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Cross Border Cooperation, the Answer to Nuclear Weaponization

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1. Abstract

The research question of this bachelor thesis is “To what extent can cross-border cooperation lower the risk of nuclear plants being weaponized during armed conflict?” The research design for this thesis will be desk research and interviews. Conducting interviews is necessary to provide for the gaps in the data collected through the desk research.

According to a news article from the BBC, The European Commission has decided that both types of energy, nuclear and gas, can classify as "sustainable investment" if they meet certain targets (BBC, 2022). Even though countries such as Austria and Germany are against this “sustainable” label on nuclear energy, countries such as France are in favor of this new label. France already planned to build more nuclear plants and add them to their current collection. This research paper is relevant to the scientific as well as the societal field. A “sustainable” label on nuclear energy will most likely increase the amount of operational nuclear plants in Europe. Baring this in mind, additional data on the risks of nuclear plant weaponization in case of armed conflict may help to improve the nuclear safety and security in the European Union. These data, in turn, may prove to be of scientific and societal relevance for cross-border citizens who will have to deal with these risks in the future.

2. Introduction

The European Commission has decided that both types of energy, nuclear and gas, can classify as "sustainable investment" if they meet certain requirements (BBC, 2022). Even though countries such as Austria and Germany are against this “sustainable” label on nuclear energy, countries like France are in favor of this new label. France already planned to build more nuclear plants. More power plants may lead to a higher risk of problems connected to these nuclear power plants which could include using a nuclear power plant as a weapon.

In order to understand the necessity of nuclear safety across borders, it is important to know what happens in case of a nuclear meltdown. The book “Sustainable Nuclear Power” by Suppes et. al. explains a nuclear meltdown using the meltdown at Chernobyl as an example. In case of a meltdown, the reactor fuel temperature increases until it reaches a temperature equal to the fuel rods' melting point. Once the temperature reaches beyond the melting point of the fuel rods, it eventually reaches the water. This water turns into steam due to the hot temperature and creates pressure. This steam pressure can break the reactor which results in radioactive material escaping (Suppes et. al., 2007). The covered range of the radioactive material before descending to the earth and poisoning the ground is dependent on the weather at that time. In case of strong winds, the lighter radioactive particles float a lot further compared to less strong winds, before finally descending. The range of the Chernobyl meltdown according to the International Atomic Energy Agency (IAEA) was around 500 kilometers north of the Chernobyl power plant. A 30-kilometer span around the nuclear power plant was called the “exclusion zone” (IAEA, 2005). This zone was evacuated and declared uninhabitable.

Chernobyl is being used in this thesis as a nuclear meltdown example even though Chernobyl’s meltdown did not originate from armed conflict. However, it does carry importance in order to properly describe the effects of such a nuclear meltdown. More on topic, there is the 10-day Slovenian war in 1991. There was armed conflict on the Slovenian-Croatian border which took place in the same area as the Krško nuclear power plant. This plant was then threatened with air strikes (Mavko et al., 1992). Even though this threat did not lead to a nuclear meltdown, it closely fits within the borders of this thesis’ topic.

30 years before the Slovenian war, the IAEA emerged. The IAEA (International Atomic Energy Agency) was founded “in response to the deep fears and expectations generated by the discoveries and diverse uses of nuclear technology” (IAEA history, n.d.). This organization, which hosts memberships to 173 countries (IAEA, 2021) including Ukraine and Russia, made Safety Standards, which provide the fundamental principles, requirements and recommendations to ensure nuclear safety (IAEA, safety. n. d.). The IAEA has the right of initiative to talk with both concerning parties if a nuclear power plant is in a conflict area. It has the right to mediate or make agreements with both parties on not damaging or taking over a power plant to use for own gain.

The Slovenian war took place in 1991, which is 31 years ago. A more recent example is the armed conflict between Ukraine and Russia which threatened a nuclear power plant. According to Matt Farmer from the Power Technology magazine, The Zaporizhzhia power plant was attacked by Russians on March 3rd this year (Farmer, M. 2022). This indicates that Russia did not pay attention to the safety regulations from the IAEA as Russia “compromised one of the seven indispensable pillars of nuclear safety and security stating that “operating staff must be able to fulfil their safety and security duties and have the capacity to make decisions free of undue pressure”” (IAEA, 2022). Due to recent events in Ukraine, the right of initiative by the IAEA to mediate between parties might not be enough. More regulations to ensure the safety of nuclear plants and the surrounding inhabitants might be necessary.

The Russian attack on Ukraine questions whether nuclear power plants are desirable due to the threats and dangers that might come with the existence of nuclear plants.

The second of the three objectives of the cross-border cooperation element of the European Commission is the goal to address common challenges like the environment, public health and, essentially for this thesis, the safety and security of the cross-border region (European Commission CBC, n.d.). To ensure or improve the safety and security of the home country as well as the neighboring countries in case of a nuclear power plant in close proximity to the border, agreements should be made between the concerning countries.

Due to the fact that nuclear power plants are usually build in the periphery of the country close to the borders, it is crucial that there is cross-border cooperation regarding those nuclear power plants. Cooperation between countries on such matters can be beneficial to both countries in the long-term due to proper communication between the involved countries. This communication should be conducted to avoid future complications ensuring the safe usage of the nuclear plant and maintaining good relations between the involved countries.

In this paper it is my aim to find answers on the extent to which cross border cooperation can prevent the usage of nuclear power plant as a weapon. The research question of this paper: "To what extent can cross-border cooperation lower the risk of nuclear plants being weaponized during armed conflict?" will be answered by targeting two sub-questions. Namely: "What risk-reducing role can cross border cooperation have in armed conflict?" and "What is the extent of the risk of nuclear weaponization?"

The first sub-question refers to what risk-reducing role cross border cooperation can have in armed conflict. Cross border cooperation in this sub-question is used as an aid in risk reduction. Cross border cooperation will be defined in this study later on. However, cooperation between neighboring countries bears relevance in events that include nuclear power plants. Especially since most nuclear power plants are build close to borders, it can be essential to include the neighboring countries in the possible exclusion zone in case of a nuclear meltdown. Nuclear power plants in armed conflict can pose a threat to the area if this nuclear power plant would be damaged enough for an explosion to occur. This is an unwanted event by either party of the armed conflict. Therefore, cross border cooperation may be a good problem-solving solution to preventing or reducing this risk of unwanted damage.

The second sub-question examines the risk of nuclear plants being weaponized. The essence of cross border cooperation as a tool for risk reduction in armed conflict only bears value once there actually is a risk that needs attention. Most people know what happened after the nuclear meltdown in Chernobyl or Fukushima. The affected area was enormous and the radiation affected nature to an extend that the effects are still present today. Weaponizing a nuclear power plant can happen in various ways which will be explained later on in this thesis. Is there a risk of nuclear power plants being damaged and will this damage have serious life-threatening consequences? Those are the questions that this study will try to answer.

The relevance of this study can be explained through various arguments. The main reason to start this study are the recent conflict events between Ukraine and Russia and Russia damaging a nuclear power plant in Ukraine. This thesis' relevance is spread across scientific as well as societal relevance. The consequences of a nuclear meltdown or usage of nuclear grade weaponry are known to most people on this earth. The world has either witnessed, heard of or felt the consequences of Chernobyl and Fukushima and the bombing of Hiroshima. These events should never happen again and require all possible ways of prevention. Thus, to prevent is better than to cure.

This paper can potentially shed a light on international conflict management within Europe on nuclear power safety regulation. This paper may help the nations within Europe to understand the need to improve their cooperation with the neighboring countries in close proximity to nuclear power plants. Furthermore, it may help to improve relations and abolish any conflict, reducing the risk of nuclear threats even further.

3. Theory

The theoretical framework of this thesis is divided into three sections. Firstly, it discusses the conceptualization of cross-border cooperation and that of nuclear power plants being weaponized. Conceptualization is necessary in order to understand what is meant with cross-border cooperation and nuclear plant weaponization. These two definitions act as the red wire through this thesis and need to be clear in order to understand the remainder of the thesis. Secondly, this thesis will discuss how a nuclear power plant can be weaponized, including the timespan of a nuclear power plant before the plant has completely cooled down, as well as several ways in which nuclear weaponization can occur. Finally, the role of cross-border cooperation in crisis management will be discussed. Cross border cooperation bears the role of handling a crisis. The theoretical framework will illustrate in what ways cross border cooperation can achieve conflict management.

3.1 Conceptualization

Before discussing the thesis' topic, there are concepts that need to be defined such as weaponization of nuclear plants and cross-border cooperation.

3.1.1 Defining Weaponization of Nuclear Plants

In the event of a nuclear power plant being damaged, a chance of a nuclear meltdown emerges. Earlier in this paper the impact of a nuclear meltdown has been explained. The span of Chernobyl's exclusion zone was 30 kilometers. The range of radioactive material however, was around 500 kilometers away from the plant (IAEA, 2005). And depending on the weather and wind conditions at that time this range could have become even larger. This radioactive material spreads and makes the surrounding area uninhabitable due to high levels of radiation. This paper uses the nuclear meltdown of Chernobyl as an example of the impact. According to the World Nuclear Association (WNA) 28 people died within a few weeks after the Chernobyl meltdown as a result of acute radiation syndrome. Furthermore, 350,000 people were evacuated as a result of the accident (WNA, 2022). These are merely the acute effects of a nuclear meltdown. In time, radioactive material descents from the atmosphere and contaminates the area around the plant. Until present time the surrounding area is still uninhabitable even though the meltdown took place 36 years ago.

3.1.2 Defining Cross Border Cooperation

In order to comprehend the extent of the research question, it is essential to have a clear view of what cross-border cooperation entails. Following Jaansoo (2019), cross border cooperation is a formal voluntary union of two or more subnational governments at the same administrative level with a common international administrative land border working regularly in a joint activity across that border while maintaining their respective jurisdictional autonomy.

3.2 Nuclear Weaponization

To properly describe nuclear weaponization, the theory is divided into the timespan of a nuclear threat and nuclear plant weaponization in theory.

3.2.1 Timespan of a Nuclear Threat

The relevance of cross border cooperation in this paper is regarding the risk of nuclear plants being used or damaged in armed conflict. Nuclear power plants are a different sort of industry than a manufacturing industry. Manufacturing industries can simply be stopped by “pulling the plug” (Jacobs et al. 1994). Nuclear power plants are not always so easily managed due to the enormous amount of energy that cannot simply be stopped on command (Jacobs et al., 1994). A nuclear power plant in an armed conflict possesses a danger for the area for as long as the plant is not completely cooled down. “The time required for the plant to cooldown is approximately 10 to 20 hours, which corresponds to a cooldown rate of 15 to 30°C per hour” (Nuclear Power, n.d.). Those twenty hours before complete cooldown is achieved is exactly what requires the attention of cross-border cooperation and improvement of nuclear safety.

3.2.2 Nuclear Plant Weaponization in Theory

May and Barack theorize on how a nuclear plant could be weaponized, either through damaging it and making it into a weapon or using the materials to craft nuclear grade weapons.

A nuclear power plant can be weaponized in different ways. One way would be to take over the nuclear power plant and use the materials to create nuclear weapons (Barzashka, 2013). This way the power plant would be indirectly weaponized. A more direct way to use a nuclear power plant would be to attack and destroy the plant (May, 2018). This way the power plant itself acts as the weapon. Spreading radioactive material which harms the civilians in the vicinity as well as making the surrounding area inhabitable. A third way to weaponize a nuclear power plant is to launch a cyberattack on the controls which can result in a meltdown (May, 2018).

If a nuclear plant was physically attacked it would not take too much effort to destroy it. According to Cade May (2018), "if a jet aircraft crashed into a nuclear reactor and only 1% of its fuel ignited after impact, the resulting explosion could compromise the integrity of the containment building, with possible release of radioactive material". In this example the author only uses 1% of the fuel being ignited. The chances of radioactive release would strongly increase once more fuel would be ignited. May mentions that nuclear power plants have many weaknesses and are not resistant to terrorist attacks should these occur (2018).

In case of indirect weaponization taking over a nuclear power plant and harvesting the materials would not prove difficult. Barzashka (2013): “exactly the same machines that produce nuclear fuel can produce weapons material. That is why uranium enrichment technology is inherently dual-use. Any civilian enrichment facility can be used to produce nuclear weapons material”. Due to the dual-use danger of these machines the International Atomic Energy Agency (IAEA) has put up safeguards to ensure this is prevented and the plants are monitored to ensure the use of the nuclear material is solely as declared (Barzashka, 2013). On top of the ability to use the same machines to make nuclear weapons, the required material for producing a nuclear bomb is 25 kilograms of enriched uranium or 8 kilograms of plutonium (IAEA, 2001). According to Barzashka (2013), a typical nuclear reactor uses 27.000 kilograms of low enriched uranium per year, meaning that, once enriched, one reactor has the capacity to produce approximately 20 bombs per year.

A second threat to direct weaponization of a nuclear power plant would be through a cyber-attack. The cyber-attack on the Iranian Natanz power plant in 2010 provides as an example of such an attack. A virus which currently bears the name Stuxnet, is believed to have destroyed an upwards of 1000 nuclear centrifuges (May, 2018). This shows that cyber-attacks now are able to do physical damage through implementing a virus. Especially a nuclear power plant cannot be defenseless against such a cyber-attack, for the consequences may be catastrophic.

3.3 Cross Border Cooperation and Conflict Management

By investigating whether cross border cooperation has an impact on reducing risk of weaponizing nuclear power plants armed conflict, is to investigate the role of cross border cooperation in conflict management. A study of the Indonesia-Timor border by Sandy Raharjo in 2016 quotes Miller who describes conflict management as "interventionist efforts towards preventing the escalation and adverse effects, especially violent ones, of ongoing conflicts" (Miller, 2005). Raharjo mentions that conflict management does not resolve the dispute, but rather reduces, downgrades, or contains the level of conflict. Cross border cooperation rather tends towards reduction of risks and conflict on several barriers than to resolve conflict. This is explained by Lee and Forss (2011) who state that border cooperation could contribute to eliminating physical and psychological barriers that strengthen the socio-economic welfare of local communities toward regional integration. Eliminating physical and psychological barriers puts the focus on disputes between citizens on either side of the border. Cross border cooperation focuses on improving relations between either side of the border to collaborate and improve together instead of fighting for their own needs (Raharjo, 2016). The socio-economic sector that cross border cooperation aspires to improve, zooms in on being more economically strengthened to decrease the risk of feeling a need for conflict. Lastly, due to the reducing impact that cross border cooperation has on conflict, cross border cooperation indirectly impacts the amount of violence in conflicts (Raharjo, 2016). Even though there are other ways to resolve a conflict that affects two or more neighboring countries, cross border cooperation is the only option in which the legal system stays out of sight as well as the involvement of third parties who should obtain sovereignty over the land of conflict (Raharjo, 2016).

The previous example of conflict management through cross border cooperation between Indonesia-Timor focused on how cross border cooperation can reduce conflict between the affected parties. However, the European Union plays a role in conflict transformation through cross-border cooperation as well. An article by Katy Hayward (2007) uses the island of Ireland and the effects of cross border programs. To understand the concept of conflict, Diez et. al. is quoted, using their definition on conflict: "the articulation of the incompatibility of subject positions" (Diez et al., 2006). The Hayward article provides 4 pathways through which the European Union can affect border conflicts. First pathway is described as 'compulsory impact' in which the European Union guides leaders of conflicted areas to solve their conflicts in a peaceful manner (Hayward, 2007). The second pathway, the 'enabling impact', has a more indirect approach. By offering the conflicted parties a European integration, their opinion on the conflict can be altered (Hayward, 2007). The 'connective impact', the third pathway, directs itself by affecting the conflict through project funding or other EU initiatives (Hayward, 2007). Lastly, the 'constructive impact' is described by Hayward (2007) as the best mode of transformation. It is the most long-term way of the EU to influence conflicted parties. The constructive impact pathway aims to construct and where necessary reconstruct the identities of conflicted parties (Hayward, 2007).

The situation around the Zaporizhzhia nuclear plant during the Ukraine-Russia conflict is a good example of how the IAEA deals with an emergency concerning nuclear power plants. An oral report presented to the Board of Governors this June explains the IAEA's course of action in a nuclear threat situation. As soon as the Zaporizhzhia nuclear power plant (NPP) was under threat, the Incident and Emergency Center (IEC) came into action. The impact of the situation is assessed between the host country in which the conflict resides and the IEC (Report IAEA, 2022). According to the IAEA's report, their actions do not remain merely communicative. The IAEA, aided by the host country and several member states of the IAEA, provided the Zaporizhzhia nuclear power plant with assistance that will help to maintain nuclear safety and security.

This report describes the course of action of the IAEA and her member states in case of a nuclear threat. This emergency response consists of communication and on-the-ground assistance that, combined, proved to be sufficient to maintain nuclear safety and security. Although there is no clear mention of which member states aided Ukraine's NPP, there was aid from member states, indicating cooperation from other countries. Perhaps these where not countries bordering Ukraine, but they cooperated nonetheless.

3.3.1 Risk Reduction through Cross-Border Cooperation

Lastly, this paper reaches the role of cross border cooperation (CBC) and her ability to prevent or reduce nuclear plant weaponization in armed conflict. Ways in which CBC could prove effective is through preventive mechanisms such as crisis preparedness and the regulation on how to respond to an emergency.

Regarding safety of nuclear power plants in the European Union, all member states rely on the IAEA and the Euratom treaty which all member states signed. There is not much to be found in the literature that indicates that neighboring countries made agreements or took measures together to prevent or reduce the risk of weaponization of their nuclear plants. The Cooperation on Nuclear Safety report by the Dutch Safety Board (DSB) explains how the organizations responsible for nuclear safety in the Netherlands interacts with neighboring countries in case of a nuclear accident, but fails to mention anything on cross border cooperation in case of armed conflict entailing an attack on their nuclear power plants (DSB, 2018). This lack of information increases the difficulty to get a grasp on the risk reduction effect of cross border cooperation.

As aforementioned, the IAEA has safeguards to prevent weaponization and it has inspectors in all nuclear power plants to make sure the machines in the plants are used for the purpose as declared (Barzashka, 2013). As long as this organization keeps true to its promises and none of the member states of the European Union decide to start a conflict with a neighboring country, this will be sufficient.

However, should a member state decide to start an armed conflict with a neighboring country, will the treaty and the IAEA be enough to keep them from targeting nuclear power plants? Russia had no regard for the measurements of the IAEA when it damaged the Zaporizhzhia power plant in Ukraine. One wonders whether this risk could have been prevented if peaceful agreements between Russia and Ukraine had been made regarding nuclear power plants in the event of conflict.

4. Methodology

The data collection methods of this thesis consist of desk research and an interview. Either collection method consists of qualitative data collection. No surveys or other quantitative collection methods have been used. Desk research has been done by extensive searching on several search engines online through keywords that matched with the topic of this thesis. No coding aid was necessary in this research therefore aid tools as Atlas.ti were unnecessary.

4.1 Desk Research

To address the research question and the sub questions, several types of documents have been studied, reviewed for relevance and the most essential, relevant sections to this thesis were implemented. Scientific articles, policy- and strategy documents as well as journals from respected websites and reports from respected associations were selected. These documents combined formed the foundation for the theoretical framework above as well as the data analysis below.

In the document selection there was no specific attention devoted to a range of publication dates. The main reason for this decision is because certain articles, as well as conventions used in this thesis, date from decades ago, but are still used and carry relevance until present time.

Scientific articles are collected based on the keywords such as cross border cooperation, conflict management, nuclear safety and cross border cooperation on conflict management. These articles are collected from search engines such as google scholar and the UT library. The scientific articles have been used to determine the discussions regarding nuclear safety and cross border cooperation and to what extent cross border cooperation aids to a prevention or reduction of nuclear plants being in danger of becoming collateral damage in armed conflict. Prominent scientific authors used in the theoretical framework are Hayward and Raharjo on conflict management and Barzaskha and May on nuclear weaponization to strengthen the foundation on which the data analysis has been build. Policy and strategy documents are collected from the Dutch Safety Board and the IAEA as well as the European Commission (EC). The non-scientific documents from e.g., the World Nuclear Association and the BBC have provided this thesis with updated information on current events such as the conflict between Ukraine and Russia when the Zaporizhzhia power plant was damaged.

4.2 Interview

Besides the use of articles, this thesis will include an interview conducted with an expert on nuclear energy and safety to fill the gaps that emerged from comparing the scientific documents with the policy-, strategy- and non-scientific documents regarding the risk reduction of weaponization of nuclear power plants in armed conflict through cross border cooperation. The method of how the interview is conducted and how the data is collected will be explained in this methodology section. The expert was asked whether he or she preferred anonymity or if mentioning of names was allowed. Anonymity was preferred causing the interview to be handled anonymously, entailing there will be no mentioning of anything leading to the expert's identity. The name of the organization the expert works at was allowed to be mentioned. Besides anonymity the expert was given the opportunity to conduct the interview online or in person. Due to the busy schedule of the expert and convenience the interview was conducted online.

The interview was initiated through promising guaranteed anonymity of the interviewee and setting up the transcription and recording tools. After completion of the setup, general questions were asked as an introduction to establish the expertise of the interviewee and getting comfortable with each other. The expert was asked in what way the Autoriteit Nucleaire Veiligheid en Straling (ANVS), which is the organization the expert works at, cooperates with their neighboring countries in general sense. Whether the ANVS works with similar counterparts or directly with foreign nuclear power plants was asked as well. The asked questions were meant to retrieve answers regarding any way of cooperation. After more general questions, the interview focused more on topic questions. The expert was asked about risk reduction of threats on nuclear plants through cross border cooperation as well as how nuclear plants could be weaponized.

The interview was conducted online through Microsoft Teams (MT) where to make recording and transcribing the interview simultaneously through recording and transcription tools easier. The spoken language was Dutch since both interviewer as well as interviewee are Dutch citizens, maximizing dialogue efficiency. For the interview, an expert was selected who knew all about nuclear plants from basic operations to course of action in case of man-induced conflict. The expert was required to have knowledge of nuclear plants in a member state of the European Union with connections to other member states in order for the expert to be able to answer European Union level questions.

After approximately 40 minutes of questioning, the interview ended with a final opinion from the expert on whether the expert thinks the current cross border cooperation agreements are sufficient to reduce nuclear plants being at risk during armed conflict. The questions asked in the interview were open ended questions. Throughout the interview there emerged closed questions who were not scheduled but came up due to the continuous conversation in which confirmation of the expert was necessary. Keeping to open ended questions enables the chance for the expert to provide more information that may prove relevant for the thesis at first. More interesting topics may emerge that can act as additional information to fill the gaps which the previously done desk research left open.

5. Data Analysis

In the coming section the findings from the desk research and the interview with the ANVS expert will be analyzed thoroughly. The analysis will be initiated with providing background information to understand the analysis. A small recap from the theoretical framework and highlighting past threats of nuclear power plants. The analysis proceeds to an oversight of conventions from the International Atomic Energy Agency describing the course of action in case of a nuclear emergency as explained in two conventions. A thorough analysis on the risk of nuclear weaponization is provided. Where emphasis is placed on whether nuclear power plants do indeed pose a risk for nuclear weaponization. Finally, there is the analysis on the role of cross border cooperation on nuclear weaponization. Desk research and interview are merged together to pave the way for answering the first sub-question.

5.1 Background

The European Commission has put a pro-environmental label on nuclear energy since 2022. The currently active nuclear power plants will most likely stay active, now that there are less environmental restrictions on producing nuclear energy. Moreover, the expert from the ANVS mentioned that new agreements are being made regarding the potential increase of nuclear plants in the Netherlands. One can only imagine all member states of the European Union are discussing this topic. The expert mentioned the likeliness of new potential nuclear plants consisting of the same technology and materials. These nuclear plants require several hours to completely cool down, making them a threat in conflict. If more nuclear power plants will be built over the upcoming years, the chance of this scenario happening will increase. Desk research indicated that a nuclear power plant in an armed conflict possesses a danger for the area for as long as the plant is not completely cooled down.

In the last 30 years there have been two threats. The first threat being the 10-day Slovenian war in 1991 in which the Krško nuclear power plant was damaged. The other one being the Ukrainian nuclear plant in 2022. Over the past 30 years there has been no reason to investigate the risk of weaponization of nuclear power plants, and more importantly, ways to reduce this risk or even prevent weaponization. However, the Zaporizhzhia power plant in Ukraine ignited the question why weaponization prevention has never been examined and to what extend risk reduction is already present.

5.2 Conventions from the International Atomic Energy Agency

The IAEA proves to be an essential organization when conflict emerges and a nuclear power plant is included. In order to make sure that nuclear threats such as the Slovenian war will not happen again or will happen safely without danger of nuclear plants being damaged, the IAEA made conventions on how the agency, as well as the member states, need to act in case of an emergency.

Convention on Early Notification of a Nuclear Accident

The actions described in the report are based on conventions signed by member states of the IAEA. In case of a nuclear accident there is the Convention on Early Notification of a Nuclear Accident (CENNA). CENNA applies in the event when a "release of radioactive material occurs or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State" (CENNA, 1986). This convention describes what information is shared to which actors in case of a nuclear accident. Article 5 from CENNA, information to be provided, states that parties will receive time and location of the accident, the facility involved, the assumed or established cause of the accident, the characteristics of radioactive release, the current forecast, predicted behavior of radioactive release and the off-site protective measures that have been taken or planned (CENNA, 1986).

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

The convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (CACNARE) is the on-the-ground measure of the IAEA and her member states to "cooperate between themselves and with the International Atomic Energy Agency (IAEA) in accordance with the provisions of this Convention to facilitate prompt assistance in the event of a nuclear accident or radiological emergency to minimize its consequences and to protect life, property and the environment from the effects of radioactive releases" (CACNARE, 1986). Article 5 of the CACNARE, functions of the agency, consists of collection and dissemination of information concerning experts, materials, equipment, methodologies and techniques for nuclear accidents and emergencies. The IAEA assists in preparing emergency plans as well as developing training programs to deal with nuclear accidents and emergencies. Article 5 compels the IAEA to make resources available to assess the accident or emergency and establish and maintain liaison with other international organizations.

5.3 Risk of Nuclear Weaponization

To assess the risk of a nuclear power plant being weaponized in armed conflict, it is important to look at Europe's past. One notices that there has not been any operating nuclear power plant that came under armed attack until very recently. On march 4th, the "Zaporizhzhia plant in southeastern Ukraine became the first operating civil nuclear power plant to come under armed attack" (Mijeon et al., 2022). The nuclear meltdown of Chernobyl and Hiroshima were both due to accidents or natural disasters, not due to an armed conflict. The Zaporizhzhia power plant's site was located in the fighting area and was hit by a projectile moments before the Russian army took over the power plant (Mijeon et al., 2022).

Other incidents concerning nuclear power plants being at risk that appeared in the European Union to emphasize that nuclear plant weaponization remains a risk are events in Monts d'Arree, France in 1975 and Belgium in 2014. In France, Breton separatists crossed the plant's artificial cooling lake by boat and cut through a fence in order to plant two bombs at the facility. The bombs detonated, damaging an air vent and a water inlet for the plant's cooling system. The reactor was temporarily shut down for inspection (NuFAD, n.d.). The Doel nuclear power plant in Belgium was attacked by a saboteur who released oil to an underground storage tank, causing a turbine to overheat and shut down. Another reactor was subsequently shut down as well (NuFAD, n.d.).

In October 2020, there was a threat when Azerbaijan threatened to bomb the Armenia Metsamor power plant during the Nagorno-Karabakh conflict. The Metsamor power plant being located close to the Turkish border and within close proximity to Georgia and Iran would have resulted in a catastrophe if these threats would have been realized (Mijeon et al., 2022). These two examples show that in recent years until the very present, there are conflicts that do involve nuclear power plants being collateral damage or even the very target in armed conflicts. According to Mijeon et al., there are plans to build up to between 600 and 700 additional nuclear power plants worldwide. This would increase the chance of nuclear power plants becoming part of a conflict due to its rapid increase in numbers.

Luckily, the aforementioned attacks all ended in nothing more than threats and small amounts of damage that did not pose a real threat. Even though these nuclear plants have been damaged, none of the attacks caused a nuclear meltdown or any effect that posed any danger to human lives. Past events prove that current nuclear plants are sufficiently protected and safe from assaults on nuclear plants. Therefore, the current risk of nuclear weaponization can be assessed as slim but present.

5.4 Analyzing the Role of Cross Border Cooperation on Nuclear Weaponization

One cannot mention nuclear without mentioning the International Atomic Energy Agency (IAEA). The IAEA's main mission regarding risk reduction or prevention of nuclear weaponization in armed conflict is verifying through inspection that States comply with their commitments, under the non-proliferation treaty and other non-proliferation agreements, to use nuclear material and facilities only for peaceful purposes" (IAEA mission statement, n. d). The international organization's documents are relevant to this thesis due to the fact that the IAEA prevents the potential threat of nuclear materials being used for non-peaceful purposes, which is what this thesis tries to answer on the cross-border level instead of the EU level. Besides the IAEA's mission statement, their safety standards carry relevance as well. These standards provide the fundamental principles, requirements and recommendations to ensure nuclear safety among all 173 state members, including all European Union states (IAEA, safety. n. d).

The interview mainly provided additional information which quickly went towards continuous collaboration between member states. The Autoriteit Nucleaire Veiligheid en Straling (ANVS) closely cooperates with similar regulators in their neighboring member states. Collaboration between such regulators consists of sharing information on matters, spreading from simple tests to machine failures or weaknesses. This way member states and their nuclear power plants learn from each other. The IAEA acts as the overarching organization. There are annual peer reviews to check up on regulations in member states. This delegation consists of the IAEA as well as neighboring countries. Besides regulatory organizations and the overarching IAEA, there is a more decentralized cooperation between nuclear power plants from neighboring countries as well. The ANVS acts similar to their German and Belgian equals through peer reviewing, information sharing and exercises to maintain security to the best of their abilities. This includes informing each other on possible weaknesses in power plants, how to prevent those weaknesses from becoming a problem and they perform training together to prepare for emergencies. This is done on a national level between organizations overlapping all nuclear plants in a single country with their respective overlapping organization in their neighboring countries, as well as more top-down between nuclear power plants in close proximity of each other.

The expert's opinion on the possible increase of nuclear power plants was confident. The current regulations appear to be sufficient if additional nuclear power plants would be built. This statement is founded on the assumption that nuclear power plants will consist of the current water-cooled system used in most active nuclear power plants.

The expert was unable to provide information on man-induced actions that would threaten the integrity of NPP's. Any information regarding plans of operations to defend the nuclear power plants and what actors would play a role in this, remains secret to anyone who is not a member of such organizations. There are plans and exercises to ensure preparedness in case a man-induced incident would occur. The question, whether cross border cooperation would reduce the risk of nuclear weaponization in case of armed conflict, resulted in silence to maintain secrecy.

The expert confirmed that in case of an accident, which compels the nuclear plants to be shut down, the initiation of the cooling down process can be done in a matter of seconds. However, lots of energy is still present in the core that needs to be kept cool. Even though the processes are reduced to a mere 10 per cent of the original activity, this will be sufficient to produce a meltdown if the coolers are destroyed.

The desk research and interview data concluded that there is not much to be found in the literature which indicates neighboring countries have made agreements or took measures together to prevent or reduce the risk of weaponization of their nuclear plants. The expert did not share such information in the interview to prevent secret security information from becoming public. This information becoming public would have resulted in becoming a security risk for nuclear plants within the European Union. The reason of absent articles on the matter is therefore comprehensible.

Regarding weaponization of nuclear power plants the expert managed to share the course of action in case of an accident or emergency. Nuclear power plants can shut down to 10 per cent of operations. Reducing the energy and heat of the processes to a minimum. Desk research confirmed this by requiring approximately 20 hours of cooling time before complete shutdown. Until this state is achieved there is a chance of weaponization.

Cross border cooperation to reduce the risk of weaponization during armed conflict remains rather unclear in either data collection method. Either method refers to the IAEA in case of an emergency that bypasses day-to-day problems and malfunctions. The desk research provided the Euratom treaty strengthened by the CENNA and CACNARE that explain what sort of aid is provided in case of an accident or emergency, but remains unclear on whether there is any existing cross border cooperation agreement in case of a nuclear weaponization threat. The expert in the interview was unable to share any information that would uncover any plans or actions in the event of any sort of man-induced conflict. This makes it difficult to assess the effect of cross border cooperation on reducing the risk of weaponization happening. Both data collection methods are similar in their way of refraining from sharing information regarding this topic.

6 Conclusion

In order to conclude this thesis and provide an answer to the research question, both sub-questions need to be answered. The data collection methods to obtain answers to the main research question as well as both sub-question were desk research and an interview. This conclusion covers the addressment of both sub-questions before addressing and answering the main research question. After addressing the sub and main questions the conclusion proceeds to the thesis' limitations that forced me to work with less data than was anticipated beforehand. The conclusion ends with the possible pathways for possible further research that can improve this thesis or improve the overall knowledge on the role of cross border cooperation in armed conflict and the mentioning of a final say to finalize this thesis.

6.1. Addressing the Sub-Questions

The Risk-Reducing Role of Cross Border Cooperation in Armed Conflict

The first sub-question that helped by eventually answering the main research question was to investigate what risk-reducing role cross border cooperation can play regarding nuclear power plants being weaponized in armed conflict. The ANVS explained in the conducted interview that the Netherlands, as well as any other member state of the IAEA, is constantly in contact with their neighboring countries. Neighboring countries in the EU share information with each other regarding possible weaknesses in power plants, how to prevent those weaknesses from becoming a problem and they perform training together to prepare for emergencies. This is done on a national level between organizations overlapping all nuclear plants in a single country with their respective overlapping organization in their neighboring countries, as well as more top-down between nuclear power plants close to each other.

As aforementioned, the ANVS is a good example of an organization that provides and constantly improves nuclear safety through cross border cooperation, cooperating with their respective overarching organizations across the border. Furthermore, there is the Dutch Safety Board (DSB) whose safety report showed that there is extensive cooperation with nuclear power plants across the border reaching from information sharing to training exercises in cases of emergency. This proves quite similar to the gathered information from the ANVS, implying that cross border cooperation to improve safety takes place on multiple levels.

Furthermore, desk research shows how the European Commission views cross border cooperation. The most relevant objective of the European Commission is to address common challenges like the environment, public health and essentially for this thesis the safety and security of the cross-border region. To provide safety in general, the European Commission uses cross border cooperation to increase safety, which evidently includes safety from nuclear power plant as well. The second objective of cross border cooperation from the European Commission mentions this, which can also be found in the theoretical framework

The one organization whose name has been present throughout the entire thesis, is known as the International Atomic Energy Agency (IAEA). The IAEA is the overarching organization that all member states answer to and call for help in case of an emergency. The ANVS mentioned in the interview with the expert that the IAEA visits the ANVS, testing everything, completely checking the state of the nuclear plants and their status. The expert explained this happens to all member states of the IAEA, entailing that it happens to all member states of the European Union. Since the IAEA's creation, events regarding nuclear safety go through the Incident and Emergency Center (IEC). As a result, the IAEA decides to what extent help is possible and necessary and what countries are allowed to help the affected country. It proves difficult to assess the extent of safety that is provided through cross border cooperation without the presence of the IAEA. The IAEA controls all actions when it comes to conflict that includes a nuclear power plant. On top of the IAEA's complete control over nuclear energy, information on risk-reducing roles is top secret to ensure the dangers are kept to a minimum.

As a result, through literature reviews as well as the interview with the ANVS this study did not provide sufficient information to properly answer the first sub-question. However, it is clear that there are various plans and agreements on how to act once a nuclear power plant is attacked or in a state of emergency. It became clear that there are annual checkups to maintain the most secure and up to date nuclear power plants. But, what risk-reducing role cross border cooperation can play in armed conflict remains unknown. Neither desk research nor the interview was able to answer this question.

The Risk of Nuclear Plant Weaponization

The second sub-question that paves the way for the concluding answer of this bachelor thesis, investigates the risk of nuclear plants being weaponized. There are three major ways how to weaponize a nuclear power plant. The first approach being harvesting materials once a nuclear power plant is taken over. These materials can, without too much effort, be shaped into weapons grade nuclear material. This is an indirect approach to nuclear plant weaponization. The more direct approaches are bombing of the plant or commencing a cyber-attack. In case of the bombing of a nuclear power plant, the nuclear power plant itself becomes the weapon. Through bombing a nuclear power plant, one forces a nuclear meltdown through which the surrounding area becomes an exclusion zone and the airborne radiation spreading much further will cause effects that align with Chernobyl and Fukushima. The second direct approach to weaponizing a nuclear power plant is through a cyber-attack. According to May (2018) and the expert from the ANVS, most parts of nuclear power plants nowadays are automated. Computer driven operations are susceptible to hacking. Such a cyber-attack could potentially disrupt the cooling of the reactors until temperatures are reached which the facility cannot handle, causing an explosion that affects human life (May, 2018).

Besides the pathways that show the risk of nuclear plant weaponization, there is the timespan in which a nuclear plant poses a risk to life in the close vicinity. If conflict should arise in close proximity of a nuclear power plant, it can be shut down. This is where the problem lies due to the large amount of time it takes for a nuclear power plant to be completely cooled down. A nuclear power plant requiring 10 to 20 hours before it will be completely cooled down, results in being a threat to nuclear weaponization for those 10 to 20 hours. During this time the armed conflict could have already reached this area (Jakobs et al, 1994).

Combining the pathways of weaponization with the amount of time it takes to completely secure a nuclear power plant gives sufficient information to state that there is a real and evident risk of nuclear plants being susceptible to being weaponized.

6.2 Addressing the Research Question

After successfully answering both sub-questions, the addressment of the main research question has arrived. The Research question is “To what extent can cross-border cooperation lower the risk of nuclear plants being weaponized during armed conflict?” As the answer to the first sub-question provided, there is cross border cooperation between nuclear power plants and their leading organizations with their neighboring countries in forms of simple training exercises to information sharing in times of emergency. The IAEA provides annual checks on nuclear power plants in the EU and stands guard to any upcoming emergency through the Incident & Emergency Agency. Even though the IAEA carries such a heavy burden of enforcing nuclear safety, unfortunately the IAEA proves to be as evenly silent as the ANVS. The expert from the ANVS was unable to say anything regarding cross border cooperation in times of armed conflict, also stating that asking a similar question to the IAEA would not increase the chance of receiving more information. Most reports on the topic of nuclear safety in armed conflict mention how to sustain minimal damage when an attack has already happened instead of what is done to prevent this risk. Sub-question one can thus not be answered.

The second sub-question provided a clear oversight in how a nuclear plant can evidently pose as a risk through nuclear weaponization. Both direct pathways as well as the indirect pathway combined with the time it takes a nuclear plant being in state of operation to complete cooldown proves to be sufficient information to answering the sub-question by confirming that nuclear power plants pose a risk to nuclear weaponization.

To conclude, in the events of armed conflict, there is one organization that mainly acts in the nuclear safety area, the IAEA. Armed conflict concerning the safety and security of a nuclear power plant is always handled through the IAEA and their Incident and Emergency Center (IEC). The expert was confident enough to state that the current agreements between neighboring countries can deal with all sorts of problems outside of armed conflict. But once conflict is present, the IAEA is the main organization that has the authority to act. The actions that will be taken by the neighboring countries of the conflicted country in a time of conflict remain secret to the public.

Both answers to either sub-question provide the final answer of the research question: “To what extent can cross border cooperation lower the risk to nuclear plant weaponization in armed conflict?” With the current information that could be obtained by one student in the timespan of several months, I conclude that the role of cross border cooperation on nuclear safety covers all that precedes armed conflict and takes over its responsibilities again once armed conflict has passed. Unfortunately, the role of cross border cooperation remains confidential to the public even though there is an evident risk to nuclear weaponization which risk could certainly be reduced by cross border cooperation.

6.3 Limitations

The main limitations in this bachelor thesis were caused by the lack of response from organizations I wanted to interview as well as the few articles that have been written about this specific topic. Armed conflict in the European Union that concerned the safety of a nuclear power plant has not happened in the past thirty years since the Slovenian war of 1991. I assume that that is the main reason for the lack of research on the matter. Beside the ANVS I contacted the IAEA, the Incident and Emergency Center (IEC), the Federaal Agentschap voor Nucleaire Controle (FANC) and the Nuclear Threat Initiative (NTI) as well as the Ministry of Defense and the Ministry of Climate. With the exception of FANC, none of them responded to my mails or calls. I am thankful for the ANVS for responding to my e-mails and for conducting an interview with me. Eventually the IAEA would have been the organization most vital in helping me with my thesis. Therefore, the lack of response proved to be the major limitation to answering the research question.

6.4 Further Research

If I may suggest how to further research this topic, it would be to expand research on conflict management through cross-border cooperation to the global level, outside the borders of the European Union. The European Union may be the main field of operations of the Management, Society & Technology program, but nuclear safety is of global interest. Countries like Ukraine with the Zaporizhzhia plant, Japan with Fukushima, the United States with their three-mile island accident and Armenia with her Metsamor plant could all provide relevant information to strengthen the argumentation of this research. Expanding this research to a global level might improve the relevance of this research which could open up doors that do answer questions on cross border cooperation's role in reducing the risk of nuclear plant weaponization.

In the end the entire world aspires to achieve safety and security and nuclear weaponization has no place in between such terms. The IAEA has member states outside of the European Union as well, therefore expanding this research to a global level would be a good way to get the best grasp possible on the extent of risk reduction of nuclear weaponization in armed conflict by cross border cooperation.

6.5 Final Words

This bachelor thesis merely attempts to shed a light on the dangers that nuclear power plants can represent, and how this danger can be reduced through cross border cooperation. My research shows that, despite the willingness of the ANVS to answer most interview questions, there is a lot of secrecy around nuclear energy in relation to conflict. This secrecy was a major obstacle in answering the first sub-question. Now that more plants will most likely be built in the coming years I wonder if this secrecy should remain. The trust of citizens regarding the capability of the governments and the IAEA is assumed even though most people will most likely have no idea of the risks. It is my hope and desire that this research may aid in further research to the wonderful topic that is called cross border cooperation. It was truly an amazing experience to do research on the relation between cross border cooperation and nuclear energy.

7 List of Abbreviations:

- CBC = Cross Border Cooperation
- IAEA = International Atomic Energy Agency
- IEC = Incident & Emergency Center
- ANVS = Autoriteit Nucleaire Veiligheid & Straling
- MT = Microsoft Teams
- UT = University of Twente
- EC = European Commission

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