Chapter 4: Adapting the Legal Framework

The previous chapter has shown that the existing framework of nuclear weapons law is characterised by gaps and ambiguity with regard to its application to fusion. While the regime prohibits NNWS from using fusion for applications in nuclear weapons programmes, the majority of rules and procedures of the verification regime do not apply to fusion. The few rules that apply do not cover all aspects of fusion's proliferation potential. The existing framework has been developed with a fission fuel chain in mind, leading to rules that do not adequately address fusion's role in nuclear weapons despite the goals of the nuclear non-proliferation and disarmament regime.

This chapter explores possibilites on how to adapt the legal framework in order for it to apply to fusion. The first section undertakes an analysis of the constraints that exist when adapting the framework in its application to fusion (1). The chapter proceeds with the application of evolutionary interpretation on the legal instruments and analyses to which extent this interpretative approach allows for the application of the existing regime to fusion (2). The third section examines how different international organisations and other institutions can extend the scope of verification measures in non-proliferation to fusion (3). The chapter proceeds with an analysis where treaty changes are required in order to allow for the verification of fusion (4). The chapter concludes with an overview of the benefits and disadvantages of the different approaches (5).

1 Constraints to Adapt the Framework

Making changes to the international legal framework of nuclear weapons law is an outstandingly difficult task. This is due both to financial and commercial interests tied to international oversight and control (1.1), and to the political interests of the various actors involved (1.2).

1.1 Financial and Commercial Interests

As analysed in Chapter 2, there is a trade-off between security and development, making any changes to the safeguards regime outstandingly difficult.

This trade-off materialises especially in the allocation of resources within the IAEA, given the Member States' zero-growth budget policy.[701] Any strengthening of the safeguards system, especially for a completely different technology such as fusion, would result in financial difficulties for the IAEA. At present, the IAEA is underway to reduce its staff by 10 % within two years,[702] while more safeguarding would require more personnel. Either the Agency would need to convince its Member States to increase its budget or relocate resources within the current budget. With respect to the former, discussions surrounding fusion safeguards have become increasingly visible among industry representatives, research institutions, and policymakers. Some publications produced by advocates of fusion energy emphasise the technological and safety differences between fusion and fission and argue that fusion presents comparatively lower proliferation risks.[703] Industry actors have also expressed concern that safeguards obligations, depending on their design, could introduce additional costs, technical constraints, or delays to commercialisation. Linking fusion and proliferation might shed a negative light on fusion and equates a good technology with a terrible use. Referring to the technology as *fusion* rather than as *nuclear fusion* is another example of the public relations dimension of fusion and the attempt to distance fusion from fission technology. These positions may shape how some States view proposals to increase the IAEA's budget if such increases are framed as primarily supporting fusion safeguards. Regarding the latter: Reallocating resources within the budget would most likely hurt the current work within safeguarding fission reactors. As analysed above, fission poses significantly higher proliferation risks than fusion due to its potential direct contributions to a nuclear weapons programme. It is therefore difficult to move resources away from this highly security-relevant part of safeguards.

701 *Trevor Findlay*, Unleashing the Nuclear Watchdog – Strengthening and Reform of the IAEA (2012), Centre for International Governance Innovation.

702 International Atomic Energy Agency, *The Agency's Programme and Budget 2022–2023*, GC(65)/2, at 3.

703 *Michael Y. Hua/Sachin S. Desai/Amy C. Roma et al.*, Nonproliferation and Fusion Power Plants, arXiv:2207 14348 (2022), 1–26; *Sachin S. Desai/Michael Y. Hua/Amy C. Roma et al.*, Building a Path Toward Global Deployment of Fusion: Nonproliferation and Export Considerations (2025), Atlantic Council.

Commercial considerations play a pivotal role in the development of fusion energy. The market for fusion energy is estimated to reach approximately USD 840 billion by the year 2040.[704] The deployment of fusion energy is driven by start-up companies, which rely to a large amount on venture capital and also on public funding. Conversely, the regulation of any technology is associated with costs and financial risks. As analysed above, this especially true for safeguards:[705] The designs have to be adapted to allow for the implementation of safeguards. The presence of inspectors can influence the operation of the plant. Inspectors also pose a potential risk of industrial espionage. As in other capital-intensive technology sectors, firms tend to favour regulatory approaches that minimise uncertainty, cost, and operational burden. These general economic incentives help explain why commercial actors express interest in ensuring that any safeguards framework for fusion is efficient, predictable, and proportionate to the assessed proliferation risk.

1.2 Political Interests

Different actors have different political interests in the discussion on adapting the regime to fusion, including individual States, groups of States, the IAEA and the EU.

1.2.1 NWS recognised the NPT

As analysed above in Chapter 2, NWS under the NPT defend the nuclear order as it stands. Consequently, NWS are in favour of strengthening the safeguards regime where ever it is possible. From their perspective, the stronger the safeguards regime, the less likely the further proliferation of nuclear weapons becomes and the easier it is to maintain the nuclear order. As mentioned above, economic interests, however, serve as a counter interest to this political interest. This is especially true for the United States as home of the majority of fusion start-ups and the biggest contributor to

704 *Allied Market Research*, Fusion Energy Market Size, Share, Competitive Landscape and Trend Analysis Report, by Technology, by Fuels: Global Opportunity Analysis and Industry Forecast, 2030–2040 (2023).

705 Chapter 2, Section I.2.

the IAEA.[706] NWS accept economic consequences of safeguards, at least to an extent where the deployment of the technology is still feasible. As a consequence, NWS have a political interest in safeguarding fusion as long as it does not hinder their domestic fusion industries to develop.

Among NWS recognised by the NPT are also other leading States in the development of fusion energy. For example, until Brexit all of these States used to be part of ITER and all States except the United Kingdom remain committed to ITER. In addition, there are important research activities in all and start-up activity in most of these States. As a consequence, these States also have a leverage to promote their interest of safeguarding fusion: Exporting fusion technology under the condition that the importing State accepts fusion safeguards.

Given their hesitation towards nuclear disarmament, their interest is mainly focused on strengthening the non-proliferation regime, while a materialisation of Article VI of the NPT and pathways to nuclear disarmament is not in their interest. In addition, any connection between the introduction of new safeguards and clear steps towards nuclear disarmament is against the political interest of NWS under the NPT.

1.2.2 NWS outside the NPT

NWS outside the NPT have no interest of strengthening the safeguards regime. As they are already outside the regime, any modification of the existing regime is of no interest for them. This is also a limitation for a safeguards regime for fusion: Any safeguards instrument to be developed for fusion would not include those States that already possess nuclear weapons and are outside the regime. While these States might already use thermonuclear weapons, meaning a combination of fission and fusion, the deployment of fusion technology still has benefits for these States.

Still, the current non-proliferation regime has indirect effects on these States: Export controls mandated under Article III.2 of the NPT prohibit exports of nuclear goods to these States. Similar limitations are found in the export control lists of the Zangger Committee and the NSG. NWS outside the NPT have an interest of deploying fusion while preventing similar indirect effects which might limit their capacity in using fusion technology for their stockpiles.

706 The United States contributes 25 % to the IAEA's regular budget, followed by China with about 15 %, Japan with about 8 % and Germany with about 6 %, GC(66)/11.

1.2.3 NNWS from the Global North

States from the Global North share several interests with NWS under the NPT. They have an interest in a strong non-proliferation regime that also encompasses fusion. While the motivation might differ between NATO and non-NATO States for having a strong non-proliferation regime, none of these States have an interest that fusion technology is used by a NNWS to develop nuclear weapons.

Within States from the Global North, a distinction between States with a fusion industry and States without a fusion industry has to be drawn. Currently, it is mainly Germany, Canada and Japan which are NNWS with a landscape of several fusion start-ups and other companies involved in a fusion supply chain. These States have an interest in promoting their technologies worldwide, leading to two consequences. First, as security interests collide with economic interests, their interest in promoting safeguards for fusion might be gradually reduced. As they do not defend their own privileged position as it is the case with NWS, this interest is not countered to a similar extent. However, as these States have historically unequivocally supported the non-proliferation despite their fission industry, it is feasible to assume that their economic interest would not limit their commitment to strengthening the safeguards regime and to advocate for fusion safeguards. In addition, given the controversial nature of nuclear technologies, a safeguards regime for fusion might increase social acceptance of fusion technology.

1.2.4 States from the Global South

As shown above in Chapter 2, there are two fractions of States from the Global South with diverging interests in nuclear non-proliferation. There are many States supporting high level of safeguards in order to prevent the acquisition of a nuclear weapons by another State, while there is also a strong group of States which is against any strengthening of the safeguards regime. The latter fraction sees any additional safeguards as a sign of a lack of trust of their commitment towards nuclear non-proliferation as long as there is no progress towards nuclear disarmament from NWS.[707]

707 *Rebecca Gibbons/Todd Robinson*, Twenty-Five Years Safer? Assessing the IAEA's Model Additional Protocol and its Role in International Politics, The Nonprolifer-

Nuclear disarmament, on the other side, is strongly supported by all States from the Global South. These States have an interest in combining a strengthened safeguards regime with clear pathways towards nuclear disarmament.

In addition, States from the Global South also have an interest in gaining access to fusion technology for peaceful applications. As fusion energy will provide a carbon-free source of energy regardless of meteorological or geographic conditions, this technology has transformative potential for their energy sectors as well. As a consequence, this allows for a trade-off between accepting new safeguards in return for getting access to fusion technology.

1.2.5 European Union and Euratom

As argued above in Chapter 2, the European Union is a supporter of a strong non-proliferation regime and typically argues for an extension in its Common Foreign and Security Policy. Therefore, it is likely that the European Union would also be in favour of adapting the regime to cover fusion. The EU's position would mirror the position of its Member States, which would in general support safeguards for fusion.

Euratom's position, however, is not entirely clear as it is charged with safeguards in two scenarios. First, where Euratom provides a Member State with nuclear material, and second, where it implements IAEA safeguards, Article 77 Euratom Treaty. Currently, there is no indication that Euratom has an interest in acting as a fusion material supplier similar to its role with fission material. Regarding the application of IAEA safeguards, Euratom acts rather neutral as the extent of IAEA safeguards depends on IAEA Member States. If IAEA safeguards are adapted to fusion, then Euratom would follow suit. If Euratom Member States require the European Commission to apply safeguards to fusion, Euratom would follow suit as well.

ation Review 29 (2022), 1–22; *Matias Spektor/Togzhan Kassenova/Lucas Perez Florentino*, Brazil's Nuclear Posture Under Bolsonaro, Arms Control Today 49 (2019), 12–17.

1.2.6 IAEA

As highlighted above, an effective safeguards regime is at the core of the IAEA's reason to exist. This existential interest also extends to fusion technology. Fusion falls under the wider mandate of the IAEA to promote atoms for peace and development.[708] In addition, the IAEA intends to define itself as the international organisation charged with not only fission, but fusion technology as well.[709] As the idea behind the IAEA's mandate to promote nuclear energy only works effectively if this promotion is paired with effective safeguards to prevent its use in nuclear weapons, the IAEA has an interest to apply safeguards to fusion facilities as well.

However, as analysed above, the IAEA suffers from a lack of proper funding. Instead of increasing its staff in order to address new technological challenges, the IAEA is on its way to reduce staff. The interest of the IAEA to extent its safeguards regime to fusion is therefore accompanied with a strong interest of increasing its funding as it would otherwise risk to reduce its safeguards activities with fission. As fission's proliferation potential is significantly higher than fusion's proliferation potential, shifting resources from fission safeguards to fusion safeguards would be against the IAEA's interest. Additionally, there might be differing views within the IAEA, with the Department of Safeguards on the one side, and the other departments promoting fusion energy on the other.

1.2.7 Summary

All NPT Member States share an interest in preventing fusion technology from being used for the development of nuclear weapons by NNWS. Most States share an interest in adapting the non-proliferation regime, with some State also having an economic interest that fusion safeguards do not harm the prospects of commercialising the technology. However, there is a significant number of States in the Global South which oppose an expansion of the safeguards regime as long as there is no tangible progress towards nuclear disarmament. This, in turn, is against the interest of the NWS recognised under the NPT. The IAEA has an interest in applying safeguards to fusion as long as such an extension of the safeguards system would not be detrimental for fission safeguards.

708 See above Chapter 3, Section 1.1.
709 Ibid.

2 Evolutionary Interpretation

This section explores the potential of evolutionary interpretation in the application of the existing regime to fusion and how it can contribute to bridging the gap between the objective of the regime and its means of verification. The section first investigates the doctrinal background of evolutionary interpretation (2.1), before applying this interpretative method to the IAEA's safeguards regime (2.2) and its implications to NWFZ Treaties and the TPNW (2.3). The section continues to interpret the Euratom Treaty evolutionary (2.4), before taking stock of the applicability of the nuclear weapons law regime to fusion (2.5).

2.1 Doctrinal Background

Evolutionary interpretation – also termed evolutive or dynamic interpretation[710] – is an interpretation method that emerged in the jurisprudence of human rights courts[711] and tends to become acknowledged as an interpretatitive method in all areas of international law.[712] While it is disputed whether this method fits within the classical canon of interpretation enshrined in Articles 31 to 33 VCLT[713] or whether it is a complementary

710 See *Christian Djeffal*, Static and Evolutive Treaty Interpretation: A Functional Reconstruction, Cambridge: Cambridge University Press 2018; *Sondre Torp Helmersen*, Evolutive Treaty Interpretation: Legality, Semantics and Distinctions, European Journal of Legal Studies 6 (2013), 127–148.

711 Human Rights Courts often refer to Human Rights Treaties as *Living Instruments*. It was first introduced in the landmark judgement *European Court of Human Rights*, Tyrer vs. United Kingdom, Application No. 5856/72, Judgement of 25 April 1978, at para. 31. On the *Living Instruments Doctrine* as evolutionary interpretation, see *Eirik Bjorge*, Evolutionary Interpretation: 'The Convention is a Living Instrument', in: Domestic Application of the ECHR: Courts as Faithful Trustees, Oxford: Oxford University Press 2015, 131–154.

712 *International Court of Justice*, Dispute Regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgement, ICJ Reports 2009, p. 213; *Eirik Bjorge*, The Evolutionary Interpretation of Treaties, Oxford: Oxford University Press 2014.

713 *Helmersen* (n 710), at 146 ff.; *Geir Ulfstein*, Evolutive Interpretation in the Light of Other International Instruments: Law and Legitimacy, in: Anne van Aaken/Iulia Motoc (eds.), The European Convention on Human Rights and General International Law, Oxford: Oxford University Press 2018, 83–94.

method outside the VCLT,[714] evolutionary interpretation is gaining increasing acceptance. This method faces the predicament that a treaty provision, due to its wording, would not apply to an instance simply because that situation did not exist when the treaty was drafted. Interpretation is based on the presumption that the text of a treaty is the "authentic expression of the intentions of the parties"[715], while the text itself is, as Max Huber framed it, "sauf de rares exceptions, la seule et la plus récente expression de la volonté commune des parties", as the only and most recent expression of the common will of the Parties, with a few rare exceptions.[716] As treaties tend to be static and amendments are rare, the reality under which the treaty operates evolves over time, especially with regard to technology.[717] Evolutionary interpretation tries to "determine the precise meaning of a rule"[718] without changing its meaning, while also recognising the fact that the reality in which the rule finds itself changes over time. Evolutionary interpretation needs to be applied restrictively to avoid reconstructing the treaty,[719] which would violate the sovereignty of the States bound by the treaty. For this reason, the use of the method itself is – not only, but especially outside human rights conventions – criticised.[720]

For interpreters, evolutionary interpretation is an attractive tool to expand the meaning of an expression beyond its original (textualist) meaning. This is especially true for courts – where the concept of evolutionary interpretation has been developed –, but also for international organisations, such as the IAEA. However, this also represents a shift of power within

714 Similarly, *Georg Nolte*, Subsequent Agreements and Subsequent Practice in Relation to the Interpretation of Treaties, A/CN.4/660, Geneva: International Law Commission 2013, at paras 54 ff.

715 *International Law Commission*, Draft Articles on the Law of Treaties With Commentaries, New York: United Nations 1966, at 220.

716 *Institut de droit interational*, Annuaires – Tome 44 (I) 1952 Travaux Préparatoires, Basel: Verlag für Recht und Gesellschaft 1952, at 199.

717 *Helmersen* (n 710), at 129.

718 Boundary Dispute Between Argentina and Chile Concerning the Frontier Line Between Boundary Post 62 and Mount Fitzroy (1994), XXII Reports of International Arbitral Awards 3, at para. 75.

719 *Permanent Court of International Justice*, Polish Nationality Case, PCJ (1923) Series B No 7, at para. 41.

720 *Rudolf Bernhardt*, Evolutive Treaty Interpretation, Especially of the European Convention on Human Rights Focus Section: The Law of International Treaties in the 21st Century, German Yearbook of International Law 42 (1999), 11–25; *Bruno Simma*, Mainstreaming Human Rights: The Contribution of the International Court of Justice, Journal of International Dispute Settlement 3 (2012), 7–29, at 26.

the actors of international law. For example, one of the most prominent critiques of the European Court of Human Rights is what is perceived as an overreach from Strasbourg as the court engages heavily in evolutionary interpretation.[721] While the text of the treaty is decided on by States, evolutionary interpretation is applied by courts or international organisations. Thus, there is a risk of losing power over the meaning of a treaty provision to the detriment of States,[722] while courts or international organisations increase their interpretative authority. As a consequence, States often perceive evolutionary interpretation as problematic.

The ICJ has applied evolutionary interpretation on several occasions.[723] Within its jurisprudence, two cumulative requirements for the application of said method have been identified: The use of a 'generic' term and a temporal element.[724] Once these requirements are met, the intention of the treaty drafters to interpret an expression evolutively is presumed.[725] While the treaty interpretation following the rules contained in the VCLT is primarily text-based,[726] the ICJ requires a subjective element and limits evolutionary interpretation to cases where the Parties had the explicit or implicit intention that the meaning of a term could evolve.[727] The combination of these two requirements tries to find a balance between the sovereignty of States and the practical necessity to adapt treaty provisions to a world in flux.

721 *Peter Hilpold*, Challenging Strasbourg – The May 2025 Letter and the Pushback Against the European Court of Human Rights (2025), in: Verfassungsblog, https://verfassungsblog.de/may-2025-letter-and-the-pushback-against-the-european-court-of-human-rights/, last accessed 3 June 2025.

722 Ibid.

723 The most prominent cases are *International Court of Justice*, Legal Consequences for States of the Continued Presence of South Africa in Namibia (South West Africa) notwithstanding Security Council Resolution 276 (1970), Advisory Opinion, ICJ Reports 1971, p. 16, at para. 53; Aegan Sea Continental Shelf (Greece v. Turkey), Judgment, ICJ Reports 1978, p. 3, at para. 77; Navigational Rights (n 712), at paras 64–66; North Sea Continental Shelf (Federal Republic of Germany v. The Netherlands), Judgment, ICJ Reports 1969, p. 3.

724 *Helmersen* (n 710), at 136; *ICJ*, Navigational Rights (n 712), at para. 66.

725 *ICJ*, Navigational Rights (n 712), at para. 66.

726 *Fuad Zarbiyev*, The 'Cash Value' of the Rules of Treaty Interpretation, Leiden Journal of International Law 32 (2019), 33–45, at 36; *International Law Commission* (n 715), at 220.

727 *Helmersen* (n 710), at 138 with vast examples of case law.

To consider a term generic, the term has to have a meaning that evolves over time.[728] The ICJ requires that the Parties to a treaty had been aware of the likeliness of such an evolution of the meaning.[729] From a temporal point of view, the ICJ requires that the treaty "has been entered into force for a very long time or is of continuing duration."[730]

2.2 The IAEA's Safeguards System

As analysed before, in its current understanding, the IAEA's safeguards system based on the NPT, the CSA, and the Additional Protocol, is largely not applicable to fusion since the scope of material and facility is too narrow. The safeguarded material is fissionable material, nuclear facilities are fission facilities. This section applies evolutionary interpretation to the key terms of the IAEA safeguards system found in the IAEA Statute and the NPT – *source and special fissionable material* and *nuclear facility* – in order to analyse, whether this allows for an application of the system to fusion and to overcome the gaps in the system.

2.2.1 Source and Special Fissionable Material

The first question is whether evolutionary interpretation would allow for fusionable material in general or at least specific fusionable materials to be covered by the term *source and special fissionable material*. The materials of specific relevance for evolutionary interpretation are the two main fusion fuels, tritium and deuterium, as well as lithium enriched in ^{6}Li, the material necessary to produce tritium within a fusion facility.

The temporal element necessary for evolutionary interpretation is unarguably fulfilled. The NPT entered into force more than 50 years ago, and the IAEA Statute is even older. However, the other requirement for evolutionary interpretation – the use of a generic term – is more difficult to argue. Firstly, it was likely in 1957 when the IAEA Statute was adopted or in 1968 when the NPT was adopted, that scientists and engineers would find other materials that can undergo fission and are potentially usable for

728 Ibid, at 136; *ICJ*, Navigational Rights (n 712), at para. 67.
729 *ICJ*, Navigational Rights (n 712), at para. 66.
730 Ibid.

nuclear weapons. For that reason, Article XX of the IAEA Statute includes a provision for the Board of Governors to determine *other fissionable* material from time to time. This provision limits the possibility for evolutionary interpretation, since the precise will of the treaty authors was to let the Board of Governors as a specific body decide, which material it considers to be potentially usable for nuclear weapons instead of other interpreters. Secondly, it is unlikely that the treaty authors expected the term *fissionable* to include *fusionable*. When the IAEA Statute was adopted in 1957, the United States, the Soviet Union and the United Kingdom had already conducted hydrogen bomb testing. In 1968, when the NPT was adopted, China had also tested its first hydrogen bomb.[731] Also, boosting of fission weapons with tritium was known.[732] Nuclear fusion was even discovered earlier than nuclear fission.[733] Fusion processes for nuclear bombs as well as the use of tritium were in the mind of the treaty authors. This is also supported by the earlier mentioned comments made by the United States during the NPT negotations to exclude fusion from the framework, as well as by the depositary note of Germany, which includes an interpretative note that the NPT would not affect the development of fusion technology.[734] Thus, *fissionable* is not a generic term that can be understood to cover *fusionable*.

As a consequence, even with evolutionary interpretation, fusionable material is not covered by the term *source and special fissionable material* in the sense of Article XX of the IAEA Statute and Art. III.1 NPT. As the CSA refers in its definition of *nuclear material* to Article XX of the IAEA Statute, this safeguards agreement does not apply to fusionable material

731 *Timothy J. Pounds*, A Chronology of Comprehensive Test Ban Proposals, Negotiations, and Debates: 1945–1993, 1994.

732 The first boosted fission weapons were detonated by the United States on 8 May 1951 and by the Soviet Union on 12 August 1953; *Alex Wellerstein/Edward Geist*, The Secret of the Soviet Hydrogen Bomb, AIP Conference Proceedings 1898 (2017), 020008, at 4.

733 Fission was discovered in 1939 by *Otto Hahn/Fritz Strassmann*, Über den Nachweis und das Verhalten der bei der Bestrahlung des Urans mittels Neutronen entstehenden Erdalkalimetalle, Naturwissenschaften 27 (1939), 11–15; fusion was discovered in the early 1930s, *Marcus Laurence Elwin Oliphant/Ernest Rutherford*, Experiments on the Transmutation of Elements by Protons, Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character 141 (1933), 259–281.

734 See Chapter 3, Section 1.2.3.2.

as material. Thus, the IAEA safeguards regime based on the NPT cannot apply to tritium, deuterium and ^{6}Li.[735]

2.2.2 Nuclear Facility

In contrast to the terms *nuclear material* or *source and special fissionable material,* the application of the principles of evolutionary interpretation enables the inclusion of fusion facilities under the term *nuclear facility* used by the NPT, CSA and Additional Protocol. As shown in the previous chapter, standard methods of interpretation largely do not allow for the application of these instruments to fusion facilities.[736]

The term *nuclear facility* contains several subsets of facilities, most notably reactors. Safeguards agreements do not apply to fusion facilities as the definition of reactors is limited to devices in which a controlled, self-sustaining fission chain-reaction can be maintained. The definition is included in both item-specific safeguards agreement INFCIRC/26[737] and INFCIRC/66[738], as well as in the Annex of the Additional Protocol.[739]

As the CSAs are based on INFCIRC/153, which was adopted in 1972, and were concluded with each State during the years that followed, the temporal element of evolutionary interpretation is fulfilled. For evolutionary interpretation to apply, it has to be shown that the term *nuclear facility* or *reactor* is a generic term. Technological evolution shapes the understanding of the technical term *nuclear facility*. The CSA attempts to cover different technical components and facilities within the fuel cycle of nuclear energy. As nuclear energy is a sector with a lot of technological development, it must have been on the mind of the States that concepts for reactors could evolve. Since the construction of the first nuclear power reactor in 1942,[740] many different types and concepts of nuclear reactors were developed. They include developments in the material used as moderator (graphite, heavy

735 On the criticism that tritium and breeding-blankets are not included in the safeguards system, see *Noah C. Mayhew/VCDNP*, Reflecting on the Annexes to the Model Additional Protocol in Support of Nuclear Governance, 2022, at 8 ff.

736 Chapter 3, Section I.3.I.2.

737 Paras 13 and 14.

738 Para. 80.

739 Para. I.1. of the Annex.

740 The first nuclear reactor was the Chicago Pile-1 reactor as part of the Manhattan Project under the leadership of Enrico Fermi, one of the most important physicists of the 20th century.

water and sodium), in reactions (thermal neutrons or fast-neutrons), in the coolant (boiling water, pressurised water) or size (gigawatt scale, small modular reactors). While these developments were focused on fission, it proves that the term is not static. Developments with regard to reactors happened and they were foreseeable.

Furthermore, the IAEA and safeguards agreements seek to define the term nuclear facility in broad terms. The definition contains a long list of different supporting facilities to cover the entire nuclear fuel cycle on order to avoid loopholes. This demonstrates the objective that regardless of the specific technology used, the definition should be wide enough to prevent any gaps in the safeguards regime.

Additionally, recent developments have demonstrated that fusion can be considered as a nuclear technology. This is shown by the application of the French nuclear code to ITER as a nuclear installation,[741] other national regulatory approaches[742] or the simple fact that the IAEA itself is engaged in the area of fusion.[743] This demonstrates that the term *nuclear facility* is a generic term. Accordingly, evolutionary interpretation enables fusion facility to fall under the term nuclear facility in the sense of the NPT, the CSA and the Additional Protocol.

In summary, evolutionary interpretation would allow for a fusion reactor to be regarded as a nuclear facility under the provisions of the CSA, providing the IAEA with the authority to apply safeguards on fusion facilities. This leads to an important implication: Where the CSA refers to obligations towards facilities, these obligations would extend to fusion facilities. This entails the obligation to provide the IAEA with design information (para. 42), a description of the facility (para. 43), and the authority for the IAEA to conduct routine inspection (para. 80). The IAEA would have the possibility to verify the absence of undeclared source and fissionable material within a fusion facility, addressing one of the key proliferation issues of fusion. The provision under which a State has to provide the IAEA with design information is of particular significance as this would address the concern of plutonium breeding within a fusion facility, given the significant

741 ITER is considered an installation nucléaire de base (INB), which is also the standard category for nuclear fission facilities in France. ITER was declared an INB by the Décret n° 2012–1248 du 9 novembre 2012 autorisant l'Organisation internationale ITER à créer une installation nucléaire de base dénommée « ITER » sur la commune de Saint-Paul-lez-Durance (Bouches-du-Rhône).

742 For example, in the United States the Nuclear Regulatory Commission is the competent authority.

743 See above, Chapter 3, Section 1.1.

modifications required from a standard commercial design. What the IAEA cannot do, however, is to verify fusionable material. As the application of IAEA safeguards, even in fusion facilities, would be limited in verifying the absence of fissionable material in the facility, other proliferation concerns such as the use of tritium for nuclear weapons programmes would not be addressed. Furthermore, the proliferation potential regarding the gaining of knowledge for the functioning of thermonuclear weapons via inertial confinement would not be addressed by expanding the existing regime to fusion facilities by applying evolutionary interpretation.

2.3 Implications to NWFZ and the TPNW

These findings outlined above carry implications for the safeguards regimes of other treaties, including the NWFZ Treaties and the TPNW, as they refer to the IAEA safeguards system. Where these treaties refer to source and special fissionable material or directly quote Article XX of the IAEA Statute, the aforementioned considerations exclude an evolutionary interpretation including fusionable material into the application of safeguards.

With regard to the application to fusion facilities, all but one[744] NWFZ Treaties refer to (at least[745]) the CSA as the baseline for the application of safeguards. As argued above, evolutionary interpretation would allow for a fusion reactor to be considered a nuclear facility in the sense of the CSA. Consequently, the IAEA could exercise its authority to inspect fusion facilities also under the NWFZ regimes, albeit with the aforementioned limitations. This would address one of three aspects in which fusion can play a role in the proliferation of nuclear weapons.

Similarly, the TPNW refers in its Article 3 para. 2 to the CSA as the baseline for safeguards for NNWS. Under the TPNW, NNWS are required to accept IAEA safeguards on the level of the CSA, and, in the event they have adopted an Additional Protocol, to maintain such a heightened level of safeguards. The TPNW's direct reference to IAEA safeguards leads to evolutionary interpretation allowing for the IAEA to apply safeguards

744 As the Treaty of Tlatelolco is older than the NPT and the CSA, there is no reference to it. However, the CSA also serves as basis for safeguards agreements under this Treaty, *Laura Rockwood*, Legal Framework for IAEA Safeguards, Vienna: IAEA 2013, at 12.

745 The Treaty of Semipalatinsk even sets the Additional Protocol as baseline, Article 8(b).

on fusion facilities. It is important to note that, as the TPNW has been adopted in 2017, the temporal element necessary for the application of evolutionary interpretation is missing for the TPNW. However, evolutionary interpretation is not applied to a provision of the TPNW, rather to the IAEA safeguards regime to which the TPNW refers to.

2.4 Euratom Treaty

The application of evolutionary interpretation partially extends the European Commission's authority under the Euratom Treaty to apply safeguards to fusion. To recall, the Euratom safeguards system is based on two pillars: The verification that ores, source materials and special fissile materials are only used for their declared use (Article 77(a)), and the implementation of international agreements (Article 77(b)).

Regarding the implementation of international agreements, the possibility to include fusion facilities into the safeguards activities based on the NPT and the CSA is also true for the Euratom Treaty. Under the Euratom-IAEA Framework, the European Commission applies the CSA, and consequently, the above-mentioned argumentation holds as well: While fusionable material is outside the scope of the safeguards, the European Commission could apply its safeguards to fusion facilities through an evolutionary interpretation of the term *nuclear facility* to the same extent as the IAEA.

However, evolutionary interpretation is not possible for Euratom to extend its own safeguards system to fusion. Extending the meaning of materials is not possible for the same reasons as it is the case with Article XX of the IAEA Statute. Although the temporal requirement is fulfilled as the treaty was signed in 1957, it is not possible to assume the use of a generic term. The Euratom Treaty mentions fusion explicitly,[746] indicating that the drafters of the treaty were aware of fusion as a technology and that leaving out fusion of the safeguards system was a deliberate choice. As the ICJ requires such an evolutive intent of the Parties, the requirement of a *generic term* of evolutionary interpretation is not fulfilled. Regardless of the question on whether such methods of international law are applicable

746 According to Article II.1.(e) of Annex I to the Euratom Treaty, the study of fusion is part of applied theoretical physics to nuclear energy as a field of research concerning nuclear energy referred to in Article 4 of the Euratom treaty.

in interpreting the Euratom Treaty,[747] the European Commission is limited to apply evolutionary interpretation in order to implement the NPT-mandated safeguards system on fusion facilities in Euratom Member States following the CSA between Euratom and the IAEA.

2.5 Stocktaking and Limitations of Evolutionary Interpretation

Before examining the options of exercising authority or treaty changes, it is necessary to take stock to which extent the existing framework – including the application of evolutionary interpretation – applies to fusion. Fusionable material falls outside the scope of safeguards instruments. Consequently, the proliferation potentials of tritium and inertial confinement fusion are not addressed. However, the existing regime can be made applicable to address the proliferation potential of producing fissile material: In States that only have a CSA in place, the IAEA is able to conduct its standard verification procedures by invoking evolutionary interpretation. Where States have concluded an Additional Protocol with the IAEA, the Agency can verify that a fusion facility is not used for breeding nuclear weapons material by environmental sampling and complementary access via a direct application. Given that many other non-proliferation and disarmament instruments refer to the CSA as the baseline for their verification instruments, this finding is also of relevance for the TPNW, NWFZ Treaties and the Euratom Treaty.

However, there are severe limitations of evolutionary interpretation with regard to its application to the safeguards regime and fusion. First, evolutionary interpretation would only address one shortcoming of the regime. It would allow for the fission-based safeguards regime to apply to fusion facilities. The consequence is that one of three aspects of fusion's proliferation potential would be addressed, namely the use of fusion facilities to produce plutonium for nuclear weapons. Evolutionary interpretation would serve to bridge the gap in the NPT System for those 44 States, that have not adopted an Additional Protocol. It also extends the authority to other safeguards

747 The European legal order is an autonomous legal order, which has been established by Court of Justice of the European Union, Judgement of 5 February 1963, *van Gend & Loos*, Case 26–62, ECLI:EU:C:1963:1, at para. 3; Judgment of 15 July 1964, *Costa v. ENEL*, Case 6–64, ECLI:EU:C:1964:66, at 593. On the role of international law in EU law, see also Judgement of 3 September 2008, *Kadi*, ECLI:EU:C:2008:461, joined Cases C-402/05 P and C-415/05 P.

regimes where an Additional Protocol is not necessary, such as the TPNW and NWFZ Treaties. However, evolutionary interpretation does not address the other aspects of the proliferation potential of fusion, namely safeguarding fusionable material and addressing inertial confinement fusion.

Second, States might see the extension of the IAEA's authority via evolutionary interpretation critically. States have been hesitant to extend the Agency's authority with treaty changes to the safeguards system, while an extension via evolutionary interpretation excludes the participation of all States. Such an interpretation would be made either by the Secretariat, where States do not have a direct influence on, the Board of Governors with its limited membership or the General Conference. As both policy-making organs can take decisions by simple majorities, while the introduction of new safeguards agreements would require the consent of the concerned State, the IAEA's authority could be extended without the agreement of a concerned State. Thus, States might perceive evolutionary interpretation as undue interference with their sovereignty.

Third, the application of existing procedures and verification techniques developed for fission to the same extent to fusion would be disproportionate given the different levels of proliferation potential. A fission facility operates with material that has direct use in nuclear weapons programmes, while a fusion facility has no use of such material in a civilian operation. The safeguards system applies to different facilities throughout the fission fuel cycle, while in fusion it is only the reactor where the application of the IAEA safeguards regime addresses a proliferation potential of fusion. Operators of fusion facilities would be burdened with safeguards, while the effects would be limited. As the system has not been designed for the specificities of fusion, such an application would lead to a level of interference disproportionate to the risks posed by fusion.

As a consequence, the next section develops pathways how the exercise of authority under the existing regime opens possibilities to address the proliferation potential of fusion in an adequate manner.

3 Acting under the Existing Regime

This section explores the possibilities of adapting the non-proliferation regime in its application to fusion by exercising authority and acting under the existing framework. The section starts by analysing how two bodies of the IAEA, the Board of Governors (3.1) and the Secretariat (3.2), can

exercise authority under the IAEA Statute, established practices and the IAEA safeguards system in order to apply safeguards to fusion. It proceeds by examining the Nuclear Suppliers Group's role to extend export controls to fusion (3.3). This is followed by an analysis of Review Conferences and Meeting of State Parties of the NPT (3.4) and the TPNW (3.5) in their role of developing safeguards for fusion. The section then gives an overview of the role of the United Nations and its possibility in exercising its authority to strengthen the non-proliferation regime for fusion (3.6). The section concludes with an overview of the findings and an analysis of the advantages and disadvantages of the various approaches (3.7).

3.1 Decisions by the Board of Governors

This section analyses the extent to which the IAEA Statute provides the Board of Governors with powers to extend the safeguards regime to fusion. It starts with an analysis of the authority of the Board in general, with a specific focus on the safeguards system, before presenting several decisions that the Board could take.

3.1.1 Authority of the Board of Governors

The IAEA's Board of Governors is the executive organ of the IAEA and is vested with a wide range of powers.

The Board of Governor consists of 35 Member States and changes its composition annually. There are no formal permanent members in the Statute, yet there are *de facto* permanent members. First, it consists of the ten members of the IAEA which are the "most advanced in the technology of nuclear energy", Article VI.A.1 IAEA Statute. Historically, these ten States always composed the United States, the Soviet Union or Russia, the United Kingdom, France, China, (West-)Germany, Canada and Japan. It is the outgoing Board which designates these ten States. The Board is further composed of the most advanced nuclear State of each regional group and of further States elected by the General Conference for a period of two years following a regional distribution, Article VI.A.2 IAEA Statute. It meets five times a year for regular meetings, sometimes more often in case of the

request for extraordinary meetings,[748] compared to the General Conference which convenes once per year.[749]

The Board of Governors takes decisions by a simple majority, with the exception of budgetary questions where a two-thirds majority is required, Article VI.E. In practice, decisions by the Board of Governors are adopted by consensus.[750] This "Vienna Spirit" has allowed the IAEA to carry out its work as an independent technical authority and has mostly escaped geopolitical tensions since its foundation in 1957.[751] Following this spirit, States have usually pursued constructive negotiations leading to consensus.[752] In recent times, however, the Vienna Spirit has more and more faded and votes take place more often.[753]

Jointly with the General Conference, the Board is further responsible to approve any new Member State and to appoint the Director General,[754] which heads the Secretariat and is "subject to the control of the Board of Governors."[755]

The Board of Governors has the "authority to carry out the functions of the Agency […] subject to its responsibilities to the General Conference", Article VI.F IAEA Statute. It submits an annual report to the General Conference and reports to the United Nations if requested, Article VI.J IAEA Statute. While the Statute sets the Board of Governors institutionally under the authority of the General Conference, the IAEA's practice is the opposite.[756] When the General Conference formally takes decisions, they are

748 An example of such an extraordinary meeting was a Board Meeting taking place on 16 June 2025, requested by Russia, following the Israeli attacks on Iranian nuclear facilities.

749 *Laura Rockwood*, The International Atomic Energy Agency (IAEA), in: Eric Myer/Thilo Marauhn (eds.), Research Handbook on International Arms Control Law, Cheltenham: Elgar 2022, 503–529, at 508.

750 Ibid.

751 Ibid; Nuclear Threat Initiative/Center for Energy and Security Studies (eds.), The Future of IAEA Safeguards: Rebuilding the Vienna Spirit through Russian-U.S. Expert Dialogue, Washington DC: Nuclear Threat Initiative 2020.

752 *Kim Fyhr*, Steering the Atoms for Peace and Development: Legal Aspects of the Board of Governors of the International Atomic Energy Agency, AUC IURIDICA 70 (2024), 31–46, at 37.

753 Ibid.

754 Articles IV.B and VII.A IAEA Statute.

755 Article VI.B IAEA Statute.

756 *Fyhr* (n 752), at 36 and 43 f.

most often prepared by the Board.[757] It is the Board which is the forum for agenda-setting, discussions, deal-making and decisions on nuclear issues.[758]

This *de facto* inversion of authority is most obvious in the area of safeguards, where it is the Board of Governors that exercises authority and can sideline the General Conference.[759] While the General Conference may discuss any matter within the scope of the Statute, Article V.D IAEA Statute, its authority ends where the exclusive competence of the Board of Governors starts. Questions on safeguards typically fall under this category of exclusive competences of the Board. The Board of Governors approves safeguards agreements and arrangements, reports any non-compliance of a State's safeguards obligations to the UN General Assembly and UN Security Council, and can recommend the suspension of such a State.[760] For example, it was the Board of Governors that found that Iran was in non-compliance with its obligations under its safeguards agreement.[761] All developments in the IAEA safeguards system were initiated by the Board of Governors. Thus, the role of the General Conference in extending the safeguards regime to fusion is deemed negligible. This section analyses where the Board can take decisions and other actions in order to extend the IAEA's safeguards regime to fusion.

3.1.2 Designate Materials

The Board of Governors has the power to extend the scope of materials under Article XX of the IAEA Statute. However, it lacks the power to include fusionable material into the definition. In accordance with Article XX.1 of the IAEA Statute, the Board of Governors has the authority to extend the list of materials designated as special fissionable material with other fissionable materials. While the Statute permits the Board to add materials to the list, they still have to be *fissionable*, thus excluding material such as deuterium, tritium and ^{6}Li. Similarly, with regard to source material, the Board can include other material into the definition, but only as long as they contain uranium or thorium in a certain concentration. In addition, as specified by para. 112 of INFCIRC/153, any determination by the Board

757 Ibid.
758 Ibid, at 38.
759 Ibid, at 39 f.
760 Articles XII and XIX IAEA Statute.
761 GOV/2025/38.

of Government would additionally require the acceptance by each State in order to be implemented under the CSA.

Lessons on how to expand the definition of nuclear materials can be learnt from processes in the late 1990s, during which the Board of Governors addressed the question on how to handle the proliferation potential of the fissionable materials of neptunium and americium. The Board of Governors considerations followed a report by the IAEA Secretariat indicating that a proliferation potential has evolved.[762] While these materials can be used to build nuclear weapons,[763] no State has yet pursued such a route. At that time, the Secretariat presented to the Board of Governors three options to address the proliferation potential of these materials: designating them as source and special fissionable material in the sense of Article XX of the IAEA Statute, monitoring international transfers and activities at relevant facilities based on voluntary co-operation with the States, or no action at all.[764] The first option would have entailed the implementation of full-scope safeguards on these materials in the same manner as they are applied to uranium and plutonium. As the proliferation potential has been deemed limited, such a step has been regarded as premature.[765] Conversely, not acting at all, could have posed a risk to the credibility of the safeguards system.[766] As a consequence, the Board of Governors opted for the second route of monitoring on a voluntary basis.[767]

While an extension of Article XX to include fusionable material is not possible, such a call for voluntary safeguards on fusionable material similar to neptunium and americium would be a feasible approach. This would allow for a gradual introduction of fusion safeguards without the necessity of treaty amendments. Given the composition of the Board, such a call would lead to a high level of diplomatic pressure.

762 *Laura Rockwood/Viatcheslav Pouchkarev/Jill N. Cooley et al.*, IAEA Implementation of the Board of Governors Decisions on Neptunium and Americium, Vienna: IAEA 2000.

763 *David Albright/Kimberly Kramer*, Neptunium 237 and Americium: World Inventories and Proliferation Concerns, Institute for Science and International Security 6060 (2005), 1–24; *Rockwood/Pouchkarev/Cooley et al.* (n 762).

764 *Rockwood/Pouchkarev/Cooley et al.* (n 762).

765 Ibid.

766 Ibid.

767 *International Atomic Energy Agency*, The Annual Report for 1999, GC(44)/4, Vienna: IAEA 2000, at 97.

3.1.3 Designate Facilities

The Board of Governors could further designate fusion facilities as facilities under safeguards agreements. Which is another limitation of the application of safeguards. Under pre-NPT safeguards, the Board of Governors had the authority to extend the definition of the term *facility*.[768] As argued above, as the documents contain a specific list of what a facility and, especially, a reactor entails, evolutionary interpretation does not allow fusion to be covered. Para. 78 of INFCIRC/66 specifies that "a facility or plant of such other type [...] may be designated by the Board from time to time." This would enable an extension of the definition by a decision of the Board of Governors. However, it must be noted that INFCIRC/66 is only applicable for India, Pakistan and Israel, as the CSA suspends the application of these item-specific safeguards.[769] These three States decide themselves which facilities they open for IAEA inspection. Under the CSA, the Board of Governors has lost the authority to amend the definition of *facility*. This is due to the extension of IAEA safeguards from a facility-by-facility basis – where the interpretation a *facility* is essential – to comprehensive safeguards, intended to cover all nuclear activities of a State and a shift to focus more on nuclear material.[770]

As a legally binding designation is not possible, the Board of Government could issue an interpretative recommendation to tackle the ambiguity. As argued above, the CSA is the only safeguards agreement which does not define a reactor as a fission reactor. The Board of Governors could thus issue a recommendation to either define the term reactor also in the sense of a fusion reactor, or to explicitly exclude it. It issued interpretative recommendations in other cases, such as the definition of the term "any military purposes" of paras 1–2 of INFCIRC/66 in 1974[771] or the term "as early as possible" of para. 42 of INFCIRC/153.[772] Both the IAEA and States can request consultations on questions of interpretation and application of

768 Para. 78 of INFCIRC/66.
769 Para. 24 of INFCIRC/153; *R. Eltayb Hassan Eltayb/I. Tsvetkov*, Past, Current Status and the Future of Safeguards Implementation under INFCIRC/66/Rev.2 (2023), INMM Working Papers, at 3.
770 *Laura Rockwood*, IAEA Safeguards: Correctness and Completeness of States' Safeguards Declarations, in: International Atomic Energy Agency (ed.), Nuclear Law: The Global Debate, The Hague: T.M.C. Asser Press 2022, 205–222, at 207.
771 *Rockwood* (n 744), at 17.
772 Ibid, at 19.; GOV/2554/Att.2/Rev.2.

the treaty, while States can also request the Board of Governors to consider "any question arising out of the interpretation or application" of the CSA.[773] As evolutionary interpretation would allow for an application of safeguards to fusion reactors, there remains some uncertainty regarding the legitimacy of such an interpretation. The legitimacy of such an interpretation would be increased by a decision by the Board of Governors.

3.1.4 Establishing Committees and Advisory Groups

Another path in which the Board of Governors can encourage the development is the establishment of specialised committees. According to Article VI.I of the IAEA Statute, the Board of Governors has the power to establish committees mandated to work on specific topics, especially safeguards. This authority is further enshrined in Rule 57 of the Provisional Rules of Procedure of the Board of Governors. This prerogative was exercised in the preparation of the Additional Protocol in 1996 and 1997,[774] as well as in 2005 to consider ways and means to strengthen the safeguards system.[775] While the mandates of the respective committees have ended, the Board of Governors retains the authority to establish a committee specifically focusing on the question of applying safeguards to fusion. Such a committee could discuss the pathways to apply fusion safeguards. This could include preparatory works for a protocol or agreement specific for fusion safeguards[776] or methods for technical implementation. As the Board of Governors can "establish such committees as it deems advisable"[777] and has the "authority to carry out the functions of the Agency"[778], which include both non-proliferation and the promotion of fusion,[779] there is a wide margin of discretion for the Board to establish fusion safeguards committees.

773 Paras 20 and 21 of INFCIRC/153.
774 The so-called Committee 24, consisting of representatives of about 70 Member States, drafted the model text of the Additional Protocol.
775 The Advisory Committee on Safeguards and Verification within the Framework of the IAEA Statute, or short Committee 25, was established on 17 June 2005.
776 See below, Section 4.2.2.
777 Article VI.I of the IAEA Statute.
778 Article VI.F of the IAEA Statute.
779 See Chapter 3, Section 1.1.

3.1.5 Call for Voluntary State Action

Another potential course of action for the Board of Governors is to call upon States for voluntarily submitting their fusion infrastructure and materials comprehensively to IAEA safeguards. Given that the Board of Governors is entrusted with carrying out the functions of the Agency (Article VI.F of the IAEA Statute), including establishing and administering safeguards (Article III.A.5 of the IAEA Statute), such a plea would fall within the competence of the Board.

With respect to NWS, voluntary approaches are the only option to apply safeguards to fusion. According to the NPT, these States are permitted to use all infrastructure for military purposes and to support nuclear weapon programmes. Presently, the five NWS place parts of their infrastructure under Voluntary Offer Agreements. As analysed above, the two Inertial Confinement Fusion Facilities (NIF in the United States and Laser Mégajoule in France) are part of military programmes and thus not part of the United States' or France's Voluntary Offer Agreements under which they voluntarily open their civilian nuclear infrastructure to IAEA safeguards.

As the first commercially feasible fusion power plant could be built either in the United States[780] or the United Kingdom,[781] there is a significant chance that the question of safeguards will arise in NWS first. NWS offered VOAs for two reasons: increasing acceptance and facilitating negotiations.[782] As safeguards lead to additional burdens and costs as well as interference with sovereignty, accepting safeguards voluntarily sets an equal playing ground for both NWS and NNWS without objecting NNWS to a competitive disadvantage. In addition, such a voluntary approach by NWS might facilitate the negotiation of international fusion safeguards. It is at the discretion of each NWS to extend these VOAs to fusion facilities. As these States decide which facilities they declare, their voluntary action is necessary for safeguards to apply to fusion.

780 ARC by Commonwealth Fusion Systems (CFS) is the most likely contender and is expected to start its operation in Virginia in the early 2030s.

781 The UK Government currently works on its STEP (Spherical Tokamak for Energy Production) project, which is expected to produce energy for the British energy grid by 2040, *Adam Baker*, The Spherical Tokamak for Energy Production (STEP) in Context: UK Public Sector Approach to Fusion Energy, Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 382 (2024), 1–8.

782 *Frank S. Houck*, The Voluntary Safeguards Offer of the United States – A Review of its History and Implementation, IAEA Bulletin 27 (1985), 13–18.

For NNWS, there is also a possibility to accept voluntary safeguards. This will be especially of relevance if either a start-up outside a NWS[783] will be the first to deploy fusion power plants or if a NWS-based start-up exports its technology to NNWS. According to Article III.A.5 of the IAEA Statute, the Agency established and administers safeguards at the request of a State. Consequently, in the absence of an international system of fusion safeguards, States entering into fusion have the option to request the IAEA to specifically apply safeguards on their fusion facilities. Similarly, these voluntary safeguards could serve as a template for the development of international safeguards standards to such novel technology.

3.2 Practice by the IAEA Secretariat

While the Board of Governors is the most powerful policy-making organ within the IAEA, it is the Secretariat, specifically its Department of Safeguards as one of six departments, that is responsible to administer and implement safeguards. It is the Secretariat that sends inspectors and analysis the data transferred to Vienna. In addition, it is the Director General as its head which reports the Secretariat's findings to the Board of Governors or the United Nations.

This section analyses whether IAEA's Secretariat has the authority to extend its safeguards activities to fusion.

3.2.1 Authority of the IAEA Secretariat

The IAEA Secretariat is led by the Director General, which in turn is subject to the control of the Board of Governors.[784] It is not a policy-making body, it merely implements the policy set by the Board and the General Conference.

The IAEA Statute is scarce on the authority of the Secretariat. In fact, it only uses the expression *staff* rather than Secretariat. Article VII is limited to declaring that there is staff, led by the Director General. The Secretariat,

783 Germany wants to be the first State in the world to have an operation fusion power plant, *CDU/CSU/SPD*, Verantwortung für Deutschland – Koalitionsvertrag zwischen CDU, CSU und SPD, 21. Legislaturperiode, Berlin: 2025, at 78.

784 Articles VII.A and VII.B.

thus, is composed of the Director General and the staff.[785] The Director General is mentioned several times, giving him the powers to represent the organisation, report to the policy-making bodies and to prepare budget estimates.[786] The Board's Provisional Rules of Procedures further clarify the powers of the Director General and the Secretariat. According to its rule 8(a), the Director General "shall perform his duties in accordance with regulations adopted by the Board and shall be guided by the policy of the Agency". Rule 10 focuses on the Secretariat itself, charging it with administrative duties in support of the Board's work as well with the task to "perform all other work which the Board, its committees and other subsidiary bodies may require". Similarly, the Rules of Procedures of the General Conference charge the Secretariat with administrative duties in support of the General Conference's work and all other work it, its committees or its subsidiary bodies may require.[787]

However, the Secretariat receives authority from the safeguards instruments, where it performs independently its verification activities.[788] For example, the Secretariat decides when, where and to which extent it performs inspections or what information it requests. In exercising its safeguarding activities, the Secretariat has to interpret the relevant provisions, which further provides the Secretariat with a certain degree of interpretative authority.

3.2.2 Advisory Groups

The IAEA Secretariat has a long-standing practice of establishing independent advisory groups to undertake specific tasks. While there is no clear reference in the IAEA Statute granting the Secretariat the authority to establish such groups, this practice has never been criticised neither by the Board of Governors nor the General Conference nor its Member States. On the contrary, the Member States recognise the valuable work of these

785 *Paul C. Szasz*, The Law and Practices of the International Atomic Energy Agency, Vienna: IAEA 1970, at 193.
786 Articles V.A, VII, XII.C, XIV, XVIII.
787 Rule 39.
788 *Pierre Goldschmidt*, The IAEA Safeguards System Moves into the 21st Century, IAEA Bulletin 41 (1999), 1–19, at 2.

independent advisory groups.[789] One of these advisory groups is the Standing Advisory Group on Safeguards Implementation (SAGSI), established in 1975, which comprises 20 experts tasked to advise the IAEA Director General on the implementation of safeguards. Established to facilitate the implementation of the comprehensive safeguards agreements, SAGSI has played a role in developing safeguards design parameters as well as in the development of the Additional Protocol.[790] SAGSI has been instrumental in defining which amount of which material is seen as sufficient for a nuclear weapon (so-called significant quantity).[791] SAGSI is also seen as an important player in updating the annexes of the Additional Protocol, which contain safeguarded activities and lists of equipment and materials for export controls.[792] This advisory group might draw the attention to fusion safeguards and play a role in their development.

Furthermore, in 2013, the IAEA Secretariat organised a Consultative Group regarding the non-proliferation potential of fusion.[793] Technical experts were interviewed on aspects of magnetic fusion and their role in nuclear non-proliferation. The group drafted a report, in which they raised several proliferation concerns, which are analysed in this book's Chapter 1. The IAEA's Secretariat took note of the report, but did not take any immediate action as the time horizon for the necessity of IAEA action was projected to extend over several decades.[794] It is only recently that the commercial sector has shortened the timeline for commercial fusion energy.

The IAEA's Secretariat could use this authority to establish new groups or charge existing groups with developing new approaches to safeguard fusion technology.

789 See for example the records of the Board of Governors' 1131st meeting, GOV/OR.1131, especially at para. 28.

790 *John Carlson*, SAGSI: Its Role and Contribution to Safeguards Development, Canberra: Australian Safeguards and Non-Proliferation Office 2007.

791 *Braden Goddard/Alexander Solodov/Vitaly Fedchenko*, IAEA "Significant Quantity" Values: Time for a Closer Look?, The Nonproliferation Review 23 (2016), 677–689, at 677 f.

792 *Laura Rockwood/Noah C. Mayhew/Artem Lazarev et al.*, IAEA Safeguards: Staying Ahead of the Game (2019), Swedish Radiation Safety Authority, Recommendation 9.

793 *IAEA*, Report of the Consultancy Meeting on "Non-Proliferation Challenges in Connection with Magnetic Fusion Power Plants", Vienna: IAEA 2013.

794 Ibid.

3.2.3 Special Inspections

As argued above, environmental sampling under the Additional Protocol allows to verify to a certain degree that a fusion facility is not used for plutonium production. However, the Additional Protocol is only ratified by 141 States and Euratom, leaving 44 NNWS that have only adopted a CSA. Among the States that did not conclude an Additional Protocol are Argentina, Brazil and Egypt; States with nuclear infrastructure that have pursued nuclear ambitions in the past century. For these States, paras 73 and 78 of INFCIRC/153 (the document on which the CSA is based) provide the IAEA's Secretariat with the authority to perform special inspections. The Secretariat can demand special inspections in the case that the information it has received "is not adequate for the Agency to fulfil its responsibilities under the Agreement", para. 73(b). Under special inspections, the Secretariat can demand access to information and locations that are otherwise not covered by the CSA.[795] The IAEA has the responsibility under the CSA to implement safeguards mandated by Article III.1 of the NPT[796] and to apply safeguards on all source or special fissionable material in all peaceful nuclear activities in the territory of the State by verifying that no such material is diverted to nuclear weapons.

These special inspections could be used to apply safeguards to fusion facilities in NNWS that have only adopted a CSA. As existing safeguards methods do not include fusion facilities, the IAEA does not have the information necessary to verify that fusion facilities are not used to produce and later divert source and special fissionable material for nuclear weapons application. Thus, the requirement for the IAEA to demand special inspections would be fulfilled. As the IAEA may, in the course of special inspections, demand access to locations other than those specified in the agreement, the IAEA may demand access to fusion facilities, as well as to locations where the IAEA may take environmental samples.[797] As a consequence, special inspections would allow for a similar approach as the Additional Protocol currently provides.

However, the IAEA has acted restrictively in demanding special inspections and only did so twice in its history: In 1992 to verify plutonium separation experiments in Romania and in 1993 to verify the North Korean

795 Para. 77 of INFCIRC/153.
796 This is explicitly laid out in para. 1 of INFCIRC/153.
797 *Rockwood* (n 770), at 209 f.

nuclear programme.[798] The IAEA's Board of Governors decided that special inspections are limited to rare occasions only.[799] While there is the legal basis for inspecting fusion facilities, the practice of the IAEA Secretariat, as well as the previous decision by the Board of Governors, limits the use of this legal basis to apply safeguards to fusion facilities.

3.2.4 Interpreting the Safeguards Instruments

Another area in which the Secretariat can perform authority is in its interpretation of safeguards agreements. As argued above, the term "reactor" would allow for the application of safeguards on fusion reactors, while current interpretations of the term would not allow to cover fusion. This current interpretation is listed in the IAEA Safeguards Glossary.

The Safeguards Glossary is drafted by the Secretariat to create transparency by defining core terms used in safeguards instruments. The Glossary serves as an important document in the application of safeguards. Although the Glossary itself states that it has "no legal status and is not intended to serve as a basis for adjudicating problems of definitions such as might arise during the negotiation or in the interpretation of safeguards agreements or protocols thereto",[800] it is the go-to document and serves as a primary reference source for definitions in the domain of safeguards.[801] Currently, the IAEA Safeguards Glossary includes the definition of a reactor that is similar to those found in INFCIRC/66 and in Annex II of the Additional Protocol. Clarifying the definition of a reactor would, equally to a decision by the Board of Governors, create some legal clarity by either

798 *Olli Heinonen*, The Case for an Immediate IAEA Special Inspection in Syria, Washington Institute PolicyWatch 1715 (2010), 1–2.

799 *George Bunn*, Nuclear Safeguards – How Far Can Inspectors Go?, IAEA Bulletin 48–2 (2007), 49–55, at 52.

800 *International Atomic Energy Agency*, IAEA Safeguards Glossary, Vienna: IAEA 2022, Foreword.

801 It is referred to for finding a definition for example in *Mark Hibbs*, Iran and the Evolution of Safeguards, in: VERTIC (ed.), Verification & Implementation – A Biennial Collection of Analysis on International Agreements for Security and Development, London: VERTIC 2015, 1–26, at 11; *Laura Rockwood*, The IAEA and International Safeguards, in: Joseph Pilat/Nathan Busch (eds.), Routledge Handbook of Nuclear Proliferation and Policy, London: Routledge 2015, 142–157, at 146; *Renaud Chatelus*, A Little Customs Glossary for IAEA Safeguards: Customs Procedures and Concepts that Matter for the Implementation of Modern Safeguards, Esarada Bulletin 47 (2012), 80–88.

facilitating or explicitly excluding the application of the CSA to fusion reactors. Such a clarification would be the implementation of evolutionary interpretation, as analysed above.

3.2.5 Evaluation of the Authorities of IAEA Bodies

As the Board of Governors is the most important body of the IAEA and given the fundamental change of the safeguards system which an extension to fusion facilities would entail, it is unlikely that the Secretariat would act without either approval or mandate of the Board of Governors. While it has recently intensified its internal considerations on fusion safeguards, especially within SAGSI,[802] the Secretariat does not intend to act without any decision by the Board of Governors. The Secretariat can draft a report to the Board, recommending extensions to the safeguards system, while the final decision to extend the safeguards system to fusion – within the existing authority granted by the NPT and safeguards instruments – would reside within the Board of Governors.

3.3 Nuclear Suppliers Group

The NSG, despite not being an international organisation, exercises authority in the realm of export controls. While the NSG Guidelines are not legally binding, they *de facto* specify the rules and procedures for nuclear equipment and materials, as its Member States – which are the leading nuclear exporting States – publicly announce their adherence and translate them into domestic legislation. In exercising its authority, the NSG has the possibility to address fusion's proliferation potential by adapting its rules and procedures to fusion.

The NSG convenes for plenary meetings once a year, during which potential updates to the export control regime are discussed. Amending the list requires consensus. While the consensus requirement renders a decision difficult, reaching consensus increases the probability that all States translate the NSG soft law into domestic law. The work of the plenary is supported by two sub-bodies: the Consultative Group responsible for holding consultations on topics related to the guidelines and the technical

802 Personal communication to the author.

annexes; and the Information Exchange Meeting where information and developments with relevance to the export control regime are discussed.[803]

3.3.1 Modifying Export Control Procedures

As analysed above, the NSG Guidelines have only limited effect on the proliferation potential, given that the procedures require the application of IAEA safeguards, which, in turn, apply only to fission. There are possibilities to adapt the guidelines in order to address fusion's proliferation concerns by developing new procedural requirements for the export of fusion materials.

An approach might be the requirement of bilateral inspections. Such an approach would be similar to United States export controls prior to the IAEA's foundation. Before international safeguards were established, the United States required other States to accept inspectors from its Atomic Energy Commission (AEC) in bilateral nuclear trade agreements.[804] As there are no proper international fusion safeguards yet, a similar approach might address the proliferation potential of fusion. A State with a fusion industry only allows the export of fusion reactors to another case if they agree on the presence of inspectors sent by the exporting State verifying that the facility is not used for proliferation purposes. The extent of these inspections would be specified in a bilateral treaty as a precondition for the export. Such an approach would be a form of national export controls on fusion technology. As the most advanced fusion start-ups are based in the United States, this would especially require verification by AEC inspectors.

Since NSG export controls try to harmonise the export controls and procedures on an international level, requiring bilateral inspections for fusion facilities could also serve as an example for the NSG regime to address the safeguarding issue for fusion until there is an international treaty-based system.

Requiring specific procedures for tritium could be another approach by the NSG. Currently, both tritium and ^{6}Li are on the Dual-Use list. However, as noted above, the mechanisms of the Dual List are too weak and porous to prevent the proliferation of tritium and tritium breeding technology for boosting nuclear weapons. To strengthen this framework, one option would

803 INFCIRC/539/Rev.8, at para. 42.

804 *Grégoire Mallard*, Fallout: Nuclear Diplomacy in an Age of Global Fracture, Chicago: The University of Chicago Press 2014, at 121.

be to extend the requirements specifically for the export of both tritium and ^{6}Li. While today the conclusion of a CSA between the IAEA and a NNWS is sufficient to allow for exports, this additional requirement could be to provide the NSG with detailed reports on tritium accounting and the end-use of ^{6}Li. Such a combination would allow for an overview of whether tritium from a fusion facility could have been used for military purposes. As tritium itself is extremely expensive, such thorough accounting is done regardless of legal requirements. This modification would not entirely eradicate the proliferation problem, but it is a viable first step given the proliferation risks and timeline of fusion technology development.

These extensions of procedural requirements would fill the gap between the existing recognition of certain materials and technologies relevant for fusion and its lack of procedural requirements designed to verify the peaceful use of such dual-use goods.

3.3.2 Safeguarding Inertial Confinement Fusion

Identifying a legal solution to the proliferation risks of inertial confinement fusion is the most difficult endeavour in addressing fusion's proliferation potential. The technology itself does not produce material that is used in nuclear weapons; rather, it is the knowledge of physics gained in these facilities that may support the development of nuclear weapons.

One approach could be to amend the NSG's Trigger List to include high performance lasers and the components needed to build them. Lasers are critical to inertial confinement fusion, as they are responsible for heating and compressing the fusion plasma while simultaneously providing insights into energy transfer in hydrogen bombs. At present, only lasers and laser systems used for uranium separation and enrichment are listed on the list.[805] Nevertheless, as mentioned above, a procedural condition for exports under the NSG Guidelines to NNWS is this State has accepted IAEA safeguards. While the IAEA safeguards system is limited to verify the use of material and technology, the IAEA cannot inspect or prevent the transfer of knowledge.

Consequently, the incorporation of ICF facilities and components within the export control regime would require new procedures as well. This would entail transparency regarding the design features and configuration,

805 INFCIRC/254/Rev.14/Part 1, at para. 5.7, in particular at 5.7.13.

thereby enabling experts to analyse the similarity to military research. The less the configuration can be modified, the fewer any insights to nuclear weapons there will be. Experimental ICF devices are designed for a wide range of configurations of physical parameters in order to maximise the scientific insights gained. Commercial ICF plants want to maximise the energy output, which will be the case for a specific configuration. Such a limit of configurability allows experts to assess the design of the plant and to determine whether a transfer of knowledge is possible. Such a transparency requirement could be included as procedural requirement within the NSG.

3.3.3 Evaluation of the NSG's Authority

Addressing fusion's proliferation potential within the NSG framework is a likely outcome of current discussions surrounding the topic. Including fusion into the Guidelines has been recommended by several authors as preferred avenue to deal with fusion's proliferation potential.[806] The advantage is that no amendments to international treaties would be necessary and the IAEA could continue to focus on fission safeguards. Furthermore, given that this would require consensus among the largest nuclear exporting States, this could create first experiences on safeguarding fusion, which could – at a later state – translate into a full-scope incorporation of fusion into the IAEA's safeguards regime. However, a key caveat remains with such a solution: Export controls only apply in the case of an export, thus, an advanced State which does not require imports of technology would still be able to use fusion technology for a nuclear weapons programme without the intended international oversight. In addition, export controls are only effectively contributing to non-proliferation when they are accompanied by a strong safeguards regime.

3.4 NPT Review Conferences

Another avenue to apply safeguards on fusion under the existing framework is through the operation of the NPT Review Conferences (RevCons). Un-

806 Wolfram Tonhauser/Karoly Tamas Olajos (eds.), FELEX – Key Issue Report, FELEX 2023, at para. 12; Karoly Tamas Olajos/Fusion For Energy (eds.), Fusion For Energy Roundtable 2024 Proceedings, Barcelona: European Commission 2024, at 62; *Desai/Hua/Roma et al* (n 703).

der Article VIII.3 of the NPT, all State Parties convene every five years to "review the operation of this Treaty with a view to assuring that the purposes of the Preamble and the provisions of the Treaty are being realised." Although these conferences are often slowed down by political divergences that impede consensus[807] – among NWS and NNWS, among Global North and Global South and among East and West – they nonetheless represent a unique institutional mechanism for collectively scrutinising and shaping the evolution of the non-proliferation regime.

From a legal perspective, RevCons do not produce binding obligations;[808] their final documents constitute soft law instruments that primarily guide political expectations. However, their significance should not be underestimated. States dedicate several weeks to intensive negotiations,[809] prepare the conferences for three years in PrepComs and the resulting documents – often extending hundreds of pages – can reinforce or recalibrate expectations of safeguards, thereby indirectly influencing both state practice and the IAEA's operational priorities. This was evident in the 2010 RevCon, which underlined the importance of strengthening safeguards by affirming that "the implementation of measures specified in the model additional protocol provides [...] increased confidence about the absence of undeclared material."[810] While such statements lack direct legal force, they contribute to a normative environment that could facilitate the integration of fusion-related risks into the safeguards discourse.

Given that the proliferation challenges posed by fusion technologies directly engage the aim listed in the NPT's preamble that "the proliferation of nuclear weapons would seriously enhance the danger of nuclear war", as well as the obligations under Articles I and II, addressing this issue is a key concern of RevCons. Yet whether they can effectively operationalise this mandate remains uncertain. The difficulty of achieving consensus outcomes – exacerbated by competing commercial and strategic interests

807 *Sergey Batsanov/Vladislav Chernavskikh/Anton Khlopkov*, 10th NPT Review Conference – The Nonproliferation and Peaceful Uses of Nuclear Energy Pillars, Arms Control Today 52 (2022), 13–19; *Harald Müller*, The NPT Review Conferences, in: Emily B. Landau/Azriel Bermant (eds.), The Nuclear Nonproliferation Regime at a Crossroads, Tel Aviv: Institute for National Security Studies 2014, 17–26; *Manpreet Sethi*, NPT Review: Issues and Challenges, Strategic Analysis 24 (2000), 867–881.

808 One exception was the 1995 Review and Extension Conference, mandated by Article X.2 NPT, which decided to indefinitely extend the duration of the Treaty beyond its inaugural 25-year period.

809 The RevCons typically last 26 days.

810 NPT/CONF.2010/50 (Vol. 1), at 4.

in fusion development – may constrain the capacity of future RevCons to demand robust safeguards measures specific to fusion. Nevertheless, their potential to place fusion explicitly on the NPT agenda makes them a valuable, if imperfect, forum for advancing fusion safeguards.

3.5 TPNW Meeting of State Parties and Review Conferences

In a manner similar to the NPT RevCons, the TPNW establishes a framework of regular conferences of the State Parties to discuss matter relating to the treaty. On a biannual basis, the Meeting of the State Parties convenes in order to consider and take decisions on the implementation and status of the Treaty as well as measures to verify the time-bound and irreversible elimination of nuclear weapons programmes and other matters relating to treaty provisions.[811] Additionally, starting in 2026 and then every six years thereafter, conferences will convene in order to review the operation of the Treaty and the progress in achieving its purposes.[812]

Both of these fora are suitable to establish safeguards for fusion. As stated before, for NNWS the CSA is the standard of safeguards under TPNW, whereas for former NWS acceding to the Treaty, safeguards are yet to be developed. In contrast to the NPT, the interests of Member States to the TPNW are more homogenous. All States share an interest in preventing the use of nuclear technology for nuclear weapons. This shared interest might facilitate the incorporation of fusion safeguards in the TPNW system. While some States disagreed on including the AP as standard for safeguards, their disagreement stems from the role of safeguards under the NPT. Thus, even those States might agree on fusion safeguards which are developed under the TPNW and not under the NPT.

In the case of the application of safeguards to NNWS (which are the only current Member States), these meetings could call on all Member States to voluntarily accept safeguards for their fusion infrastructure and to engage in developing safeguards for fusion. In the hypothetical case of NWS joining the treaty, the Meeting of States Parties could decide on concrete actions

811 Article 8 para. 1 TPNW. There have been Meetings of State Parties in 2022, 2023 and 2025. On their progress, see *Rebecca Davis Gibbons/Stephen Herzog*, The First TPNW Meeting and the Future of the Nuclear Ban Treaty, Arms Control Today 52 (2022), 12–17; *Mackenzie Knight*, TPNW2MSP: Overview And Key Takeaways (*Federation of American Scientists*, 2023), https://fas.org/publication/tpnw2msp-overview-and-key-takeaways/, last accessed 17 July 2025.

812 Article 8 para. 5 TPNW.

to safeguard fusion, including the vertical proliferation potential associated with tritium and inertial confinement fusion.

3.6 United Nations

The United Nations is another actor that could support the development of fusion safeguards. The UN Charter gives a mandate to the United Nations to act in this area of international law via the broader disarmament and regulation of armament provisions,[813] as well as in the context of maintaining international peace and security.[814] The United Nations has been instrumental in developing and strengthening the non-proliferation framework in the past and could take up such a role with regard to fusion as well.

The UN General Assembly called in A/RES/41(I) for the establishment of a verification system for nuclear weapons, predating the establishment of the IAEA by more than a decade. The UN General Assembly has consistently demonstrated its commitment to enhancing non-proliferation and disarmament efforts, as evidenced for example by endorsing the work of the ENDC, in which States negotiated the NPT,[815] and by the work of its First Committee. Furthermore, it was the General Assembly that mandated the negotiations of the TPNW in 2016.[816] As a non-consensus decision-making organ without veto powers, the General Assembly provides flexibility in supporting processes in nuclear non-proliferation and disarmament.[817]

The UN General Assembly is a suitable forum to discuss topics more broadly than within the IAEA context. Its focus is not only on nuclear questions, but more broadly on maintaining international peace and secu-

813 Articles 11 para. 1, 26 and 47 of the UN Charter. On this, see *Daniel H. Joyner*, Non-proliferation Law and the United Nations System: Resolution 1540 and the Limits of the Power of the Security Council, Leiden Journal of International Law 20 (2007), 489–518, at 491.

814 Articles 1 para. 1, 39 of the UN Charter.

815 A/RES/1722 (XVI).

816 A/RES/71/258 para. 8 reads: *Decides* to convene in 2017 a United Nations conference to negotiate a legally binding instrument to prohibit nuclear weapons, leading towards their total elimination.

817 On potential roles of the General Assembly in the future, see *Konstantin Larinov*, Expanding the UN General Assembly's Role in Managing Disarmament and Non-Proliferation Challenges (*European Leadership Network*, 2023), https://europeanleadershipnetwork.org/commentary/expanding-the-un-general-assemblys-role-in-managing-disarmament-and-non-proliferation-challenges/, last accessed 17 July 2025.

rity[818] as well as on promoting its sustainable development goals.[819] This would allow for discussing fusion and its implications to the international order more comprehensively. In addition, given the historic precedents, the UN General Assembly could also initiate for a conference which aims at developing new instruments on safeguarding fusion. However, as resolutions by the UN General Assembly are limited to recommendations without legal bindingness,[820] the General Assembly could not take legally binding decisions which would directly expand the safeguards regime. Its role is limited to facilitate discussions and negotiations.

The Security Council's engagement with non-proliferation, notably through UNSCR 1540, illustrates both the potential and the constraints of this body in shaping safeguards relevant to emerging technologies such as fusion. By acting under Chapter VII, the Security Council imposed binding obligations on all states to strengthen export controls and prevent non-state actors from acquiring nuclear capabilities.

As explored in the previous chapter, UNSCR 1540 does contain provisions of indirect relevance to fusion, by requiring States to establish and maintain effective export controls and domestic measures to prevent non-state actors from acquiring nuclear weapons or related materials. This framework could, in principle, help mitigate the risks of sensitive fusion technologies – particularly inertial confinement fusion, which bears direct parallels to thermonuclear weapons physics – falling into the wrong hands. However, the resolution's primary orientation toward combating terrorism and illicit trafficking means it lacks the technical specificity and sectoral focus necessary to address the proliferation challenges unique to commercial fusion reactors.

In contrast, UNSCR 1887 explicitly underscored the importance of strengthening the global safeguards architecture by urging States to conclude Comprehensive Safeguards Agreements and Additional Protocols with the IAEA, and by calling for adequate resources for the Agency and for an *effective* safeguards system.[821] Yet, because the Council did not invoke Chapter VII, these calls remain legally non-binding.[822] For the context of fusion, this points to a critical gap: while the Security Council has

818 Article 1 para. 1 UN Charter.

819 A/RES/70/1. On the role of fusion under the SDGs, see above Introduction, Chapter 1.

820 Article 10 UN Charter.

821 S/RES/1997, at para. 15b.

822 *Michael Wood*, United Nations, Security Council, in: Anne Peters/Rüdiger Wolfrum (eds.), Max Planck Encyclopedia of Public International Law, Heidelberg, Oxford:

signalled sustained political concern over the robustness of safeguards, it has stopped short of imposing obligations that might directly integrate emerging technologies like fusion into the safeguards regime. This suggests that future Security Council engagement – potentially through similarly worded resolutions – may continue to shape political expectations but is unlikely to substitute for dedicated, technically tailored frameworks necessary to regulate fusion's proliferation-sensitive aspects.

The Security Council's selective activation of its Chapter VII powers – often driven by acute security crises – raises doubts as to whether it would similarly intervene to proactively regulate fusion safeguards, as there is no immediate threat. This suggests that while the UN Charter provides the UN Security Council with the authority to act, its practical utility of the Council's authority for safeguarding fusion may be limited without sustained political will from key permanent members.

3.7 Evaluation and Summary

As this section has shown, various actors have the possibility to establish or implement safeguards for fusion by exercising authority. As these pathways to adapt the regime for fusion do not require treaty changes, they present feasible approaches to address the proliferation potential of fusion. They include the use of existing authorities by the IAEA and its organs, the Nuclear Suppliers Group, review conferences, meetings of State Parties, and the United Nations.

The different approaches offer various advantages and disadvantages. As the IAEA is the most important institution in administering safeguards, actions by the Board of Governors and the IAEA Secretariat are the most relevant. This is particularly salient in the context of majority voting rules or institutional practices, which enable the implementation of these approaches despite the potential objections of individual States, including both NWS and NNWS, but also potentially raising legitimacy concerns by those States. Given the bureaucratic structure of the IAEA, such approaches could be lengthy, but shorter than others such as treaty changes.

Oxford University Press 2008; *Stefan Talmon*, The Security Council as World Legislature, American Journal of International Law 99 (2005), 175–193; *International Criminal Tribunal for the former Yugoslavia*, Prosecutor v. Tadić, Appeal on Jurisdiction, Decision of 2 October 1995, No. IT-94–1-AR27, at para. 44.

While the IAEA Secretariat is the organ which is charged with implementing the safeguards agreements, it seems unlikely that the Secretariat would change the interpretation of these agreements without the consent of the Board of Governors. As it is the Board which adopts the structure and content of safeguards agreements, the Board is the organ of the IAEA which sets the boundaries of the implementation of these agreements. Thus, safeguards activities by the IAEA on fusion technology depends on a decision by the Board of Governors. The Board is dominated by States that represent the most advanced in the technology of atomic energy, while these States are also those most advanced in fusion technology. As a consequence, any action by the IAEA would require the consent of States home to fusion start-ups to apply safeguards on the technology of their promising industries. The probability of such a consent would depend on the perceived proliferation potential of the technology and the scale of interference of fusion safeguards. As the topic of fusion and non-proliferation gains attention within the scientific community, States and international organisations, such a coalition seems possible within the next years or decade.

In contrast, the NSG would offer the possibility to relatively quickly implement new rules. However, as its tools are limited to soft law, their implementation requires all States to support the new measures, requiring consensus and State commitment, as there would be no legal obligation or legal recourse to implement them. Given their non-bindingness and less-intrusive nature compared to safeguards, a modification to export controls regime is the likeliest outcome on addressing fusion's proliferation potential, at least in the near- and mid-term. In addition, export controls are also the preferred approach by start-ups to fusion's proliferation potential.

Given the political character of the implementation of the NPT and its Review Conferences, as well as the opposition by some NNWS to strengthen safeguards as long as there is no progress in nuclear disarmament, decisions by Review Conferences or Meetings of State Parties seem unlikely. In these fora, States cannot agree on universalising the existing safeguards regime, thus any progress in safeguards beyond the status quo seem even more out of reach. Even if States could find consensus, these decisions are also non-binding, and the benefit would be limited. Finally, the United Nations can implement recommendations to develop or apply safeguards on fusion technology, while binding resolutions by the Security Council under Chapter VII of the UN Charter are unlikely. As endorsement of safeguards agreements by the UN were historically tied to existing safeguards

agreements, thus, these steps would require first the adoption of new agreement on safeguarding fusion.

These different uses of existing authority would most likely follow each other. Once States hosting start-ups agree within the Board of Governors to expand the safeguards system to fusion, the IAEA Secretariat, supported by SAGSI, would follow suit. Once such an agreement is reached, it is likely that consensus could also be reached among the same States within the NSG to expand the export control procedures to address fusion's proliferation potential. Once these decisions are made, other fora could follow. This could lead to momentum within the NPT Review Conference and the TPNW Meeting of State Parties to recognise and endorse the developments within the IAEA and the NSG. Once agreed upon in these fora, an endorsement by the United Nations bodies could follow. It must be noted, however, that once the topic is discussed outside the IAEA, not only States home to fusion start-ups have to agree, but also States without a fusion industry. Gaining their support without any progress in other areas of nuclear weapons law, either by technical assistance or progress in nuclear disarmament, is unlikely.

As the actors' authority under the existing regime has its limits, the next section analyses the necessity and possible avenues of treaty changes to the regime of nuclear weapons.

4 Treaty Changes

The most complicated approach to address the proliferation potential of fusion is amendments to the existing treaties and agreements.

This chapter has so far demonstrated that some aspects of fusion can be addressed under the application of existing legal instruments, evolutionary interpretation, or the exercise of authority. These approaches allow fusion facilities to be included into the safeguards regime in order to verify that they are not used to produce fissile material for nuclear weapons. In addition, export controls under the NSG can play a role in safeguarding inertial confinement fusion.

What remains outside the scope of these options is the proliferation potential of the substantial quantities of tritium produced. This section analyses how these this aspect could be addressed by new international treaties.

However, it must be noted that treaty changes are most difficult to achieve, especially in the area of nuclear non-proliferation. While States

struggle to agree to non-binding outcome documents of the NPT Review Conference, accepting changes to the NPT regime seems even more out of reach. Also, other treaties in the area of nuclear weapons law lack ratification of major States such as the CTBT or the TPNW. The probability of successful negotiations which then turn into the adoption and ratification of a new treaty in nuclear weapons law is very low at the moment. Nevertheless, in order to draw a complete picture of possibilities to adapt the framework and in light of the possibility of changing geopolitical structures, this section analyses the content and procedures of such treaty changes.

4.1 General Considerations on Safeguarding Tritium

The idea of safeguarding tritium is not new. For decades, the proliferation potential of tritium has been raised by academics already in the 1990s,[823] some even proposing the adoption of a tritium freeze treaty.[824] These proposals have consistently been ignored by States. The explanations are manifold. First, the possession of tritium alone is not sufficient to build a weapon, leading to States considering the potential for horizontal proliferation as limited, which is what the entire safeguards system is designed around. This first step in acquiring a nuclear weapon as a NNWS is normally a regular fission-only based nuclear weapon. The question of boosting a weapon or even developing a hydrogen bomb is a secondary one due to the increased degree of technical complexity. For these reasons, it was left out of the Additional Protocol to the CSA.[825] The main proliferation issue of tritium lies within its vertical proliferation potential, which is a core shortcomings of the non-proliferation regime, as it mainly deals with horizontal proliferation.[826] The role of tritium has been predominantly

823 *Martin B. Kalinowski/Lars C. Colschen*, International Control of Tritium to Prevent Horizontal Proliferation and to Foster Nuclear Disarmament, Science & Global Security 5 (1995), 131–203; *Lars C. Colschen/Martin B. Kalinowski*, Can International Safeguards Be Expanded to Cover Tritium?, International Atomic Energy Agency (IAEA): IAEA 1994; *Mayhew/VCDNP* (n 735), at 8 f.

824 *Robert E. Kelley*, Starve Nuclear Weapons to Death with a Tritium Freeze (*Stockholm International Peace Research Institute*, 2020), https://www.sipri.org/commentary/topical-backgrounder/2020/starve-nuclear-weapons-death-tritium-freeze, last accessed 17 July 2025.

825 *Mayhew/VCDNP* (n 735), at 10.

826 On the role of vertical non-proliferation with the NPT, see *Katarzyna Kubiak*, Vertical Proliferation in Light of the Disarmament Commitment, in: Tom Sauer/Jorg

discussed in the context of disarmament.[827] In addition, the safeguarding of tritium has the potential to interfere with commercial interests.[828] When a material is subject to safeguards, civilian and academic actors are burdened with additional expenditures. For instance, tritium is used in a wide range of radioluminescent lamps such as emergency exit lights, as a radioactive tracer in medical diagnostics, and in various scientific research areas such as determining the weight of neutrinos.[829] As a consequence, any amendments which lead to safeguarding tritium might lead to opposition by nuclear exporting States. However, as fusion increases the annual tritium production by many orders of magnitude, this increased availability of fusion might change the opinion of States and can lead to a recognition of the material's proliferation potential.

The next sections analyse to which extent treaty changes can be implemented to include tritium under safeguards regimes.

4.2 Changing the IAEA Safeguards System

As the IAEA is mandated to verify compliance with the cornerstone of nuclear non-proliferation, the NPT, this section analyses options on how to adapt the Agency's safeguards system to include tritium.

4.2.1 Amending the NPT and IAEA Statute

In principle, both the NPT and the IAEA Statute are open to amendment. To amend the NPT, each Party may propose an amendment, which will be

Kustermans/Barbara Segaert (eds.), Non-Nuclear Peace: Beyond the Nuclear Ban Treaty, Cham: Springer International Publishing 2020, 59–84. On the interlinkage between nuclear proliferation and disarmament see *Tom Sauer*, Nuclear Proliferation and Nuclear Disarmament – A Complicated Relationship, in: Harsh V. Pant (ed.), Handbook of Nuclear Proliferation, Abingdon: Routledge 2012, 317–326.

827 Kelley (n 824).; *Martin Kalinowski*, International Control of Tritium for Nuclear Nonproliferation and Disarmament, Boca Raton: CRC Press 2004. More on disarmament below.

828 *Mayhew/VCDNP* (n 735), at 10.

829 The most important research project is KATRIN (Karlsruhe Tritium Neutrino Experiment). On that, see *Max Aker/Konrad Altenmüller/Marius Arenz et al.*, First Operation of the KATRIN Experiment with Tritium, The European Physical Journal C 80 (2020), 264.

considered by a conference if requested by one third of the Member States, Article VIII.1. At such a conference, the amendment has to be approved by a majority of Parties, including all NWS and those States that are Members of the IAEA's Board of Governors, Article VIII.2 cl. 1.[830] Such an amendment comes only into effect for those States who ratify the amendment, once a qualified majority has ratified the amendment, Article VIII.2 cl. 2. To date, the NPT has never been amended. As all ten Review Conferences over the last fifty years have shown, it is difficult to reach consensus on this highly political treaty. Keeping the status quo is difficult enough, thus, a treaty change does not seem to be in sight.

Amending the IAEA Statute follows a multi-step process as well. An amendment may be proposed by any Member State, Article XVIII.A of the IAEA Statute. Amendments then need to be approved by two thirds of the General Conference after having considered observations submitted by the Board of Governors, Article XVIII.C.i. However, in contrast to the NPT, amendments to the IAEA Statute bind every Member to the Statute, not only those who ratified the amendment.[831] The only requirement for such an *erga omnes partes* effect is the ratification by two thirds of the Member States, Article XVIII.C.ii. The IAEA Statute has been amended three times in order to change the article on the composition of the Board of Governors, which is Article VI.[832] Since 1999, two amendments are pending (on the composition of the Board of Governors[833] and on budgeting[834]), as they still lack the ratification requirement.

Regardless of the political difficulties in the process of amending these treaties, the content of such an amendment is not trivial either. One possibility would be to change the wording in Article III NPT from "source

830 These are 35 States: Algeria, Argentina, Armenia, Australia, Bangladesh, Brazil, Bulgaria, Burkina Faso, Canada, China, Costa Rica, Denmark, Ecuador, Finland, France, Germany, India, Indonesia, Japan, Kenya, Republic of Korea, Namibia, Netherlands, Paraguay, Qatar, Russian Federation, Saudi Arabia, Singapore, South Africa, Spain, Türkiye, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, and Ukraine.

831 This is in contrast to the *pacta sunt servanda* rule in international law, also enshrined in Article 40 para. 4 VLCT. On this rule, see *Jan Klabbers*, Treaties, Amendment and Revision, in: Anne Peters/Rüdiger Wolfrum (eds.), Max Planck Encyclopedia of Public International Law, Heidelberg, Oxford: Oxford University Press 2006.

832 GC(V)/RES/92; GC(XIV)/RES/272; GC(XXVIII)/RES/422.

833 GC(43)/RES/19.

834 GC(43)/RES/8.

and special fissionable material" to "source, special fissionable and special fusionable material." In addition to that, this term would also need to be defined. As analysed above, the definitions are drawn from Article XX of the IAEA Statute, which suggests that the Statute itself may also require amendments. These revised definitions would need to add tritium as a special fusionable material and lithium enriched in ^{6}Li as source material. In addition to that, the Board of Governors could have the authority to designate other isotopes as special fusionable material, similar to the competence already existing for special fissionable material in Article XX.1 of the IAEA Statute. Instead of listing materials as it is the case with fissionable material, a broader definition of fusionable material could be used. As mentioned above, a definition of "fusionable material" in the context of nuclear non-proliferation and disarmament was first proposed in the context of a Nuclear Weapons Convention in 1997,[835] which was reiterated in the Model Nuclear Weapons Convention in 2007[836]. It was defined as "any isotope capable of undergoing fusion with the same kind of nuclide or with any other nuclide by applying sufficient conditions (pressure, temperature and inclusion time) with technical means."[837] Consequently, these amendments could draw on previous works.

4.2.2 Second Additional Protocol to the CSA

Another option of treaty changes that would not require the amendment of the IAEA Statute or the NPT would be the adoption of a Second Additional Protocol to the Comprehensive Safeguards Agreements.

The adoption and implementation of such a protocol would involve several actors, as evidenced by the existing safeguards agreements. The IAEA Safeguards Committee drafted the CSA, and each Member State was invited to participate. It was then formally adopted by the IAEA Board of Governors. Similarly, the Additional Protocol was drafted in a combined

835 Costa Rica submitted this proposal into the UN General Assembly as UN document A/C.1/52/7. Fusionable material is defined in para. 48.

836 Costa Rica submitted this proposal into the Preparatory Committee for the 2010 NPT Review Conference as conference document NPT/CONF.2010/PC.I/WP.17.

837 Ibid, para. 17.

effort by the IAEA Secretariat and the so-called IAEA Committee 24, where approximately 70 Member States were represented.[838]

Such a Second Addition Protocol could specifically address the proliferation potential of fusion, encompassing specific procedures and methods for fusion, covering all three proliferation aspects of fusion. The protocol could either amend the existing Additional Protocol by adding additional definitions, or be a genuine risk-appropriate new protocol, addressing fusion's proliferation potential based on its different risks compared to fission.

However, two caveats remain: the duration to adopt the protocol and the scope of the protocol.

Firstly, it is a lengthy process for the IAEA to negotiate new protocols with each NNWS. To recall, safeguards instruments are first agreed upon by the Board of Governors, who then instructs the Director General to conclude an agreement with each Member State. While the drafting process of the model of the (First) Additional Protocol started in 1993 and was adopted by a decision of the Board of Governors in 1997, even a decade later, it was only legally binding for less than half of all NNWS.[839] Presently, more than a quarter century later, 141 States and Euratom have concluded an Additional Protocol and brought it into force, 13 more have signed it, with 44 NNWS currently not covered.

Second, this approach would only address the horizontal dimension. While the risk of horizontal proliferation is non-zero – given the potential facilitating effect of an abundant tritium availability – it is significantly lower than the other risks analysed in this chapter. The largest proliferation potential of tritium is of vertical nature and thus mainly relevant for NWS. The NPT stipulates safeguards exclusively for NNWS, and no NWS has concluded a CSA. The five NWS under the NPT have concluded Voluntary Offer Agreements (VOA), which cover specifically selected civilian nuclear facilities, where the IAEA verifies that the nuclear material in these facilities remains in peaceful activities. It is therefore at the discretion of each NWS to decide if and which fusion facilities they open for safeguards. The situation is similar for the NWS outside the NPT. While the NWS under the NPT (United States, United Kingdom, Russia, China, France) adopted protocols that bear a certain resemblance to the Additional Protocol for

838 *Goldschmidt* (n 788); *International Atomic Energy Agency*, IAEA (ed.), The Evolution of IAEA Safeguards, Vienna: IAEA 1998, at 26.

839 https://www.iaea.org/sites/default/files/20/01/sg-ap-status.pdf, last accessed 25 February 2025.

NNWS, the NWS outside the NPT (India, Pakistan, Israel, North Korea) fall short to implement any progress of the safeguards regime.

If States were to agree on a Second Additional Protocol, the soft law instruments analysed in Section 3 of this Chapter could serve as an additional catalyst for the implementation of such a Second Additional Protocol and play a role in allowing the treaty change. One such factor could be a recommendation under Chapter VI of the UN Charter by the UN Security Council, as evidenced in 2009 when it called upon all States to sign, ratify and implement the existing Additional Protocol with UN Security Council Resolution 1887. Another option is within the NPT context. A Review Conference could encourage States to adopt a Second Additional Protocol by the NPT State Parties. In 2010, the Review Conference "noted that the implementation of measures specified in the model additional protocol provides [...] increased confidence about the absence of undeclared material."[840] Authoritative support from bodies such as the UN Security Council or consensus reached at NPT Review Conferences can significantly influence the adoption of a Second Additional Protocol. While not legally binding, such endorsements carry substantial political and normative weight. They can help build momentum among States by signalling consensus and creating diplomatic pressure to conform.

4.3 International Tritium Control System

The introduction of an international control on tritium may not necessarily be limited to only surgical changes to the current framework, but could also follow a new treaty approach outside the framework based on the NPT and implemented by the IAEA. Since the late 1990s, a separate international agreement has been proposed, introducing an International Tritium Control System (ICTS).[841] The primary function of such a system would be to detect and deter illegal diversions of tritium from civilian facilities to military purposes.[842] The proposed system would be governed by four principles: Firstly, tritium produced in civilian facilities is to be

840 NPT/CONF.2010/50 (Vol. 1), at 4.

841 *Kalinowski/Colschen* (n 823); *Colschen/Kalinowski* (n 823); *Lars C. Colschen*, Die Internationalisierung der Tritiumkontrolle als Baustein des Nichtverbreitungsregimes für Kernwaffen: Bedingungen, Einflussfaktoren und Folgen, Aachen: Shaker Verlag 1998.

842 *Kalinowski* (n 827), at 41.

used exclusively for peaceful applications, including NWS. Secondly, the export of tritium to non-Member States is to be prohibited under the ICTS Treaty. Thirdly, the acquisition of tritium is to be permitted exclusively through import or production, subject to accountancy measures, verified by an international agency, and inspections of tritium facilities and stocks. The IAEA would be an obvious candidate to carry out these inspections. Fourthly, a definition of a significant quantity in the range of one gram is introduced, which must be verified for its end use.[843] Such a system, specifically developed for tritium, would allow the highest level of assurance that the tritium produced within the fusion fuel cycle remains in peaceful uses. However, verifying tritium at such low levels is a major technological challenge.

4.4 NWFZ Treaties

Including tritium into the safeguards regimes of NWFZ Treaties would also require treaty changes.[844]

The procedures for changing the treaties differ, but all have in common that each Party may propose an amendment. The Treaties of Bangkok, Rarotonga and Semipalatansk stipulate a consensus requirement for the adoption process, either by all Parties (Semipalatansk) or by the specific treaty body (Bangkok – Commission, Rarotonga – Consultative Committee). The Treaties of Rarotonga and Semipalatansk require ratification by all State Parties for entry into force, while the Bangkok regime requires only seventeen ratifications. In all these treaties, amendments only enter into force for those States that have ratified them. A different approach is followed in Africa, where the Treaty of Pelindaba only requires a two-thirds majority for the adoption of an amendment, and where the ratification of a simple majority suffices for entry into force for all State Parties.

843 Ibid, at 41.

844 Articles on amendments: Art. 19 Treaty of Bangkok, Art. 11 Treaty of Rarotonga, Art. 19 Treaty of Pelindaba, Art. 17 Treaty of Semipalatansk.

4.5 Euratom Treaty

There are two possibilities for adapting the Euratom framework to include tritium. The first is on the basis of Article 77 (b). If the IAEA amends the international regime and Euratom ratifies the respective instruments, then this new framework would automatically apply within Euratom. The second possibility is to change Article 77 (a). Here, amending the article with similar wording such as "special fusionable material" by simultaneously defining it in Article 197, either by listing tritium or by a broader definition as it was included in the Model Nuclear Weapons Convention,[845] could address the proliferation potential caused by tritium.

Within the Euratom Treaty, there are two procedures to amend the powers of the community. First, Article 203 provides for the possibility to provide additional powers to the community if "action by the Community should prove necessary to attain one of the objectives of the Community." Such an ad-hoc competence requires unanimity of the Council on a proposal from the Commission and after consulting the European Parliament. However, unlike the NPT, the non-proliferation of nuclear weapons is not part of the objectives of the Treaty. In contrast, its only objective in that sense is to "make certain […] that nuclear materials are not diverted to purposes other than those for which they are intended."[846] This objective is considerably narrower than those of the NPT. As Euratom does not provide tritium, this excludes the option of utilising Article 203.

The incorporation of fusion directly into Euratom safeguards would thus necessitate substantial treaty changes, following the procedure of Article 48 TEU.[847] Such an amendment would require consensus among and ratification by all 27 Member States. It is noteworthy that the Euratom Treaty has never been amended in substance.[848]

4.6 Summary

Treaty changes are necessary to address the proliferation risk that is neither covered by the existing framework, nor by possible evolutionary interpre-

845 See above, Section 4.2.1.
846 Article 2(b) Euratom Treaty.
847 Article 48 paras 2 to 5 TEU are applicable via Article 106a para. 1 Euratom Treaty.
848 *Anna Södersten*, Explaining Continuity and Change: The Case of the Euratom Treaty, International Journal of Constitutional Law 20 (2022), 788–817.

tation, nor by actions of international organisation or intergovernmental fora, namely tritium. The potential treaty changes to address tritium and other fusionable material include amendments to the NPT and the IAEA Safeguards System, the adoption of a specific international tritium control system, amendments to NWFZ Treaties and the Euratom Treaty. Caveats remain for approaches involving treaty changes: They require either consensus or qualified majorities, leading to lengthy procedures and the risk of an increased fragmentation of the safeguards system. Nevertheless, treaty changes reflect explicit State consent to these specific changes, which would increase the legitimacy of future fusion safeguards, including secondary measures taken by international organisations and other institutions. As there are no clear political incentives for States to accept fusion safeguards, treaty changes to the regime seem difficult to achieve at the moment.

5 Conclusion

The legal framework of nuclear weapons is situated within a broader economic and political context, constraining the possibilities of adapting the framework in order to apply the regime to fusion. To handle these constraints, an evolutionary interpretation of the IAEA safeguards has been proposed, which would allow for a limited extension of said safeguards regime to fusion facilities under the NPT, CSAs, the Euratom Treaty, the TPNW and NWFZ Treaties. In instances where evolutionary interpretation has its limits, the exercise authority by various actors under the existing regime has been demonstrated to facilitate in bridging the gap between the objective of nuclear non-proliferation and the application of its verification regime. This includes actions undertaken by the IAEA and its bodies, namely the Board of Governors and Secretariat, Review Conferences and Meeting of State Parties under the NPT and TPNW, the NSG, the United Nations.

Where the exercise of authority under the existing regime does not suffice, especially with regard to tritium, there is a necessity for treaty changes, either by amending existing treaties or by adopting new legal instruments. Such changes could include amending the IAEA Statute, the NPT, the TPNW, NWFZ Treaties and the Euratom Treaty. Another approach to create new law for safeguarding fusion could be the adoption of a Second Additional Protocol to the CSA or the establishment of an International Tritium Control System.

While such changes to the system provide for the highest level of legal clarity by defining clear obligations and eliminating ambiguity, their realisation is challenging. The regime of nuclear weapons law faces several challenges, and even the adoption of non-binding documents has recently proven impossible due a convolution of different challenges to the regime. Any changes to the system would necessarily open the Pandora's box, leading to discussions on a wide range of issues within the regime. Furthermore, there are no clear political incentives to strengthen the regime to fusion as this would involve a regulatory burden on a technology that shows great promise in its infancy. The next chapter will address the option of adopting a dedicated treaty on fusion, which could implement fusion safeguards while circumventing the state of crisis of the nuclear weapons regime by offering clear incentives.