified that the company owning and operating Yankee Rowe had satisfied the requirements necessary to return the land of the facility to greenfield status.[41] The NRC is the agency in the United States responsible for handling matters related to nuclear facilities, including the decommissioning process. The decommissioning of the Yankee Rowe facility is an example of one of the few nuclear sites which has been successfully decommissioned.

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[36] "Decommissioning Nuclear Facilities." *Nuclear Decommissioning: Decommission Nuclear Facilities - World Nuclear Association*, World Nuclear Association, May 2021, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/decommissioning-nuclear-facilities.aspx.
[37] *Ibid*.
[38] United States, Congress, Document Control Desk, and Brian Smith. *Yankee Nuclear Power Station Post-Shutdown Decommissioning Activities Report*, pp. 6–17. www.nrc.gov/docs/ML1706/ML17062A412.pdf.
[39] *Ibid*.
[40] Mullin, John R., and Zenia Kotval. "The Closing of the Yankee Rowe Nuclear Power Plant: The Impact on a New England Community." *ScholarWorks@UMass Amherst*, *University of Massachusetts Amherst*, Journal of the American Planning Association, 1997, scholarworks.umass.edu/cgi/viewcontent.cgi?article=1024&context=larp_faculty_pubs.
[41] Harrison, Tom. "Decommissioning activities completed at 11 sites in FY-07." *Inside N.R.C.*, 24 Dec. 2007.

While the Yankee Rowe facility did not encounter any particularly extreme roadblocks during the 16 year decommissioning process, there were many concerns regarding funding.

When the operating company first submitted their decommissioning proposal to the NRC, they had estimated it would cost $368M USD. When the facility was finally certified to be greenfield status, the operating company had spent $508M USD on decommissioning activities.[42] While not the most extreme case of an underestimate for decommissioning costs, the experiences of the Yankee Rowe facility informed much of the U.S.'s policies for budget planning. In particular, the operating company only estimated the costs for the *entire* decommissioning process. Operators now make estimates based on each stage of the decommissioning process, not in totality. This allows for estimates that can vary based on the timescale and science of each stage in the decommissioning process. For instance, the nuclear fuel rods for the Yankee Rowe facility needed to be placed in Spent Fuel Pools for five and a half years, but the operating company ended up keeping the spent fuel rods in the SFPs for an additional three years.[43] By accounting for the costs of operating the SFPs over the entire five and a half year period rather than estimating by year based on radioactivity predictions, the operating company underestimated the costs of maintaining the SFPs.

In addition to problems with cost estimates, the operating company underestimated the scope of radiation contamination at the site. For instance, the 1995 Cost Estimate for the facility underestimated the level of radiological contamination that would be present in the paint and concrete in the facility. It assumed that only 25% of the surfaces in containment would need remediation. However, 100% of the surfaces ended up needing remediation due to these underestimates in radioactive contamination, costing an additional $23.1M USD, approximately.[44] While this scientific knowledge has now been disseminated to be used in the decommissioning of other facilities, these underestimates in radiological contamination occur frequently and often lead to additional costs. By not setting aside a portion of the decommissioning budget to these unexpected costs, operating companies can face tight budget constraints later in the process, when proper maintenance of spent nuclear rods is most critical. While these are just a few of the examples

[42] Armaroli, Nicola, and Vincenzo Balzani. *Energy for a Sustainable World — From the Oil Age to a Sun-Powered Future*, Wiley-VCH, pp. 142-144.
[43] Terrell, M. S., and D. McGee. X-CD Technologies, *Waste Management Symposia*, archive.wmsym.org/2001/50/50-1.pdf.
[44] *Ibid*,

of unexpected costs which raised the overall cost of decommissioning, the experiences of Yankee Rowe demonstrate that operating facilities and regulatory agencies must incorporate emergency funds into the budgetary planning process.

The United Kingdom's Dounreay

The Dounreay Nuclear Power Development Establishment, hereafter referred to simply as Dounreay, is a settlement of two nuclear research facilities in northern Scotland. The site was used by the government for research purposes, including the development of nuclear reactors to be used on nuclear submarines.[45] The site began operation in 1955 and provided energy to the National Grid from 1962 to 1994, when the site ceased operations.[46] The site had one accident which spread radioactive particles across the area, and another which resulted in a ban on fishing within 2 km of the plant. The decommissioning process for the facility began in 1998 when the United Kingdom Atomic Energy Authority (UKAEA) announced that the site would no longer seek commercial contracts for the facility, laying the groundwork for the UKAEA to focus on decommissioning Dounreay.[47] The decommissioning process is ongoing, but due to the radiological contamination from the two accidents, the UKAEA claims the site will not be ready for other uses until after the year 2333.[48] This case shows that when proper safety precautions are not taken, it takes incredible lengths of time for radiation near the nuclear facilities to reach safe levels for humans. It is estimated that the decommissioning process would cost ￡2.9 B ($4.03B USD) due to the poor safety practices employed in the facility during operation.49

While the operation of Dounreay was littered with poor planning and waste management practices which greatly hindered the decommissioning process, scientists are employing new and innovative

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[45] Cockburn, Harry. "Nuclear Power Facility in Scotland Will Not Be Safe for Other Uses until 2333, Report Says." *The Independent*, Independent Digital News and Media, 20 Aug. 2020, www.independent.co.uk/climate-change/news/nuclear-power-dounreay-scotland-thurso-decommissioning-radiation-a9680611.html.
[46] *Ibid*.
[47] United Kingdom, Congress, Thompson, P. J., et al. *Radiation Protection During the Early Stages of Site Decommissioning at the UKAEA's Dounreay Site*, The United Kingdom Atomic Energy Authority.
[48] Cockburn, Harry. "Nuclear Power Facility in Scotland Will Not Be Safe for Other Uses until 2333, Report Says." *The Independent*, Independent Digital News and Media, 20 Aug. 2020, www.independent.co.uk/climate-change/news/nuclear-power-dounreay-scotland-thurso-decommissioning-radiation-a9680611.html.
[49] United Kingdom, Congress, Thompson, P. J., et al. *Radiation Protection During the Early Stages of Site Decommissioning at the UKAEA's Dounreay Site*, The United Kingdom Atomic Energy Authority.

solutions to work around these problems. One such example is the robot named 'Reactorsaurus' which will be remotely operated to take apart highly radioactive structures in the nuclear facility which have been deemed too dangerous for humans to take apart. The robot began use in 2013 and is expected to finish demolition of the necessary parts by 2025 and will have been instrumental to the safe decommissioning of the facility.[50] While robots and other remotely-operated machinery are often used in the decommissioning process, reactorsaurus is one of the largest robots used in the history of decommissioning. Given its success, it is likely that similar robotics will be employed in other decommissioning processes, as this method provides the greatest protection to workers while also allowing decommissioning efforts to continue despite potentially lethal levels of radiation.

While there are many lessons to be learned from the poor operating methods of Dounreay, the most critical is the importance of good nuclear waste management. A 213 foot shaft in the facility was turned into a nuclear waste depository on an ad hoc basis beginning in 1959 and was used to store intermediate level nuclear waste until 1977 when an explosion exposed the poor practices and forced the storage to end.[51] The shaft was never meant to be used as a waste depository and was poorly monitored, with few reliable waste disposal records available. In addition, it was discovered that waste in the shaft was contaminating groundwater. While the shaft may have been a convenient way to store nuclear waste in the facility, these unsafe practices have made the clean-up process difficult. Work began in 2020 to retrieve the material and repackage it for safe, above-ground safekeeping, but these practices have greatly inflated the costs and time it will take for decommissioning to be completed at the facility.[52] The misuse of the shaft demonstrates how poor operating practices can impact decommissioning processes later down the line. Ultimately, the ongoing decommissioning process at Dounreay demonstrates the importance of building plants which are functional during operation but can also plan ahead to the decommissioning stage.

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[50] "Monster Robot for Dounreay." *World Nuclear News*, World Nuclear Association - World Nuclear News, 6 May 2009, www.world-nuclear-news.org/WR_Monster_robot_for_Dounreay_0605092.html.
[51] "Dounreay: 'World's Deepest Nuclear Clean-up' to Begin." *BBC News*, BBC, 9 Sept. 2020, www.bbc.com/news/uk-scotland-highlands-islands-54085592.
[52] *Ibid*.

France's Brennilis

The Brennilis Nuclear Power Plant was a prototype nuclear reactor which operated between 1972 and 1981 and was permanently shut down in 1985.[53] The Brennilis plant's history is unique as the Liberation Front of Brittany claimed responsibility for two separate attacks on the plant during the 1970s. The second attack, which occurred in 1979, destroyed the electrical lines which transferred electricity from the plant to the grid. As a result of this attack, the plant began the process of closing, marking the only time in history that a nuclear power plant was closed due to the actions of a terrorist group.[54] While incidents such as these are rare, they nonetheless underscore the importance of security at nuclear facilities. These attacks happened while the plant was in operation, but even during the decommissioning process, it is critical that security measures are in place to protect radioactive materials.

Decommissioning on the plant began in 1997 and continued until 2007 when the 2006 decommissioning license was cancelled by the French Council of State because a necessary environmental impact study had not been published prior to the granting of the license. However, the decommissioning process is expected to begin in 2022 after the French government undertook an extensive review of decommissioning procedures, in 2016.[55] The project is expected to be completed in 2039, angering many of the local residents surrounding the plant. Brennilis was a part of the French government's plan to begin the dismantling of most of its first-generation nuclear power plants whose outputs fail to meet the output of modern reactors. However, like most reactors, decommissioning requirements were not taken into account when constructing Brennilis. In addition to the complex piping system surrounding the reactor core, the high amounts of radioactivity make manual work impossible, requiring the use of time-consuming remote work. The difficulty in decommissioning Brennilis highlights the great difficulty in decommissioning older

[53] "Breaking up Brennilis." *Www.neimagazine.com*, 7 July 2020, 12:12:24, www.neimagazine.com/features/featurebreaking-up-brennilis/.
[54] Tschantret, Joshua. "Nuclear Legitimacy: Why Insurgents Seek and Destroy Nuclear Technology." *Studies in Conflict & Terrorism*, 5 May 2019, pp. 1–22., doi:10.1080/1057610x.2019.1616930.
[55] "Breaking up Brennilis." *Www.neimagazine.com*, 7 July 2020, 12:12:24, www.neimagazine.com/features/featurebreaking-up-brennilis/.

reactors because they were not designed to be deconstructed. However, these reactors are the ones which urgently need to be decommissioned due to the fact that they are old and no longer in use.

Due to its difficulty and the length, the decommissioning process has become incredibly expensive. The EDF, a pseudo-government-funded French company responsible for operation and decommissioning the nation's nuclear power plants, has already spent €480M ($542.5M USD) on decommissioning the plant (as of 2016).[56] That amount is more than twenty times the anticipated cost of decommissioning and dismantling the reactor—and the decommissioning process is still not complete. This large gap in expected versus actual costs highlights many of the funding problems that decommissioning efforts encounter. The problem is particularly clear in France where the decommissioning of power plants is paid for by the French government. Informed by the experiences at Brennilis and other plants, many citizens in France believe that the EDF is too optimistic when estimating decommissioning costs. For instance, Germany has earmarked €38B for the decommissioning of its 17 nuclear reactors, while France has apportioned €36B to decommission its 56 reactors.[57] It is estimated that €75B ($81B USD) will be needed to decommission France's entire fleet of nuclear reactors, an estimate many politicians and citizens are suspicious of being too low.[58]

In addition to the costs associated with decommissioning, many in France are concerned with the storage of the radioactive waste. France is set to begin the construction of a €25B national repository in Cigéo in order to store the large amounts of nuclear waste which are quickly accumulating from France's many reactors.[59] The estimates for the national repository were €5B more than anticipated and the EDF, which is already facing immense financial strain, is tasked with paying for the majority of the repository's construction. The facility is scheduled to be opened in 2025, but a protracted legal battle with local communities has stalled much of the work on the project.[60] As a result of the delays in the construction of the repository, the radioactive waste in France's current nuclear disposal sites

[56] "Decommissioning Costs - The Global State of Nuclear Decommissioning: Costs Rising, Funds Shrinking, and Industry Looks to Escape Liability by Decades of Delay." *Beyond Nuclear*, 27 Apr. 2016, www.beyondnuclear.org/nuclear-decommissioning-costs/2016/4/27/the-global-state-of-nuclear-decommissioning-costs-rising-fun.html.
[57] Stothard, Michael. "Nuclear Reactor Clean-up Weighs on EDF." *Financial Times*, Nikkei Company, 19 Apr. 2016, www.ft.com/content/c82ae2c4-0582-11e6-9b51-0fb5e65703ce.
[58] "EDF Defends Reactor Decommissioning Plans." *World Nuclear News*, World Nuclear Association, 2 Feb. 2017, www.world-nuclear-news.org/Articles/EDF-defends-reactor-decommissioning-plans.
[59] Stothard, Michael. "Nuclear Reactor Clean-up Weighs on EDF." *Financial Times*, Nikkei Company, 19 Apr. 2016, www.ft.com/content/c82ae2c4-0582-11e6-9b51-0fb5e65703ce.
[60] *Ibid*.

is in a state of limbo. This has only served to inflate the costs of storing radioactive waste. Repositories must be designed to hold waste for thousands of years, but current storage methods are relying on the construction of these expensive facilities which governments hope will solve many of their storage and financial woes related to nuclear waste.

Switzerland's Lucens Reactor

The final reactor in this series of case studies is the Lucens reactor in Switzerland which began supplying electricity to Switzerland's grid in 1968 and suspended operations after an accident almost one year later.[61] The response to this accident is more pertinent to this committee than the cause of the accidents. Specifically, the response to the accident at Lucens highlights the response mechanisms and the decommissioning process in the event of "small-scale" nuclear accidents which force the closure of nuclear plants. While larger incidents such as those at Russia's Chernobyl or Japan's Fukushima Daiichi have had greater ramifications on the decommissioning process (specifically, SAFSTOR procedures), events such as those at Lucens are more common.

Luckily, the workers nor the population near the reactor were exposed to any significant amounts of radiation. However, the cavern which housed the reactor was greatly contaminated and posed the greatest difficulty in the decommissioning process. Specifically, inadequate lifting equipment, the lack of space, and floor loading capacity all contributed to decommissioning difficulties.[62] After some decommissioning work was completed, the facility was allowed to sit until 1988 in a safe enclosure with an intricate drainage system created in order to monitor radiation levels in groundwater. By taking this careful approach, Switzerland was able to wait for radiation levels to significantly decrease, while continually monitoring for any ways that radiation could have potentially escaped. The radioactive waste was eventually safely stored in dry casks and all radioactive waste was totally removed by 2003.[63] The waste was moved to a temporary storage facility in the north part of Switzerland. While there were no outstanding problems with the decommissioning of Lucens, accidents often will take nuclear plants offline and force an early start to the decommissioning

[61] "Lucens." *ENSI EN*, Swiss Federal Nuclear Safety Inspectorate, www.ensi.ch/en/topic/versuchsatomkraftwerk-lucens/.
[62] International Atomic Energy Agency, 1999, *On-Site Disposal as a Decommissioning Strategy*, www-pub.iaea.org/MTCD/publications/PDF/te_1124_prn.pdf.
[63] "Switzerland's First Nuclear Plant Decommissioned." *SWI*, 17 Sept. 2003, www.swissinfo.ch/eng/switzerland-s-first-nuclear-plant-decommissioned/3518582.

process. Early closures can prove to be a source of financial burden, especially if adequate funds have not yet been secured for the decommissioning process.

Past Actions

The decommissioning of nuclear facilities as an inherently one-state process. However, while only the state/operating company which built that facility is responsible for its safe decommissioning, there has been an increasingly globalized approach to the problem over the past couple of decades. A number of international conventions and other instruments have been submitted to the IAEA in order to promote greater international cooperation on matters relating to decommissioning. However, to date, no international conventions exist which are specific to the decommissioning process. While the number of member states confronting this problem may be small, the environmental and economic impacts on other nations cannot be understated. Furthermore, a growing number of states are at various stages of creating their own nuclear regulatory agencies and plants. Ultimately, more IAEA member states are realizing the global implications of poor decommissioning strategies. What follows are some of the first steps taken to address related problems on an international level.

Convention on Nuclear Safety

One of the landmark documents overseen by the IAEA is the Convention on Nuclear Safety (CNS), which established safety principles for the operation of land-based civil nuclear power plants. However, the CNS does not cover nuclear reactors used for military purposes. The goal of the CNS is to provide a legally binding instrument that actively works to improve and harmonize safety standards. The CNS was drafted in the aftermath of several high-profile nuclear accidents including Three Mile Island and Chernobyl. A series of meetings between 1992 and 1994 led to the drafting and adoption of the CNS in 1994.[64] As of March 15, 2021, there were 91 Parties to the CNS who have agreed to abide by the provisions outlined in the convention. With the exception of Iran, all nations which currently operate nuclear power plants are contracting parties to the CNS.[65]

In order to achieve its stated goal of improving safety standards for nuclear plants, the CNS incorporated a peer review process into the framework of the convention. This review process occurs

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[64] International Atomic Energy Agency. *Convention on Nuclear Safety (CNS): Introduction to the CNS and Its Associated Rules of Procedure and Guidelines*, 2017, www.iaea.org/sites/default/files/19/09/19-00679e_web_cns.pdf.
[65] Hibbs, Mark. "A Failed Effort to Toughen Nuclear Safety Standards." *Carnegie Endowment for International Peace*, 18 Feb. 2015, carnegieendowment.org/2015/02/18/failed-effort-to-toughen-nuclear-safety-standards-pub-59114.

every three years at a review conference during which each Contracting Party presents their national safety standards. Prior to the meeting, each Contracting Party must prepare a National Report on measures that have been taken since the previous conference to implement the safety standards outlined in the CNS.[66] These National Reports must be published in advance of the Review Meeting and other Contracting Parties are encouraged to send written questions asking for clarification in the four months preceding the Review Meeting. The drafters of the CNS hoped that the peer review process would promote three goals relating to increasing nuclear safety. Those goals were transparency, collaboration, and self-assessment. With regards to transparency, by forcing all Contracting Parties to submit publicized National Reports, countries would share more information than previously. Through encouraging transparency, there would be greater information-sharing amongst nuclear states which would also facilitate greater levels of trust between member nations. This would help with the second goal, collaboration, as Contracting Parties could easily access the National Reports of all other Contracting Parties and learn from each other to improve safety practices. In addition, the peer review process provides a place where every Contracting Party can ask for constructive criticism or even assistance when confronted with major nuclear problems in their country. Finally, self-assessment assists in forcing each Contracting Party to look inwardly on their nuclear program and find ways to improve existing standards. By forcing Contracting Parties to submit a National Report which will be scrutinized by other Contracting Parties, each nation is forced to contend with the current shortcomings of their nuclear safety standards. Through facilitating the successful achievement of these three objectives, the CNS ultimately aims to make nuclear power reactors safer in every nation around the world.

TABLE 1. REVIEW SCHEDULE

Months prior to the Review Meeting	Event
T - 36	Previous Review Meeting
T - 19	Organizational Meeting to assign Country Groups and elect Officers, i.e. a President, two Vice-Presidents, and Country Group Officers (Chairpersons, Vice-Chairpersons, Rapporteurs and Coordinators for each Country Group) for the subsequent Convention Review Meeting
T - 7.5	Deadline for submission of National Reports by each Contracting Party (available on CNS secure website)
T - 4	Deadline for submission of written questions and comments on the National Reports of all Contracting Parties (available on CNS secure website)
T - 1.5	Officers Meeting
T - 1	Deadline for answers to written questions submitted by each Contracting Party (available on CNS secure website)
T = 0	Review Meeting

[66] International Atomic Energy Agency. *Convention on Nuclear Safety (CNS): Introduction to the CNS and Its Associated Rules of Procedure and Guidelines*, 2017, www.iaea.org/sites/default/files/19/09/19-00679e_web_cns.pdf.

Despite its attempts at improving safety, the CNS is not without its share of criticisms. Especially in the wake of Japan's Fukushima Daiichi disaster, many independent organizations have levied criticisms at the peer review process instituted in the CNS. With regards to Fukushima, the CNS covers many of the poorly planned factors that played a role in the disaster including the chosen site, design, and emergency preparedness. In Japan's National Report for the 2010 Review Meeting, it asserted that "Japan has ensured implementation of the CNS."[67] However, Japan failed to abide by the convention's standards outlined in articles 8 and 17 regarding regulatory independence and safe siting of nuclear power plants, respectively. This debate over the CNS' inability led to contentious debate at subsequent meetings as the CNS had no mechanism to compel states to implement standards they are "legally" required to uphold.[68] In this case, the CNS could not compel Contracting Parties to equip and/or decommission older plants which failed to abide by the CNS' safety standards such as Fukushima Daiichi.

While a proposal from Switzerland attempted to amend article 18 of the CNS to specify that safety targets were meant to include both new and existing reactors, the amendment was bogged down with two big problems. Firstly, countries with many existing plants like the United States argued that the cost of shutting down older plants in order to install the state-of-the-art equipment necessary to meet the CNS' standards was incredibly prohibitive. These nations argued that they may as well decommission their entire fleet of older, non-compliant reactors if the amendment were to pass. Secondly, international conventions are incredibly difficult to actually amend. For instance, the Convention on the Physical Protection of Nuclear Material was amended in 2005 but the amendment still has not entered into force due to the fact that the required ⅔ of Contracting Parties have not ratified the Convention.[69] In the face of these two difficult obstacles to overcome, Switzerland and its European counterparts which were the largest proponents of the amendment ultimately dropped the amendment. As a result, the CNS continues to operate with its review process and guidance—to varying degrees of success.

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[67] Hibbs, Mark. "A Failed Effort to Toughen Nuclear Safety Standards." *Carnegie Endowment for International Peace*, 18 Feb. 2015, carnegieendowment.org/2015/02/18/failed-effort-to-toughen-nuclear-safety-standards-pub-59114.
[68] *Ibid*.
[69] *Ibid*.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

Perhaps the most important international convention which has been adopted to date, the IAEA notes that the "Joint Convention is the first legal instrument to address the issue of spent fuel and radioactive waste management safety on a global scale."[70] Due to its lengthy name, the convention is simply referred to as the Joint Convention from here on out. The Joint Convention was adopted and opened for signature in 1997 at the IAEA's 41st session of the General Conference. As of the time of this writing, 83 member nations are parties to the Joint Convention, demonstrating the growing importance of international mechanisms to tackle issues related to decommissioning.[71]

Taking inspiration from the Convention on Nuclear Safety, the Joint Convention's most important feature is the peer review process. The peer review process sees all Contracting Parties submit a National Report every three years detailing how that Party followed the expectations and met any obligations specified in the Joint Convention.[72] Then, other nations that are party to the Joint Convention can seek clarification on anything in the National Reports through a written system of questions and answers in the months prior to the Review Meeting. Contracting Parties are encouraged to submit questions prior to the meeting so that the actual Review Meeting can be spent presenting and discussing the National Reports. The peer review process facilitates the dissemination of information as Contracting Parties are able to learn from the reports or other nations. In addition, the Review Meeting provides an opportunity for the global community to provide objective, independent analysis of each nation's safety practices. This gives neighboring states an international platform to voice concerns over nuclear waste safety.

As can be seen from the full name, the Joint Convention covers spent fuel, usually from nuclear facilities, along with radioactive waste—which may come from several sources, including nuclear

[70] "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management." *IAEA*, IAEA, 25 July 2014, www.iaea.org/topics/nuclear-safety-conventions/joint-convention-safety-spent-fuel-management-and-safety-radioactive-waste.
[71] International Atomic Energy Agency. *The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, International Atomic Energy Agency, 2020, www.iaea.org/sites/default/files/20/09/jc-brochure-2020-e.pdf.
[72] *Ibid*.

facilities.[73] However, it is important to note that not all radioactive waste covered in the Joint Convention necessarily refers to waste from nuclear power facilities. Radioactive waste can come from a number of sources including medical research and agricultural applications. However, as it pertains to the work of this body, the Joint Convention should be seen as a historical instrument that has facilitated greater international cooperation in nuclear safety, especially with regards to nuclear reactors. Specifically, the Joint Convention has harmonized national approaches with regards to the construction and design of nuclear reactors, spent fuel waste management, and safe operating practices. In addition, the Joint Convention includes safety provisions on responsibility mechanisms for operators, emergency responsiveness, and decommissioning.[74] Notably, the Joint Convention has explicit language supporting international cooperation of shared facilities, including for waste. While not specific to the decommissioning process, the Joint Convention was the first-step towards greater cooperation in the decommissioning process across national lines.

Conventions on Liability for Nuclear Damage

The 1963 Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Compensation for Nuclear Damage are the two most important international conventions which aim to provide some sort of legal and financial framework in the event of a nuclear accident. Neither Convention specifically discusses nuclear damage that can arise from the decommissioning process, but some background knowledge on these two Conventions is important nonetheless. Generally speaking, the two Conventions aim to provide minimum standards for financial protection and compensation in the event of damage arising from peaceful uses of nuclear energy.[75] However, the mechanisms for providing this financial assistance differ for each Convention. The full text of resources like the Vienna Convention and the Convention on Supplementary Compensation can be found on the IAEA's website.

[73] *Ibid*.
[74] *Ibid*.
[75] "Vienna Convention on Civil Liability for Nuclear Damage." *IAEA*, IAEA, 27 Aug. 2014, www.iaea.org/topics/nuclear-liability-conventions/vienna-convention-on-civil-liability-for-nuclear-damage.

Convention on the Physical Protection of Nuclear Material

Unlike the aforementioned Joint Convention, the Convention on the Physical Protection of Nuclear Material (CPPNM) provides an international legal framework aimed at increasing the physical safety of nuclear and other radioactive materials. At the time of this writing, the 162 nations are party to the CPPNM, making the CPPNM one of the most universally adhered to documents in the realm of nuclear materials. The CPPNM provides a number of legal instruments and recommendations to assist in preventing and responding to criminal acts involving nuclear materials.[76] With the ultimate goal of international cooperation among Contracting Parties, the CPPNM provides guidance on physical protection measures for nuclear material in international transport along with measures for criminal offenses. However, the original CPPNM failed to include any provisions beyond those related to international transportation.

In 2005 after an extensive amendment process, the Parties to the Convention adopted an amendment to the CPPNM which extended the CPPNM's coverage to include the protection of radioactive waste and other materials that must be stored during the decommissioning process. The Amendment also strengthened cooperation among Contracting Parties to cooperate together to locate and recover any stolen or lost nuclear material which could pose serious health risks to unprotected members of the public.[77] Despite its unanimous support from Contracting Parties, many states have failed to ratify the Amendment through their respective national legislatures, making it difficult to truly enforce the Amendment. As such, the CPPNM could be an effective instrument to protect nuclear waste and materials which need to be stored during and well-after the decommissioning process. While the IAEA cannot do anything to speed up the ratification process in individual member nations, reaching the ⅔ majority of the Parties to the CPPNM is critical to implementing these protections for nuclear materials. As such, the focus is not on how international treaties can protect radioactive materials, but how quickly states which have not ratified the Amendment push the ratification of the Amendment through their respective legislatures. Movement on the Amendment, which was passed unanimously, has only slowed down as time goes

[76] "Nuclear Security Conventions." *IAEA*, IAEA, 8 June 2016, www.iaea.org/topics/nuclear-security-conventions.
[77] *Ibid*.

on, possibly necessitating incentives or other measures to ensure the eventual ratification of the Amendment.

Possible Solutions

Ultimately, it is the debate and discussions of this committee which will find the best solutions to the task at hand. Rather than attempting to provide an extensive list of potential solutions, what follows are a series of potential solutions that address some of the problems related to the decommissioning of nuclear plants. This list should, by no means, be considered exhaustive and there are many great solutions waiting to be discovered and implemented. Additionally, the solutions outlined below, even in conjunction with one another, cannot adequately address all aspects of the problem. Instead, they should be viewed as a launching pad for further research.

International Repository

The idea of a shared international repository is not a new one. In fact, an IAEA-sponsored report in 1980 called the International Nuclear Fuel Cycle Evaluation (INFCE) recommended the creation of "multinational and international repositories."[78] Since then, there have been a number of proposals by several countries and working groups. Of these proposals, the two which have gained the most attention are the ongoing ERDO organization in Europe and the 2016 South Australian Nuclear Fuel Cycle Royal Commission report.

Beginning with the 2016 South Australian report, the Royal Commission found that the state of South Australia "has the necessary attributes and capabilities to develop a world-class waste disposal facility."[79] The report estimated that the repository could generate $75B (USD) in income, even when factoring in approximately $25B for the facility's closure and monitoring over its 120-year life. However, no significant movement has been made on the proposal as legislative changes at the state and national levels would be necessary in order for Australia to create serious plans for such a project.

The ERDO organization has a history dating back until 2002 when the Association for Regional and International Underground Storage (ARIUS) was set up. ARIUS was intended to be a non-

[78] "International Nuclear Waste Disposal Concepts." *World Nuclear Association*, World Nuclear Association, Apr. 2020, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/international-nuclear-waste-disposal-concepts.aspx.
[79] *Ibid*.

commercial body with open membership laws looking at ways to create shared radioactive waste management facilities.[80] ARIUS focused its efforts over the next several years in Europe through a series of projects conducted with approval from the European Commission aimed at exploring the feasibility of regional waste repositories. After several feasibility studies, 14 countries resolved to create the European Repository Development Organization (ERDO) through the creation of a self-financing working group. Building off the work of the ARIUS study's (namely, SAPIERR II), the ERDO Working Group has slowly been making steps towards achieving its goals. In fact, on January 7, 2021, ERDO was launched by Denmark, Norway, and the Netherlands as an official organization.[81] More countries are expected to join ERDO. However, no official plans exist for a multinational waste repository.

While there have been other proposals for a multinational or international repository over the past decade or so, the actual implementation of such a proposal is difficult at best. There are many technical and legal considerations that the Royal Commission and ERDO reports identified which need to be taken into consideration. In the legal sense, there is no legally-binding document which outlines the legal treatment of nuclear waste when stored in other countries. The closest governments have come to any sort of agreement is contained in the preamble of the Joint Convention which mentions that it is the right of any nation to refuse to store another nation's nuclear waste. However, if, for example, another country's waste was to be stolen or tampered with in any way, countries would find themselves in murky waters on how to proceed forward with the situation. The 2016 Royal Commission's report noted that countries wishing to store waste at the proposed repository would need to sign agreements with the federal and state governments in Australia.[82] With regards to the technical aspects of transferring radioactive waste, the CPPNM provides the best framework for developing transnational travel plans, if necessary, to move waste from the country which generates it to the country which will store it.

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[80] *Ibid*.
[81] "European Organisation Launched for Cooperation in Waste Disposal." *World Nuclear News*, World Nuclear Association, 8 Jan. 2021, world-nuclear-news.org/Articles/European-organisation-launched-for-cooperation-in.
[82] "International Nuclear Waste Disposal Concepts." *World Nuclear Association*, World Nuclear Association, Apr. 2020, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/international-nuclear-waste-disposal-concepts.aspx.

Ultimately, the greatest obstacle to multinational repository proposals is the fact that the idea is still a novelty. As stated earlier, the only repository which stores HLW is the WIPP in the United States. While some countries are in the process of building their deep geological repositories, there simply has not been enough experience to inform other countries of the feasibility of these proposals. Deep geological repositories, which are necessary for long-term disposal of highly radioactive waste, are not possible everywhere, making the hunt for a potential international repository an ever-more pertinent problem. In addition, as more nations begin to develop their own nuclear programs—including nuclear reactors—the need to find long-term waste disposal solutions will increase pressure on governments to act. While there may not be much experience on the matter, beginning the process of constructing an international repository can only assist the international community as nuclear energy expands to more countries.

Nuclear Recycling Programs

The idea of nuclear recycling exists as a pseudo-alternative to long-term storage solutions such as repositories. Nuclear waste (specifically, reactor fuel) can be treated and reused as reactor fuel if a series of complex chemical processes are performed in a radiologically shielded area. As an added bonus, recycled nuclear waste will decay into harmless products within a few hundred years, rather than millions. However, the process is rather expensive and generates liquid radioactive material which ultimately needs to be stored.[83] As a result of the trade-offs associated with recycling nuclear fuel, different countries have taken different approaches to their radioactive waste. Most notably, the United States treated all nuclear fuel as waste and does not currently recycle any of it. On the other hand, France, Japan, Germany, Belgium, and Russia have all used recycled plutonium to get further use out of spent nuclear fuel.[84]

A growing number of nations are adopting or integrating nuclear recycling programs into their nuclear energy policy. There are currently five commercial reprocessing facilities, some of which will reprocess waste from other countries. These facilities are located in France, Russia, Japan, the

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[83] Touran, Nick. "Recycling Nuclear Waste and Breeder Reactors." *What Is Nuclear?*, Mar. 2009, whatisnuclear.com/recycling.html.
[84] "What Is Nuclear Waste, and What Do We Do with It?" *World Nuclear Association*, World Nuclear Association, world-nuclear.org/nuclear-essentials/what-is-nuclear-waste-and-what-do-we-do-with-it.aspx.

United Kingdom, and India and are able to reprocess approximately 3,860 tons of nuclear fuels per year. This growth is also fueled by developments in reactor technology which could potentially create reactors which run entirely on recycled spent fuel. In particular, fourth-generation fast neutron reactors could change perceptions of nuclear waste dramatically. These reactors are still in the design stages and current projections estimate that such a reactor will not be available to go online until at least 2030, but likely later.[85]

The recycling of nuclear waste continues to remain an especially effective solution to the problem of storing nuclear fuels, despite several drawbacks. One final reason to consider the expansion of nuclear recycling programs is rooted in limiting the proliferation of nuclear weapons. There is growing interest in gathering long-lived radionuclides that are a part of the **actinides** series in order to recycle those waste products en-masse for use in fast reactors. By turning these products, which are all radioactive, into recycled fuel, the possibility that plutonium waste products are diverted into military use is significantly reduced. This would reduce the time that the radioactive products are a danger to human health by converting HLW products with long half-lives into shorter-lived fission products.[86]

International Safety Standards

While advances in fields relating to nuclear waste contribute to safer decommissioning practices, accidents will continue to happen. As such, it is important that the IAEA take steps to limit potential accidents throughout the decommissioning process. The IAEA regularly publishes technical documents and provides other resources in order to facilitate the dissemination of as much information as is shared with the agency. However, there is a difference between publishing safety guidelines and finding ways to actually enforce such recommendations. The IAEA exists primarily as an advisory agency which offers guidance and suggestions to member nations. It is incumbent upon individual member states to implement the recommendations of the IAEA at the national level.

[85] "Generation IV Nuclear Reactors." *World Nuclear Association*, World Nuclear Association, Dec. 2020, world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/generation-iv-nuclear-reactors.aspx#:~:text=A%20two%2Dstage%20development%20programme,more%20advanced%20higher%2Dtemperature%20designs.
[86] "Processing of Used Nuclear Fuel." *World Nuclear Association*, Dec. 2020, world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/processing-of-used-nuclear-fuel.aspx.

While the IAEA's guidelines are well-regarded and well-adhered to, several improvements can be made to make the decommissioning process safer.

One of the greatest challenges in the decommissioning process is the safety culture that exists pre- and post-shutdown of a facility. Many workers mistakenly believe that nuclear facilities are safer once nuclear fuel has been removed. Bearing this in mind, some workers may take shortcuts or fail to adhere to all necessary precautions while performing their jobs. Additionally, the added stresses of uncertain future job prospects contribute to decreases in staff morale. Some staff may have worked at the plant that they are now helping to decommission for decades. These two forces pose serious health risks to workers and little international action has been taken to address such concern.[87] In addition, independent contractors may not necessarily adhere to the same safety standards as the staff, also jeopardizing the health of the workers. Even in non-hostile or friendly work environments, some workers may not feel comfortable reporting incidents of co-workers failing to adhere to safety standards. Finding ways for workers to create a culture of safety throughout the decommissioning process, even as contractors and others come and go, is important to increasing the safety of decommissioning efforts. While the IAEA cannot take unilateral action to amend the situation, more work certainly needs to be done in order to increase the occupational safety of workers.

The IAEA must remain vigilant during the planning and operating phases of nuclear reactors as the decisions made during these times can have substantial impact on the decommissioning experience. As evidenced by the Dounreay nuclear reactor case study, poor safety practices during the operation of a nuclear reactor can also negatively impact the decommissioning process. The IAEA publishes numerous documents every year highlighting advances in safe reactor practices; enforcement of these practices is critical to easing the decommissioning process. This committee must find ways to incentivize operating companies and workers themselves to adhere to safe practices, such as reporting incidents and wrongdoings that jeopardize the decommissioning of a facility.

[87] International Atomic Energy Agency, Radiation Safety and Monitoring Section. *International Atomic Energy Agency*, International Atomic Energy Agency, Apr. 2021. www-pub.iaea.org/MTCD/Publications/PDF/TE-1954web.pdf.

The Issue of Funding

Perhaps the greatest challenge that could confront the decommissioning process is the problem of funding. The experiences of reactors such as France's Brennilis reactor demonstrate that even the best of planning could severely underestimate the true cost of decommissioning. Adequate funds must be available for decommissioning so that future generations are not confronted with paying costs on a nuclear plant from which they reaped no benefits. While placing a reactor in SAFSTOR might make economic sense for a given plant, if funds are not available when the time comes to remove a reactor from SAFSTOR, operators and local community members would be effectively stranded.

Currently, most countries force nuclear reactors to operate under the "polluter pays principle" which aims to eliminate financial burdens on future operators by forcing the current operators to finance the cost of decommissioning a plant, even if decommissioning operations won't be happening for several years.[88] While improvements in the estimates of decommissioning would assist operators in planning for decommissioning costs, the greater problem remains preparing for accidents and deviations from plans. Other than accidents, many costs arise from changes in the endgame of a project (i.e., greenfield status, SAFSTOR, etc.), adherence to updated regulatory standards, and storage infrastructure for radioactive materials.[89] By creating better guidelines for decommissioning proposals at the national level, cost estimates can better reflect the true cost of decommissioning a nuclear plant.

[88] Nuclear Energy Agency - Organization for Economic Co-Operation and Development, 2016, *Financing the Decommissioning of Nuclear Facilities*, www.oecd-nea.org/upload/docs/application/pdf/2019-12/7326-fin-decom-nf.pdf.
[89] *Ibid*.

Bloc Positions

The decommissioning process, for the most part, is a largely non-political issue. While politics can—and sometimes does—interfere with the decommissioning process, all countries are committed to safe practices to ensure the health of their citizens. As this guide has demonstrated, there are many problems confronting the broader topic of decommissioning nuclear facilities. At the end of the day, every member state of the IAEA is committed to ensuring the safe decommissioning of their nuclear reactor fleet. Despite artificial differences in approach, every nation's aim is the safety of its citizens, albeit along different avenues.

States with Nuclear Energy

The first bloc of nations are those which currently operate nuclear reactors within their borders. Many of these nations, while active members of the IAEA who abide by its safety standards, do not necessarily need the guidance nor assistance of the IAEA. These member states are usually part of the international conventions outlined in this guide. In addition to signing international conventions, these nations also act in good faith towards other nations that are developing their nuclear energy programs by participating in conferences, submitting National Reports, and offering assistance and services.

While these nations are happy to offer technical assistance to the Emerging Nuclear Energy Countries, they may be more hesitant to support broad-sweeping international mechanisms which would force a dramatic change in the way they currently decommission their nuclear fleets. As these nations have nuclear energy programs which can operate without the oversight of the IAEA, they are less-inclined to see the IAEA take a large role in regulating the decommissioning process. Several of these nations, especially those with older reactors, have an interest in the decommissioning of older reactors. This interest is not necessarily shared by other nations without nuclear energy programs. Ultimately, these nations are keen on keeping the IAEA out of the regulatory frameworks established in their countries but are more than willing to provide technical assistance to the next bloc of countries.

Emerging Nuclear Energy Countries

As of March 2021, 30 countries were considering, planning, or starting nuclear power programs with a further 20 having expressed interest at some point recently.[90] While these nations may be in different stages of the construction of their nuclear power programs and plants, they share similar desires for the IAEA to play a more important role in the development of nuclear energy programs—including decommissioning. In particular, these nations would like the IAEA to be more involved in the review of safety standards at the national level.[91] Safety is critical to the development of a successful, well-supported nuclear energy program at the national level. By stressing the importance of these safety standards, these nations not only protect their citizens, but are attempting to avoid making the mistakes made by the previous bloc of nations. In short, these nations understand the value of information-sharing and have benefitted from the open exchange of information thus far.

Many of the nations in this bloc are driven by the need to meet the growing energy demands of their citizens. Especially for the Asian and African nations which are actively exploring nuclear energy as an option for their energy needs, these nations are in need of assistance with getting their programs started quickly. In addition, these nations may find themselves constrained by the poor geology or a lack of geographic space when it comes time to store nuclear waste. As such, these nations would be very interested in the creation of a multinational or international repository in order to store their nuclear waste. As the storage of waste is often one of the more expensive components of decommissioning a reactor, these nations are interested in finding ways to reduce the cost of operating nuclear facilities.

States with No Current Nuclear Program Plans

This bloc consists of nations with no plans for nuclear programs. While technically unaffected by the regulations surrounding the decommissioning of nuclear reactors, these nations are motivated by their desire to keep their citizens safe. These nations are most concerned with the safe storage of

[90] "Emerging Nuclear Energy Countries." *World Nuclear Association*, World Nuclear Association, Mar. 2021, world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries.aspx. x
[91] International Atomic Energy Agency, 2017, *International Status and Prospects for Nuclear Power 2017*, large.stanford.edu/courses/2018/ph241/holland1/docs/iaea-gc-61-inf-8.pdf.

nuclear waste and safe decommissioning of reactors—without any major accidents whose effects could spill into their country. As such, these nations will generally be pushing for stringent rule-making by the IAEA and want to see legal protections in the event of any potential accidents involving nuclear reactors. However, this bloc of countries is large, and several nations could begin planning to construct in the next several years. Bearing this in mind, some nations in this bloc may be pushing for greater international collaboration in decommissioning reactors as the standards published now could help or hurt future aspirations for nuclear programs.

Glossary

Actinides: The series of elements beginning with actinium and ending with lawrencium that are radioactive; some elements like thorium and uranium are used in nuclear energy.

Gamma Radiation: The radiation emitted when a photon is spontaneously emitted by a radioactive substance.[92]

Greenfield Status: Returning a land that a nuclear plant was once on back to an undeveloped and unpolluted area that can be used in the future.

Half-Life: The time required for half of all the atoms in a radioactive isotope to decay into products.[93]

Isotope: The name of a species of atoms of a chemical element with the same atomic number, but differing atomic mass or mass number, usually with different physical properties.[94]

Radioisotopes: An isotope that is radioactive.

Spent Fuel: Nuclear reactor fuel that can no longer be used to sustain a chain reaction and thus, cannot efficiently produce energy.

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92 "Gamma Ray." *Merriam-Webster Dictionary*, Merriam-Webster Dictionary, www.merriam-webster.com/dictionary/gamma%20ray.

93 "Half-life." *Merriam-Webster Dictionary*, Merriam-Webster Dictionary, www.merriam-webster.com/dictionary/gamma%20ray.

94 "Isotope." *Merriam-Webster Dictionary*, Merriam-Webster Dictionary, www.merriam-webster.com/dictionary/gamma%20ray.

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TOPIC B: ENFORCEMENT OF THE NPT

Statement of the Problem

The detonation of the first and second nuclear bombs over Hiroshima and Nagasaki, respectively, demonstrated humanity's ability to inflict unparalleled destruction. Around the world, people have been forced to reckon with the existence of nuclear weapons which can level cities and kill thousands in an instant. The global community has strived to curb the proliferation of such weapons. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) represents the only binding, multilateral treaty aimed at reducing nuclear arms around the world. The NPT was drafted with three goals, those being: (1) **non-proliferation** of nuclear weapons, (2) **disarmament**, and (3) peaceful use of nuclear energy. To that end, the NPT contains numerous articles enumerating how signatories should work to achieve those goals.

The critical provision of the NPT is its distinction between nuclear and non-nuclear weapon states. The NPT defines nuclear weapon states (NWS) as those which "had manufactured and detonated a nuclear explosive device prior to 1 January 1967."[95] The nations which fit this definition were the P5 nations (China, France, Russia, the United Kingdom, and the United States) of the United Nations Security Council. All other states were to be considered non-nuclear weapon states (NNWS). The NWS were not to transfer any nuclear weapons nor encourage or assist any NNWS in the development, manufacturing, or acquiring of any nuclear weapons. In addition to these provisions, Article VI of the NPT called for all Parties to pursue negotiations, in good faith, for the end of the nuclear arms race and to strive for total nuclear disarmament. Finally, the NPT encourages all states to develop and utilize peaceful uses of nuclear energy.[96]

In order to verify compliance with the mandates of the NPT, the IAEA and signatories are tasked with two different responsibilities. The IAEA is tasked with verifying NNWS adherence to the commitments of the NPT through country-specific negotiations. If an agreement cannot be reached

[95] "Treaty on the Non-Proliferation of Nuclear Weapons (NPT)." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, 30 Apr. 2020, www.nti.org/learn/treaties-and-regimes/treaty-on-the-non-proliferation-of-nuclear-weapons/.
[96] *Ibid*.

between the Signatory and the IAEA, the IAEA Board of Governors is empowered to report non-compliance to the U.N. Security Council and General Assembly. There is no verification process for nuclear disarmament provisions that NWS are committed to upholding. This has been a source of tension among the NPT signatories for a number of years. Finally, States meet every five years in order to review the implementation of the NPT and, since 1995, set a forward-looking agenda.[97]

Over the lifetime of the NPT, the total number of nuclear weapons has decreased a great deal with a current estimate of approximately 13,100 warheads currently in existence. This number is down from the peak of an estimated 70,300 nuclear weapons that were in existence in 1986.[98] Whether analysts attribute this significant reduction to the NPT or not, the NPT has achieved its promise to curb the number of nuclear weapons in existence. However, the pace of reduction has slowed since the 1990s, when disarmament was proceeding fastest. The work of the NPT will not be done until total and sustained nuclear disarmament is a global political norm.

Drafted over 50 years ago, the NPT continues to serve as the cornerstone of the international community's commitment to complete nuclear disarmament. While changes and updates have been made to the NPT, the text of the document has largely remained unchanged for one reason—it continues to remain the best political document aimed at tackling global nuclear disarmament. However, a number of problems, most of them political in nature, threaten the NPT's lofty goal of total nuclear disarmament. What follows is a broad overview of the numerous situations which threaten to destabilize the nuclear weapons regime outlined in the NPT.

Non-Signatory Nations

The NPT has enjoyed such widespread success and praise due to the fact that "[it] has the widest adherence of any arms control agreement."[99] The NPT has achieved near-universal membership as South Sudan, India, Israel, and Pakistan are the only U.N. members who are non-parties to the

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[97] *Ibid*.
[98] Kristensen, Hans M, and Matt Korda. "Status of World Nuclear Forces." *Federation Of American Scientists*, May 2021, fas.org/issues/nuclear-weapons/status-world-nuclear-forces/.
[99] Kimball, Daryl. "The Nuclear Nonproliferation Treaty (NPT) at a Glance." *Arms Control Association*, Mar. 2020, www.armscontrol.org/factsheets/nptfact.

Treaty.[100] In general, it is widely-accepted that India, Israel, and Pakistan have not joined the NPT because they would be required to join as NNWS—despite being known or thought to currently possess nuclear weapons. While India and Pakistan have confirmed, through the testing of their weapons, to have nuclear arsenals, Israel has never commented on the matter. However, Israel is widely believed to possess nuclear weapons.[101] This perception of Israel's possession of nuclear weapons has led to nuclear policy instability in the Middle East—especially with regards to the situation with Iran. South Sudan, on the other hand, is still a young country experiencing significant social and political turmoil. As a result, the nation has not signed the NPT but is perceived to pose no threat to the global nuclear order.

The lack of participation from these three countries on this monumental document, especially those known to have nuclear weapons, is of paramount concern to the other members of the NPT. While the NPT demonstrates the global community's consensus on the status of the international nuclear order, these outliers threaten to destabilize the agreed-upon nuclear regime. As an international regulatory agency, the IAEA cannot commandeer international politics, nor should it try to do so. While a later section will detail the motivations of these three nations' decisions, what is more important to the work of this body is the fact that they have not signed the NPT and the perpetuation of their nuclear arsenals represents a significant threat to international order and stability.

These states' non-adherence to an agreed-upon international regime of nuclear arsenal poses threats to international security. However, there are few substantive actions that can be taken to amend the situation. Since these states are not party to the NPT, they are not bound by its provisions. Instead, India, Pakistan, and Israel have negotiated item-specific agreements with the IAEA on safeguards to ensure nuclear materials, facilities, and other included items are not used for the manufacturing of any nuclear weapons.[102] However these Safeguards Agreements fall short of the Comprehensive Safeguards Agreement (CSA) which are required for the NNWS under the NPT. These CSAs allow states to declare all types and quantities of nuclear material subject to the CSA. In

[100] *Ibid*.
[101] Davenport, Kelsey, et al. "Nuclear Weapons: Who Has What at a Glance." *Arms Control Association*, Arms Control Association, Aug. 2020, www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat.
[102] "Safeguards Agreements." *IAEA*, IAEA, 8 June 2016, www.iaea.org/topics/safeguards-agreements.

turn, the IAEA is allowed to independently verify a state's declaration of nuclear material is correct and factual. Most importantly, the IAEA is compelled to verify that none of the declared nuclear material is being used in the development of nuclear weapons or explosives.[103] The important difference between the Safeguards Agreements signed with the non-NPT nations and the CSAs with NPT nations is the IAEA's ability to verify that declared nuclear material is not being used for nuclear weapons. The Safeguards Agreements only allow whatever material a state chooses to declare, to be subject to the Safeguards Agreement (which can include provisions which allow the IAEA to independently verify the information in the Safeguards Agreement). On the other hand, CSAs require nations to declare all nuclear material and empower the IAEA to conduct inspections and independent verifications. To summarize, the Safeguards Agreements with non-NPT nations do not substantively aim to decrease a state's nuclear capacity, nor do they force a state to engage in active disarmament of nuclear arsenals.

In addition to the three "non-compliant" nations, North Korea's status is also murky. North Korea announced it was withdrawing from the NPT in 2003, effective the day after the announcement. However, this violated Article X of the NPT which requires three months' notice in advance of withdrawing from the Treaty. North Korea argued it had satisfied the requirement, but this claim is disputed. Regardless, subsequent tests from North Korea in the years afterwards indicate that it also has nuclear weapons capabilities.[104] The status of the North Korean nuclear program will be discussed in more detail later, but the international community recognizes that North Korea does have a small nuclear arsenal.

The Situation in the Middle East & South Asia

The situation in the Middle East and South Asia may present the trickiest situation for nuclear disarmament. Rather than providing some gross simplification of the historical factors which have contributed to the current situation, what follows will outline the numerous problematic situations,

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[103] Davenport, Kelsey. "IAEA Safeguards Agreements at a Glance." *Arms Control Association*, Arms Control Association, June 2020, www.armscontrol.org/factsheets/IAEASafeguards.
[104] *Ibid*.

some of which are interconnected, which have posed a myriad of problems to global nuclear disarmament.

As discussed previously, Israel has not signed the NPT and is considered to have nuclear weapons capabilities. It is the only nation in the Middle East which has not signed the NPT. However, Israel's non-accession to the NPT has prompted uncertainty about the region's broad commitment to possessing nuclear weapons. It is critical to note that Israel is not the sole reason for this instability—that would be a gross oversimplification of the political landscape. However, the concept of Israel possessing nuclear weapons has motivated several nations in the region to develop their own nuclear weapons program. This problem is compounded by the fact that Israel has not signed any Safeguards Agreement with the IAEA, signaling an unwillingness to allow international inspection of its nuclear program. As a result of Israel's policy of opacity with regard to matters of nuclear weapons, several other Arab states and Iran have felt threatened by Israel's nuclear weapons.[105]

There have been calls from many sides to create an agreement to declare the Middle East a **Weapons of Mass Destruction Free Zone** (WMDFZ). Since nuclear weapons are considered a weapon of mass destruction (WMD), such an agreement would not only lead to greater regional trust-building, but also temper fears of the future for nuclear proliferation in the region. While the history of the topic will be expanded upon later in this guide, the United Nations Secretary-General held a conference in November of 2019 in order to begin discussions on the matter. The conference invited all states in the Middle East, the P5 nations of the UNSC, the IAEA, among other relevant organizations to participate. However, Israel and the United States announced they would not participate in the conference stating that the conference was nothing more than an opportunity to single out Israel by allowing the 21 nation Arab majority at the conference to dictate the terms of any potential agreements.[106] This view comes from the fact that it was excluded from consultations which resulted in the U.N. General Assembly resolution that created the conference. It seems that Israel will maintain its boycott of the annual November conference on the establishment of a WMDFZ in the Middle East, with its representative stating that "from now on Israel will not

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[105] Vicente, Adérito. "The Imminent Risk of Nuclear Proliferation in the Middle East." *EUIdeas*, European University Institute, 12 Nov. 2019, euideas.eui.eu/2019/11/12/the-imminent-risk-of-nuclear-proliferation-in-the-middle-east/.
[106] Bino, Tomisha. "A Middle Eastern WMD-Free Zone: Are We Any Closer Now?" *Arms Control Association*, Arms Control Association, Sept. 2020, www.armscontrol.org/act/2020-09/features/middle-eastern-wmd-free-zone-we-any-closer-now.

cooperate with regional arms control initiatives."[107] Notably, Iran participated in the conference despite ongoing tension with several Arab states, most noted with Saudi Arabia.

The next, and perhaps most prominent, situation in the Middle East is that with Iran and its nuclear aspirations. Iran has had an extensive history with its nuclear development program, stemming from assistance from the U.S. in the 1950s, before the NPT was signed. In 2015, negotiations between the P5+1 (the +1 refers to Germany) and Iran resulted in the Joint Comprehensive Plan of Action (JCPOA), more colloquially known as the Iran Nuclear Deal.[108] The JCPOA was intended to limit Iran's "**breakout time**" to the development of a nuclear weapon from an estimated few months to a year or more. In order to achieve this goal, the JCPOA limited Iran's ability to enrich uranium by constraining the number of centrifuges Iran in operation and enforcing limits on the amount and type of enriched uranium Iran could possess. Additionally, Iran agreed to unprecedented access to its nuclear facilities and signed an agreement with the IAEA regarding concerns it had regarding other military uses of its nuclear program. The IAEA published quarterly verification and monitoring reports on Iran's progress in the implementation of the JCPOA. However, experts at the Institute for Science and International Security are concerned that the reports are too sparse to properly address international concerns regarding Iran's nuclear program.[109]

Despite strong opposition in the Iranian and U.S. governments, the legislation was ratified by each country's respective legislative bodies and entered into force on January 16, 2016. However, ongoing questions of Iran's "good faith" implementation of the JCPOA, primarily from the United States and Israel, threatened the perpetuity of the deal. On May 8, 2018, President Trump announced the U.S. would withdraw from the JCPOA and reimpose nuclear-related sanctions on Iran—sanctions which the U.S. agreed to lift after the JCPOA was signed. The move, some believe, was informed by a presentation of 100,000 documents seized from "Iran's secret atomic archives" by Israeli intelligence from Israeli Prime Minister Benjamin Netanyahu which showed Iran pursued a nuclear weapons program until it ended in 2003. In response, Iranian President Hassan Rouhani announced he "asked [Iran's] Atomic Energy Organization to prepare the necessary order to start unlimited

[107] *Ibid*.
[108] "Iran." *Nuclear Threat Initiative*, June 2020, www.nti.org/learn/countries/iran/nuclear/.
[109] *Ibid*.

enrichment."[110] While the two subsequent IAEA compliance reports declared Iran was in good standing to its commitment to the IAEA verification and monitoring, once the U.S. re-imposed sanctions Iran began a five phase reduction in compliance with the JCPOA by exceeding limits specified in the JCPOA. While Iran has continued to cooperate with IAEA inspectors in the verification and monitoring of sites specified in the JCPOA, it has refused access to IAEA inspectors to sites associated with the 2018 Israeli presentation.[111] However, the United States and its partners have met with Iranian diplomats several times since June 2021 to discuss a revival of the JCPOA.

The aftermath of the U.S.'s decision to effectively terminate the JCPOA further destabilized the Middle East by reigniting nuclear aspirations in Saudi Arabia. Saudi Arabia was never particularly supportive of the JCPOA because they believed that the "deal does not deal with Iran's ballistic missile program nor does it deal with Iran's support for terrorism."[112] However, statements made in the months leading up to and after the U.S.'s announcement indicated that if Iran developed a nuclear bomb, the Saudi government would quickly follow suit. Many officials suspect that the Pakistani government would quickly supply the Saudi government with warheads if Saudi Arabia were to make a request, especially if Iran were to announce its successful development of a warhead. This is due to the close relationship between the two countries and reports that the Saudi government may have financed as much as 50-60% of Pakistan's nuclear weapons program.[113] The country's decision is also informed by Israel's possession of nuclear weapons. Saudi Arabia does not currently have any capabilities to make nuclear weapons due to the fact it possesses no nuclear power plants nor any facilities which are necessary to enrich uranium. Since the JCPOA's effective termination, Saudi Arabia has aggressively increased its timeline for the acquisition of nuclear energy. Close cooperation with China has made many suspicious of Saudi Arabia's true intentions as its plans would lead to the production of nuclear fuel which could be enriched to weapons-grade level. Additionally, Saudi Arabia may have constructed a facility which could extract uranium yellowcake, a crucial ingredient for both nuclear power and weapons, but Saudi officials deny this.[114]

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[110] *Ibid*.
[111] *Ibid*.
[112] Reif, Kingston. "Saudi Arabia Threatens to Seek Nuclear Weapons." *Arms Control Association*, Arms Control Association, June 2018, www.armscontrol.org/act/2018-06/news/saudi-arabia-threatens-seek-nuclear-weapons.
[113] Urban, Mark. "Saudi Nuclear Weapons 'on Order' from Pakistan." *BBC News*, BBC, 6 Nov. 2013, www.bbc.com/news/world-middle-east-24823846.
[114] Alkhowaiter, Meshal, et al. "Saudi Arabia's Nuclear Program and China." *Middle East Institute*, Middle East Institute, 9 July 2021, www.mei.edu/publications/saudi-arabias-nuclear-program-and-china.

The final cause for concern has been Saudi Arabia's refusal to sign onto IAEA's international standards, a decision which has led to deadlock in negotiations to cooperate with the United States and informed the country's turn towards China, which is more than happy to overlook such rejections of standards which limit the proliferation of nuclear weapons.[115] Saudi Arabia has one of the most limited Safeguards Agreement with the IAEA, again, indicating that the country is attempting to limit international inspection of its peaceful nuclear program, raising concerns of another nuclear state coming into the fold. The development of a nuclear weapon by the Saudi government would obviously contradict its obligations of nonproliferation under the NPT.

The Situation in East Asia

While the situation in East Asia may not have the "domino effect" that the situation in the Middle East experiences, it instead demonstrates a greater threat—discord among the nuclear powers outlined in the NPT. What follows is an overview of the current state of affairs in East Asia, mostly focusing on North Korea and China along with responses from the other NNWS.

As stated previously, the Democratic People's Republic of Korea (DPRK, or North Korea) effectively withdrew from the NPT in January of 2003. Since that time, the country has actively pursued a nuclear weapons program. While the country's nuclear aspirations date back to the Korean War, the nuclear program is presently viewed as essential to the survival of the nation, particularly as a deterrent to a U.S. invasion of the nation. Unlike many other states suspected of developing nuclear weapons, the DPRK has brazenly developed its nuclear weapons program, breaking promises and showcasing its developments at military parades.[116] The country's brazen defiance and unwillingness to compromise on its development of nuclear weapons over the past two decades is what poses the greatest threat to the international nuclear order. Unlike other states, which attempt to conduct their nuclear programs in secret, North Korea is willing to show off its nuclear weapons program and make threats against countries like the United States, Japan, and South Korea. North Korea has

[115] *Ibid*.
[116] Martin, Timothy W. "North Korea's Missiles and Nuclear Weapons: Everything You Need to Know." *The Wall Street Journal*, Dow Jones & Company, 24 June 2021, www.wsj.com/articles/north-koreas-missiles-and-nuclear-weapons-everything-you-need-to-know-11610712018.

conducted six nuclear tests, each with increasing sophistication, since 2006.[117] In response to these tests, the international community has imposed sanctions on North Korea which have not worked to stop the country's nuclear aspirations. While North Korea participated in the Six-Party Talks, the talks fell apart in 2009. Those talks, in addition to North Korea, included China, Japan, Russia, South Korea, and the United States. However, North Korea initiated discussions with several of those countries in 2018 and 2019, but no agreements materialized. In fact, in June of 2021, North Korea's foreign minister made statements entirely dismissing the possibility of talks with the United States.[118] Without the U.S. at the negotiating table, any agreement would have little staying power.

Unlike the previous threats to the NPT, China's modernization and expansion of its nuclear arsenal threaten the nuclear order among the NWS, especially Chinese-American relations. According to the Arms Control Association, China's nuclear arsenal currently consists of approximately 320 total warheads of varying capacities.[119] However, commercial satellite images indicate work is underway near the northwestern city of Yumen for the construction of more than 100 new silos for intercontinental ballistic missiles.[120] These new silos, 119 in all, are identical to China's existing launch facilities for its nuclear-tipped ballistic missiles. While China has deployed decoy silos in the past, growing tension between the U.S. and China has some experts concerned that the two could be heading towards a new nuclear arms race. Others, however, believe China is diversifying its nuclear arsenal in order to maintain a proper nuclear deterrent to potential U.S. nuclear or conventional strikes.[121] While China is likely not trying to match the U.S.'s nuclear arsenal—a tall feat—China's modernization of its nuclear arsenal is likely an attempt to defend itself against advancing U.S. missile defense capabilities. China maintains a "No-First-Use" policy with regards to

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[117] "North Korea." *Nuclear Threat Initiative*, Nuclear Threat Initiative, Oct. 2020, www.nti.org/learn/countries/north-korea/.
[118] Martin, Timothy W. "North Korea's Missiles and Nuclear Weapons: Everything You Need to Know." *The Wall Street Journal*, Dow Jones & Company, 24 June 2021, www.wsj.com/articles/north-koreas-missiles-and-nuclear-weapons-everything-you-need-to-know-11610712018.
[119] Davenport, Kelsey, et al. "Nuclear Weapons: Who Has What at a Glance." *Arms Control Association*, Arms Control Association, Aug. 2020, www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat.
[120] Warrick, Joby. "China Is Building More than 100 New Missile Silos in Its Western Desert, Analysts Say." *The Washington Post*, WP Company, 1 July 2021, www.washingtonpost.com/national-security/china-nuclear-missile-silos/2021/06/30/0fa8debc-d9c2-11eb-bb9e-70fda8c37057_story.html.
[121] Kimball, Daryl. "Engage China on Arms Control? Yes, and Here's How." *Arms Control Today*, Arms Control Association, June 2021, www.armscontrol.org/act/2021-06/focus/engage-china-arms-control-yes-heres-how.

nuclear weapons.[122] This means that the nation will not strike first, but, if attacked, it will use its nuclear arsenal. With its comparatively small nuclear arsenal (at least compared to the U.S. and Russia), China's moves can be seen as nothing more than an increase in security for its nuclear deterrence. China's expansion and modernization, to its government, is nothing more than a way to maintain effective capabilities if it were to be attacked. As will be discussed shortly, China is not the only nuclear power that is modernizing its arsenal—India, Russia, and the United States are also upgrading their systems. Nonetheless, this modernization tacitly demonstrates that the nuclear powers have no intention of curbing their nuclear arsenals any time soon. In fact, the potential expansion of their arsenals only suggests a regression on the provisions of the NPT.

Commitment Issues

As alluded to above, the United States and Russia have regressed on some of their responsibilities as Parties to the NPT. Russia and the United States's nuclear arsenals far outnumber any other state with nuclear capabilities, regardless of the state's accession to the NPT. Combined, the arsenals of the two nations number around 11,800 nuclear warheads and account for more than 90% of the world's total nuclear arsenal.[123] Under the provisions of the NPT, both states are required to make good-faith attempts to fulfill their disarmament obligations; the pace of disarmament has significantly slowed from its rapid pace in the 1990s. While the NPT is partially responsible for the disarmament efforts both countries undertake, bilateral agreements between the two countries have proven more effective in spurring the nations to disarm.

At present, the nuclear relationship between the two nations is almost entirely facilitated through the New START (Strategic Arms Reduction Treaty), which was recently renewed until 2025. While a number of mechanisms encouraged the two powers to faithfully fulfill their disarmament responsibilities, the treaty network which provided this framework is quickly expiring without any replacement.[124] A number of the agreements which the two nations signed during and after the Cold

[122] "How Is China Modernizing Its Nuclear Forces?" *China Power Project*, Center for Strategic and International Studies, 28 Oct. 2020, chinapower.csis.org/china-nuclear-weapons/.
[123] Kristensen, Hans M, and Matt Korda. "Status of World Nuclear Forces." *Federation Of American Scientists*, May 2021, fas.org/issues/nuclear-weapons/status-world-nuclear-forces/.
[124] "Nuclear Arms Control Regime: State of Play and Perspectives." *European Parliament's Subcommittee on Security and Defense*, European Union, 2 Dec. 2020, www.europarl.europa.eu/RegData/etudes/IDAN/2020/603496/EXPO_IDA(2020)603496_EN.pdf.

War have either expired or failed to cover significant new developments in nuclear technology.[125] New START regulates the two nations' **strategic nuclear force** by placing the same limitations on the number and type of nuclear warhead that both nations possess. In order to effectively regulate the other nation, New START establishes a Bilateral Consultative Commission which must meet at least twice a year in Geneva to discuss the implementation of the treaty.[126] At these meetings, the two delegations discuss the implementation of the New START and concerns they may have about the other nation's implementation of the deal. To gather facts which are used during these consultations, both nations are empowered to use technical means (for example, satellite images), on-site inspections, and data exchanges to collect data on the other nation. The treaty also allows each country to conduct 18 on-site inspections of facilities used in the deployment or containing of strategic systems. Additionally, both nations are required to provide 48 hours' notice of every weapon covered by the treaty which is transported from the production facility to a new site.[127] These measures are all intended to promote high levels of transparency between the two nations which helps to build trust and cooperation between the two countries. While the treaty has been successful in limiting the nuclear weapons programs of both countries, recent concerns raised by both parties threaten to destabilize the delicate balance struck between the two powers.

As successful and applauded as the New START is, there are still several outstanding issues which have been brought up and not been addressed. Firstly, the decision to renew New START came without changes to the existing Treaty. This means that the two nations did not reduce the number of strategic and **non-strategic** weapons currently in deployment. In other words, no attempts were made by either party to actually disarm. Furthermore, nearly two-thirds of U.S. and Russian nuclear stockpiles are considered non-strategic and **non-deployed** warheads which are not subject to any restrictions in the New START.[128] While the U.S. has attempted to bring up the inclusion of such components of each nation's nuclear stockpile, Russia has refused to commit to any deal which will

[125] Russell, Martin. "The New START Treaty between the US and Russia." *European Parliament*, European Union, Mar. 2021, www.europarl.europa.eu/RegData/etudes/BRIE/2021/690523/EPRS_BRI(2021)690523_EN.pdf.
[126] "Treaty between The United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START)." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey, 25 Feb. 2021, www.nti.org/learn/treaties-and-regimes/treaty-between-the-united-states-of-america-and-the-russian-federation-on-measures-for-the-further-reduction-and-limitation-of-strategic-offensive-arms/.
[127] *Ibid*.
[128] Russell, Martin. "The New START Treaty between the US and Russia." *European Parliament*, European Union, Mar. 2021, www.europarl.europa.eu/RegData/etudes/BRIE/2021/690523/EPRS_BRI(2021)690523_EN.pdf.

freeze on these types of nuclear weapons. Russia has nearly ten times as many non-strategic warheads than the U.S. which pose threats to neighboring countries. Talks on the reduction of such warheads are likely to remain at an impasse unless both nations can find some way to correspondingly restrict these types of warheads—an unlikely outcome given the importance of similar weapons in U.S. protection measures of its allies. Additionally, large stockpiles of non-deployed warheads in storage units pose the greatest threat if the nations were to find themselves incapable of renewing new arms limitations agreements in the future. Finally advances in nuclear technology mean that both nations have access to technology which is technically not covered under the terms of New START and has only served to further inflame tensions between the two.

History of the Problem

The sections below constitute a brief overview of some of the most important historical factors which contributed to the current state of nuclear weapons diplomacy. While not an exhaustive overview of the history of any of the topics, what follows should be considered a touchstone for further investigation into the factors which have led to the general instability currently seen today. Similar to the previous section, this section attempts to guide readers through the history of nuclear proliferation by bringing in relevant actors as they become important. To that end, this section is not meant to be placed in chronological order, but rather an order that allows subsequent subsection to build off the previous sections. It is more important to see the broad security trends that informed nations as the current situation is built on a foundation of historical distrust between different countries.

The Road to the NPT

The origins of NPT date back to 1963 when the United States and the Soviet Union signed the Limited Test Ban Treaty.129 The leaders of both nations realized that the excessive costs of the development and deployment of an ever-expanding nuclear fleet constituted an increasing drain on the budgets of both nations. Both powers had interests in negotiating agreements that would curtain the pace of the nuclear arms race that had developed and a series of treaties throughout the decade set the framework for multilateral and international treaties down the line. Towards the end of the decade, it became clear that nuclear weapons knowledge was widespread, and many nations had the technical ability to build and test a nuclear bomb. The nuclear powers at the time (China, France, Russia, the United Kingdom, and the United States), especially the Cold War superpowers (Russia and the United States), realized the dangers of more countries producing nuclear weapons. If these countries could not be trusted to responsibly use their nuclear arms as deterrents, the repercussions could result in mutually assured destruction. As such, the nuclear powers agreed that a nuclear nonproliferation treaty was essential to maintaining global security.

[129] "The Nuclear Non-Proliferation Treaty (NPT), 1968." *Office of the Historian*, U.S. Department of State, history.state.gov/milestones/1961-1968/npt.

In a meeting of the General Assembly in 1961, Ireland proposed a ban on the distribution of nuclear technology. While the resolution was approved, it wasn't until 1965 that negotiations began for a nonproliferation treaty. The most difficult part of the negotiations was maintaining the nuclear weapons of the nuclear powers, while asking non-nuclear nations not to pursue the bomb. Essentially, the nations with developed nuclear programs were being asked to abandon all future intentions of attempting to develop the nuclear bomb. Eventually the nuclear nations were able to make enough concessions to induce as many non-nuclear states to sign. As evidenced by the non-signatory status of several nuclear weapons states, the treaty was not able to achieve universal support. At the time, however, the final terms of the NPT seemed to be the best compromise that would receive the most widespread support.[130]

Non-Signatory Nuclear Weapons States

India

India's nuclear weapons program was only conceived by the nation's first Prime Minister in order to provide a cheap and self-reliant energy source while also boosting the country's prestige to other powers. The nation decided to develop the **complete nuclear fuel cycle** for its energy program, potentially giving it the technical capability to pursue nuclear weapons. Generally, scientists wanted to prove India's technical capabilities while security officials believed conflict with China necessitated the development of a nuclear deterrent. However, politicians were morally and economically opposed to the development of the bomb, arguing the bomb would only put a greater target on India. They reasoned that global nuclear disarmament was the best solution to India's nuclear question. Theoretical development of the bomb was authorized and culminated in a "peaceful nuclear explosion" in 1974.[131] The test was condemned globally and contributed to the formation of the Nuclear Suppliers Group, a group of nations which agreed to supply nuclear materials provided that they could verify that the intention of such supplies was to be used for peaceful purposes. India, for its part, did not weaponize the fission device until the late 1980s due to two factors: (1) international backlash and (2) nuclear threats from Pakistan in response to the Brasstacks crisis.

[130] *Ibid*.
[131] "India." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Nov. 2019, www.nti.org/learn/countries/india/nuclear/.

Work on the bomb continued throughout the 1990s while negotiations for the Comprehensive Test Ban Treaty (CTBT) was being debated. India regarded the CTBT as an attempt to freeze countries' nuclear capabilities—an unacceptable term for the country and its growing arms race with Pakistan. Coupled with the indefinite extension of the NPT, the government accelerated work on the bomb and resulted in two tests on May 11 and May 13, 1998.[132] These tests, which blind-sided the international community, officially declared India to be a nuclear-weapon state—and one unbound by any international nonproliferation agreement.

The immediate reaction to India's nuclear tests were quite negative, but as a result of a changing political landscape, the country's development of its nuclear program yielded the country rewards in strange ways. While the domestic reactions to the successful testing of the bomb were overwhelmingly positive, India's test received widespread criticism with countries such as the United States and Japan imposing varying degrees of sanctions on the nation.[133] Most importantly, the tests led to Pakistan also testing its nuclear capabilities and beginning an arms race between the two nations. Driven by changing U.S. security prerogatives, the U.S. effectively spearheaded a tacit acceptance and integration of India into the nuclear power order despite the fact that India had circumvented international consensus in the NPT. A 2005 agreement between the U.S. and the Indian governments saw the Nuclear Suppliers Group endorse India and allow it to engage in international nuclear trade in exchange for inspections at all "civilian" classified nuclear facilities.[134] Additionally, India was able to conclude a Safeguards Agreement for some of India's civilian nuclear facilities in 2009. This agreement essentially sent a message to the international community that India would continue to remain a nuclear power for the foreseeable future.

Pakistan

Pakistan's nuclear weapons program is largely, if not entirely, built in order to deter its long-time adversary, India. The two countries are openly hostile towards one another and have engaged in several conflicts, many of those over the contested region of Jammu and Kashmir. The Pakistan

[132] *Ibid*.
[133] "India Detonates Two More Bombs." *BBC News*, BBC, 31 May 1998, news.bbc.co.uk/2/hi/special_report/1998/05/98/india_nuclear_testing/93111.stm.
[134] "India." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Nov. 2019, www.nti.org/learn/countries/india/nuclear/.

Atomic Energy Commission was founded in 1956.[135] In the aftermath of a 1971 conflict with India, Pakistan's President issued a directive to the PAEC to construct a nuclear weapon within three years. India's successful testing of its fission device in 1974 further motivated the country's leaders to fast-track the development of a robust nuclear weapons program. **Export controls** introduced in the wake of India's 1974 test inhibited Pakistan's development of nuclear weapons. In order to circumvent these export controls, Pakistan resorted to buying individual components to build the necessary technology needed to enrich uranium.[136] Additionally, China began assisting Pakistan in the late 1970s by providing designs, equipment, and missile system components. It is unclear when Pakistan successfully developed its nuclear weapon, but Pakistan began transferring nuclear technology and technical expertise to Iran, Libya, and North Korea in the 1980s.[137]

After India's tests in 1998, Pakistan's Prime Minister authorized tests of its nuclear weapons on May 28 and May 30 of the same year. By testing its weapons, Pakistan's ambiguity on the status of its nuclear program was officially answered. Pakistani leaders declared that its program was intended to serve as a "credible minimum deterrent" against India. Unlike India, which officially maintains a "no-first-use" policy, Pakistan never formally declared a nuclear doctrine. However, a 2002 speech from President Pervez Musharraf stated that "nuclear weapons are aimed solely at India," and used only if "the very existence of Pakistan as a state was at stake."[138]

Since then, Pakistan's nuclear weapons have been the subject of international concern in the case of a terrorist group taking control of Pakistani nuclear weapons facilities. Indeed, small-scale attacks on the Minhas Air Force Base from 2007-2009 were particularly worrying despite Pakistani officials' repeated denial of any nuclear weapons being stored there.[139] Cooperation between the U.S. and India in 2008 led to increased cooperation with China on Pakistan's civilian nuclear operations. The U.S. voiced serious concerns over deals which saw China supply Pakistan with nuclear reactors on the basis that China was violating commitments as a member of the Nuclear Suppliers Group (NSG). China retorted that the reactor transfer was based on a contract that had been negotiated prior to

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135 "Pakistan." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Nov. 2019, www.nti.org/learn/countries/pakistan/nuclear/.
136 *Ibid*.
137 *Ibid*.
138 *Ibid*.
139 *Ibid*.

China's joining of the NSP, meaning that it had been grandfathered in when China joined the NSG. The situation with Pakistan and India demonstrates the polarizing trends in nuclear weapons policy as the NWS of the NPT choose which states to support. It also demonstrates some instances of hypocrisy by several NWS in order to achieve their own policy objectives despite their commitments to nonproliferation as outlined in the NPT.

Israel

Israel's nuclear aspirations date back to the state's inception. Informed by the horrors of the Holocaust and surrounded by hostile neighbors, Israel's first Prime Minister commenced the nation's nuclear program in the late 1950s with establishment of special relations with France. France, once a leading country in nuclear physics, found itself far behind in the field after World War II. French scientists and policy-makers decided that close cooperation with Israel, at a similar level of expertise in the post-war world, would be most beneficial to the development of a nuclear weapon. The respective nuclear agencies remained closely linked throughout the 1950s. Cooperation greatly increased in the wake of the Suez Canal Crisis of 1956 due to France's embarrassment for not assisting the Israelis more than they did during the crisis.[140] This resulted in French construction of a new reactor complex at Dimona which was capable of large-scale plutonium production and reprocessing. While the U.S. found the facility two years later, the Israeli government relied on deception and delay tactics in order to keep the Americans at bay. Cooperation with the French waned in the early 1960s and the Israelis continued the project without much assistance from the French. Leading up to the 1967 Six-Day War, Israel reportedly constructed a number of nuclear devices, although this claim has never been verified. However, Israel had a sophisticated arsenal of nuclear weapons prior to the 1973 Yom Kippur War.[141]

While the United States was initially opposed to Israel's possession of nuclear weapons technology, the two nations reached an agreement in 1969 which saw the U.S. accept "nuclear facts on the ground" in Israel, while Israel agreed to remain opaque in its nuclear status by not testing or declaring itself a nuclear-weapon state. At the time, the U.S. and Israel shared the same view that

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[140] Farr, Warner D. "The Third Temple's Holy of Holies: Israel's Nuclear Weapons." *Federation of American Scientists*, USAF Counterproliferation Center, Sept. 1999, fas.org/nuke/guide/israel/nuke/farr.htm.
[141] *Ibid*.

nuclear weapons were essential to their own nation's security, but dangerous if acquired by their enemies. This agreement, which still stands to this day, led to greater cooperation between the two on nuclear matters. While the U.S. has feigned interest in getting Israel to sign onto some nonproliferation agreements, Israel has never seriously considered any proposals as they view them as a "slippery slope" towards disarmament. This policy has been one of the largest roadblocks to relative stability in the Middle East—or at least the perceived stability from the signing of a WMDFZ in the Middle East.[142]

History of Non-Compliance Issues

Iraq

Iraq's nuclear activities, like Iran, India, Israel and Pakistan, have their origin linked to the U.S. Atoms for Peace program. While the U.S. program was used to disseminate nuclear technology to other nations in the world. Unlike the aforementioned nations, which diverted U.S. assistance to military uses, Iraq's cooperation with the U.S. was entirely peaceful. It was not until the 1970s that Iraq launched its nuclear weapons program, after Iraq had signed the NPT in 1968.[143] The Iraqi policy towards nuclear weapons procurement during the 1970s consisted of "openly acquiring a latent capability to produce and recover plutonium for weapons."[144] To that end, Iraq purchased several research reactors and other facilities from France and Italy which were almost entirely under IAEA inspector supervision. When Israel bombed of one of Iraq's nuclear facilities in 1981 over concerns of Iraq's rapidly advancing knowledge, Iraq shifted to a covert development of uranium enrichment at facilities which were not declared to the IAEA.

Throughout the 1980s, Iraq pursued nuclear weapons capabilities covertly and had made significant headway by the end of the decade. However, the prospect of a U.S.-led intervention in response to Iraq's invasion of Kuwait forced Iraq to change its approach to more quickly, but less discreetly,

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[142] Miller, Marvin, and Lawrence Schienman. "Israel, India, and Pakistan: Engaging the Non-NPT States in the Nonproliferation Regime." *Arms Control Today*, Arms Control Association, www.armscontrol.org/act/2003-12/features/israel-india-pakistan-engaging-non-npt-states-nonproliferation-regime.
[143] "Iraq." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Jul. 2015, www.nti.org/learn/countries/iraq/nuclear/.
[144] *Ibid*.

acquire nuclear capabilities. In fact, had coalition bombing during the Gulf War not unknowingly destroyed several critical facilities for this process, it was estimated that Iraq would have been able to manufacture a single low-yield nuclear device. The conclusion of the Gulf War in 1991 saw UNSC Resolution 687 direct the IAEA to find and dismantle Iraq's nuclear weapons program. The inspection campaign which ran throughout the 1990s revealed Iraq's nuclear program was much further along than many policy experts believed which reinforced the UNSC's decision to ensure future Iraqi compliance through a more stringent and comprehensive monitoring and verification process.

In October of 1998, President Saddam Hussein announced that he would end all cooperation with U.N. inspectors. In response, the U.N. Special Commission (UNSCOM) issued a scathing report to the UNSC detailing Iraq's effort to obstruct the commission's work. The report became the basis of the U.S. and U.K.'s bombing campaign known as Operation Desert Fox in December 1998, which resulted in IAEA and U.N. inspectors withdrawing from Iraq. After four years and U.S. threats to invade over claims of weapons mass destruction, Iraq allowed IAEA inspectors to restart verification and inspection activities. While there may have been some small, independent attempts at constructing nuclear weapons, the post-Saddam Iraqi government took several important steps to demonstrate its commitment to nonproliferation.[145]

<u>Democratic People's Republic of Korea</u>

North Korea began its nuclear program in the early 1950s with close collaboration with the Soviet Union. While the country received early assistance from the Soviet Union, North Korea's nuclear program was largely homegrown and did not rely on much foreign assistance until the late 1970s. It was then that North Korea acquired plutonium reprocessing technology, critical for nuclear weapons development, from the Soviet Union. However, North Korea signed a Safeguards Agreement with the IAEA and the USSR in 1977 despite not having signed the NPT. It wasn't until 1985 that North Korea would sign the NPT as a NNWS. Even in the 1980s, North Korea's development of nuclear technology was mostly indigenous (meaning the knowledge came from scientists in North Korea). In September 1991, the United States announced it would withdraw its nuclear weapons from South Korea in order for North and South Korea to sign the Joint Declaration on the Denuclearization of

[145] *Ibid*.

the Korean Peninsula.[146] The agreement saw the two nations promise to "not test, manufacture, produce, receive, possess, store, deploy or use nuclear weapons" by forgoing the possession of "nuclear reprocessing and uranium enrichment facilities."[147] While the agreement created an inspections regime, the two countries could not agree on how to implement it.

The rest of the 1990s, however, was characterized by rising suspicions of the nuclear program in North Korea. Questions about the peaceful nature of the country's nuclear weapons program were raised when IAEA analysis indicated that North Korean technicians had reprocessed plutonium in 1989, 1990, and 1991. When the IAEA requested access to two nuclear waste sites, North Korea declared the sites to be military sites and consequently off-limits.[148] After the denial of access, the IAEA requested the UNSC authorize special ad hoc inspections. Following this, North Korea announced its intention to withdraw from the NPT. This prompted the beginning of long, tense negotiations between the U.S. and North Korea over the nation returning to the NPT. North Korean technicians continued to operate reactors under question. The continued operation of these reactors worsened the deteriorating situation when technicians began removing the spent fuel rods without IAEA inspector supervision, compromising the IAEA's ability to reconstruct the operational history of the reactor—needed to accurately account for North Korea's plutonium reprocessing discrepancies. The threat of economic sanctions for this action were put to rest when former U.S. President Jimmy Carter helped formalize the Agreed Framework whose provisions included, among other things, that the IAEA would monitor North Korea's freezing of certain reactors and facilities which were suspected of being used in the uranium enrichment process. Neither party was particularly enthusiastic about the deal. Coupled with the discovery that Pakistan had transferred technology and/or materials necessary for nuclear weapons in 2002, the two nations came back to continue negotiations. Negotiations quickly fell apart and the U.S. announced it was suspending heavy oil shipments, a part of their commitments in the Agreed Framework, to which North Korea responded by expelling IAEA inspectors and announcing its withdrawal from the NPT.

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146 "North Korea." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Oct. 2018, www.nti.org/learn/countries/north-korea/nuclear/.
147 *Ibid*.
148 *Ibid*.

Iran

Iran's nuclear program in the 1950s and was another beneficiary of the United States' *Atoms for Peace* program which saw the U.S. help jumpstart Iran's nuclear program at the time. In 1973, the Shah unveiled ambitious plans for nuclear power levels in Iran by the end of the century.[149] In the years following this announcement, Iran had made significant investments in education and training for personnel. When the 1979 revolution arrived, Iran had made significant developments in nuclear technologies. However, the exodus of much of the country's nuclear talent after the Revolution resulted in the program nearly falling apart.

Interest in nuclear technology acquisition renewed following the conclusion of the costly war with Iraq in the late 1980s and early 1990s. Cooperation agreements with Pakistan, China, and Russia throughout that time period help quickly restart the country's nuclear program. U.S. intelligence agencies began closely monitoring Iran over suspicions that it was hiding a clandestine weapons program under the guise of a civilian nuclear program. The U.S. government actively pressured potential suppliers to limit nuclear cooperation agreements with Iran, which resulted in China and Argentina suspending deals with Iran. Additionally, the U.S. caught wind of secret negotiations between Iran and Russia, where Russia offered to secretly supply Iran with a large research facility.[150] While U.S. pressure forced Russia to scale down nuclear cooperation between the two countries, American officials strongly believed that individual scientists within both governments were under direction to assist each other.

International concerns about Iran's nuclear program manifested when several undeclared nuclear facilities were detected in 2002. Iran allowed the IAEA to conduct a number of inspections and the IAEA Board of Governors noted with concern Iran's previous efforts to conceal its nuclear program. Iran entered into negotiations with France, Germany, and the United Kingdom (EU-3) in order to avoid referral to the UNSC. While the four nations were able to come to an agreement, Iran exploited ambiguities in the agreement's definition of "suspension" of conversion and enrichment activities.[151]

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[149] "Iran." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Jun. 2020, www.nti.org/learn/countries/iran/nuclear/.
[150] *Ibid*.
[151] *Ibid*

However, the CIA received thousands of pages of information detailing Iran's continued progress on its nuclear progress which Iran claimed was a "forgery." Negotiations for a long-term agreement quickly fell apart as Iran signaled its intention to resume uranium conversion and enrichment activities and proved unresponsive to the IAEA and UNSC's demands for the suspension of enrichment activities. While the P5+1 began negotiating with Iran to halt its nuclear energy program throughout the rest of the 2000s, no substantial progress was made as Iran defied agreements and negotiation promises. The international community increased sanctions they had begun in 2005 via UNSC resolutions aimed at harming Iran's nuclear-related investments. While other countries, notably Turkey and Brazil, tried to assist when negotiations stalled, no agreement could be reached.

Libya

When Libya signed the NPT in 1968, it had little ambition for acquiring nuclear weapons. However, the 1969 coup which put Muammar Gaddafi into power until 2011 brought the idea of a nuclear weapons program into the Libyan government. As a consequence of the low level of development in the field, Libya's efforts were focused on foreign suppliers and throughout the 1970s, Libya looked to China, India and Pakistan, unsuccessfully, to purchase nuclear weapons. During this time, Libya covertly operated facilities with enrichment technology that would have enabled it to produce weapons-grade uranium which was in violation of the NPT and IAEA safeguards. Additionally, Libya intentionally under-reported the amount of uranium ore concentrate it was importing from French-controlled mines in Niger throughout the late 1970s.[152]

The 1980s saw Libya continue much of its covert operations. Libya again experienced several failed attempts to purchase nuclear facilities necessary for the creation of a nuclear bomb. Much of these failed negotiations were a consequence of U.S. pressure on national governments and private entities to suspend contracts and negotiations before signing. However, one success did come in 1984 when the country reached an agreement, without supervision or authorization by the IAEA, with an undisclosed "nuclear weapon state." The agreement, exposed in 2004, saw Libya export several kilograms of **uranium ore concentrate** for processing in this undisclosed NWS in exchange

[152] "Libya." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies, Jan. 2015, www.nti.org/learn/countries/libya/nuclear/.

for receiving a variety of other compounds back. The 2004 IAEA report on the matter never states the name of the undisclosed NWS.[153] Sanctions, imposed for unrelated reasons, in the late 1980s severely hampered Libya's nuclear program in the latter half of the decade and the beginning of the 1990s. In the wake of the collapse of the Soviet Union, Libya tried to, largely unsuccessfully, recruit Soviet nuclear scientists to their nuclear program. However, Libya was successful in joining a growing network of secret proliferation, organized by the chief architect of the Pakistan nuclear weapons program, Dr. A.Q. Khan. Libya joined the network of nations, which included Iran and North Korea, in 1997 and accelerated its nuclear activities heading into the 21st century. Libya continued to publicly support the nuclear nonproliferation regime, but it made statements which raised suspicions of its desire for nuclear weapons aspirations.

By 2000, Libya began informing the IAEA of its purchases of various equipment in order to install a centrifuge plant for uranium enrichment. In 2003, however, U.S. intelligence agencies discovered that Libya was participating in the group of countries that were receiving assistance from Dr. A. Q. Khan, included a blueprint for a fission weapon. Hoping to avoid a fate similar to that of Iraq, Gaddafi began making amends with the U.S., including promising to dismantle its nuclear weapons program. The aforementioned 2004 IAEA report on the matter noted that Libya had acknowledged receiving documentation related to nuclear weapons design in late 2001 or early 2002. The designs were sent from Pakistan but were based on a 1960s Chinese design that China had shared with Pakistan.[154] Libya then told IAEA investigators that it did not have any personnel competent to interpret the designs they were sent. Libya is still subject to IAEA inspections, but has made several steps to amend for past actions.

[153] *Ibid*.
[154] *Ibid*.

Past Actions

Argentina-Brazil and the Latin American Nuclear-Weapon-Free Zone Agreement

While not technically a result of the NPT, the relationship between Argentina and Brazil's nuclear policies has demonstrated the good that can come about from the global nonproliferation regime. Without going into too much unnecessary detail, the two nations had been historic rivals since they had gained independence in the early 1800s. This rivalry characterized much of the two nations' interactions with each other and fueled a nuclear technology and development race between the two nations in the 1950s. It should be noted that this race was fueled primarily by each nation's desire to keep up with the other, not necessarily national security concerns. However, there was still a sense of mutual mistrust between the two nations.[155] For instance, neither country had fully committed to the provision in the Treaty of Tlatelolco (the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean) while Brazil had not signed the most important component and expressed major reservations. Nonetheless, the IAEA was concerned that the two nations would try to develop nuclear weapons. While Brazil signed the NPT in 1968, Argentina did not sign the treaty until 1995. Bearing this in mind, tension between the two nations reached a climax in the 1970s over a dispute on the waters of the Parana River.

However unlikely as it may have been, the two countries signed the "Agreement on Cooperation for the Development and Application of the Peaceful Uses of Nuclear Energy" in 1980—the first step taken to restrain competition between the two countries. This step towards a peaceful resolution to this development race slowed as civilian governments overthrew military juntas in both countries in 1983 and 1985. The two countries conducted a series of meetings and agreements which made cooperation on a number of issues between the two countries significantly easier. In particular, the two countries worked closely to negotiate an extensive nuclear cooperation agreement which culminated in the 1990 Joint Declaration on Nuclear Policy. This agreement created a Common System of Accounting and Control through which the two nations would negotiate Safeguards Agreements with the IAEA. It also created the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and gave a timeline for both nations to fully sign the Treaty of

[155] Goldemberg, José, et al. "The Denuclearization of Brazil and Argentina." *Journal for Peace and Nuclear Disarmament*, vol. 1, no. 2, 23 May 2018, pp. 383–403., doi:10.1080/25751654.2018.1479129.

Tlatelolco.[156] The two nations signed the treaty after proposing several changes to improve the verification process while placing some limitations in order to maintain industry secrets during the verification process. These changes were made with the unanimous consent of all other Parties.

The situation with Argentina and Brazil demonstrates the ability of states to come together and join the nuclear nonproliferation regime and teaches several important lessons. While the two nations shared a set of unique circumstances which allowed for the two to come together and cooperate on nuclear matters, the role of the international community cannot be understated. Negotiations from 1985 to 1989, while applauded by the international community, were believed to be a ruse for the two nations to distract the international community from the non-peaceful intentions of their respective nuclear programs. However, the goal of the two nations during this time was to promote reciprocal trust. The text of every bilateral agreement between the two included language like "trustworthiness" and "confidence" rather than words like "inspection"—a clear demonstration of the two nations' intentions to build bilateral trust. The moves in the 1990s came after that trust had been built and was aimed at satisfying the international community with concrete actions to join the international nonproliferation regime. The experiences of these two nations demonstrates the importance of trust-building mechanisms in ensuring the preservation of the nonproliferation regime.

Nuclear-Weapon-Free Zones

The idea of Nuclear-Weapon-Free Zones (NWFZ) has its origins in the earliest days of the Cold War when Poland proposed the Rapacki Plan in the 1950s. The idea behind such a proposal was to offer a regional approach to strengthening the global nuclear non-proliferation regime since, at the time of the proposal, no nuclear nonproliferation treaty existed.[157] While the proposal ultimately fell to the wayside as tension between the Soviet Union and the United States continued brewing, the Rapacki Plan served as a model for future NWFZs. When the NPT was signed, it affirmed the right of countries to create NWFZs; but still allowed for the development of nuclear technologies for

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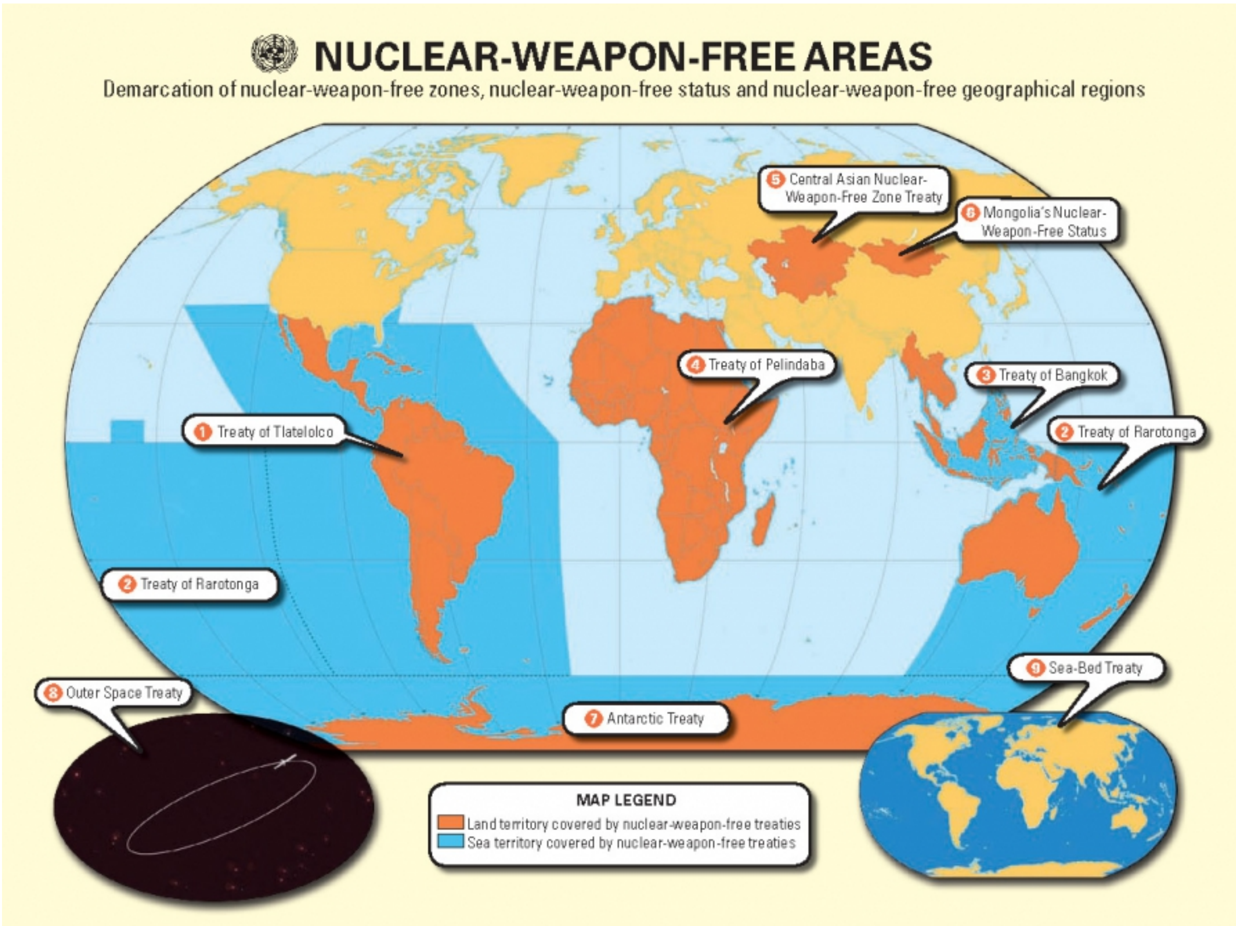
[156] Carasales, Julio C. "The Argentine-Brazilian Nuclear Rapprochment." *The Nonproliferation Review*, vol. 2, no. 3, 1995, pp. 39–48., doi:10.1080/10736709508436591.
[157] "Nuclear-Weapon-Free Zones." *United Nations Office for Disarmament Affairs (UNODA)*, United Nations, www.un.org/disarmament/wmd/nuclear/nwfz/.

peaceful purposes. Five treaties and one U.N. resolution have created six NWFZs around the world. In addition, other international treaties have designated the Antarctic, Moon, outer space, and seabed as NWFZs. In the graphic below, countries in orange are considered a part of a NWFZs.



There are several important components to a Nuclear-Weapons-Free Zone treaty which will now be discussed. The treaties remain in effect indefinitely, but all provide a withdrawal option, similar to the NPT, in which a state must notify the other Parties well in advance of withdrawal (usually twelve months). All states that are party to a NWFZ treaty also agree to undergo comprehensive verification procedures through the IAEA in order to ensure compliance. In addition to the land area of a nation that is party to a NWFZ, the treaties also cover territorial waters. However, this has been put under contention by several nuclear powers. For instance, the United Kingdom and United States dispute the inclusion of the Chagos Archipelago in the African NWFZ as it contains a U.S. military base.[158] Additionally, all the nuclear states contest the Latin American treaty, which extends

[158] Davenport, Kelsey. "Nuclear-Weapon-Free Zones (NWFZ) At a Glance." *Arms Control Association*, Arms Control Association, July 2017, www.armscontrol.org/factsheets/nwfz.

hundreds of miles from the coastline of the territory into the Pacific and Atlantic Oceans, citing their freedom at sea. The final provision that is included in a NWFZ agreement is a protocol for nuclear weapon states (nuclear weapon states as defined in the NPT). These protocols, which are legally binding, compel the NWS to respect the treaty and agree not to threaten the use of nuclear weapons against states which are party to the agreement. Threats to use nuclear weapons are often referred to as negative security assurances. However, the nuclear powers have declared conditions in which they reserve the right to use nuclear weapons. Usually, these declarations are vague, and the nation claims they reserve the right to respond with all options to a chemical or biological attack, implying nuclear retaliation. In addition to the problems this can cause, no NWS has ratified the treaty which created a zone in Southeast Asia due to concerns that it would conflict with the right of ships and aircraft to potentially carry nuclear materials in international waters and airspace.[159] Nonetheless, these reservations demonstrate that these proposals are still highly contentious, despite almost every nations' commitment to disarmament and nonproliferation.

Program 93+2

Building on the experiences with Iraq, North Korea, and South Africa, the IAEA Board of Governors requested that the Standing Advisory Group on Safeguards (SAGSI) improve the verification process to ensure compliance with the NPT. This request was submitted in 1993 and the Board of Governors intended to have a plan of action in place by the 1995 NPT Review Conference.[160] The name "Program 93+2" is derived from this timescale. As discussed previously, the IAEA had discovered discrepancies and noncompliance issues in the early 1990s in both Iraq and North Korea. The experiences with both countries "highlighted the need to develop the IAEA's tools to detect non-compliance."[161] The IAEA realized that verification of nuclear weapons and related activities was incredibly difficult. Particularly in Iraq, where the IAEA had UNSC mandates and a ceasefire (conditions which should have made verification relatively straightforward and easy), the IAEA had a difficult time ensuring that it had properly and sufficiently dismantled Iraq's nuclear weapons program. By contrast, South Africa's voluntary transparency regarding the dismantling of its

[159] *Ibid*.
[160] Moyland, Suzanna van. "Verification Matters: The IAEA's Programme '93+2'." *VERTIC*, Jan. 1997, www.vertic.org/media/Archived_Publications/Matters/Verification_Matters_No10.pdf.
[161] *Ibid*.

program prior to ascension to the NPT provided valuable insight that would be carried over into the verification process for ex-Soviet states.

When the IAEA finally announced the measures that would constitute Program 93+2, it was met with heavy political and technical objections. For one, the proposed measures still needed the details to be written up; this meant the IAEA was asking State Parties to agree to increases in the IAEA's verification regime without actually knowing what those increases in the verification process would actually entail. Many states opposed this blanket approval over fears of the unintentional sharing of nuclear information which could, among other things, affect commercial competitiveness on the global nuclear market. In order to overcome these obstacles, the Board of Governors divided Program 93+2 into two parts. Part I essentially redefined the IAEA's authority on full-scope safeguards agreements with every State in order to accelerate future detections of unreported activities. Part II, however, departed from the IAEA's more traditional nuclear material accountancy regime and expanded the scope of what the IAEA could inspect. In addition, it gave the IAEA greater access for inspectors. While almost all State Parties were in favor of these proposals, the actual implementation of Program 93+2, especially Part II, only served to spark debate on the scope of Program 93+2. Many non-nuclear weapons states (NNWS) objected to how much information the IAEA wanted to collect through Part II. Part II expanded the information that the IAEA wanted to collect to include all information on all nuclear fuel cycle R&D (research & development), the manufacturing of specific items, and import and export information. States feared that, for example, the sharing of private research could not only divulge important nuclear developments a country was hoping to market, but also become a loophole for States trying to hide clandestine activities. While States supported the IAEA's attempts to improve information sharing, the IAEA was able to push the improvements of the IAEA verification program with significant pushback.

Perhaps the most contentious paradigm shift that came from Program 93+2 was its stance on third-party information. In 1992, 1 year before Program 93+2 was put into place, the Board of Governors released a statement acknowledging that the IAEA would use all available sources of information for its verification activities. This included State intelligence agencies which had begun supplying the IAEA with information on North Korea and Iraq in the preceding years. Many States objected to this position because they reasoned that third-party information could be unreliable, biased, and/or mischievous, especially if it came from intelligence agencies. The IAEA countered that the information provided by third-parties, even if they were intelligence agencies, only served to increase the veracity of each states' claims. By relying on outside sources, the IAEA became less dependent on trusting every nation to be honest, opting for information which could be contradicted and independently interpreted. While nothing could be done to change the IAEA's position on the matter, many States continue to object to the IAEA decision to include third-party information. This debate has continued in IAEA treaties to the present.

Humanitarian Initiative & Treaty on the Prohibition of Nuclear Weapons

As a consequence of the lack of intent to disarm, many nations have begun taking a more radical approach to the nuclear weapons problem by calling for the outright prohibition of nuclear weapons. These nations have formed the Humanitarian Initiative and consist entirely of states which are considered NNWS by the NPT. The group, depending on which pledge or statement one looks at for signatories, consists of between 100-150 nations which are dissatisfied with the current pace of nuclear disarmament. The group frames the question of the proliferation of nuclear weapons as a threat to human security rather than state security. In the lead-up to the 2015 NPT Review Conference, the Austrian government issued the Austrian Pledge which called for the total prohibition and elimination of all nuclear weapons "in light of their unacceptable humanitarian consequences and associated risks"[162] and received the endorsement of 66 countries. During the Review Conference an additional 41 states endorsed the Pledge due to perceived intransigence of nuclear weapons states throughout the proceedings of the Review Conference. The unraveling of several other bilateral nuclear arms limitations' agreements, particularly between the United States and Russia also helped inform many nations' decisions. Following this event, 124 nations entered negotiations on a treaty which would prohibit nuclear weapons—all nuclear weapon states boycotted the negotiations. This meeting resulted in the Treaty on the Prohibition of Nuclear Weapons which opened for signature in September 2017 and entered into force on January 22, 2021. All the current signatories of the treaty are NNWS, and no NWS has signaled any intention of signing the Treaty. The NWS went so far as to boycott the open-ended working group which presented the

[162] Linhart, Michael. "Vienna Conference on the Humanitarian Impact of Nuclear Weapons." Pledge presented at the Vienna Conference on the Humanitarian Impact of Nuclear Weapons.

final report to call for the U.N. General Assembly to prohibit nuclear weapons in 2017. In addition to receiving no support from the nuclear weapons state, many of the NWS' military allies, including most NATO countries, have not signed the Treaty on the Prohibition of Nuclear Weapons.

Possible Solutions

Fissile Material (Cutoff) Treaty

The continued production of fissile material—the key component to producing a nuclear weapon—has been a significant issue facing the NPT. One solution which has been proposed and is currently being debated at the UN Conference on Disarmament (CD), is a Fissile Material (Cut-Off) Treaty. Such a treaty would prohibit the future production of highly-enriched uranium (HEU) and plutonium, two important components of nuclear weapons. France, Russia, the United Kingdom, and the United States have all declared that they have halted production of fissile material for nuclear weapons while China is widely believed to have ceased production.[163] While this would seemingly lay the groundwork for a treaty to be quickly negotiated, there are several important considerations which have slowed progress on such a treaty.

The two issues which primarily stall progress on negotiations of a treaty on fissile material: verification and pre-existing stocks.[164] The issue of pre-existing stocks comes down to whether or not the treaty should only limit future production or also include fissile materials which have already been produced and stockpiled.[165] While nuclear weapons states tend to favor the former, many non-nuclear weapons states, especially those in the non-aligned movement, favor the latter's scope. This distinction is important as the language surrounding a treaty on fissile material is a bit nuanced. A fissile material cut-off treaty would only ban the future production of fissile material. However, a number of states have called for a fissile material treaty which would impose limits on future production and existing stockpiles. The issue of verification illustrates how the political issues surrounding the NPT permeate into other nuclear concerns. Under the NPT all NNWS commit to not producing any fissile material for weapons. The IAEA verifies each state's commitment to this promise. However, the NWS (in addition to the non-signatory nuclear states) are not subject to such verifications. Therefore, any treaty on fissile material would need to include an agreeable verification

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[163] Kimball, Daryl, and Kingston Reif. "Fissile Material Cut-off Treaty (FMCT) at a Glance." *Arms Control Association*, Arms Control Association, June 2018, www.armscontrol.org/factsheets/fmct.
[164] "Proposed Fissile Material (Cut-off) Treaty (FMCT)." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey, 14 May 2020, www.nti.org/learn/treaties-and-regimes/proposed-fissile-material-cut-off-treaty/.
[165] "Fissile Material Cut-off Treaty." *Reaching Critical Will*, Women's International League for Peace and Freedom, www.reachingcriticalwill.org/resources/fact-sheets/critical-issues/4737-fissile-material-cut-off-treaty.

regime that these states can follow. However, without the participation of one or more of the nuclear weapons states in a fissile material treaty, especially the nuclear weapons states which have not signed the NPT, a treaty on fissile material would serve little value. Synthesizing these two difficulties confronting a treaty on fissile material, Pakistan has been a staunch advocate for a fissile material treaty which addresses existing stocks. Pakistan argues that "not addressing these stocks will 'freeze existing asymmetries' that threaten Pakistan."[166] While this concern is undoubtedly pointed at Pakistan's concerns regarding India's larger stockpile of fissile material, it also represents the reason the world has been unable to move forward on a treaty addressing fissile material. Pakistan has been the only state opposing the commencement of negotiations for a treaty on fissile material in the UN Conference on Disarmament. Since the UN Conference on Disarmament operates by consensus, Pakistan's lone objection has held up the conference from moving forward on this critical issue. This objection nonetheless demonstrates the slanted political climate on this issue which helps states with weapons versus those without weapons.

Comprehensive Test Ban Treaty (CTBT)

The Comprehensive Test Ban Treaty (CTBT) is another treaty dealing with the issues related to the proliferation of nuclear weapons. The CTBT faces similar force problems as the NPT in that there are still several key States which have yet to ratify the treaty. Unlike the NPT, however, the CTBT has not been implemented because eight States, categorized as Annex 2 States, have yet to ratify the treaty. Annex 2 States are the states which must ratify the CTBT in order for it to enter into force. There are 44 states which are considered Annex 2 because they possessed nuclear power or research reactors while the treaty was negotiated from 1994-1996. China, Egypt, Iran, Israel, and the United States are Annex 2 States who have signed but not ratified the treaty. North Korea, India, and Pakistan are Annex 2 States which have not signed the CTBT.[167]

In short, the CTBT bans all nuclear weapons tests or explosions for any reason around the world, including in the sea, air, space, and underground. In order to carry out the mission of the treaty, the

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166 *Ibid*.
167 "CTBT: Annex 2 States." *U.S. Department of State*, U.S. Department of State, 2009-2017.state.gov/t/avc/rls/159264.htm#:~:text=U.S.%20Department%20of%20State&text=Key%20Point%3A%20%E2%80%9CAnnex%202%E2%80%9D,CTBT)%20to%20enter%20into%20force.

treaty creates the CTBT Organization (CTBTO) which is responsible for overseeing the implementation of the treaty and its provisions. The 51-member Executive Council is responsible for carrying out the mission of the CTBT and allots each region with a certain number of seats on the Executive Council. The CTBT has three important components. Part I of the CTBT details the International Monitoring System (IMS) which is responsible for worldwide monitoring of any tests through a variety of scientific monitoring techniques in labs and monitoring stations around the world.[168] Part II outlines what on-site inspections entail. States can request an on-site inspection if there are at least 30 affirmative votes in the Executive Council for an inspection. On-site inspections have not begun since the treaty has not entered into force. Additionally, the Executive Council must act within 96 hours of receiving an inspection request.[169] Part III of the CTBT outlines the confidence-building measures (CBMs) which are intended to promote compliance with the treaty. Such measures include each State selecting a Technical Secretariat which a State can assist in the calibration of monitoring labs and stations mentioned in Part I.[170]

As stated previously, the CTBT is not currently in effect due to eight Annex 2 States not ratifying the treaty. Much of the political narrative around the CTBT has been focused on getting these final eight states to ratify the treaty. As one can imagine, getting these eight states to sign will be quite difficult. Nonetheless, the CTBT remains an important component of the global nonproliferation regime and its entry into force is essential in achieving nuclear nonproliferation and nuclear disarmament. While the CTBT may not necessarily be in force, it has demonstrated efficacy in deterring the further testing of nuclear weapons. However, three countries, India, Pakistan and North Korea, have conducted tests since the CTBT was opened for ratification. Both India and Pakistan have conducted one test since the CTBT was opened up for signature in 1996. Meanwhile, North Korea has conducted six announced tests along with two unannounced tests which the CTBTO detected through its monitoring system.[171]

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[168] "Comprehensive Nuclear-Test-Ban Treaty (CTBT)." *Nuclear Threat Initiative*, James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey, 21 May 2021, www.nti.org/learn/treaties-and-regimes/comprehensive-nuclear-test-ban-treaty-ctbt/.
[169] *Ibid*.
[170] Kimball, Daryl. "Comprehensive Test Ban Treaty at a Glance." *Arms Control Association*, Arms Control Association, July 2020, www.armscontrol.org/factsheets/test-ban-treaty-at-a-glance.
[171] Shaffer, Leslie. "North Korea Claims Successful Hydrogen Bomb Test." *CNBC*, CNBC, 3 Sept. 2017, www.cnbc.com/2017/09/03/north-korea-claims-successful-hydrogen-bomb-test.html.

Cooperation Among Nuclear Weapons Free Zones

While a great start to the maintenance of the nuclear nonproliferation regime, NWFZs are not the end all be all of nuclear nonproliferation. As described earlier, the reservations of the NWS demonstrate that more work needs to be done in order to enforce the provisions of the NWFZ treaties more effectively. In particular, the NWSs reservations on negative security assurances question the validity of each nuclear weapon state's commitment to maintaining each NWFZ. If each zone cannot rely on empty promises from the nuclear weapons states, then some experts have proposed that they must find strength in each other. NWFZs still encounter "difficulties", and most could stand to benefit from greater cooperation among the zones.

The first area of improvement relies on greater cooperation and communication between the various NWFZs. Given the existing limitations of uneven institutionalization, information exchange between the various zones is seen as a critical first step towards reaping the benefits that should come from participating in a NWFZ. Through an increase in communication, NWFZs stand to benefit from a greater spread of knowledge and the activities being conducted in each zone. This knowledge is not only technical, as it can include information such as how to approach negotiations with NWS or improving verification methods. Despite past attempts to improve communication between the zones, the NWFZs still do not have any secretariat or even a contact in order to foster communication.[172] States that are a part of an NWFZ can only benefit from the greater cooperation among the states—whether technical skills, negotiating tactics, or coordinating multi-zonal nuclear disarmament policy.

Multilateral New START Agreement

While the United States and Russia were able to negotiate an extension to the New START treaty until 2026, the relationship between the two is deteriorating. In addition, growing concerns of China's opacity regarding its nuclear stockpile lay the groundwork for Russia and the US to bring China into negotiations, especially the US. Several scholars have proposed that the nuclear powers

[172] Muller, Harald, et al. Vienna Center for Disarmament and Non-Proliferation, 2018, *Cooperation among Nuclear-Weapon-Free Zones: History, Challenges and Recommendations*, vcdnp.org/wp-content/uploads/2018/03/NWFZ-TF-Report-final-1.pdf.

of the world, particularly Russia, China and the United States, conclude a multilateral treaty, similar to the provisions of New START, in order to strengthen the global nonproliferation regime. While the United States has been the largest proponent of bringing in China, Russia has demonstrated that they are open to the idea. However, Russia has declared that it is only willing to engage in multilateral arms reduction treaties if France and the United Kingdom, the US' 'nuclear allies,' are also included in the treaty. Complicating the situation more, China has declared it would only participate in a nuclear arms control treaty if all countries agreed to limit their nuclear arsenals to the size of China's—1/15th the size of Russia and the US.[173] Otherwise, as China argues, it is under no obligation to limit its nuclear arsenal when those of Russia and the US are so much larger.

By agreeing to limit themselves to an equal number of weapons, verified by the other nation, Russia and the US have demonstrated that it is possible for two nuclear powers to act in good faith in order to meet the total nuclear disarmament goals outlined in the NPT. However, negotiations for the extension of New START in the past two years have demonstrated that there are more problems in need of discussion for an effective treaty. For one, New START does not limit stockpiles of non-strategic and non-deployed warheads—warheads which do not pose a threat to the other nation but do pose a threat to neighboring nations. In addition, the US' accelerating research into missile defense and long-range weapons has Russia concerned with including those weapons in a new arm reduction treaty. Finally, while New START does put into place a robust inspections and verification process, there have been complaints from both sides about the ability to easily follow through with the terms outlined in New START.[174] Nonetheless, New START provides an excellent touchstone for what the provisions of a future multilateral arms reduction treaty could look like.

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[173] United States, Congress, European Parliamentary Research Service, and Martin Russell. *The New START Treaty between the US and Russia*, Mar. 2021. www.europarl.europa.eu/RegData/etudes/BRIE/2021/690523/EPRS_BRI(2021)690523_EN.pdf.
[174] *Ibid*.

Bloc Positions

NATO & Allies

These states have extensive military ties to the United States, primarily through NATO, and consequently follow the US on nuclear policy. This group also includes countries like Australia and Japan that are not officially a part of NATO but cooperate closely with the US and NATO. As with all the blocs on this topic, these countries are not a monolith and do not blindly follow US nuclear policy. However, many of these nations signed onto the NPT with assurances from the US that they would be protected by the US nuclear umbrella. In fact, several NATO countries (Belgium, Germany, Italy, the Netherlands, and Turkey) currently host nuclear weapons through NATO's nuclear sharing policy. While not being allowed to possess weapons, these countries are involved in the planning and operation of nuclear weapons housed within their borders.[175] This policy has received significant criticism as many countries, especially those in the Non-Aligned Movement, believe NATO's nuclear sharing constitutes a violation of the commitment each NNWS agrees to when signing the NPT. Furthermore, NATO has been the subject of significant criticism due to the ways it interprets the validity of the NPT during wartime. NATO has maintained that the NPT is no longer void if the alliance were to enter into a conflict. This runs in contrast to the NPT's procedures which necessitate a three month waiting period before a country can officially leave the NPT. While the countries in this bloc understand the importance of maintaining the NPT, NATO and its allies view the NPT more as a deterrent to the development of weapons in enemy states around the world, favoring bilateral deals (like New START) and multi-party negotiations to actually control nuclear arms.

Russia & China

As the two NPT nuclear weapons states that are not a part of NATO, China and Russia are often seen as the two nations which oppose the France-UK-US bloc of nuclear weapons states. More often than not, however, China, Russia and the US are viewed as the three leading nuclear powers—especially in addressing the situations in North Korea and Iran. It should be stressed that these three work constructively in order to realize shared nonproliferation goals. However, deteriorating relations

[175] Kristensen, Hans M., and Matt Korda. "United States Nuclear Weapons, 2021." *Bulletin of the Atomic Scientists*, vol. 77, no. 1, 26 Jan. 2021, pp. 43–63., doi:10.1080/00963402.2020.1859865.

with the U.S. have forced the two nations to work more closely, including matters of nuclear diplomacy. While the two may support the idea of undercutting American nuclear diplomacy hegemony in Iran and North Korea, both countries understand that nuclear weapons cannot be allowed to proliferate without restrictions. This has not stopped the two countries from inching closer towards defending Iran and North Korea, albeit for different reasons than one might expect. Nonetheless, the two view the NPT as an important cornerstone in nuclear diplomacy because both countries have neighbors which the U.S. could easily arm if the NPT were to expire. For Russia, the maintaining of the nuclear world order is intended to keep Germany from acquiring nuclear weapons. Meanwhile China is focused on maintaining Japan and other less-than-friendly neighbors as non-nuclear weapon states. The two nations are instead caught between a metaphorical rock and a hard place in which they must support the perpetuation of the existing nonproliferation regime, while tactfully navigating strategic relations with Iran and North Korea in order to undermine American goals. Russia has also taken issue with the IAEA's decision to use third-party information during the verification process.[176] As the situations in Iran and North Korea stagnate, the importance of these two nations in upholding the nuclear nonproliferation regime will become more obvious.

Non-Party Nuclear Weapons States

Consisting of India, Israel, and Pakistan these states have not ratified the NPT for reasons that were outlined previously. Other than not signing the treaty, these three nations do not necessarily share any similar views or goals with respect to the question of nuclear nonproliferation. It will be very difficult to persuade these nations to join the NPT. Whether these nations admit to possessing nuclear weapons or not is irrelevant as the security rationale behind their acquisition and maintenance of their nuclear stockpiles is virtually unshakeable. Similar to China and Russia, these nations do not necessarily want other countries to gain nuclear capabilities. However, these nations must strike a balance in creating a global nonproliferation regime that will still allow these nations to maintain their nuclear stockpiles. While outward acknowledgement of these three states as nuclear weapons states is an unattainable goal, ensuring that the NPT does not have tougher enforcement mechanisms for non-party states is the ultimate goal of these countries. One could even argue that

[176] Einhorn, Robert. "Revitalizing Nonproliferation Cooperation with Russia and China." *Brookings*, Brookings, 23 Mar. 2021, www.brookings.edu/research/revitalizing-nonproliferation-cooperation-with-russia-and-china/.

Iran and North Korea could be included as they are in the process of acquiring nuclear weapons. Ultimately, these states are focused on maintaining the existing nuclear order, even if it means they are not officially recognized as states that are technically allowed to possess nuclear weapons.

The Humanitarian Pledge States

The final bloc on this issue are those nations which are classified as NNWS and have no desire for nuclear weapons. The largest bloc on this issue, these nations come from around the world but are united in their aspirations for a nuclear-free world. These nations, through the Humanitarian Pledge, have demonstrated that they are fed up with the current state of the nuclear nonproliferation regime. The Humanitarian Pledge and the Treaty on the Prohibition of Nuclear Weapons were not significant because they made any significant progress on global disarmament. Rather, they showed that a majority of the nations in the United Nations are tired of the lack of progress made by the nuclear powers. As these nations would argue, the asymmetries present in global nuclear diplomacy only serve to keep the NNWSs in-line while allowing the NWS all the power to disarm at their own slow rate. These nations, while outnumbering the nuclear powers, do not out "power" the nuclear powers. As such, these nations will be eager for nuclear powers—especially Russia and the United States—to significantly reduce their stockpiles. This bloc must find a way to bolster their soft power despite the hard power that the nuclear nations possess. If an effective diplomatic approach can be found, however, these nations stand to make many steps towards a nuclear weapons-free world.

Glossary

Breakout Time: The time required to produce enough weapons-grade uranium for one nuclear weapon, usually a nation's first nuclear weapon.

Complete Nuclear Fuel Cycle: The steps involving the preparation of uranium for use in nuclear reactors along with the safe management and disposal of spent fuel.

Export Controls: A set of rules which regulate the handling, disclosure, shipment, use and transfer of any materials used in the production of nuclear technology.

Fissile Material: Materials capable of sustaining a nuclear fission chain reaction used in nuclear reactors and weapons.

Hard Power: The use of, oftentimes, coercive economic and military tools to affect change in other political bodies (other nations, international institutions, national legislature, etc.).

Negative Security Assurances: Guarantees by one or more nuclear weapon states to not use or threaten the use of nuclear weapons against non-nuclear weapon states.

Non-Deployed Weapons: Weapons, oftentimes nuclear ones, which are in storage and not capable of being deployed in their present state (need to be moved, loaded, etc.).

Non-Strategic Nuclear Weapons: Usually in reference to nuclear arms reduction agreements between Russia and the U.S., these are nuclear weapons which do not have the ability to strike the other State-Party.

Nuclear Disarmament: The reduction and/or elimination of nuclear weapons.

Nuclear Non-Proliferation: The prevention of the spread of nuclear weapons to countries that do not currently possess nuclear arms.

Soft Power: The use of persuasion and negotiation to achieve foreign policy objectives, usually through network building, establishing international rules, and highlighting attractive resources a country shares with the world.

Strategic Nuclear Weapons: Usually in reference to nuclear arms reduction agreements between Russia and the U.S., these are nuclear weapons which have the capability to attack and destroy military and industrial targets in the other State-Party (also known as: tactical nuclear weapons).

Uranium Ore Concentrate: An intermediate step in the processing of uranium ore, it is a uranium concentrate powder that has not been enriched nor fabricated for nuclear fuel.

Weapons of Mass Destruction Free Zones: An area, usually established through a treaty, which prohibits the use, or threats of use, of any weapons of mass destruction (chemical, biological, or radioactive).

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