FROM OIL TO URANIUM: SHOULD NUCLEAR-POWERED MERCHANT SHIPS BE GOVERNED BY A SPECIAL INTERNATIONAL LIABILITY CONVENTION?

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1. Introduction

The development of the law of the sea has largely been reactive. Major maritime catastrophes from the *Torrey Canyon* (1967) to the *Prestige* (2002) have each served as catalysts for new treaties, higher limits of liability, and expanded compensation funds.[1] Yet the legal community has consistently failed to recognise a fundamental lesson – the law must be built before disaster strikes[2], not reconstructed amid its wreckage.

The prospective deployment of nuclear-powered merchant vessels reflects this issue with particular urgency. Nuclear marine propulsion is now gaining tangible momentum, while the corresponding legal framework remains significantly inadequate. It is a patchwork of conventions written for different eras, different risk assumptions, and obsolete technologies, wholly unfit for the regulation of 21st-century nuclear-powered merchant ships.

However, nuclear-powered merchant ships are not new technology. The United States Navy alone has operated more than 160 nuclear-powered warships and submarines without a reactor accident.[3] The commercial sphere, though, is fundamentally different, shaped by flag-state variability, port-state access rights, third-party cargo interests, commercial insurance dynamics, and non-state actors. The absence of any unified international liability convention tailored to nuclear-powered merchant shipping produces a regulatory landscape marked by heightened uncertainty and persistent controversy.

This legal lacuna is not merely theoretical. A nuclear casualty at sea, whether arising from a reactor incident, collision, grounding, or terrorist attack, could produce catastrophic and transboundary consequences that would surpass even the most severe oil pollution disasters. The *Deepwater Horizon* spill alone generated an estimated USD 65 billion in economic losses and gave rise to long-lasting litigation.[4] A comparable nuclear marine incident, involving both atmospheric and oceanographic contamination pathways, could generate harms that are geographically expansive and epistemologically unprecedented, rendering them incomparable to any existing liability case.[5] Accordingly, the law must be constructed before such vessels enter service.

Apropos of this, the legal problem is complex. There is no single, comprehensive international law governing nuclear propulsion in commercial vessels, and the resulting fragmentation creates uncertainty for shipowners, insurers, and port authorities, who are already required to navigate the challenges of decarbonisation. This essay examines the legal framework governing nuclear propulsion in the maritime industry, critiques the existing regulatory regimes, and identifies the core liability tensions they present. It further considers the operational challenges arising from regulatory fragmentation and proposes a harmonised, nuclear-specific international convention to address current gaps and facilitate the transition to nuclear-powered commercial shipping.

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[1] M Faure, et.al., 'Civil Liability and Financial Security for Offshore Oil and Gas Activities' (Cambridge University Press, 2016) p.1-11.
[2] Nicolas de Sadeleer, *Environmental Principles: From Political Slogans to Legal Rules* (2nd edn, OUP 2020) ch 3 p.91-99.
[3] 'Nuclear-Powered Ships' (February 2025) https://www.world-nuclear.org/information-library/non-power-nuclear-applications/transport/nuclear-powered-ships accessed 28 March 2026.
[4] United States Environmental Protection Agency, 'Deepwater Horizon – BP Gulf of America Oil Spill' https://www.epa.gov/enforcement/deepwater-horizon-bp-gulf-america-oil-spill accessed 28 March 2026.
[5] Eric Yong Joong Lee, et.al.,'Resisting oblivion: scientific criticism and legal possibilities concerning the discharges of radioactive water from Fukushima' (2026) 13 *Frontiers in Marine Science* 1773304 https://doi.org/10.3389/fmars.2026.1773304 accessed 28 March 2026.

2. Why Nuclear Is Back?

The international shipping industry transports more than 80 per cent of global trade by volume[6], and accounts for approximately three per cent of global greenhouse gas (GHG) emissions.[7] Without effective mitigation measures, these emissions could rise to up to 13 per cent of the global total.[8] Following this, the IMO's revised GHG Strategy, which targets net-zero emissions by 2050[9], has created a pressing need for alternative propulsion technologies. From ammonia and methanol to hydrogen and battery-electric systems, each option presents distinct technical, commercial, and legal challenges. Against this backdrop, the long-standing operational experience of nuclear propulsion in the naval sector has brought nuclear technology into consideration as an alternative for commercial shipping.

Conventional maritime fuels, even in their lowest-emission forms, cannot deliver zero-carbon propulsion at the scale and energy density that deep-sea, high-endurance shipping demands. Moreover, the NuProShip project[10] argues that green alternative fuels may not exist in sufficient quantities for a full deep-sea transition in the foreseeable future, leaving effectively two real options: continue the existing trajectory or investigate nuclear propulsion.

Additionally, nuclear propulsion is distinguished from alternative fuels by its unmatched energy density and operational endurance.[11] Nuclear systems offer energy densities orders of magnitude greater than marine diesel, refuelling intervals of between 10 and 20 years[12] eliminating the need for frequent refuelling voyages and port calls, passive safety features in certain Generation IV designs, and zero tank-to-wake emissions.[13] These characteristics render nuclear propulsion particularly attractive for long-haul, high-power applications, such as large container ships and bulk carriers, precisely where the scalability and viability of alternative fuels remain most uncertain.

It follows that technology has evolved significantly from the pressurised water reactors (PWRs) employed in early civilian nuclear vessels. Recent developments have focused on next generation reactor designs including small modular reactors (SMRs) and molten salt reactors (MSRs), which seek to enhance commercial viability through improved safety standards, passive cooling mechanisms and compact architectures.[14] Consequently, marine nuclear propulsion is a credible candidate in the transition to greener energy sources and

[6] United Nations Conference on Trade and Development, Review of Maritime Transport 2023 (United Nations 2023) p.126.
[7] N Olmer et.al, Greenhouse Gas Emissions from Global Shipping, 2013–2015 (International Council on Clean Transportation 2017) p.27.
[8] King, A., 'Emissions-free sailing is full steam ahead for ocean-going shipping, in Horizon' (European Commission, 2022) https://ec.europa.eu/research-and-innovation/en/horizon-magazine/emissions-free-sailing-fullsteam-ahead-ocean-going-shipping accessed 28 March 2026.
[9] 'Initial IMO Strategy on Reduction of GHG Emissions from Ships' (IMO) https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhousegas-emissions-from-ships.aspx accessed 26 March 2026.
[10] Final Report of the Nuclear Propulsion for Merchant Ships (NuProShip I) project (2025) https://www.vard.com/assets/Documents/NuProShip-I-Final-Report-2024-12-31-compressed_Optimized.pdf p.15.
[11] Ian Coates, *Nuclear-Powered Maritime Vessels* (Stanford University, 2024) http://large.stanford.edu/courses/2024/ph241/coates1/ accessed 28 March 2026.
[12] International Atomic Energy Agency, *Nuclear Law The Global Debate* (T. M. C. Asser Press, 2022), p.95-101.
[13] Claudianus David Kunze, 'The Role of Generation IV Nuclear Reactors in Decarbonising International Shipping: A Multi-Criteria Decision-Making (MCDM) Framework for Matching Potential Decarbonisation Pathways to Different Ship Types and Sizes' (World Maritime University Dissertation, 2022) https://commons.wmu.se/cgi/viewcontent.cgi?article=3073&context=all_dissertations accessed 28 March 2026.
[14] OECD Nuclear Energy Agency, *Small Modular Reactors: Challenges and Opportunities* (OECD Publishing 2021) https://www.oecd-nea.org/jcms/pl_57979/small-modular-reactors-challenges-and-opportunities?details=true accessed 28 March 2026.

presents a rare case in which industry consideration has already begun, making regulatory attention necessary.

Beyond the maritime industry, interest in nuclear-powered vessels is also driven by broader strategic considerations. Nuclear propulsion can reduce dependence on volatile fossil-fuel import and export markets, enhancing energy security and limiting exposure to geopolitical events that affect fuel prices, supply, and sanctions regimes. As nuclear reactors provide continuous, self-contained power, ships are more resilient to fuel shortages and onboard power disruptions.[15] Overall, nuclear propulsion could make the shipping industry less vulnerable to geopolitical fuel risks and operational disruption, while mitigating fuel-cost volatility due to the relative price stability of uranium.

3. Early Civil Nuclear Experiments – Technical Success, Commercial Failure

Civil nuclear propulsion has previously been attempted through government pilot projects, developed primarily for research and technological demonstration. These vessels proved that nuclear propulsion is technically feasible but can fail commercially.[16] Although the technology is not comparable today, these cases remain instructive for understanding past limitations and preparing for any future transition.

The *NS Savannah*, launched in 1959, remains the most significant case study in civilian nuclear propulsion. Entering nuclear service in 1962, the vessel operated for nearly a decade without any nuclear incidents, demonstrating the technical safety and feasibility of nuclear propulsion in merchant shipping.[17] However, high operating costs, including specialised crew training, restrictive port-access requirements, and the substantial cost of mandatory indemnity insurance, rendered the vessel commercially unviable.[18] Although no operational accidents were reported, nuclear insurance premiums remained disproportionately high relative to realised risk, ultimately contributing to the Savannah's withdrawal from service.[19]

The German *NS Otto Hahn*, launched in 1968, further illustrates that the challenges facing civilian nuclear propulsion are institutional rather than technical. The vessel operated for approximately fifteen years with demonstrable technical success but faced persistent restrictions on port entry, driven by public perceptions of nuclear safety and the absence of a coherent regulatory framework.[20] This case confirms that, even where nuclear propulsion performs successfully, the lack of regulatory harmonisation and assured port accessibility can prevent commercial deployment.

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[15] P A Duong, et.al, 'Nuclear Propulsion for Merchant Ships: A Path to Sustainable Maritime Energy' (2025) 44(1) International Journal of Sustainable Energy 2579469 https://doi.org/10.1080/14786451.2025.2579469 accessed 26 March 2026.
[16] H. Chøyen and K. Steger-Jensen, 'Nuclear Propulsion in Ocean Merchant Shipping: The Role of Historical Experiments to Gain Insight into Possible Future Applications' (2017) 169 *Journal of Cleaner Production* p.152–160.
[17] United States Maritime Administration (MARAD), NS Savannah Updated Final Safety Analysis Report (Revision VII, 2013) https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/national-defense-reserve-fleet/ns-savannah-program/6096/nss-ufsar-rev-vii-2013.pdf accessed 29 March 2026.
[18] Ferhat Celik, 'Nuclear Powered Merchant Vessels' (More Than Shipping, 4 January 2017) https://www.morethanshipping.com/nuclear-powered-merchant-vessels/ accessed 29 March 2026.
[19] US General Accounting Office, Costs of Operating the Nuclear Ship Savannah (GAO, 26 June 1970) https://www.gao.gov/assets/b-136209.pdf accessed 25 March 2026.
[20] Rebecca McReynolds, 'Nuclear Powered International Commercial Shipping: A Note on the Greenest Solution and the Challenges of International Regulations' (2023) https://fileserver-az.core.ac.uk/download/588003761.pdf accessed 21 March 2026.

Another experiment was the Japanese *NS Mutsu*, launched in 1969, widely regarded as the most problematic project in civilian nuclear propulsion. The vessel experienced serious reactor shielding deficiencies that resulted in radiation leakage and significantly damaged public and institutional confidence. Unlike the *Savannah* and *Otto Hahn*, which failed primarily on economic and regulatory grounds, the *Mutsu* encountered intense domestic criticism, including protests by local fishing communities that ultimately terminated its deployment.[21] Remediation costs exceeded the vessel's initial value, leading to its decommissioning and conversion into a non-nuclear research ship.

These experiments demonstrate that nuclear propulsion is technically feasible, but that feasibility alone is insufficient for successful deployment. Even advanced modern technologies remain constrained by enduring regulatory, economic, and societal factors. Unless the challenges revealed by earlier experiments, particularly in relation to regulatory readiness, operational viability, and public acceptance are addressed in advance, any renewed deployment risks experiencing the same obstacles.

4. The Existing Legal Framework

4.1. The Maritime Safety Pillar

The main international instruments governing nuclear-powered ships within the maritime context are Chapter VIII of the International Convention for the Safety of Life at Sea (SOLAS) 1974[22], and the International Maritime Organisation Code of Safety for Nuclear Merchant Ships ("the Code"), adopted by Resolution A.491(XII) in 1981.[23] SOLAS Chapter VIII was adopted in 1960 and has not been amended ever since except for adding a reference to the Code.[24] Apparently, the Code's application is restricted to conventional nuclear ships using pressurised water reactors.

This technological discrepancy is not merely a technical limitation but a structural legal gap. Although the International Maritime Organization (IMO) anticipated future technological evolution, the Code has become outdated and overly prescriptive, remaining anchored to obsolete reactor technologies and thereby obstructing the deployment of advanced designs. This regulatory stagnation has been acknowledged by the IMO itself, prompting calls for reform.[25] The IMO had argued that any credible revision must therefore adopt a technology-neutral, goal-based framework aligned with contemporary nuclear safety governance.[26] In this respect, the role of the International Atomic Energy Agency (IAEA) which is the United Nations specialised agency responsible for establishing global nuclear safety standards and the International Commission on Radiological Protection (ICRP), the

[21] GlobalSecurity.org, '*NS Mutsu*' https://www.globalsecurity.org/military/world/japan/ns-mutsu.htm accessed 29 March 2026.
[22] International Maritime Organization, International Convention for the Safety of Life at Sea (SOLAS), 1974 https://www.imo.org/en/about/conventions/pages/international-convention-for-the-safety-of-life-at-sea-(solas),-1974.aspx accessed 29 March 2026.
[23] International Maritime Organization, Code of Safety for Nuclear Merchant Ships (IMO Res A.491(XII), adopted 19 November 1981) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.491(12).pdf accessed 21 March 2026.
[24] Royal Academy of Engineering, Future Ship Powering Options (Royal Academy of Engineering 2013) https://raeng.org.uk/media/klonlmyx/future_ship_powering_options_report.pdf accessed 29 March 2026.
[25] World Nuclear Transport Institute, Gap Analysis of the Code of Safety for Nuclear Merchant Ships (IMO Maritime Safety Committee, 108th sess, Agenda Item 5, Doc MSC 108/INF.21, 12 March 2024) https://www.wnti.co.uk/wp-content/uploads/2024/04/MSC-108-INF.21-Gap-analysis-of-the-Code-of-Safety-for-Nuclear-Merchant-Ships-WNTI.pdf accessed 29 March 2026
[26] Ibid.

independent scientific body that defines internationally accepted principles for radiation protection, is central in the reform.[27] Their standards provide the authoritative benchmark for reactor safety, radiation exposure, and risk management worldwide.

Accordingly, the implications of this policy gap extend beyond safety regulation and into liability. Where the standards used to define acceptable risk are obsolete or inapplicable, the legal foundations for risk allocation, insurance, and responsibility are fundamentally undermined. In this context, SOLAS Chapter VIII and the Code remain formally in force yet functionally unusable, attenuating legal certainty and precluding the effective governance of modern nuclear-powered merchant vessels. No further development has occurred in the regulation of nuclear propulsion safety or liability, leaving Chapter VIII as a static and outdated framework within a rapidly developing technological and commercial environment.[28]

On a national level, some countries have been proactive and have designed their domestic frameworks to be prepared for nuclear-powered vessels, recognising the opportunities and market interest. One such example is the UK, through the Merchant Shipping (Nuclear Ships) Regulations 2022[29], which incorporate SOLAS Chapter VIII and the Nuclear Code, supplemented by the Marine Guidance Note 679.[30] The UK regime requires a non-UK nuclear ship intending to call at a UK port to provide a safety assessment 12 months before arrival in UK waters. However, the UK legislation fails to provide guidance on the liability for nuclear incidents. Similarly, Russia has established a clear organisational framework for nuclear ships, drawing on its state classification society, which has enabled the deployment of several nuclear vessels, particularly icebreakers. Furthermore, the Russian civilian nuclear fleet rarely operates in foreign waters, allowing it to circumvent many international regulatory and diplomatic requirements.[31]

While these initiatives underpin genuine regulatory progress at the national level, they nevertheless highlight the risk of a non-consistent approach, where the absence of a unified framework makes it difficult to measure and assess safety and other regulatory standards.

4.2. The Nuclear Liability Regime: Designed for Land, Not Sea

The international liability framework stands within the Paris Conventions 1960[32], the Vienna Convention 1963[33], the Brussels Supplementary Convention 1963 and the Convention on Supplementary Compensation ("CSC 1997")[34]. These conventions were established around the fundamental assumption that nuclear installations are stationary, designed for land and subject to a single regulatory authority.

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[27] Anthony R Valiaveedu, Nat Edmonds and Drew Honson, 'Navigating the Regulatory Seas for Commercial Maritime Nuclear Propulsion' (2025) *MIT Science Policy Review*, ed Swetha Tadisina and Nathan Bradshaw https://sciencepolicyreview.pubpub.org/pub/bbyy4txd/release/2 accessed 25 March 2026.

[28] See n.25.

[29] Merchant Shipping (Nuclear Ships) Regulations 2022, SI 2022/1169 https://www.legislation.gov.uk/uksi/2022/1169/contents/made accessed 29 March 2026.

[30] Maritime and Coastguard Agency, *MGN 679 (M): Nuclear Ships* (UK Department for Transport) https://www.gov.uk/government/publications/mgn-679-nuclear-ships/mgn-679-m-nuclear-ships accessed 29 March 2026.

[31] 'MIT Consortium Releases Handbook for Design Safety of Nuclear Ships' (SAFETY4SEA, 23 October 2025) https://safety4sea.com/mit-consortium-release-handbook-for-design-safety-of-nuclear-ships/ accessed 30 March 2026.

[32] Convention on Third Party Liability in the Field of Nuclear Energy (adopted 29 July 1960, entered into force 1 April 1968) (Paris Convention).

[33] Vienna Convention on Civil Liability for Nuclear Damage (adopted 21 May 1963, entered into force 12 November 1977) (Vienna Convention).

[34] Convention on Supplementary Compensation for Nuclear Damage (adopted 12 September 1997, entered into force 15 April 2015) (CSC Convention).

While these instruments, developed in coordination with the International Atomic Energy Agency (IAEA), establish principles such as strict and exclusive liability, channelling of liability to the operator, mandatory insurance, liability caps, and exclusive jurisdiction, their application to nuclear-powered merchant ships is fraught with structural difficulty.[35]

The channelling principle, which concentrates liability exclusively on the operator of a nuclear installation, is central to international nuclear liability law but translates poorly to nuclear-powered merchant shipping. While it offers clarity in land-based contexts, it sits uneasily with maritime practice, where responsibility is dispersed among owners, operators, managers, and charterers. Channelling may therefore misallocate risk, insulating shipowners while imposing potentially uninsurable, strict liability on a single operator in a far more hazardous and unpredictable environment than a stationary nuclear plant.[36] It also removes liability from suppliers and service providers, weakens accountability across the supply chain, and relies on defences, such as natural disaster exemptions that are more likely to arise at sea.[37] Combined with jurisdiction rules that may force victims to litigate in distant flag-state courts and the neglect of routine operational pollution, the channelling model ultimately reveals itself as incompatible with the realities of mobile, transboundary maritime nuclear operations. At the same time, existing conventions fail clearly to address routine operational discharges or cumulative radiological harm in marine environments.[38]

It follows that existing liability conventions do not directly contemplate nuclear-powered ships, creating ambiguity over responsibility, attribution across borders, and jurisdiction, thereby complicating the provision of insurance coverage. The absence of explicit provisions on nuclear-ship liability gives rise to the perception that such vessels fall outside established regimes, potentially leaving victims without effective redress in the event of an incident at sea, as insurance coverage under the existing conventions may be open to dispute.

4.3. Why the Brussels Convention 1962 Failed?

The 1962 Brussels Convention on the Liability of Operators of Nuclear Ships[39] was drafted to address the absence of a liability framework for nuclear-powered ships; however, it was never ratified. The failure of ratification can be attributed to political reluctance, institutional overreach, and poor alignment with commercial reality. A principal reason was the proposed inclusion of nuclear-powered naval vessels, which generated strong opposition among states operating nuclear fleets, who argued that ratification could lead to indirect regulation of warships.[40] Moreover, the development of nuclear-powered merchant ships was still limited at that time. The Convention also failed to resolve port-access issues, expressly preserving coastal and port state discretion to deny entry, thereby undermining its practical value for commercial operators.[41] Its failure illustrates that without addressing sovereignty concerns,

[35] International Atomic Energy Agency, Handbook on Nuclear Law (IAEA, 2010) https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1160_web.pdf accessed 29 March 2026.
[36] Qiuwen Wang, et.al, 'Using Nuclear Energy for Maritime Decarbonization and Related Environmental Challenges: Existing Regulatory Shortcomings and Improvements' (2023) 20 International Journal of Environmental Research and Public Health 2993 https://doi.org/10.3390/ijerph20042993 accessed 29 March 2026.
[37] Ibid.
[38] Ibid.
[39] Convention on the Liability of Operators of Nuclear Ships (Brussels, 1962).
[40] Hardy, M. The liability of operators of nuclear ships. Int. Comp. Law Q. 1963, 12, p.778–788.
[41] 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'. Int. J. Nucl. Law 2009, 2, p.313–333.

port accessibility, and market viability alongside liability, multilateral regulation of nuclear-powered merchant ships is unlikely to succeed.

4.4. UNCLOS and Environmental Law: Necessary but Insufficient

Another important layer of governance is the United Nations Convention on the Law of the Sea (UNCLOS)[42]. It imposes general obligations on States to protect and preserve the marine environment and allows coastal States to adopt precautionary measures, including navigational certification requirements and special controls over nuclear-powered ships and vessels carrying nuclear substances.[43] Article 23 specifically requires such ships to carry appropriate documentation and to observe special precautionary measures when exercising innocent passage through the territorial sea.[44] However, UNCLOS is primarily a framework convention governing jurisdictional rights and environmental duties rather than a liability and compensation regime. It allocates obligations at the level of State responsibility but does not create a channelled, insurable, or judicially enforceable civil liability system capable of addressing nuclear damage arising from commercial operations.

Although complementary environmental instruments such as MARPOL[45] and the London Convention[46] may apply to certain discharge or dumping scenarios, these regimes regulate pollution control rather than accident compensation.[47] The result is a legal landscape where maritime safety law, nuclear liability conventions, and international environmental law operate in parallel rather than as an integrated system. This lack of doctrinal coordination leaves a gap as none of these instruments delivers the comprehensive, predictable liability framework required by insurers, port States, and investors to support the commercial deployment of nuclear-powered ships.[48]

5. Liability and Limitation: Can Nuclear Damage Be Subject to Maritime Limitation of Liability?

The conflict between maritime limitation of liability and nuclear liability regimes is not merely technical but structural.[49] At its core lies a fundamental incompatibility between two legal philosophies that were designed to operate in isolation rather than in coordination. Maritime law traditionally treats limitation of liability as an essential tool to stabilise global commerce, ensuring that shipowners are not exposed to catastrophic, unquantifiable risks that would prevent or undermine shipping investment. By contrast, nuclear liability law is premised on concentrating responsibility and ensuring sufficient compensation for victims of exceptional harm, even at the cost of exposing operators to high levels of liability. When these regimes

[42] United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (UNCLOS).
[43] Ibid.
[44] UNCLOS, Art.23.
[45] 1973 International Convention for the Prevention of Pollution from Ships (MARPOL).
[46] 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention).
[47] See n.41.
[48] Ibid.
[49] D E J Currie, 'The Problems and Gaps in the Nuclear Liability Conventions and an Analysis of How an Actual Claim would be Brought under the Current Existing Treaty Regime in the Event of a Nuclear Accident' (2006) 35 Denver Journal of International Law and Policy 85.

coexist in the context of nuclear-powered merchant ships, neither framework performs its intended function effectively.[50]

The Convention on Limitation of Liability for Maritime Claims 1976[51] (LLMC) exemplifies this tension. While the LLMC provides a near-unbreakable right to limit liability for most maritime claims, it expressly excludes claims for nuclear damage caused by nuclear ships.[52] This exclusion reflects a deliberate policy choice: nuclear risks were assumed to fall within a separate, specialised nuclear liability system.[53] However, in the absence of an applicable international nuclear-ship liability convention, this exclusion produces a regulatory vacuum. Rather than reallocating claims to a functioning alternative regime, it removes access to limitation altogether, exposing shipowners or operators to potentially unlimited liability under domestic tort law. The effect is not enhanced victim protection but legal uncertainty, fragmentation, and a loss of predictability that undermines both compensation and safety planning.[54]

This uncertainty becomes particularly acute when viewed through the lens of insurability. Limitation of liability is not merely a doctrinal privilege but a prerequisite for the effective functioning of marine insurance markets. P&I Clubs, which collectively insure the majority of the world fleet, rely on quantifiable worst-case exposure to mutualise risk across members. Nuclear risks, however, are treated as aggregation risks capable of producing losses far beyond the capacity of the marine insurance market, particularly where liability is uncapped or jurisdictionally unpredictable.[55] As a result, nuclear risks are systematically excluded from standard P&I cover, not due to inherent technological unsafety, but because the legal framework fails to provide calculable exposure boundaries. In this sense, the absence of an agreed limitation architecture renders nuclear-powered merchant shipping commercially uninsurable, regardless of its technical merits.[56]

It is suggested that denying limitation for nuclear damage is normatively desirable, on the grounds that exceptional harm warrants exceptional accountability. However, this argument overlooks the consequences of operating without any structured limitation mechanism.[57] In the maritime context, limitation is paired with procedural tools such as limitation funds and exclusive jurisdiction that facilitate orderly claims handling and equitable distribution among victims. An unstructured tort-based approach risks forum shopping, inconsistent damage awards, and prolonged litigation, outcomes that ultimately delay compensation and increase

[50] See n.35.
[51] Convention on Limitation of Liability for Maritime Claims (adopted 19 November 1976, entered into force 1 December 1986) 1456 UNTS 221 (LLMC).
[52] Tom Walters, et.al, 'Shipping's Nuclear Option in the Move Towards Net Zero: Is It Viable?' (HFW, November 2023) https://www.hfw.com/app/uploads/2024/04/005503-HFW-Shippings-nuclear-option-in-the-move-towards-net-zero-Is-it-viable.pdf accessed 29 March 2026.
[53] LLMC 1976, art 3.
[54] International Atomic Energy Agency (INLEX), Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime (IAEA).
[55] The Swedish Club, P&I Rules and Comments, Rule 11 Section 7 (Nuclear Risks) https://www.swedishclub.com/rules-and-exceptions/part-two-comments/chapter-iv/rule-11/section-7-nuclear-risks/ accessed 30 March 2026.
[56] Reed Smith LLP, 'Nuclear propulsion for commercial shipping: can the law keep up?' (13 May 2025) https://www.reedsmith.com/our-insights/blogs/viewpoints/102kaqf/nuclear-propulsion-for-commercial-shipping-can-the-law-keep-up/ accessed 30 March 2026.
[57] OECD Nuclear Energy Agency, 'Nuclear Liability' https://www.oecd-nea.org/jcms/pl_31319/nuclear-liability accessed 30 March 2026.

transaction costs.[58] The experience following large-scale maritime pollution incidents demonstrates that predictability and prompt payment better serve the interests of both victims and States.[59]

Furthermore, at the core of this conflict also lies an unresolved classification problem as to whether a nuclear-powered merchant ship is to be treated as an ordinary vessel subject to maritime limitation regimes, or as a mobile nuclear installation engaging the specialised liability rules of nuclear law.[60] This is not merely a taxonomic distinction, as the legal characterisation of a marine reactor determines whether liability is channelled to an operator under the Paris or Vienna Conventions, excluded from limitation under Article 3 of the LLMC, or left to fragmented domestic tort law in the absence of a clearly applicable international regime.

The absence of a coherent limitation regime therefore leaves nuclear-powered merchant ships in an anomalous position.[61] Unlike oil tankers, which benefit from the Civil Liability and Fund Conventions' layered compensation structure, or land-based nuclear operators, who operate within clear national and international liability caps, nuclear ships fall between systems. They are excluded from maritime limitation without full inclusion in nuclear liability regimes, resulting in a legal orphan risk. This status not only discourages private investment but also places port States in a difficult position, as they may respond by imposing unilateral access restrictions or insurance requirements that further fragment the regulatory landscape.[62]

Accordingly, the question is not whether nuclear damage should be subject to limitation of liability, but how limitation can be redesigned to reconcile maritime commerce with nuclear risks. Any future international regime must move beyond the binary choice between unlimited exposure and static nuclear caps. Instead, it should adopt a hybrid approach with a defined but elevated liability limit, compulsory financial security, and access to a supplementary international compensation fund. Such a structure would preserve the protective logic of maritime limitation while respecting the exceptional nature of nuclear harm. Without this recalibration, nuclear-powered merchant ships will remain legally exceptional, commercially marginal, and institutionally unsupported.

6. Why Liability Reform Is Not Enough?

Even if an international liability regime were clarified, nuclear-powered merchant ships would continue to face significant operational challenges rooted in law and regulation. A primary obstacle is port State acceptance. While UNCLOS recognises the right of innocent passage, it also requires nuclear-powered ships to carry special documentation and observe precautionary measures, effectively leaving coastal States with wide discretion to permit or

[58] Steven McIntosh, Liability During Transport: Principles of Nuclear Liability Law (INLEX) https://www.osti.gov/etdeweb/servlets/purl/21535469 accessed 30 March 2026.

[59] International Maritime Organization, Liability and Compensation Regimes for Oil Pollution Damage https://www.imo.org/en/OurWork/Environment/Pages/Liability-and-Compensation.aspx accessed 30 March 2026

[60] See n.35 at 15-19.

[61] Sophie Becker, 'Regulatory limbo threatens maritime fuel source whose time has come' (World Ports Organization, 4 April 2025) https://www.worldports.org/regulatory-limbo-threatens-maritime-fuel-source-whose-time-has-come/ accessed 30 March 2026.

[62] Port Technology International, 'Bridging legal gaps in nuclear-powered shipping liability' (11 July 2025) https://www.porttechnology.org/bridging-legal-gaps-in-nuclear-powered-shipping-liability/ accessed 30 March 2026.

refuse entry. In practice, this discretion allows States to impose additional conditions or deny access altogether, creating uncertainty for routine trading operations.

Crew competence presents a further challenge. Nuclear-powered ships require a hybrid skill set that will include conventional maritime qualifications combined with nuclear-sector licensing, radiological protection training, and emergency preparedness. The difficulty is not simply expanding training programmes but ensuring mutual recognition of qualifications across flag States and ports, while also aligning maritime command structures with nuclear regulatory requirements. Furthermore, refuelling operations compound this problem. Although infrequent, refuelling would require access to specialised ports, nuclear-licensed personnel, and supporting infrastructure that does not yet exist at scale in the commercial maritime sector.[63]

Moreover, the 1989 Salvage Convention[64], though expanded to address environmental harm, was designed for conventional pollution and offers no framework for radiological contamination, specialist licensing, or the financing of nuclear salvage operations. Similarly, the Nairobi Wreck Removal Convention[65] establishes duties to remove hazardous wrecks and mandates insurance, yet it offers no guidance on managing radiological hazards. In a nuclear casualty, States and salvors would be forced to improvise operational standards and cost allocation, precisely where clarity and preparedness are most critical. Where radiological exposure cannot be insured or priced, salvage capacity may simply not be available, turning legal duties into practical impossibilities.

Additionally, fuel supply is another structural constraint. Nuclear propulsion depends on managing the entire nuclear fuel cycle, from uranium mining and enrichment to fuel fabrication, operation, and spent-fuel management.[66] Predictable fuel supply and waste pathways are therefore integral to commercial viability, but existing international arrangements were not designed with mobile nuclear reactors in mind. Coordinated international rules will be required to ensure lawful, safe, and secure uranium-fuel production, movement and disposal.

Finally, security risks are highly present. Cyber-risk requirements developed for conventional ships become more serious where digital systems interface with reactor monitoring and emergency shutdown functions, meaning cyber incidents could have radiological consequences.[67] Nuclear-powered ships must also be protected against sabotage, piracy, and hostile interference, with strict control over access to reactor compartments.[68] In conflict-affected zones, merchant vessels have increasingly been pressured to serve state objectives, and the presence of nuclear material raises further concerns over weaponisation, diversion, or symbolic targeting of such ships. Without a harmonised framework addressing nuclear security, safeguards, liability, and emergency response, port States and insurers are likely to impose restrictive unilateral measures, undermining the commercial feasibility of nuclear-powered shipping.

[63] DNV, Maritime Nuclear Propulsion: Technologies, Commercial Viability, and Regulatory Challenges for Nuclear-Powered Vessels (2025) https://www.dnv.com/maritime/publications/maritime-nuclear-propulsion-download/ accessed 30 March 2026.
[64] International Convention on Salvage (adopted 28 April 1989, entered into force 14 July 1996).
[65] Nairobi International Convention on the Removal of Wrecks (adopted 18 May 2007, entered into force 14 April 2015).
[66] See n.63.
[67] See n.10.
[68] Louise Isted, 'Re/insurers Must Plan Now for Nuclear-Powered Ships: AXA XL' Insurance Day (2026).

7. The Need for a Special Liability Convention for Nuclear Shipping

The discussion above highlights that the case for an international liability convention specialised for nuclear-powered ships is not merely a philosophical question but an operational necessity. The market is already moving decisively ahead of the law. Lloyd's Register continues its work with Deployable Energy on the integration of micro nuclear reactors (MNRs) into commercial vessels, while nine Korean organisations have signed a memorandum of understanding for the development of molten-salt-reactor-powered merchant ships.[69] In parallel, HD Korea Shipbuilding & Offshore Engineering has secured Approval in Principle from DNV for a 15,000 TEU container ship powered by SMR technology.[70] These developments demonstrate that commercial actors are no longer waiting for legal certainty. By contrast, the legal framework remains conspicuously underdeveloped, with no binding international regime governing nuclear-powered merchant ships currently in force to provide even baseline guidance, let alone a coherent and predictable liability structure.

A unified framework would provide a single set of rules for all cases of nuclear damage at sea, clarifying who is liable, the extent of liability, where claims may be brought, and what constitutes recoverable damage.[71] This would benefit all parties: victims would have clear access to compensation, operators and insurers could quantify and manage risk, and courts would avoid protracted jurisdictional disputes. As recognised in the nuclear sector, traditional tort-based approaches are inadequate for managing catastrophic risk – the same reasoning applies to nuclear shipping.[72]

While nuclear propulsion offers clear environmental advantages, including zero GHG emissions, it introduces radiological risk of a fundamentally different nature. Even a low-probability incident requires a credible compensation and remediation framework. A new convention should therefore mandate financial security, emergency response planning, and robust environmental liability provisions. Crucially, it should address gaps in existing nuclear law by allowing claims not only for property damage and personal injury, but also for environmental monitoring, preventive measures, and long-term ecological restoration following a radioactive release at sea. It should also establish a clear methodology for classifying and recording nuclear propulsion emissions, without which liability allocation remains uncertain.[73]

The drafting of such a convention must depart from traditional approaches. A regime of this complexity cannot be produced by legal actors alone. It must be developed through a multidisciplinary process involving nuclear engineers, marine designers, environmental experts, insurers, and classification societies alongside lawyers and States.[74] This is essential to ensure that the framework is technically credible, operationally viable, and capable of adapting to evolving technologies. At the same time, the convention must operate within the broader constraints of international non-proliferation law. The dual-use nature of nuclear

[69] See n.52.
[70] SAFETY4SEA, 'Nuclear Emerged as a Promising Energy Source for Shipping in 2025' (SAFETY4SEA, 2025) https://safety4sea.com/cm-nuclear-emerged-as-a-promising-energy-source-for-shipping-in-2025/ accessed 30 March 2026.
[71] See n.36.
[72] See n.57.
[73] See n.35.
[74] Y-C Chang, Ocean Governance: A Way Forward (Springer, Dordrecht 2012).

propulsion to create weapons means that safeguards, export controls, and nuclear cooperation agreements will directly affect how a global nuclear fleet can function.[75]

Institutionally, the convention should introduce targeted innovations to enhance effectiveness. A dedicated Nuclear Maritime Claims Tribunal could provide a specialised forum for resolving transboundary nuclear disputes, replacing the current fragmentation across national courts. In parallel, a standardised Nuclear Ship Financial Security Certificate recognised by all contracting States could operate as a binding condition of port entry, ensuring compliance and facilitating global operations.

Importantly, the convention must avoid the delays that have stigmatised many international instruments. Prolonged negotiation and ratification processes risk rendering the framework obsolete before it becomes operational.[76] A pragmatic and flexible approach is therefore required. This urgency is reinforced by developments in the market: shipbuilders, reactor designers, and insurers are already structuring commercial arrangements for nuclear-powered vessels, and classification approval processes are underway. In effect, practice is advancing ahead of regulation.

Finally, the framework should incorporate technological tools to address practical challenges. Artificial intelligence could support real-time monitoring, risk assessment, and cross-border reporting, improving both compliance and incident response. The international community first needs to seek a more unified framework, and the organisation leading its drafting must address highly disputable issues to ensure broad international recognition and consensus, thereby avoiding future ratification deadlock.[77] The market will not wait, nor can the law.

8. Conclusion

The prospective deployment of nuclear-powered merchant ships exposes a fundamental mismatch between technological capability and legal preparedness. While nuclear propulsion offers a credible pathway towards deep-sea decarbonisation and the elimination of oil pollution, the existing legal framework governing liability for nuclear damage at sea remains fragmented, outdated, and structurally ill-suited to cover nuclear risks. Neither maritime liability conventions nor land-based nuclear liability regimes were designed to regulate nuclear-powered commercial shipping, leaving such vessels suspended between systems and creating uncertainty over liability, jurisdiction, insurability, and compensation.

This essay has demonstrated that the absence of a dedicated international liability convention is not merely a doctrinal deficiency but an operational barrier. The exclusion of nuclear damage from maritime limitation regimes, combined with the inapplicability of existing nuclear conventions to ships, produces a regulatory lacuna that undermines victim protection while simultaneously rendering nuclear-powered merchant shipping commercially uninsurable. Environmental law and UNCLOS obligations, while essential, remain insufficient substitutes

[75] NukeSim, 'Atoms for Peace, War'(2025) https://www.nukesim.com/blog/atoms-for-peace-war accessed 30 March 2026.
[76] M Maslin, et.al, 'A short history of the successes and failures of the international climate change negotiations' (2023) 5 UCL Open: Environment 08.
[77] Q Wang, et.al., 'The Development of Floating Nuclear Power Platforms: Special Marine Environmental Risks, Existing Regulatory Dilemmas, and Potential Solutions' (2023) 15(4) Sustainability 3022.

for a structured civil liability regime capable of delivering prompt, predictable, and adequate compensation following a nuclear incident at sea.

A special international liability convention tailored to nuclear-powered merchant ships is therefore not optional but necessary. Such a regime would provide legal certainty by harmonising rules on liability allocation, financial limits, jurisdiction, and compensable damage, while accommodating the exceptional nature of radiological harm. It would also allow environmental liability to evolve beyond the narrow confines of traditional nuclear law, enabling recovery for monitoring, preventive measures, and long-term marine restoration. Crucially, it would recalibrate limitation of liability in a manner that reconciles maritime commerce with nuclear risk, rather than forcing an untenable choice between unlimited exposure and legal paralysis.

For such a convention to succeed where earlier attempts failed, its design must be fundamentally different. It must be multidisciplinary, technologically informed, and institutionally innovative, integrating nuclear safety standards, maritime operational realities, and modern insurance practices from the outset.

Finally, urgency is no longer hypothetical. Commercial actors are already advancing nuclear propulsion projects. If regulation continues to remain behind practice, liability will be shaped retrospectively through litigation rather than prospectively through design. The lesson of maritime history is clear – liability regimes built after catastrophe arrive too late. Consequently, the law must be constructed before the first commercial reactor goes to sea.

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