

JRC SCIENCE FOR POLICY REPORT

Applicability of the international nuclear legal framework to small modular reactors (SMRs)

Preliminary Study

VAN KALLEVEEN, A.

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Contact information

Name: Alexandra van Kalleveen

Email: Alexandra.VAN-KALLEVEEN@ec.europa.eu

Name: Franck Wastin

Email: Franck.WASTIN@ec.europa.eu

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Abstract

This study is a review of the international nuclear legal framework and its applicability to SMRs. The author reviewed the scope and applicability of fourteen international legally binding instruments in the fields of nuclear safety, nuclear liability, nuclear safeguards and non-proliferation, and nuclear security. The objective was to draw preliminary conclusions, disseminate them, and further the conversation among experts currently assessing the applicability of the nuclear legal framework to SMRs. The IAEA Small Modular Reactor (SMR) Regulator's Forum, the European Nuclear Safety Regulators Group (ENSREG), the IAEA International Expert Group on Nuclear Liability (INLEX), OECD NEA Committees, the Western European Nuclear Regulators Association (WENRA), and the International Nuclear Law Association (INLA), are current interested parties.

Author

Alexandra van Kalleveen is a nuclear law expert within the Directorate for Nuclear Safety and Security at the European Commission's Joint Research Centre (JRC). She previously worked at the International Atomic Energy Agency (IAEA) in the Department of Nuclear Safeguards, and the Department of Nuclear Energy.

Executive summary

This study is a review of the international nuclear legal framework and its applicability to SMRs. The author reviewed the scope and applicability of fourteen international legally binding instruments in the fields of nuclear safety, nuclear liability, nuclear safeguards and non-proliferation, and nuclear security. The objective was to draw preliminary conclusions, disseminate them, and further the conversation among experts currently assessing the applicability of the nuclear legal framework to SMRs. The IAEA Small Modular Reactor (SMR) Regulator's Forum, the European Nuclear Safety Regulators Group (ENSREG), the IAEA International Expert Group on Nuclear Liability (INLEX), OECD NEA Committees, the Western European Nuclear Regulators Association (WENRA), and the International Nuclear Law Association (INLA), are current interested parties.

Policy context

The development and deployment of Small Modular Reactor (SMRs) in the European Union (EU) is at the core of many discussions. The potential of SMRs as a competitive, low-carbon component of future integrated energy systems has been attracting the interest of every sector, from generators and power companies to policymakers and energy analysts around the world. In June 2021, the European Commission organised the first EU workshop on SMRs to engage interested EU industrial actors in joining forces to create European alternatives to other SMR models, and to consolidate the industrial value chain.

One of the EU's major objectives is to develop a common strategy on practical developments for the safe deployment of SMRs in the EU by the beginning of the next decade. Discussions involving the nuclear industry, nuclear regulators, public authorities, as well as public and private financing institutions, demonstrated that the inherent safety features and the overall flexibility of the SMR concept are of significant importance in meeting future energy needs but that the potential of the global SMR market could strongly vary depending on factors such as successful licensing, supply chain maturity, simplification and standardisation that could make SMRs far easier and cheaper to deploy. In this context an adapted nuclear legal framework is of central importance.

Key conclusions

- The international nuclear legal framework does not address SMRs in a consistent fashion, but does not intentionally exclude SMRs from its scope. It can in some instances apply to all SMRs; in others, to certain types only.
- The international nuclear legal framework does not make a distinction based on technology but rather a distinction based on the location of the SMR (land-based vs floating) or based on the purpose of its use (military vs civilian use, or transportation use).
- The current international legal framework would need adjustment or interpretation to cover all SMRs.
- The binding international legal instruments reviewed in Chapter 1 showed that:
 - › some SMRs could be exempted from their application, in the event of lower risks compared to other reactor types
 - › some SMRs could be exempted from their application, if they used small quantities of nuclear material
 - › some SMRs could be exempted from their application, in the event they would have a limited impact in case of an accident.
- Questions on the level of risk, level of quantities of nuclear material, and extent of potential transboundary impact arose from this study on the applicability of the international nuclear legal framework to SMRs.
- A technical perspective could prove valuable for pursuing discussions on the adaptation of the legal framework to novel technologies such as SMRs.
- A further review of maritime law, space law, environmental law, other instruments related to non-proliferation, as well as EU laws would prove useful to further the discussion on the applicability of the legal framework to SMRs.

- It would be beneficial to keep updating the current study and to add input from external stakeholders.

Related and future JRC work

The technical aspects of nuclear safety, safety of the fuel cycle, nuclear waste management, safeguards and security are cross-cutting several projects in the Joint Research Centre (JRC), both from its institutional programme and in relation with indirect actions led by EU Member States.¹ Within the Horizon 2020, JRC also investigated the role and implementation of SMRs from integrating small flexible nuclear reactors in hybrid energy systems and their economic viability. With the increase of interest and potential development of the technology and policy making decision, JRC could anticipate and develop an integrated review study from a multi-disciplinary approach covering state of the art and upcoming challenges.

¹ Some selected references published, or to which JRC contributed to, are given in the chapter 'Further Reading' at the end of this study.

1 Review of the international nuclear legal framework and its applicability to SMRs

This chapter focuses on the international legal framework – for example IAEA and, OECD-NEA treaties and conventions. It identifies the scope of each instrument and assesses whether it applies to small modular reactors. EU, maritime, and environmental laws are not covered, nor are international recommendations.

For the purpose of this study, small modular reactors (SMRs) are advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit, which is about one-third of the generating capacity of traditional nuclear power reactors. SMRs harness nuclear fission to generate heat to produce energy and have reduced fuel requirements (they are most commonly fuelled by uranium-235). Power plants based on SMRs may require less frequent refuelling, every 3 to 7 years, in comparison to between 1 and 2 years for conventional plants. Some SMRs are designed to operate for up to 30 years without refuelling.²

1.1 Nuclear safety

1.1.1 Convention on Nuclear Safety (CNS) and 2015 Vienna Declaration

CNS's scope: A "nuclear installation" means any land-based civil nuclear power plant under Contracting Parties' jurisdiction including such storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of the nuclear power plant. (Article 2)

The 2015 Vienna Declaration on Nuclear Safety elaborates principles to guide countries in the implementation of the objective of the CNS. It covers new nuclear power plants and existing installations – same definition as in Article 2 of the CNS (land-based NPP).

Conclusion: The scope of the CNS is quite limited as it refers to land-based nuclear power plants. Water-based SMRs are excluded from the CNS and the 2015 Vienna Declaration as well as SMRs used for military purposes. In addition, the CNS does not cover SMRs used for research purposes (they fall under the scope of the IAEA Code of Conduct on the safety of Research Reactors).

1.1.2 Joint Convention (JC) on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

SMRs use the same fuel as conventional, large nuclear power plants (source: IAEA), therefore they will generate spent fuel and radioactive waste. Their spent fuel can be managed in the same way as that of large reactors. Countries that are new to nuclear power will need to consider spent fuel management and establish a relevant infrastructure as they work on introducing nuclear energy.

Joint Convention's scope: the JC covers the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors (Article 3.1); safety of radioactive waste management when the radioactive waste results from civilian applications (Article 3.2).

"Nuclear facility" means a civilian facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required (Article 2f).

Conclusion: There is no restriction to land-based reactors. All SMRs are covered except SMRs used for military purposes.

1.1.3 Convention on Early Notification of a Nuclear Accident

Early Notification Convention Scope: This Convention shall apply in the event of any accident involving facilities or activities of a State Party or of persons or legal entities under its jurisdiction or control, referred to in paragraph 2 below, from which a release of radioactive material occurs or is likely to occur

² Liou, J., *What are Small Modular Reactors (SMRs)?*, IAEA Office of Public Information and Communication, <https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs>

and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State (Article 1.1).

The facilities and activities referred to in paragraph 1 are the following: (a) any nuclear reactor wherever located; (d) transport and storage of nuclear fuels or radioactive wastes;

Conclusion: The Early Notification Convention applies to all SMRs on the condition that there is an international transboundary release (i.e. the Convention may not apply to very remote SMRs whether on land or at sea).

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

Assistance Convention's scope: The States Parties shall cooperate between themselves and with the International Atomic Energy Agency in accordance with the provisions of this Convention to facilitate prompt assistance in the event of a nuclear accident or radiological emergency to minimize its consequences and to protect life, property and the environment from the effects of radioactive releases (Article 1.1).

Conclusion: The Assistance Convention applies to all SMRs. Assistance can be requested in the event of any nuclear accident or radiological emergency.

1.2 Nuclear liability

1.2.1 Vienna Convention on Civil Liability for Nuclear Damage

Vienna Convention's scope: The Preamble recognizes the desirability of establishing some minimum standards to provide financial protection against damage resulting from certain peaceful uses of nuclear energy.

"Nuclear reactor" means any structure containing nuclear fuel in such an arrangement that a self-sustaining chain process of nuclear fission can occur therein without an additional source of neutrons (Article 1.1.i).

"Nuclear installation" means any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose (Article 1.1.j).

An Installation State may, if the small extent of the risks involved so warrants, exclude any small quantities of nuclear material from the application of this Convention, provided that (a) maximum limits for the exclusion of such quantities have been established by the Board of Governors of the International Atomic Energy Agency; and (b) any exclusion by an Installation State is within such established limits (Article 1.2).

Conclusion: The definitions of nuclear installation and nuclear reactor are quite broad. The Vienna Convention applies to SMRs except those used in air or sea transportation and those used for military purposes.³ Small quantities of nuclear materials – with smaller risks – are also excluded from the convention.

1.2.2 Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage

Amended Vienna Convention's scope: It applies to nuclear reactors and installations as defined in the Vienna Convention above (all nuclear reactors except the ones used in air or sea transportation). In addition, it applies to reactors in installations excluded by a State (new provision).

³ For instance, as regards SMRs used in sea transportation, over 160 ships are powered by more than 200 SMRs. Although most are submarines, the others range from icebreakers to aircraft carriers (source: World Nuclear Association, *Nuclear-Powered Ships*, <https://world-nuclear.org/information-library/non-power-nuclear-applications/transport/nuclear-powered-ships.aspx> (November 2021)). The SMRs onboard are excluded from the convention.

An Installation State may, if the small extent of the risks involved so warrants, exclude any nuclear installation or small quantities of nuclear material from the application of this Convention provided that (a) with respect to nuclear installations, criteria for such exclusion have been established by the Board of Governors of the International Atomic Energy Agency and any exclusion by an Installation State satisfies such criteria; and (b) with respect to small quantities of nuclear material, maximum limits for the exclusion of such quantities have been established by the Board of Governors of the International Atomic Energy Agency and any exclusion by an Installation State is within such established limits (Article 1.2).

This Convention shall apply to nuclear damage wherever suffered. However, the legislation of the Installation State may exclude from the application of this Convention damage suffered - (a) in the territory of a non-Contracting State; or (b) in any maritime zones established by a non-Contracting State in accordance with the international law of the sea (Article 1a).

This Convention shall not apply to nuclear installations used for non-peaceful purposes (Article 1b).

Conclusion: The Amended Vienna Convention applies to SMRs except the ones used in air or sea transportation, the ones in an installation excluded by a State, and the ones used for military purposes. In addition, nuclear damage is not covered if suffered in a maritime zone established by a State not Party to the convention, which is relevant in the case of floating SMRs located in a State Party's maritime zone but for which the damage could be suffered in a non-Party State's maritime zone.

1.2.3 Convention on Supplementary Compensation for Nuclear Damage (CSC)

CSC's scope: "Nuclear reactor" means any structure containing nuclear fuel in such an arrangement that a self-sustaining chain process of nuclear fission can occur therein without an additional source of neutrons (Article 1.d).

"Installation State", in relation to a nuclear installation, means the Contracting Party within whose territory that installation is situated or, if it is not situated within the territory of any State, the Contracting Party by which or under the authority of which the nuclear installation is operated (Article 1.e).

"Nuclear installation" means any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose (CSC Annex, Article 1.1.b) (idem as Vienna Convention).

This Convention shall apply to nuclear damage for which an operator of a nuclear installation used for peaceful purposes situated in the territory of a Contracting Party is liable under either one of the Conventions referred to in Article I or national law mentioned in paragraph 1(b) of this Article (Article 2.2).

The funds provided for shall apply to nuclear damage which is suffered: (a) in the territory of a Contracting Party; or (b) in or above maritime areas beyond the territorial sea of a Contracting Party: (i) on board or by a ship flying the flag of a Contracting Party, or on board or by an aircraft registered in the territory of a Contracting Party, or on or by an artificial island, installation or structure under the jurisdiction of a Contracting Party; or (ii) by a national of a Contracting Party; excluding damage suffered in or above the territorial sea of a State not Party to this Convention; or (c) in or above the exclusive economic zone of a Contracting Party or on the continental shelf of a Contracting Party in connection with the exploitation or the exploration of the natural resources of that exclusive economic zone or continental shelf; provided that the courts of a Contracting Party have jurisdiction pursuant to Article XIII (Article 5.1).

Conclusion: The CSC applies to SMRs except the ones used in air or sea transportation, and the ones used for military purposes (idem as Vienna Convention). The definitions of nuclear reactor and nuclear installation, which are the same as in the Vienna Convention, are very broad as they encompass any structure containing nuclear fuel, and any nuclear reactor. Therefore, all types of SMRs could fall under such definitions. As regards damage suffered, the CSC provides clear geographical boundaries that are relevant to water-based SMRs: damage can be suffered on the territory of a state (according to common knowledge, territory covers the land and waters belonging to or under the jurisdiction of a state), in maritime areas beyond the territorial sea, on board a ship or aircraft or on an artificial island or structure under the jurisdiction of that state. However, the CSC does not cover damage suffered in or above the exclusive economic zone (EEZ) of a state or on its continental shelf

when in connection with the exploitation/exploration of natural resources. For information, a state's EEZ is generally an area beyond and adjacent to the territorial sea, extending seaward to a distance of no more than 200 nautical miles - 370 km - out from its coastal baseline. Therefore damage caused by most floating SMRs would also be covered by the CSC.

1.2.4 Paris Convention on Third Party Liability in the Field of Nuclear Energy

Paris Convention's scope: "A nuclear incident" means any occurrence or succession of occurrences having the same origin which causes damage, provided that such occurrence or succession of occurrences, or any of the damage caused, arises out of or results either from the radioactive properties, or a combination of radioactive properties with toxic, explosive, or other hazardous properties of nuclear fuel or radioactive products or waste or with any of them, or from ionizing radiations emitted by any source of radiation inside a nuclear installation (Article 1.a.i).

The definition of "Nuclear installation" includes reactors other than those comprised in any means of transport (Article 1.a.ii).

"Nuclear fuel" means fissionable material in the form of uranium metal, alloy, or chemical compound (including natural uranium), plutonium metal, alloy, or chemical compound (Article 1.a.iii).

The Steering Committee may, if in its view the small extent of the risks involved so warrants, exclude any nuclear installation, nuclear fuel, or nuclear substances from the application of this Convention (Article 1.b).

Conclusion: The Paris Convention applies to SMRs as long as they are not used in means of transport. It also covers their fuel. If SMRs, their fuel or nuclear substances involve small risks, they can be excluded from the scope of the convention.

1.2.5 Brussels Convention Supplementary to the Paris Convention (BSC)

BSC's scope: Each Contracting Party shall ensure that all nuclear installations used for peaceful purposes situated in its territory, and falling within the definition in Article 1 of the Paris Convention, appear on the list referred to in Article 2.a.i. (Article 13.a).

Article 2.a: The system of this Convention shall apply to damage caused by nuclear incidents, other than those occurring entirely in the territory of a State which is not a Party to this Convention:

- i. for which an operator of a nuclear installation, used for peaceful purposes, situated in the territory of a Contracting Party to this Convention, and which appears on the list established and kept up to date in accordance with the terms of Article 13, is liable under the Paris Convention; and
- ii. suffered in the territory of a Contracting Party; or on or over the high seas on board a ship or aircraft registered in the territory of a Contracting Party; or on or over the high seas by a national of a Contracting Party, provided that, in the case of damage to a ship or an aircraft, the ship or aircraft is registered in the territory of a Contracting Party, provided that the courts of a Contracting Party have jurisdiction pursuant to the Paris Convention.

Conclusion: The BSC refers to the Paris Convention's definition of nuclear installation that applies to SMRs other than those comprised in any means of transport, and covers those situated in a state's territory. The BSC does not apply to SMRs used for military purposes. The BSC applies to transboundary damage caused by an SMR situated in the territory of a state (according to common knowledge, territory covers the land and waters belonging to/under the jurisdiction of a state, i.e. it includes internal waters and territorial sea), but not floating SMRs that are beyond the state's territorial sea. As regards damage suffered, the BSC covers damage suffered during transport on ship in high seas or aircraft.

1.3 Nuclear safeguards and non-proliferation

1.3.1 Non-proliferation Treaty (NPT)

NPT's scope: Procedures for the safeguards required by this Article shall be followed with respect to source or special fissionable material whether it is being produced, processed or used in any principal

nuclear facility or is outside any such facility. The safeguards required by this Article shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere (Article 3).

Conclusion: SMRs are fuelled by special fissionable material, which is covered by the NPT. It does not matter whether the material is on the territory of the state or somewhere else under its control (at sea for instance) because safeguards are applied to source material or special fissionable material. Therefore the NPT applies to nuclear material used for or in SMRs whether they are land-based, water-based, or mobile. The NPT does not apply to special fissionable material used for military purposes (i.e. SMRs used by the military are excluded).

1.3.2 Comprehensive Safeguards Agreement (CSA)

CSA's scope: The Agreement should provide for the International Atomic Energy Agency's right and obligation to ensure that safeguards will be applied, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices (para. 2).

"Facility" means: (a) a reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or (b) Any location where nuclear material in amounts greater than one effective kilogram is customarily used (para. 106).

"Nuclear material" means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue (para. 112). For information, according to Article XX of the IAEA Statute the term "special fissionable material" means plutonium-239; uranium-233; uranium enriched in the isotopes 235 or 233; any material containing one or more of the foregoing.

Nuclear material that would otherwise be subject to safeguards shall be exempted from safeguards at the request of the State, provided that nuclear material so exempted in the State may not at any time exceed: One kilogram in total of special fissionable material (para. 37).

The Agreement should provide, with respect to nuclear material subject to safeguards thereunder, for notification of transfers of such material out of the State, in accordance with the provisions set out in paragraphs 92–94 below. The Agency shall terminate safeguards under the Agreement on nuclear material when the recipient State has assumed responsibility therefor, as provided for in paragraph 9. The Agency shall maintain records indicating each transfer and, where applicable, the re-application of safeguards to the transferred nuclear material (para. 12).

The Agreement should provide that nuclear material subject or required to be subject to safeguards thereunder which is transferred internationally shall, for purposes of the Agreement, be regarded as being the responsibility of the State: (a) In the case of import, from the time that such responsibility ceases to lie with the exporting State, and no later than the time at which the nuclear material reaches its destination; and (b) In the case of export, up to the time at which the recipient State assumes such responsibility, and no later than the time at which the nuclear material reaches its destination. The Agreement should provide that the States concerned shall make suitable arrangements to determine the point at which the transfer of responsibility will take place. No State shall be deemed to have such responsibility for nuclear material merely by reason of the fact that the nuclear material is in transit on or over its territory or territorial waters, or that it is being transported under its flag or in its aircraft (para. 91).

Conclusion: Since the NPT is the legal basis of the CSA, the conclusion for this section is similar to that above. SMRs are fuelled by special fissionable material therefore safeguards (SG) are applicable except if the nuclear material is used for military purposes or if it is below one kilogramme. Several SG methods are used such as nuclear material accountancy, material flow and balance, declaration of location of nuclear material and changes of location, and notification of transfers of such material out of the State (in which case, SG terminate). The definition of facility is broad (any reactor or any location where there is nuclear material > 1kg). As regards international transfers, import/export, border crossing, the nuclear material is always under the responsibility of one state and the point at which the transfer of

responsibility takes place is clear. This provision is particularly relevant in the case of mobile SMRs because the geographic location of nuclear material is relevant. SG are always applied to their associated nuclear material.

1.3.3 Additional Protocol (AP)

AP's scope: A State shall provide the International Atomic Energy Agency with a declaration containing: (i) A general description of and information specifying the location of nuclear fuel cycle-related research and development activities not involving nuclear material; (ii) Information on operational activities of safeguards relevance at facilities and at locations outside facilities where nuclear material is customarily used; (vii.a) Information regarding the quantities, uses and locations of nuclear material exempted from safeguards; (ix) information regarding specified equipment and non-nuclear material listed in Annex II (Article 2).

Facility means (i) A reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or (ii) Any location where nuclear material in amounts greater than one effective kilogram is customarily used (Article 18.i).

Location outside facilities means any installation or location, which is not a facility, where nuclear material is customarily used in amounts of one effective kilogram or less (Article 18.j).

Conclusion: The AP provides broad definitions of facility and location (idem as in CSA). It also provides a broad definition of location outside facilities. The AP offers more means to the IAEA to conduct safeguards activities. Information submitted by States and areas of inspection are broader than in the CSA (e.g. complementary access by inspectors). SMRs are therefore covered by the AP including SMRs or SMR-related R&D activities not involving nuclear material (<1kg), decommissioned SMRs, and a decommissioned location which is not a facility where there was >1kg of nuclear material. SMRs are also covered by Annex I (single use item list) and Annex II (list of equipment and material) since they may be composed of single and dual use items.

1.4 Nuclear security

1.4.1 Convention on the Physical Protection of Nuclear Material (CPPNM)

CPPNM's scope: This Convention shall apply to nuclear material used for peaceful purposes while in international nuclear transport (Article 2.1).

This Convention shall also apply to nuclear material used for peaceful purposes while in domestic use, storage and transport (Article 2.2).

"Nuclear material" means plutonium except that with isotopic concentration exceeding 60% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore-residue; any material containing one or more of the foregoing; "international nuclear transport" means the carriage of a consignment of nuclear material by any means of transportation intended to go beyond the territory of the State where the shipment originates beginning with the departure from a facility of the shipper in that State and ending with the arrival at a facility of the receiver within the State of ultimate destination (Article 1).

Conclusion: the CPPNM applies to nuclear material used for SMRs whether it is in international transport or used in domestic use, storage and transport, but not to nuclear material used in military SMRs. This is particularly relevant for mobile SMRs where the geographic location of nuclear material is relevant.

1.4.2 CPPNM Amendment

CPPNM Amendment's scope: A "nuclear facility" means a facility (including associated buildings and equipment) in which nuclear material is produced, processed, used, handled, stored or disposed of, if damage to or interference with such facility could lead to the release of significant amounts of radiation or radioactive material (para. 3.d) ; "sabotage" means any deliberate act directed against a nuclear facility or nuclear material in use, storage or transport which could directly or indirectly endanger the health and

safety of personnel, the public or the environment by exposure to radiation or release of radioactive substances (para. 3.3).

This Convention shall apply to nuclear material used for peaceful purposes in use, storage and transport and to nuclear facilities used for peaceful purposes, provided, however, that articles 3 and 4 and paragraph 4 of article 5 of this Convention shall only apply to such nuclear material while in international nuclear transport. This Convention shall not apply to nuclear material used or retained for military purposes or to a nuclear facility containing such material (para. 5).

Conclusion: the CPPNM Amendment applies to SMRs and their nuclear material wherever it is produced, used, handled, stored or disposed of, if damage could lead to significant radioactive release. The definition of nuclear facility is quite broad. The CPPNM Amendment also applies to the sabotage of SMRs if it can directly or indirectly endanger the health and safety of personnel, the public or the environment by exposure. The geographic location of nuclear material and the SMR geographic location are both relevant. Excluded from the CPPNM Amendment are SMRs and associated nuclear material used for military purposes.

1.5 IAEA Safety Standards

The IAEA is currently assessing the level to which existing IAEA safety standards can be applied to innovative technologies. The IAEA expects to publish a Safety Report on the applicability of IAEA safety standards to SMR technologies in 2022.

The IAEA webinar on the Applicability of IAEA Safety Standards to the Design of Novel Advanced Reactors including SMRs held on 8 December 2021⁴ disclosed the findings of their review of SSG-52 (reactor core), SSG-53 (reactor containment), SSG-56 (reactor coolant), SSG-34 (electrical power systems), SSG-39 (instrumentation and control systems), SSG-62 (auxiliary systems), as well as SSR-2/1 (safety of NPPs: design). The review showed that SSR and SSG mostly apply to water-cooled SMRs but that in order to apply to non-water cooled SMRs they would require interpretation and adjustment. With the help of the Small Modular Reactor (SMR) Regulators' Forum and the Safety Standards Committee, the IAEA plans to improve the technology neutrality of the Safety Standards when the next updates are scheduled.

⁴ IAEA, *Webinar on IAEA Applicability of IAEA Safety Standards to the Design of Novel Advanced Reactors including SMRs*, <https://www.iaea.org/resources/webinar/webinar-on-iaea-applicability-of-iaea-safety-standards-to-the-design-of-novel-advanced-reactors-including-smrs> (08.12.2021)

2 Preliminary conclusions

This chapter provides preliminary conclusions on whether the current international nuclear legal framework applies to SMRs. They are based on the individual conclusions written in Chapter 1.

2.1 SMR types covered by the international nuclear legal framework

The study in Chapter 1 reveals that when the scope of an instrument is broad enough to cover SMRs, not all types of SMRs may be concerned.

There are more than 70 SMR designs that are in various stages of development.⁵ Despite the variety of SMRs, including:

- light water/metal/salt
- High temperature/fast neutron/molten salt
- Different sizes: 2Mwe to 300 Mwe
- different uses: electricity, desalination, heat, hydrogen,

the international nuclear legal framework does not make a distinction based on technology but rather a distinction based on the location of the SMR (land-based vs floating) or based on the purpose of its use. For instance, the reviewed instruments generally exclude SMRs used for military purposes. Some of the instruments (such as the liability conventions) do not apply to SMRs used in a means of air or sea transport. Other instruments such as the Amended Vienna Convention exclude SMRs that could use small quantities of nuclear materials and therefore be prone to lower risks. Only in the case of the CSA and the CPPNM, the location of the SMR is irrelevant because the instruments cover their nuclear materials wherever they are.

The international nuclear legal framework can in some instances apply to all SMRs, in others to certain types only. On the one hand, an instrument can have such a broad scope that all SMRs types are covered. For instance, the Vienna Liability Convention provides a broad definition of nuclear reactor (any structure containing nuclear fuel), and nuclear installation (any structure with nuclear fuel), and the Early Notification Convention a broad definition of nuclear facility (any nuclear reactor wherever located). On the other hand, an instrument can be very restrictive in its scope and applicability to SMRs. For instance, the Convention on Nuclear Safety, a fundamental convention in the field of nuclear safety, only covers land-based SMRs.

2.2 Inconsistency of legal framework towards SMRs – rationale and solutions

The international nuclear legal framework does not address SMRs in a consistent fashion, but does not intentionally exclude SMRs from its scope. Each instrument should be read alone in order to identify whether it applies to SMRs.

One of the reasons SMRs are not addressed is that they are innovative technologies that were not broadly available when the international nuclear legal framework was developed (to date SMRs are not available on a commercial scale). However, the framework can progressively be adapted to encompass new technologies and respond to legal challenges they create. Amendments to existing nuclear treaties and conventions, or interpretation, could allow for application of the existing framework to SMRs. For instance, the OECD NEA suggests that experts interpret the terms land-based or nuclear power plant (cf. Convention on Nuclear Safety) and whether they can include mobile SMRs, floating SMRs, or floating nuclear power plant anchored at shore.⁶

The other reason is that although SMRs are not a new technology in the military field, the international community has not examined the legal challenges associated with their use because existing instruments do not cover military installations or uses. One instrument, though, the Convention on the Liability of

⁵ Liou, J., *What are Small Modular Reactors (SMRs)?*, IAEA Office of Public Information and Communication, <https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs> (04.11.2021)

⁶ OECD NEA, *Small Modular Reactors: Challenges and Opportunities*, NEA No. 7560, Paris, 2021, https://www.oecd-neo.org/upload/docs/application/pdf/2021-03/7560_smr_report.pdf

Operators of Nuclear Ships, attempted to determine uniform rules concerning the liability of operators of nuclear-powered ships, but this convention has not yet been ratified.⁷

There is currently more discussion on the legal challenges in the fields of safety and nuclear liability associated with SMRs because a few countries started scrutinizing the applicability of their safety regulations. For instance, this phenomenon occurs in states where the licensing process for SMRs has started (i.e. US, UK...) and where the nuclear regulatory body and the operators are interested in getting legal clarity and certainty. Their challenges and solutions could help the international community move forward with the adjustments or interpretation of the international nuclear framework.

The inadequacy of the current international legal framework towards SMRs is an opportunity to harmonize the legal framework at the multilateral level. For instance, the IAEA SMR Regulator Forum provides discussions between countries and relevant stakeholders regarding common SMR regulatory issues. The NEA continues to explore the potential of design-specific licensing co-ordination as well as the potential for greater harmonization of industrial codes and standards.⁸

2.3 Questions raised by the study

The study revealed a series of questions that are summarised below. In order to answer them, provision of technical input could prove useful.

2.3.1 Level of risk

The instruments reviewed in Chapter 1 showed that some SMRs could be exempted from their application, in the event of lower risks compared to other reactor types.

The review of the Convention on Nuclear Safety, the Joint Convention, the CPPNM and its amendment, and the Vienna and Paris liability conventions raised the question of the level of risk.

The questions are:

1. Are there safety reasons such as lower safety risks that would support the idea that SMRs, including micro reactors, should not be considered “nuclear power plants” in the sense of the Convention on Nuclear Safety and the Vienna Declaration?
2. Are there safety reasons such as lower safety risks that would support the idea that SMRs should not be considered “nuclear facilities” as defined in the Joint Convention (a “nuclear facility” being a civilian facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required)?
3. Can SMRs release “significant amounts” of radiation of radioactive material as written in the CPPNM amendment, and to what extent could they be sabotaged and endanger people and the environment?
4. In the amended Vienna Liability Convention and Paris Conventions, one of the exceptions is an installation excluded by a State. Could a state exempt an SMR because of lower risks? To which extent would those risks be lower than for conventional nuclear power plants?

2.3.2 Level of quantities

The instruments reviewed in Chapter 1 showed that some SMRs could be exempted from their application, if the SMR used small quantities of nuclear material.

The review of the Vienna Liability Convention, Comprehensive Safeguards Agreement, and the Additional Protocol raised the question of the level of quantities.

⁷ Handrlica, J., *Facing Plans for Multiplying Nuclear-Powered Vessels: Lessons Gained from the Brussels Convention on the Liability of Operators of Nuclear Ships of 1962*, International Journal of Nuclear Law, Vol. 2, No. 4, pp. 313-333 (2009)

⁸ OECD NEA, *Small Modular Reactors: Challenges and Opportunities*, NEA No. 7560, Paris, 2021, https://www.oecd-nea.org/upload/docs/application/pdf/2021-03/7560_smr_report.pdf

The questions are:

1. In the Vienna Liability Convention, small quantities of nuclear materials – with small risks – are excluded from the convention. Which SMR types use small quantities of nuclear material?
2. According to the Comprehensive Safeguards Agreement, safeguards are applicable to special fissionable material used by or in SMRs except if the nuclear material is below one kilogramme. Is there a SMR type that uses less than 1 kg of nuclear material?
3. Under the Additional Protocol, SMRs or SMR-related R&D activities not involving nuclear material (<1kg) are covered by the AP. Are there SMR types or SMR-related R&D activities involving less than 1kg of nuclear material?

2.3.3 Level of impact

The instruments reviewed in Chapter 1 showed that some SMRs could be exempted from their application, in the event they would have a limited impact in case of an accident.

The review of the Convention on Early Notification of a Nuclear Accident, and the Amended Vienna Liability Convention raised the question of the level of impact.

The questions are:

1. The Convention on Early Notification of a Nuclear Accident applies to all SMRs on the condition that there is an international transboundary release. Could all SMRs (even remote on land or at sea) cause an international transboundary release in case of accident? How extensive would the radioactive release be in such scenario?
2. Could a SMR cause damage in a different maritime zone than the one it is located as mentioned in the Amended Vienna liability Convention? What would the radius of radioactive release be in case of an accident caused by floating or immersed SMRs?

2.4 Other questions

The study on the applicability of the international nuclear legal framework to SMRs raised further questions. Some instruments apply to land-based and/or water-based SMRs, but the use of SMRs in outer space seems to be excluded from the scope of the treaties and conventions reviewed in Chapter 1. One might ask whether space-specific treaties apply to them.

Also, although there are few commercial SMR-propelled means of transport, the current international nuclear legal framework (e.g. nuclear liability conventions) does not cover them. Its inadequacy would prove more challenging should commercialisation of SMR-powered transport methods expand. Similarly, SMRs in international waters (high seas) are not covered by all liability conventions. This issue would need to be addressed as the presence of SMRs in international waters (high seas) could increase with broader adoption of the technology.

Further questions on the practical implementation of the treaties and conventions to SMRs came up, but they were beyond the scope of the study. To name just one, the application of safeguards to new and advanced reactors including SMRs can prove challenging. This question was already raised by the IAEA at the 2018 International Safeguards Symposium.⁹

⁹ IAEA, *Symposium on International Safeguards*, 5-8 November 2018, Book of Abstracts, <https://www.iaea.org/sites/default/files/19/07/cn-267-book-of-abstracts.pdf>

3 Further actions

3.1 Review of further laws

Further areas of law can be reviewed such as maritime law, space law, environmental law, and other instruments related to non-proliferation (e.g. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter; Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material; International Convention for the Safety of Life at Sea; Convention for the Protection of the Marine Environment of the North-East Atlantic, Espoo Convention on Environmental Impact Assessment; Treaty on the prohibition of nuclear weapons; the five space-specific treaties, etc.).

In addition, a review of EU laws, as well as some country laws where pre-licensing started like in the US and the UK, could be conducted.

3.2 Opening dialogue

Since the objective of the study was to draw preliminary conclusions, disseminate them, and further the conversation among experts currently assessing the applicability of the nuclear legal framework to SMRs (e.g. international organizations, working groups and fora), it would be beneficial to keep updating the current study and to add input from external stakeholders. The IAEA Small Modular Reactor (SMR) Regulator's Forum, the European Nuclear Safety Regulators Group (ENSREG), the IAEA International Expert Group on Nuclear Liability (INLEX), OECD NEA Committees, the Western European Nuclear Regulators Association (WENRA), and the International Nuclear Law Association (INLA), are current interested parties.

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