Committee: Disarmament Committee (GA1)

Issue: Nuclear forensics as a means to improve nuclear security and non-proliferation

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INTRODUCTION

Nuclear forensics is a relatively new topic within the forensic sciences. However, its importance should not be underestimated as it plays a key role in maintaining global international and nuclear security. Ever since the nuclear bombings of Hiroshima and Nagasaki, the concern for the future of nuclear weapons and nuclear power has been a common topic among peacekeeping discussion. This has led to the implementation and creation of a variety of organizations, both governmental and non-governmental, to ensure that the stability and security of nuclear power are maintained.

Despite the countless efforts to control and regulate the use and acquisition of nuclear materials and nuclear power, illegal trade and misuse remain a prevalent issue. An increase in the reporting of unregulated nuclear materials and weapons in the early 1990s suggested an increase in the illicit trafficking of such materials, and thus posed a great risk to international security. This is what led to the eventual adoption of nuclear forensics into the forensic sciences, which is the examination of nuclear weapons and materials to determine their source, intended use and movement.

Figure 1: Scientist Conducting an Investigation

Since nuclear power is considered one of the most viable energy sources of the future, it is vital that when using nuclear forensics, the feasibility of nuclear power is maintained. It is also important that any nuclear materials and weapons out of regulatory control are located and accounted for. The security and regulation of such processes and materials is important to maintaining international security, which is the target of this committee.

DEFINITION OF KEY TERMS

Nuclear Forensics

"The examination of nuclear and other radioactive materials using analytical techniques to determine the origin and history of this material in the context of law enforcement investigations or the assessment of nuclear security vulnerabilities."[1]

Nuclear Security

The achievement of stability with regards to global tensions and conflicts among countries and entities with nuclear power. Nuclear security concerns both the security of the global community, ensuring nuclear conflicts are abolished, and the safety measures regarding the handling of nuclear materials, as well as the use of nuclear materials in the context of nuclear power production.

Non-Proliferation

"The controlling of the spread and/or amount of something, especially nuclear or chemical weapons."[2]

Nuclear Materials

Fissile materials are capable of sustaining a chain reaction in a process that releases energy called nuclear fission. The materials include isotopes of uranium, thorium, and plutonium."[3] Can be extended to include items made from these materials, such as nuclear weapons.

Forensic Evidence

"Evidence usable in a court, especially obtained by scientific methods."[4] In the context of nuclear forensics, this includes fingerprints, nuclear genetic markers such as nuclear radioisotopes and contamination, shoe and tire impressions, chemicals, etc.[5]

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[1] "Nuclear Forensics For Nuclear Security Vulnerabilities | IAEA". *Iaea.Org*, 2020, https://www.iaea.org/topics/nuclear-forensics.

[2] "NON-PROLIFERATION | Meaning In The Cambridge English Dictionary". *Dictionary.Cambridge.Org*, 2020, https://dictionary.cambridge.org/dictionary/english/non-proliferation.

[3] "Understanding Nuclear Materials". *NTI Index*, 2020, https://ntiindex.org/about-the-index/understanding-nuclear-materials/. Accessed 23 July 2020.

[4] "What Is Forensic Evidence? Definition And Meaning". *Businessdictionary.Com*, 2020, http://www.businessdictionary.com/definition/forensic-evidence.html.

[5] International Atomic Energy Agency. *Nuclear Forensics In Support Of Investigations.*. IAEA

Mutually Assured Destruction (MAD)

"Mutual deterrence between countries possessing nuclear weapons, based on the capacity of each to inflict major damage on the other in response to a first strike."[6]

Illicit Trade of Nuclear Weapons

The smuggling, illegal transaction and transport of nuclear materials and weapons without the permission and regulation of relevant authorities and overseeing organizations. More specifically, it usually consists of the trade of 20% enriched or more pure nuclear materials or weapons.

BACKGROUND INFORMATION

The matter of nuclear security and the regulation of nuclear materials and weapons is of the utmost importance in ensuring global security. However, the study of nuclear forensics and nuclear peacekeeping is hampered by a variety of issues that plague this situation. The illicit trafficking of materials and nuclear weapons is a key issue, which has severe consequences on the nuclear market, as well as being a threat to international security. Another key issue is the misuse of nuclear materials and nuclear weapons, along with the theft and loss of such items. The lack of regulation for a large number of nuclear materials stems from this, an issue that must be addressed.

Historical Use of Nuclear Materials

<u>The Introduction of Nuclear Weapons</u>

The development of nuclear weapons began in the 1930s due to the need for a new type of weapon to allow the United States to maintain its military power over rival countries. The atomic bombs dropped on Hiroshima and Nagasaki in Japan by the United States, resulting in 130,000 casualties, have been the only demonstration of nuclear power and the destruction it can create, rendering it one that must not be replicated.

Library, Vienna, 2015, https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1687web-74206224.pdf. Accessed 23 July 2020.

[6] "Mutual Assured Destruction Definition And Meaning | Collins English Dictionary". *Collinsdictionary.Com*, 2020, https://www.collinsdictionary.com/dictionary/english/mutual-assured-destruction.

The end of WW2 sparked a new arms race between the United States and the Soviet Union, appropriately called the Cold War. Running between 1947-1991, the Cold War saw building tensions between the United States and the USSR, as well as an arms race for the creation of bigger, more powerful nuclear weapons. Since the end of WW2, there have been 2121 nuclear tests, involving 2476 nuclear devices.[7] However, the use of nuclear weapons testing has seized for the most part since the signing of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), with the United States completing its last test in 1992.

Figure 2: Explosion of the Tsar Bomba by the Soviet Union

The Use of Nuclear Power

Despite the destructive use of nuclear materials in weapons, nuclear power is another use for radioactive nuclear materials introduced in the 1950s. Nuclear power plants produce clean energy, with the only residue from the process being water vapor. Today, nuclear power stations power 12% of the world's power,[8] a step towards sustainable ways of producing energy and replacing fossil-fuel-based sources.

Figure 3: A Nuclear Power Station

Global nuclear security also greatly depends on the security of nuclear power plants. As demonstrated in the Three Mile Island disaster in 1979, Chernobyl in 1986 and the Fukushima nuclear disaster in 2011, the failure of a nuclear power plant can lead to catastrophic consequences, such as radioactive fallout, ecosystem destruction, fatalities, loss of power, and financial losses. While ensuring the safety of these plants is not within the mandate of the committee, ensuring these plants are kept secure from threats and potential terrorist attacks is vital to maintaining international security.

[7] Yang, Xiaoping et al. *Worldwide Nuclear Explosions*. Columbia University, Arlington, 2020, https://www.ldeo.columbia.edu/~richards/my_papers/WW_nuclear_tests_IASPEI_HB.pdf. Accessed 23 July 2020.

[8] "Nuclear Power Today | Nuclear Energy - World Nuclear Association". *World-Nuclear.Org*, 2020, https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx.

Illicit Trade of Nuclear Weapons

The illegal transfer of nuclear weapons and materials can lead to proliferation and the development of improved and enhanced weapons; thus, measures and steps to detect and deter such actions are essential parts of nuclear security frameworks.

The Rise of Illicit Nuclear Material Trade

Since the early 1990s, the illicit nuclear material trade market has increased significantly, with the rise of terrorist groups such as Al Qaeda, ISIS, and other militant organizations seeking to acquire such devices to further their cause. Today, between 150-200 cases are reported each year to the IAEA's Incident and Trafficking Database.[9] These figures include events such as theft, loss of materials, unauthorized access, illegal transfer of weapons and materials. The ever-increasing number of cases per year signifies that much of the global nuclear material is still unregulated.

According to the IAEA's Incident and Trafficking Database (ITDB), as of December 2019, there have been 3686 incidents of trafficking or malicious use reported by participating states since the start of data collection in 1993. Most of the reported incidents and the seizures made on these illicit trades include pure materials, such as highly enriched uranium (HEU), plutonium, and plutonium beryllium neutron sources.

Figure 4: Illicit Nuclear Weapons in the DPRK

Consequences on Global Security

One of the most notable consequences is nuclear terrorism. Many terrorist organizations use the illicit nuclear trade market to harbor nuclear materials. If not appropriately handled, this can have disastrous physical, environmental, and socio-economic consequences on the global society.

In developing approaches and methods to combat the potential for the future, it is essential to recognize the broad spectrum of threats, including different weapons, attack methods, radioisotopes used, etc. Adding to the use of nuclear weapons by these independent entities, it is important to note other potential methods of nuclear terrorism,

[9] Dahl, Fredrik. "Missing Nuclear Material May Pose Attack Threat: IAEA". *U.S.*, 2013, https://www.reuters.com/article/us-nuclear-security-iaea/missing-nuclear-material-may-pose-attack-threat-iaea-idUSBRE95R0BV20130628.

such as attacks on existing stockpiles, or attacks and sabotage against nuclear power stations. It is also essential to recognize the threat posed by states themselves conducting such illicit trade to create new nuclear stockpiles, even under the strict restrictions enforced by the NPT, the CTBT, and other such treaties.

Introduction to Nuclear Forensics

To tackle the rising threat of illicit trafficking of nuclear weapons, and perhaps of nuclear terrorism, nuclear forensics was introduced in the forensic sciences in the early 1990s, hence the data provided by the IAEA dates back to 1993.

The Structure of Nuclear Forensics

Classical forensic science uses an examination of physical, biological, and often behavioral evidence in the context of international and national law. It has played an essential role in the detection and deterrence of illicit nuclear trade, as well as regulating the use of such materials and avoiding malicious conduct. Its induction as a science followed the increase in illicit trafficking in the early 1990s. It is a vital method that all states should recognize and adopt, as it plays a significant role in supporting global nuclear security. The IAEA first published technical guidance on nuclear forensics in a 2006 publication, following a generalized approach created by the Nuclear Forensics ITWG (see below). While nuclear forensics is supported and given a basic structure by the IAEA and ITWG, it is up to states to enforce it and implement measures to prevent, detect, and respond to nuclear security events. Each state has to implement its own extension of the ITWGs guide, depending on the capabilities and responsibilities of that state, such as budget, infrastructure, and involvement in nuclear research and use.

Tackling the Illicit Trade of Nuclear Materials Through Nuclear Forensics

Nuclear forensics has contributed significantly to investigations, leading to the uncovering of trafficking routes and the misuse of nuclear materials. Since the publication of guides by the IAEA and ITWG, such as the ITWG Model Action Plan (MAP), nuclear forensics has been involved in numerous cases, and the foundations for its use have been implemented in many states. The methods of nuclear forensics have also improved, leading to both organizations needing to update their guides for countries wishing to implement nuclear forensics. As successful nuclear forensics has been, the data presented by the ITDB suggests that trafficking and misuse of nuclear materials have not been lowered, and thus presenting a current, valuable threat to international security.

A Case Study of Nuclear Forensics

In April of 2003, four samples of nuclear powder were analyzed from batches that were seized in the Czech Republic between 1994 and 1995. This powder consisted of Highly Enriched Uranium (HEU), thus classifying it as weapons-usable or nuclear material that is enriched enough to be used in nuclear weapons. This, of course, presented a significant risk to international security, as it could be used for the unregulated production of nuclear weapons. The full process of nuclear forensics was followed to determine the source and the age of the powder. Using various dating techniques, the age of the samples was deduced to have been anywhere between 1973 to 1978. This uncertainty is caused due to the impurities of the substances; hence why multiple techniques and trials are used to deduce an average. An investigation was also conducted by the Institute of Transuranium Elements (ITU) into the seizures and the potential sources of the substance. Along with the deduced age of the samples as well as reports of missing materials connected to the seizure, the process of nuclear forensics allowed the substances to be traced to have been produced at the Scientific Research Institute for Atomic Reactors (SRIAR) in Dimitrovgrad, Russia, and were intended for use as fuel for nuclear reactors as Mixed Oxide Fuel (MOX).

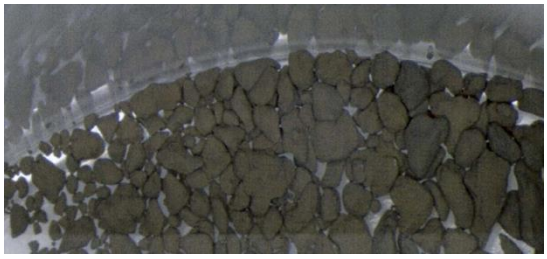

Figure 5: The Uranium Powder Which Was Investigated

MAJOR COUNTRIES AND ORGANISATIONS INVOLVED

United States of America

One of the recognized nuclear-weapon states, the United States is known to have roughly 6,200 nuclear warheads ready for deployment in present times. The United States is also the only country to have deployed a nuclear attack on another state during a war, through the bombings of Hiroshima and Nagasaki in 1945. The state has also been a leader in nuclear forensics for years and is perhaps the standard for nuclear security.

The Russian Federation

With a stockpile of roughly 6,500 nuclear warheads, it is a major superpower in terms of nuclear power, magnified through its significant involvement in the Cold War. While the state has significant nuclear forensics capabilities, Russia has the biggest stockpile

of unsecured nuclear warheads, as well as porous borders and poor internal security,[10] making it a target to illicit nuclear trade.

The Democratic People's Republic of Korea (DPRK)

While the DPRK is not internationally involved in the process of nuclear forensics, it is one of the only recognized states which has conducted nuclear tests in recent years. None of the state's nuclear weapons are regulated by the international community, which is a major security threat in terms of their use by both the DPRK and the acquisition of these weapons by other states or organizations through illicit trafficking.

International Atomic Energy Agency (IAEA)

The IAEA's involvement in nuclear forensics is vital, as the UN organization has provided technical guidelines and structures for the implementation of nuclear forensics. It is also responsible for overseeing the enforcement of treaties such as the NPT and the CTBT. If anything, the IAEA is the focal point for nuclear forensics and is the key organization that allows for measures for nuclear security to function.

Nuclear Forensics International Technical Working Group (ITWG)

The ITWG was formed as a result of a G8 summit in 1995, and still informally reports to the Nuclear Safety Group of the G8. It is a multinational organization, whose primary purpose to function as a platform for international cooperation in the field of nuclear forensics. It is also responsible for providing technical guidelines and specifications and advancing best practices for nuclear forensics investigations. The ITWG has also worked on improving the functions of nuclear forensics.[11]

[10] Dunlop, William, and Harold Smith. "Who Did It? Using International Forensics To Detect And Deter Nuclear Terrorism | Arms Control Association". *Armscontrol.Org*, 2020, https://www.armscontrol.org/act/2006-10/features/using-international-forensics-detect-deter-nuclear-terrorism.

[11] Biro, Tamas et al. Https://Www.Jaea.Go.Jp/04/Iscn/Activity/2010-10-05/2010-10-05-13.Pdf. 2010.

TIMELINE OF EVENTS

Date	Description of Event
1942	The first controlled nuclear chain reaction takes place in the United States as part of the Manhattan Project.
1945	The United States drops two atomic bombs in Japan, on the cities of Hiroshima and Nagasaki. Japan surrendered days later, with the bombing of the cities effectively leading to the end of WWII.
1946	First nuclear-reactor-produced radioactive isotopes are created. Framework for future power plants.
1946	Atomic Energy Commission is created in the US.
1947	Cold War begins.
1957	The International Atomic Energy Agency (IAEA) is formed.
1961	The Tsar Bomba is detonated by the USSR, the largest nuclear weapon known to human history.
1968	The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) is signed.
1970	The NPT is fully implemented and goes into effect.
1974	The Energy Reorganization Act is passed by US Congress, splitting the Atomic Energy Commission into the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC).
1979	The Three Mile Island disaster takes place.
1986	The Chernobyl nuclear disaster takes place near Pripyat, Ukraine. The biggest disaster to date, Chernobyl released a radioactive cloud covering most of Europe and parts of Asia.
1991	The first seizures of nuclear weapons are made in Switzerland and

	Italy.
1991	The Cold War ends with the dissolution of the USSR.
Early 1990s	The field of nuclear forensics begins its implementation in nuclear security infrastructure.
1994-1995	8 grams of weapons-grade highly enriched uranium are seized in the Czech Republic.
1994-Present	Several other seizures of radioactive materials have been made, due to the increased use of nuclear forensics.
2006	The IAEA's Nuclear Forensics Support Technical Guidance Reference Manual is published, which is an expansion on the work of the IWTG and previous conferences, and provides a structure and set of standard procedures to be followed during nuclear forensics investigations.

UN INVOLVEMENT: RELEVANT RESOLUTIONS, TREATIES AND EVENTS

Outside of the work of the IAEA, the United Nations General Assembly has not drafted or passed a resolution directly on nuclear forensics. However, there have been numerous actions regarding nuclear security:

Treaty on the Non-Proliferation of Nuclear Weapons (NPT) - 1970

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was a major step forward in ensuring global security regarding the usage of nuclear materials. Its objective is to "prevent the spread of nuclear weapons and weapons technology, to promote cooperation in the peaceful uses of nuclear energy and to further the goal of achieving nuclear disarmament and general and complete disarmament."[12] The treaty opened for signature in 1968 and entered into force in 1970. Today, 191 states have signed including the five official nuclear-weapon states (China, France, the Russian Federation, the United Kingdom, and the United States). More countries have ratified it than any other arms limitation or disarmament agreement outlining its significance. The IAEA plays a major role

[12] "Treaty On The Non-Proliferation Of Nuclear Weapons (NPT) – UNODA". *Un.Org*, https://www.un.org/disarmament/wmd/nuclear/npt/.

in the success of this treaty, through conducting checks and establishing safeguard systems to ensure the treaty's full enforcement. This includes the IAEA's ability to conduct investigations, which include the use of nuclear forensics to aid the investigation.

Convention on the Physical Protection of Nuclear Material - 1980

The "Only international legally binding undertaking in physical protection of nuclear material. It establishes measures related to the prevention, detection and punishment of offenses relating to nuclear material."[13]

International Convention for the Suppression of Acts of Nuclear Terrorism - 2007

Criminalizes acts of nuclear terrorism and promotes judicial cooperation to punish such acts.

United Nations Security Council – Resolution 1373 - 2001

Requires member states to establish measures to enhance their abilities to combat terrorist activities.[14]

United Nations Security Council – Resolution 1540 - 2005

The following clause was adopted with regard to weapons of mass destruction:

"States shall refrain from providing any form of support to non-State actors that attempt to develop, acquire, manufacture, possess, transport, transfer or use nuclear, chemical or biological weapons and their means of delivery, in particular for terrorist purposes."[15]

Treaty on the Prohibition of Nuclear Weapons (TPNW) - 2017

Adopted through UN Resolution 71/258. It is an initiative which seeks a legal instrument banning the use of any nuclear weapons.[16]

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Figure 6: A Uranium Pellet Part of the Seizure

The issue that lies within using nuclear forensics as a means to increase nuclear security stands on two factors. Firstly, nuclear forensics can never be totally accurate and

[13] United States, Congress, *Convention On The Physical Protection Of Nuclear Material*. International Atomic Energy Agency, 1979.

[14] UNSC Counter-Terrorism Committee. *Global Survey Of The Implementation Of Security Council Resolution 1373 (2001) By Member States*. United Nations Security Council, New York, 2016, https://www.un.org/sc/ctc/wp-content/uploads/2016/10/Global-Implementation-Survey-1373_EN.pdf. Accessed 23 July 2020.

[15] "UN Security Council Resolution 1540 (2004) – UNODA". *Un.Org*, 2020, https://www.un.org/disarmament/wmd/sc1540/.

[16] "Treaty On The Prohibition Of Nuclear Weapons – UNODA". *Un.Org*, 2020, https://www.un.org/disarmament/wmd/nuclear/tpnw/.

absolute. Secondly, nuclear security risks must be deterred and prevented, which is clearly not the case due to the ever-increasing number of trafficking cases. Such trafficking cases, along with the inability to always accurately resolve them are a major threat to international security and proliferation, as they warrant the presence and use of unregulated nuclear weapons.

In a 1992 case in Lithuania, Uranium-235 pellets were stolen from a nuclear power plant. While the enrichment level of the pellets was too low to be used in weapons, therefore they did not pose a significant threat, over 100kg were stolen from the power plant. This is an immense amount of Uranium and suggests that security measures must be put in place. Since then, efforts have been undertaken to increase the security of materials both at storage facilities and at power plants: however, many of these efforts have not been substantial.

Other attempted solutions include the creation of a database of all known regulated and unregulated materials, creating databases with the results of previous cases, and increasing the general security of nuclear stockpiles. While these have seen minimal results, perhaps a further implementation of these strategies could provide significant results in the future.

POSSIBLE SOLUTIONS

There is a variety of possible solutions that can and must be implemented to increase the effectiveness of nuclear forensics and increase global nuclear security. The most substantial of these solutions, which directly pertains to the use of nuclear forensics, is to improve the guidelines which outline the process of nuclear forensics. These guidelines should include numerous factors, such as the optimization of nuclear forensics processes, both during evidence collection and analysis, and the final reporting to national and international entities. The forensics processes could focus on the improvement of existing technology, such as nuclear dating and isotope tracking, in order to increase accuracy. Reporting to various entities could also become more efficient in order to speed up the process and facilitate the tracking down of illicit materials. These guidelines could be created in cooperation with existing guidelines and organizations, such as the technical guidelines created by the IAEA and the ITWG. An emphasis on international cooperation, both between states but also between states and organizations, to create a uniform, reliable, and optimized approach to investigating nuclear security events (effectively extending the ITWGs MAP Guide). The procedures of these guidelines could also be refined and could be adjusted

to encourage international cooperation between More Economically Developed Countries (MEDCs) and Less Economically Developed Countries (LEDCs). Transparency into investigations that use nuclear forensics could also be given a thought; however, it must be ensured that the sovereignty of each nation is not breached.

Lastly, there is the vital issue of addressing the prevention of nuclear security threats and events. Security on nuclear stockpiles should be increased and internationally regulated, and so do nuclear forensics investigations to identify the source of illicit nuclear trade, as well as tracing the trade routes and identifying the market. Such investigations, which would take a broader form from standard investigations, would allow for future attacks and nuclear security risks to be limited, and will also allow for an increase in the regulation of currently unregulated nuclear materials, while significantly lowering the global illicit nuclear trade market and reducing the likelihood of future nuclear terrorist attacks.

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