# Surf City XVIII

Huntington Beach High School


Topic A: Management of Nuclear Disasters

Topic B: Nuclear Technology In Developing Nations

Chris Bertels

Evan Wood

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# Welcome Letter

Dear Delegates,

On behalf of the Huntington Beach High School Model United Nations Program, we would like to welcome you to our virtual Surf City XVIII advanced conference!

Our annual Surf City conference upholds the principles and intended purpose of the United Nations. Delegates can expect to partake in a professional, well-run debate that simulates the very issues that those at the United Nations discuss every day. Both novel and traditional ideas will be shared, challenged, and improved.

It is our hope that all delegates will receive the opportunity to enhance their research, public speaking, and communication skills as they explore the intricacies of global concerns through various perspectives, some of which may be very different from their own. We hope their experiences here give them new insight and values that they can apply outside of the realm of Model UN for the betterment of the world community.

Although we will be entertaining a new style of a virtual conference, we hope all delegates will experience a fruitful and enhancing debate.Please do not hesitate to approach our Secretariat or Staff Members with any questions or concerns that you may have throughout the day. We wish the best to all our participants and hope that they may share a fulfilling experience with us! Enjoy the conference.

Sincerely,

Summer Balentine
*Secretary-General*

Jenna Ali
*Secretary-General*

Kayla Hayashi
*Secretary-General*

Hailey Holcomb
*Secretary-General*

# Meet the Dias

**Chair 1**

Hello! My name is Chris Bertels and I will be your head chair for Surf City XVIII. I have loved being in IAEA as a delegate and I am eagerly anticipating chairing this conference regardless of the fact that it will be like none other that I have chaired before. I have been in MUN here at Huntington for the past 4 years and have had the opportunity to attend countless conferences with excellent debate. Outside of MUN, I enjoy a good bike ride, talking on the phone with my friends late into the night, and tinkering with electronics and woodworking projects. On that, I love all things nuclear related and I hope to earn a master's degree in nuclear engineering at some point in my life. I can't wait to see how you all will surprise us with outstanding research and country policy in committee come January 9th and I eagerly await seeing your faces on camera.

**Chair 2**

Howdy, my name is Evan Wood and I am your co-chair for Surf City XVIII. I personally love the discussion of nuclear energy and its application whether it be civilian or military use. A little about me and some hobbies of mine include watercraft sports, reading about National Defense and policy, along with an interest in Modern History. I am sure I will be pleased with the papers and performance you all will give during the conference.

**Chair 3**

Hi! My name is Devon Chen and I am your co-chair for Surf City XVIII. This is my first time chairing an IAEA conference and I enjoy talking about implementing nuclear technology for developing nations. This is my third year in HBHS's MUN program and I have had the privilege to attend many conferences across Southern California. Apart from that, I enjoy doing martial arts, surfing, and singing. I am so excited to co-chair your committee and I am looking forward to hearing all of your creative and innovative solutions!

## All Papers are due on January 2, 2020 by 11:59pm to surfcity.iaea@gmail.com

# TOPIC 1: Management of Nuclear Disasters

## BACKGROUND

Nearly all modern nuclear technology relies on the process of nuclear fission - the splitting of large, unstable isotopes of a given atom to make smaller, more stable nuclei. Apart from these physical byproducts, there is also an electromagnetic release of energy from any given fission event which is known as gamma radiation.[1] Gamma radiation is the most powerful form of nuclear radiation (as compared to alpha and beta, which are comparatively weak) and has the ability to cause significant and severe damage to all tissues in the human body. Gamma radiation is so damaging because it can penetrate deep into the body where, within the nucleus of each cell, it will hit DNA molecules and 'corrupt' the genetic code that our cells rely upon to reproduce.[2] In fact, gamma radiation is so good at killing cells by damaging their genetic code (among other things such as cellular machinery and proteins) that it is used to sterilize medical equipment before use in an operating room.[3] Should a person survive an initial exposure to significant amounts of ionizing radiation, they will be at a very high risk of developing certain cancers later in life such as thyroid cancer, esophagus cancer, and leukemia as well as other cancers in nearly every other part of the body.[4] [5] Clearly, radiation from fissile nuclear material poses a significant threat to human safety and thus must be closely monitored and contained in order to protect everyone in society.

This committee (The International Atomic Energy Agency or IAEA) has defined a nuclear and radiation accident to be any "event that has led to significant consequences to people, the environment or the facility" as a result of a release of radioisotopes from a safe containment unit.[6] The IAEA has also developed a disaster rating scale known as the International Nuclear Event Scale (INES) that assists nations in communicating the severity of a disaster to the international community. The INES scale is from 0 to 7 with 0 being inconsequential to personnel safety and 7 being the most severe.[7] With 44 new nuclear reactors under construction in the world today and about 70 new reactors planned to begin construction in the next 15 years, looking at the history of past nuclear disasters and their effects is essential to understanding how to make necessary safety improvements in modern installations.[8]

The clearest example of a nuclear disaster is of course from a nuclear reactor that goes out of control and enters a state known as meltdown. A meltdown is when the radioactive fuel of a nuclear reactor is unable to be adequately cooled and heats itself to such a degree that it turns from the solid to liquid state. This molten material then melts through the containment unit that it is intended to be housed in and burns through the ground until it hits a source of groundwater at which point it will flash the water to steam and expel radioactive material into the atmosphere.[9] Nuclear reactor meltdowns have caused the most severe nuclear accidents to date with two of six known accidents - the Chernobyl disaster in 1986 and the Fukushima Daiichi disaster in 2011 - scoring a major accident rating of 7 on the INES.[10]

While a reactor meltdown is what typically comes to mind with the mention of the words "nuclear disaster," there are far less known accidents that can still cause significant consequences to people and the environment. For example, the third worst nuclear accident to occur since the development of nuclear technology was at a nuclear fuel reprocessing plant in the Soviet Union during the 1950s.[11] Known as the Kyshtym disaster (INES score of 6), this accident had more radioactive fallout and caused more damage to the environment than the 3-Mile Island accident in the United States in 1979.[12] In fact, the Kyshtym Disaster spread radioisotopes over 20,000 square miles where an estimated 270,000 people lived.[13] Similar accidents have happened at other nuclear fuel processing plants around the world, but the Kyshtym disaster has been identified as having the most severe consequences.

Further examples of nuclear accidents that occured in nuclear facilities that were not intended to produce power can be seen with the nuclear medicine industry. Nuclear technology is used extensively in the field of modern medicine to both image and treat patients with an assortment of conditions with minimal risk of medical complications.[14] However, the sources of radiation for these procedures and imaging machines are usually far less protected than say an entire nuclear power plant. Thus, it is far more likely for accidental exposure to occur as a result of carelessness and malpractice. This is exactly what happened with the Goiânia accident which happened in 1987 in Brazil. A small capsule containing just 3.3 ounces of a radioisotope used in cancer radiotherapy treatment (caesium chloride) was left in an abandoned hospital and was taken out of the hospital by local thieves that believed they could sell it for scrap.[15] Upon attempting to disassemble the capsule, both thieves fell ill, but remained persistent in their efforts and eventually punctured the capsule and observed an "eerie blue glow" from within.[16] Thinking that the substance inside must be extremely valuable or even supernatural, they invited neighbors and family to come observe and eventually these people took pieces of the caesium chloride home with them.[17] When local authorities discovered radioactive activity, an enormous cleanup effort immediately began which involved the cleansing or demolition of several houses as well as the removal of contaminated topsoil.[18] Only about 250 people were contaminated as a result of this incident, but the IAEA classified the incident as a level 5 accident on the INES.[19]

Less common, but still important to consider is the aspect of nuclear disasters and incidents caused by military activity. The clearest example of this is the testing of nuclear weapons (most recently in North Korea as of 2017) which obviously releases significant amounts of radioactive material into the atmosphere and environment.[20] [21] However, less known incidents also occur such as the "Broken Arrows" of the United States nuclear arsenal. These are nuclear weapons - fusion or fission based - that have been lost under all sorts of circumstances such as plane crashes, accidental drops, and more.[22] These undetonated weapons pose a threat to the environment as they fall apart and should be properly addressed. Further, nuclear powered submarines - specifically historical Soviet-era subs that were prone to meltdowns - pose a lasting threat to oceanic life as they deteriorate and release radioisotopes into the oceans.[23]

An important aspect of this topic to consider is the vulnerability of nuclear power plants to attack during military campaigns. While the risk of an ordinary nuclear reactor having a catastrophic disaster is very low, these complex machines could easily be attacked causing severe nuclear disasters all over the world. This issue is heightened by modern communications technology that could allow nations to remotely hijack and destroy nuclear power plants in acts of cyberwarfare.[24] Sabotage of nuclear reactors is something that needs international attention as there are multiple offensive mechanisms by which a reactor can be disabled and relatively few solutions regarding defensive measures that can be employed in response.

While disaster from nuclear technology is a serious threat to the health and safety of millions of people and the wellbeing of natural environments all around the world, it is important to remember that modern technology is allowing us to create new reactors with advanced safety systems as well as safer implementations of nuclear technology in other fields that significantly decreases this risk. It is essential that nations around the world embrace these new technologies and renovate old systems in such a way that the nuclear industry can thrive and provide the most utility with the least risk. Transparency and trust is crucial to management of nuclear disasters (see Case Study) and it is essential that the international community does all in its power to build a culture of safety and security in the growing nuclear industry around the world. The IAEA and the UN have historically played, and will continue to play a central role in this process as is discussed in the next section.

## UNITED NATIONS INVOLVEMENT

With about 33 active projects pertaining to general nuclear waste management and 16 active technical cooperation projects for emergency preparedness, the IAEA has made huge advancements in the prevention of nuclear disasters.[25] [26] They strive to provide general guidelines for nuclear safety and maintain the IAEA Incident and Emergency System (IES) so that the IAEA's secretariat issues appropriate actions and responses following an emergency, regardless of the emergency being accidental, fostered by negligence, or a deliberate action. The IAEA established the Incident and Emergency Centre in 2005 to expand upon the work the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency set to establish a formal center to provide 24/7 communication and emergency response in the instance of a nuclear emergency.[27] The center arose as more nations began to utilize nuclear technology, driving the focus of the center to IES Operations and preparedness; member states preparedness; and emergency communications and outreach.[28]

One of the IAEA's most notable publications is their comprehensive guidelines on Safety Standards which consists of the Safety Fundamentals, the Safety Requirements, Safety Guides, and the Safety Practices.[29] They set the basis for fundamental nuclear safety worldwide. The primary users of the standards are regulatory bodies; professionals studying in the IAEA's School of Radiation Emergency Management; outside organizations responsible for operating, designing, and producing nuclear facilities; and joint sponsoring organizations.[30] The 1996 Convention of Nuclear Safety further strengthened nuclear security by ensuring signatories operating nuclear power plants follow IAEA Safety Standards.[31] Other more recent publications in regards to nuclear power plant safety include the November 2019 Technical Safety Review (TSR) Service Guidelines, the February 2019 Accident Management Programmes for Nuclear Power Plants, and the August 2018 Medical Management of Persons Internally Contaminated with Radionuclides in a Nuclear or Radiological Emergency.[32] [33] [34] These guidelines set standards for optimal stability in operation as well as directions in the instance of a crisis in the nuclear industry. The IAEA held an international conference from September 6-7, 2005 in Vienna in which they informed the international community on the state of Chernobyl, and plans to host another International Conference discussing nuclear safety and progress following the Fukushima-Daiichi incident in Vienna from February 22–26, 2021. These are examples of vital international cooperation that can lead to the sustainable cleanup of nuclear disaster zones.

Following the crisis of Chernobyl, the Convention on Early Notification of a Nuclear Accident of 1986 and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency of the same year were established to allow sharing of information and assistance to neighboring nations in the instance of an event. In the decades following the disaster, the IAEA has provided support to Ukraine, Belarus, and Russia in regards to mitigating damage and managing radioactive waste.[35] Following the Fukushima-Daiichi disaster of March

11, 2011, the IAEA has issued several research missions and reports diagnosing the decommissioning of the plant by the Japanese government. Their final report on January 31, 2019, noted that Japan has made significant progress recovering, in large part to their following of IAEA safety protocols.[36]

While there has clearly been huge leaps in international cooperation since the first development of nuclear technology, there still remains the issue of creating organizations and international teams of professionals to immediately respond to threats of nuclear disaster. Time is of the essence when attempting to mitigate the effects of any such disaster and comprehensive action remains to be taken to provide the necessary resources to all nations with nuclear technology that may require them.

## CASE STUDY: 1986 Chernobyl Incident

The events of April 26, 1986 and the following months and years will forever be remembered in the history of nuclear technology. What had begun as a safety test turned into the worst nuclear accident on account of human error, faulty design, and environmental conditions.

The Chernobly disaster - one of only two accidents in history rated as a 7 on the INES - took place in the north of the Ukrainian SSR just outside the city of Pripyat where roughly 50,000 people lived.[37] The Chernobly nuclear power generation station supplied power to Pripyat and other nearby cities and contained 4 RBMK type nuclear reactors (RBMKs are still used to this day in the region).[38]

In order to understand the events that led to the explosion at Chernobyl, it is essential to understand the basic workings of a RBMK reactor. The fuel used in most nuclear reactors around the world is uranium-235 (U-235). This atom has the property of decaying into smaller atoms upon being hit with a high-energy neutron while simultaneously releasing multiple high-energy neutrons after undergoing fission. This is the principle behind most nuclear reactors, the products of one fission event (heat, neutrons, radiation, and nuclear byproducts) will go on to trigger another fission event in a sustainable reaction. During nuclear fission for energy production, it is necessary that each atom of U-235 that splits causes exactly one other atom of U-235 to split, otherwise, the number of fission events would skyrocket exponentially and cause a meltdown.[39] Thus, in order to slow the reaction rate, keeping the number and type of neutrons in check is key. In a nuclear reactor, materials such as boron or cadmium are used to absorb neutrons to slow the reaction to a stable rate.[40] These absorbing materials are contained in movable control rods that can be inserted into the reactor core to slow the progression of the reaction. Note that another neutron absorbing material in an RBMK reactor is water.[41] In addition to functioning as a neutron absorber, water is essentially the only mechanism by which the nuclear fuel inside the reactors is cooled. Thus, water will work with the control rods in case of an emergency inorder to stop the reaction and cool the reactor to a safe level.[42] The neutrons that are required to sustain a nuclear reaction are 'slow' neutrons that move at roughly the speed of sound as compared to 'fast' neutrons that travel at an appreciable fraction of the speed of light. Thus, in order to slow the 'fast' neutrons that are released from a fission event, we use materials known as neutron moderators.[43] Graphite is the only moderator that needs to be noted when studying an RBMK reactor.

With an adequate understanding of the functioning of an RBMK reactor, we can now analyze the circumstances that led to the explosion in 1986 at Chernobyl. Reactor 4 at the Chernobyl power generation station was attempting to utilize a new system of driving the coolant water pumps in the event of an emergency reactor shutdown. While the emergency diesel generators came up to speed, there was a period of time in the case of loss of power where water would not be moving over the core. In order to combat this, the plant engineers designed a steam turbine system that could use the residual energy stored in the spinning steam turbines to pump cooling water while the diesel pumps spun up to speed.[44] The plant operators failed to acknowledge that the reactor had been running under significant load for the past 24 hours entering the test and had thus developed something known as 'the xenon pit' because xenon-135 (a byproduct of nuclear fission and an excellent neutron absorber) had built up in the core from the decay of byproducts of the reaction.[45] As a shift change occurred in the control room, the operators managed to completely stall the reactor bringing it to about 1% of normal operation power output.[46] This means that the xenon-135 in the reactor was no longer being 'burned off' by the fission events occurring around it and, worsening the issue, xenon-135 continued to be produced as other byproducts decayed into it. Furtening the lack of neutrons in the reactor core was the fact that there were no longer steam voids in the water surrounding the fuel rods (because of reduced reactor heat production) meaning that the neutron absorption properties of water were in full effect.[47] The lead manager of the power plant pressured those under him to get the reactor back up to operational temperatures and in following these orders, the engineers pulled out the control rods (tipped with graphite neutron moderators to displace water which slowed the reaction) and effectively removed all of their control systems from the core.[48] The operators were not concerned by this fact and carried on with the safety test well below the reactor operation temperature that was required in the documentation (the reactor was only heated to about 30% of the recommended level).[49] This is the point at which the safety test turned into an exercise in nuclear disaster management. Upon stopping the flow of water through the core for the test, steam gaps began to form and with these steam gaps came an increase in reactor heat generation which in turn generated more steam in a loop that is summarized with the term "positive void coefficient."[50] This was the fault in the design of the RBMK reactor that led to the disastrous outcome, and, upon inserting the moderator-tipped control rods back into the core, there was a huge increase in temperature in the lower region of the reactor that is thought to have caused the first explosion as enormous amounts of steam were produced. Following this first explosion, there was a second, much larger, explosion that was the result of oxygen rushing into the core and reacting with the superheated fuel and graphite.[51] The effect of this second explosion was to spew radioactive material high into the atmosphere creating a radioactive fallout about 400 times more severe than the fallout of both Hiroshima and Nagasaki, combined.[52]

The aftermath of the explosion at Chernobyl shows the incredible loss of life and damage to the environment that a severe nuclear disaster can bring about. The explosions of the nuclear reactor core ignited the graphite moderators which then released radioactive smoke into the atmosphere for days following the initial disaster.[53] The initial explosions killed only two plant staff, but the firefighters, first responders, and citizens of nearby Pripyat were all doused in radioactive fallout particles and many of them died of acute radiation poisoning soon after the disaster. However, cancer holds the largest death toll as a result of the events at Chernobyl and is responsible for anywhere between 10,000 and 60,000 deaths based on the controversial linear no-threshold model for radioactive exposure.[54] The effects on the natural environment surrounding Chernobyl were even more severe. In the immediate vicinity of the nuclear power plant, topsoil had to be removed and shipped away so that cleanup crews could begin their work.

Evacuation of villages and entire cities were widespread, and in order to prevent massive changes in the local biosphere from mutations, local animal populations (household pets, wild animals, anything that moved) were exterminated.[55]

The international community was never fully aware of the threats of the Chernobyl incident as the Soviet Union immediately attempted to cover up the incident. Nearly all of the response to the disaster came entirely from state-sponsored sources with very little international involvement. About 800,000 "liquidators" were recruited from the Soviet Union population to assist in the cleanup of the site and many of these individuals have suffered from diseases related to their lack of protective equipment.[56] The coverup of the disaster was so significant that radiation from the fallout was detected in Western European nations before the Soviet government ever announced that there had been an accident to the international community.[57]

The lesson to be learned from the events of the Chernobyl nuclear accident is that international cooperation and support is essential to proper disaster management. Because the Soviet Union was so intent on hiding the fact that there had been an accident to begin with in an effort to save face with the international community, they essentially closed their doors to outside help. Not only did they isolate themselves, but they also put millions of people in Europe and beyond in harm's way as the radioactive fallout spread out from the reactor thousands of miles away. Clearly, lives could have been saved if transparency was supported and evacuations and protections of individuals living in affected regions were prioritized over the veil of secrecy that the Soviet government valued so much. In today's political climate, this is especially concerning as more and more developing nations begin to look at nuclear technology for power generation. While the technology may be available to them through partnerships with developed countries (or any other means), there is significant fear that these developing nations will not employ proper safety measures utilizing well-trained individuals when operating their domestic plants. Further, remnant tensions between the United States and Russia as well as communist China may lead to similar circumstances of secrecy and unilateral action that causes unnecessary loss of life and damage to environments. Thus, it is essential that international cooperation is supported in the development of new nuclear technologies.

## QUESTIONS

1. Who should fund cleanup? Should the companies who manufactured a nuclear power plant (or other containment system) be held responsible, or should it be a nation's government's responsibility?
2. How can we improve safety standards in nuclear reactors around the world? Specifically, how can we ensure that old and aging nuclear reactors are renovated or improved to modern standards.
3. What role does human ignorance play in the accidental release of radioactive material and how can institutions that utilize dangerous substances ensure that these materials do not fall into the wrong hands?
4. How will you plan to dispose of nuclear waste? Are there any innovative methods your country has put in place to discard it?
5. Are there countries more susceptible to nuclear emergencies? What geographical factors can proliferate the spread of nuclear waste?
6. What improvements can be made to make nuclear power safer? Are there any new developments that the international community can implement to ensure safety?

# TOPIC 2: Nuclear Technology in Developing Nations

## BACKGROUND

The International Atomic Energy Agency (IAEA) was formed on July 29th 1957 with its main mission being to create a safe, secure, situation for the peaceful use of nuclear energy worldwide. They are a major part of the United Nations' Sustainable Development Goals for securing a more peaceful world.[58] The International Atomic Energy Agency send inspectors worldwide to inspect nuclear facilities to make sure they are kept up in accordance to international guidelines and safety standards.[59] Along with inspections for Weapons of Mass Destruction (WMDs) to ensure that countries are being transparent in their efforts to be nuclear powered peacefully. Such missions the IAEA have conducted routinely happen currently in areas such as the Middle East with many developing nations and key players seeking to access the power of the atom and unlock its secrets.[60]

Worldwide the IAEA has stated that there are 30 countries that have nuclear energy power plants within their countries.[61] These nuclear energy power plants help provide the countries with clean energy for vast amounts of time. nuclear fission the main way nuclear energy is provided was first found by Lise Meiter in 1938 during an experiment in which he first split an atom from a sample of Uranium which cause a chain reaction thus nuclear fission was discovered.[62] Just four years later in 1942 the world's first nuclear reactor was built by Enrico Fermi named Chicago Pile 1. It was the world's first manmade and controlled nuclear chain reaction which was the first stepping stone into nuclear energy being used to generate power consumption. However this great power is not without other utilization as the Manhattan Project starting in 1939 and comprising of some of the world's most brilliant scientists such as Albert Einstein, Edward Teller and Robert Oppenheimer.[63] On July 16th 1945, the Trinity Test underneath the Manhattan Project detonated the world's first nuclear bomb. The bomb named nicknamed "Gadget" produced between 15-20 Kilotons of TNT.[64]

Fast forward decades now into the Cold War the United States and the Soviet Union are the world's two most predominant nuclear powers each having dozens of nuclear reactors powering their countries and each also having thousands of nuclear weapons. The Soviets opened their first nuclear power plant in 1954 named the Obninsk Nuclear Power Plant and the Americans opened their first nuclear power plant in 1958 the Shipping Port Nuclear Power Plant.[65] [66] Both provided clean energy to countless individuals within each nation. Over the period of the Cold War both sides would improve upon various reactor designs and increase outputs of energy a reactor could provide to the populace. However even as their investment into nuclear energy has driven down the cost - especially during that era - it is still incredibly expensive for the upfront investment into nuclear power plants. On average the costs of a nuclear power plant are between $6 Billion and $9 Billion USD.[67] This cost is only for incredibly large nuclear power plants capable of providing 1,110MW of electricity. Smaller nuclear reactor designs generally cost less due to simplicity and less material and time spent on completing the project. These Smaller Designs such as those within the 300MW range can provide nuclear energy for around the range of $3 Billion Dollars.[68] As such smaller reactors are generally seen as a better alternative for developing nations seeking to invest into a nuclear infrastructure and set up a system to better accommodate future nuclear power plants increasing in size. The small reactors are generally built to be completely modular and thus are more cost effective and easier to manufacture and manage for developing countries across the world.[69] While upfront costs in the short term are higher than compared to conventional energy methods such as oil, coal, and natural gas the long term costs are much cheaper and cleaner for the environment as a whole.[70] This long term pay off along with cleaner alternative to conventional energy with the massive amount of energy a single reactor is capable of giving off lures many developing nations across the world to nuclear power.

Countries such as South Korea following the aftermath of the Korean War, South Korea before rising to its powerful economical powerhouse status within Asia constructed its first nuclear power plant in 1978. This nuclear power plant was named Kori Nuclear Power Complex.[71] At first the nation was seeking to arm itself with nuclear weapons with plutonium to defend itself against North Korea. However due to join efforts by France and the United States, they managed to convince the South Korean government to pursue a peaceful nuclear energy program that would be in the interests of the nuclear non-proliferation movement.[72] This is perhaps one of the earliest examples of a developing country at the time accessing nuclear energy for peaceful purposes and now South Korea exports their own nuclear reactor designs and products worldwide making up a significant portion of the economic interests of the nation.[73] [74] Most countries who are vying for nuclear power to produce energy for their countries are signatories on the Nuclear Non-Proliferation Treaty (NPT) which states that countries promise not to weaponize their nuclear power for weapons of mass destruction.[75] A major focal point on developing countries seeking nuclear power is their ability to weaponize them and their intent on doing so. Countries such as North Korea are seen as hostile, reckless, wild, and generally unpredictable. Yet the nation with so few allies and shut off from most of the world continued to seek nuclear energy not only for power production, but for weaponization for Intercontinental Ballistic Missiles (IBCMs).[76] A developing nation such as North Korea seeking a nuclear weapons program with a hostile intent should be taken into account of discussion regardless of the fact that there are other developing nations who are seeking a nuclear energy program as well for peaceful purposes. Due to the ease of how a nation can convert its nuclear energy program to a weapons program many countries that do border nuclear interested countries take an issue to such matters.

Although within the 21st Century due to major changes in the geopolitical landscape across the world and globalization, nuclear energy is more accessible to developing countries wishing to gain access to it.[77] One major source of concern when these nations build nuclear power plants is what to do with all the nuclear waste that is accumulated. While no developing nation at the moment has created a dedicated nuclear waste site, the United States has taken the initiative in that department. Located in the Yucca Mountains within Nevada and established in 1987, the Yucca Mountain Nuclear Waste Repository is responsible for handling and storing the US's nuclear waste. However, due to cost overruns and delays storing nuclear waste within this repository has been a very slow process for the United States and the project has lost essentially all of its funding and public support.[78] In conclusion when developing nations decide to enter the field of nuclear energy it is important that they consider the costs, potential weaponization, and nuclear waste disposal aspects of the issue and that the international community assist them in whatever they might need.

## UNITED NATIONS INVOLVEMENT

Established in 1957 as an autonomous international organization within the UN, one of the primary functions of the IAEA is to assist developing nations endeavors to develop nuclear power. Since roughly 30 countries around the world are currently considering nuclear energy, the IAEA is working to provide international cooperation and aid.[79] The IAEA created the Senior Expert Group (SEG) in 1986 with the task of identifying constraints to nuclear expansion and introduction; analysing systems to combat identified issues; and assisting developing nations to finance and promote nuclear power. They completed their work and published a formal report by late 1987, focusing their research on acceptability of nuclear energy; financing and planning projects; contractual agreements; economics and feasibility of nuclear ventures; and infrastructure and manpower.[80] [81]

Both the UN and the IAEA created the Milestone Approach, and although the system doesn't target developing nations in particular it helps developing countries to consider obligations required for utilizing nuclear power. This unique approach is divided into three separate phases regarding the development and deployment of infrastructure to support nuclear power: a Pre-Feasibility study to help a country consider why they decided to chose nuclear energy (partially to deter nuclear proliferation) and develop a policy decision; contracting and construction planning; and the undertaking of licencing, contracting, and constructing nuclear facilities. Each phase is required to reach the following milestones: commitment to developing a nuclear power program; readiness to negotiate contracts for construction; and readiness to commission and operate a nuclear power plant. Further the Milestone Approach identified the three main organizations involved with developing a nuclear power program: the government, a regulatory body, and the owner/operator(s). All nations who wish to develop a nuclear power program are expected to follow the Milestone Approach so they understand the commitment necessary for maintaining nuclear power facilities.[82]

The UN has also passed several resolutions to promote international cooperation between nations in developing sound nuclear power programs. Resolution GA/11578 of 2014 stressed the importance of peaceful applications of nuclear technology and promoted international cooperation.[83] This concept can be applicable to developing nations receiving infrastructural aid or funding in the case they wish to develop a nuclear program. Further, resolution A/72/L.6 promoted international cooperation specifically regarding nuclear science research and nuclear technology development.[84] Among other forms of bilateral/multilateral state cooperation, the UN and the IAEA heavily recommend the use of peer review between neighboring nations to ensure safety measures and infrastructure are up to date following the latest IAEA guidelines. Furthermore, the UN recognizes the need for state cooperation in the case of a nuclear emergency, harkening back to the Chernobyl disaster which encompassed the nations of Belarus, Ukraine, and the Soviet Union. Their cooperation in mitigating the spread of nuclear waste is a product and an inspiration for the IAEA's work in multilateral state cooperation. Nation states can request the IAEA to enact a  Safety Aspects of Long Term Operation (SALTO) peer review, which essentially checks up nation states' nuclear program and power grid to make sure they follow the IAEA's Safety Standards and provides recommendations for infrastructure and research.[85] In general, the UN and the IAEA work alongside each other in projects and legislature, Resolution A/70/10 highlighting the relationship between the two bodies.[86]

International cooperation regarding this topic is similarly essential to the necessity of international cooperation and transparency regarding the topic of managing nuclear disasters. Transparency is key to any process regarding the use of radioactive material because the proliferation of nuclear weapons and other negative uses of the technology is a significant fear.

## CASE STUDY: Development of Nuclear Technology in the Middle East

Perhaps one of the most convoluted regions in the entire world with many developing nations seeking to acquire nuclear energy has to be the Middle East. Wars have been fought over this subject and war continuously looms over the region due to tensions between neighboring countries concerning nuclear power. While many countries in the region have achieved nuclear power they are under constant threat of invasion if they decide to weaponize similar to Iraq's situation in 2003 and currently Iran's situation. Thus many Middle Eastern Countries are wise to abide by the International Atomic Energy Agency's (IAEA) inspectors and nuclear safety guidelines to show transparency for all nations and to allow them to seek peaceful nuclear energy for civilian use in powering their nations.

Middle Eastern countries for decades have been pursuing nuclear energy. Countries such as the United Arab Emirates (UAE) have been pursuing nuclear energy to peacefully power their country with clean energy. Consulting with the IAEA over the course of the entire project the UAE has been able to open up their first nuclear reactor in 2020.[87] The Barakah-1 Nuclear Reactor is a Pressurized Water Reactor capable of producing 1300MW of electricity and it is a South Korean design.[88] Construction of the nuclear power plant first began in 2012 with it finally finishing this year in August of 2020. However some countries such as Israel which is also a nuclear power in the region has brought grievances upon the UAE with fears they would use nuclear energy for weaponization.[89] Moreover, due to working closely with the IAEA and their inspectors the UAE has a clean track record and is on point to open up three more nuclear power plants.[90]

Such grievances by countries like Israel have made acquiring peaceful nuclear energy extremely difficult for developing countries in the region. For example, when Iraq's leader Sadaam Hussien promised to halt all nuclear weaponization programs and to only peacefully pursue nuclear energy, Israel was one of the nations to directly challenge the findings of UN inspectors who declared Iraq WMD-free.[91] Israel's heavy lobbying within the United States Government along with some of the US government's feelings about Iraq culminated in the invasion of Iraq in 2003.[92] [93] This has left developing nations fearing invasion and massive repercussions by larger powers for seeking to develop a peaceful nuclear program such as Iraq did in the past. Israel within the region has been highly critical of its developing neighbors seeking to use nuclear energy for peaceful purposes due to fears of weaponization.[94] [95] However at the same time Israel is speculated to hold a massive nuclear arsenal capable of destroying the entire Middle East. While Israel does not confirm nor deny its nuclear capability, even its allies such as the United States are confident that Israel does indeed possess nuclear weapons and in significant numbers.[96] This heightened sense of tension between a possible nuclear neighbor/rival has made Israel gone to extreme lengths to prevent is rivals in the area from acquiring or using nuclear energy. Countries such as Iran have signed Nuclear Peace Agreements in the past about their civilian nuclear program and promised not to develop nuclear weapons grade materials. Yet, Israel has taken matters into their own hands by bombing multiple nuclear facilities within Iran. Hoping to deter scientists and engineers within the region from continuing their work on nuclear energy.[97] [98] [99] As such this has lead to heightened tension in the Middle East especially after the US pulled out of the Iran Nuclear Deal and put back on sanctions.[100] This is not the first time Israel has been on the offensive about its developing neighbors acquiring nuclear energy. In 1981 Operation Opera was a limited Israeli military airstrike against Iraqi Nuclear Reactor Plants just south of Baghdad.[101] The act saw Israeli fighters jets fly low to the ground to avoid radar detection and then climb aggressively to drop bombs onto the Iraqi facility. The move was highly condemned by Arab nations and the United States for the bombing of the facilities.[102]

However, this has not stopped Arab nations supported by the US such as Saudi Arabia from acquiring nuclear energy. Despite threats from its more well developed neighbor Israel on the subject Saudi Arabia is planning on building two nuclear reactors.[103] These reactors are to propel the once underdeveloped nation of Saudi Arabia into a nuclear future helping provide clean energy. Saudi Arabia is expected by 2040 to have 15% of its entire nation be provided energy by nuclear reactors.[104] Bilateral relationships between less developed Middle Eastern Nations and more developed nations such as the relationship between South Korea and United Arab Emirates are the basis upon which of how developing countries are gaining access to nuclear energy.[105] This symbiotic relationship is very beneficial between both countries providing jobs and profit for both parties involved. When developing countries are seeking nuclear energy projects they will usually seek out help from other countries to guide them. Along with guidance these more developed countries make sure that the technology is used for peaceful purposes, and peaceful purposes only. To completely avoid nuclear weaponization these nations must place a great trust in each other not to void these terms and must embrace the idea of transparency in the industry as a trust building measure.

Iran is currently working with the Russian Government to enact peaceful nuclear energy.[106] Although, Iran's original beginning as a developing nation acquiring nuclear energy was first aided by the United States underneath the Atoms for Peace program. Iran of course was then at the time led by the Shah of Iran. After the 1979 Islamic Revolution the country has been forced to seek its nuclear know how and knowledge from other countries willing to help it due to its hostile nature towards the US and Israel.[107] As such it is important to the IAEA that international guidelines and inspections are followed and become routine to allow for even developing countries at odds with each other to use nuclear energy peacefully. In conclusion the Middle East is a convoluted mess of alliances and with so many developing nations seeking to acquire nuclear energy within the region it is up to the IAEA to maintain transparency for all involved to allow for peaceful, clean nuclear energy to be provided to all in the region who embrace its peaceful benefits.

# QUESTIONS

1. What action should the international community take to encourage the safe development of nuclear technology in developing nations who may not locally have the resources necessary to pursue such technologies.
2. How does the topic of nuclear non-proliferation play into improving the nuclear infrastructure of developing nations. In other words, how can we support only the beneficial aspects of nuclear technologies and prevent nations from 'dirty bombs' or even traditional nuclear weapons?
3. How can the international community innovate nuclear waste transportation to assist developing countries?
4. Does your nation have nuclear power? If so, what nuclear facilities does your nation possess?
5. What are the costs and benefits of Nuclear Energy? How can nuclear technology be implemented to help developing states beyond providing access to electricity?
6. Is Nuclear Energy worth it for a country? Does your country have the infrastructure and coordination needed to maintain a nuclear power program?

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