NUCLEAR 21
PERSPECTIVE FOR YOUR DECISIONS

IAEA ATLAS PROGRAMME — PERSPECTIVE REPORT

A Practical and Innovative Approach

Towards Standards Applicable to the Maritime Uses of Nuclear Energy

Replacing a 44-year-old code, and why the fastest route to a workable nuclear-maritime licensing framework may already be sitting inside the IAEA's own library of standards.

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EDITION
Summary of full report

ABOUT THIS SUMMARY

This is a short-form, public summary of a full Nuclear-21 Perspective Report submitted to the IAEA in connection with the "Atomic Technologies Licensed for Applications at Sea" (ATLAS) programme.

The full report includes a preliminary clause-by-clause comparison of the 1981 IMO Code against current IAEA Safety Standards, worked examples of the proposed drafting method on two technical approaches, and a preliminary reference requirement set used as its technical foundation. It is available only to named recipients on request; see the closing page for contact details.

01 A Fast-Moving Industry, Waiting on an Old Rulebook

Nuclear energy at sea is no longer a niche conversation. Over the past few years, advisory work has been carried out for a range of clients assessing and conceptually designing nuclear options for maritime and offshore use: in-port power supply, energy for floating vessels operating far offshore including on the high seas, and propulsion for large ships such as container carriers. Small, Advanced and Micro Modular Reactor concepts (SMR, AMR, MMR), spanning multiple coolant technologies, are all being proposed for these roles, from anchored barges near the coast, to platforms serving high-seas mining activity, to genuinely mobile propulsion applications.

None of this is entirely new in principle. Civilian and naval nuclear propulsion has existed for decades, but always inside national regulatory frameworks conceived for a small number of countries operating a small number of vessels. What is new is the ambition to deploy nuclear power at sea commercially, at scale, and internationally, which means vessels and platforms crossing borders, entering multiple ports, and needing a licensing basis that regulators in different countries can recognise and trust without renegotiating first principles each time.

Various initiatives have already been charting a path toward that kind of renewed regulatory context, generally calling for a worldwide harmonisation of nuclear rules in step with existing maritime legislation. That is undoubtedly the right long-term goal, particularly once nuclear-propelled vessels begin entering ports across many jurisdictions. In this context a meaningful set of applications can already become achievable well before that full harmonisation is complete, based largely on today's nuclear and maritime legislation, provided the connections between them are made explicit and workable.

The natural reference point for a dedicated maritime safety basis already exists: the IMO's 1981 *Code of Safety for Nuclear Merchant Ships*. It was a genuinely comprehensive document for its era, covering the full life cycle of a nuclear ship (design, construction, commissioning, operation and decommissioning) across every safety function that matters, from the reactor systems themselves through radiation protection, machinery, emergency power and quality assurance, down to survey and inspection regimes. The scope, at a glance, looked like this:

SECTION	SCOPE (1981 IMO CODE)
Chapter 1	General
Chapter 2	Design criteria and conditions
Chapter 3	Ship design, construction and equipment
Chapter 4	Nuclear steam supply system (NSSS)
Chapter 5	Machinery and electrical installations
Chapter 6	Radiation safety
Chapter 7	Operation
Chapter 8	Surveys
Appendices 1–6	Sinking velocity, seaway loads, safety assessment, dose-rate limits, quality assurance, single failure criterion

The problem is that this Code was, in practice, never really used. It was written to guide administrations on internationally accepted safety standards, but no commercial nuclear merchant ship programme materialised in the following decades to put it into practice. It was also written around a single technology (pressurised water reactors) and it predates over four decades of accumulated nuclear safety lessons, including the Fukushima Daiichi accident, as well as the modern IAEA standards architecture that now underpins most land-based nuclear licensing worldwide. Several international initiatives, including work carried out by the World Nuclear Transport Institute, have already flagged the resulting gaps; what has been missing is a concrete, workable route to closing them, one detailed enough for designers to actually build a licensable Safety Case around.

02 Why an Update Is Not Enough

The 1981 Code anticipated its own eventual obsolescence: its own text (§1.6.1) lists the conditions that would call for revision, namely technical progress in reactor and ship design and in safety analysis methods, application of the Code to new ship types, changes in port risk profiles from larger numbers of nuclear ships calling simultaneously, compatibility with future codes and conventions, and the emergence of international agreement on revised safety standards. Every one of those conditions has by now been comfortably met. Add to that the fact that the Code only ever contemplated PWR technology, at a time when SMR, AMR and MMR concepts across multiple coolant families are now the ones actually being proposed for maritime duty, and “revision” starts to look like understatement. What is needed is replacement, not a patch.

Several specific characteristics of the Code shape what a credible replacement effort has to look like in practice:

01 **Terminology has moved on.** Many terms used in the 1981 text now carry a different, internationally settled meaning under the IAEA Safety Glossary, some earlier terms are effectively obsolete, and the same underlying concept is sometimes labelled differently across nuclear and maritime instruments. A systematic terminology pass is a precondition for any credible update, not an afterthought.

02 **International consensus is not optional, and this cuts both ways.** Unlike ordinary IAEA standards, which national regulators remain free to endorse (or not) at their own pace, a code governing a mobile nuclear installation that may visit the waters of many states needs agreement among all the states that could host it, even temporarily. The 1981 Code says as much in its own text, and that principle has to carry through, unchanged, to any successor instrument.

03 **It has to be technology neutral.** With multiple reactor types and coolant choices now genuinely in competition for maritime use, a replacement anchored to one technology, as the original Code effectively was to the PWR, would be obsolete on the day it is adopted.

04 **The "prescriptive versus goal-setting" debate is partly a misreading of the existing text.** Critics often describe the Code as overly prescriptive, in contrast to today's preference for goal-setting, Risk-Informed and Performance-Based approaches to safety. This criticism is only partly fair: much of what reads as prescriptive is really boundary-condition information (environmental loads, external hazards, and similar design inputs) that any designer needs in order to build a Safety Case in the first place, regardless of which regulatory philosophy sits above it.

Taken together, these characteristics point toward a specific kind of solution: not a fresh, bespoke maritime code written from a blank page, but one deliberately built to interoperate, term for term and principle for principle, with the land-based safety approach for the design and the assessment the nuclear industry, and its regulators, already trust.

03 The Approach, in Brief

The starting premise is that the IAEA's own safety publications' architecture, comprising Safety Fundamentals, Safety Requirements (the documents that use "shall"), Safety Guides (the documents that use "should"), and the practical, worked examples found in Safety Reports and TECDOCs, is already comprehensive enough to serve as the foundation for nuclear maritime and offshore ("M&O") licensing, at least in terms of principles. Rather than proposing a parallel, maritime-specific rulebook built from scratch, starting from the fundamentals universally accepted, the approach adopted is to extend this

existing, internationally trusted structure into the maritime domain, modified or supplemented only to the extent the maritime context genuinely requires.

> “Don't disrupt what exists. Extend it, deliberately and only as deeply as needed.”

To test that premise rather than simply assert it, a preliminary, function-by-function review of the 1981 Code against the current body of IAEA Standards and publications was carried out, checking, safety function by safety function, what is already covered, what is partially covered and would need supplementing, and where a genuine gap exists that only a maritime-specific addition could realistically close. That detailed, clause-level analysis is not reproduced in this summary (it forms a substantial appendix in the full report), but the headline conclusion can be stated: from a technical standpoint, the large majority of the Code's subject matter already has a counterpart, wholly or partially, in current IAEA Standards and publications. A full replacement of the Code, built this way, looks genuinely feasible; it is primarily a matter of disciplined mapping and targeted, careful drafting, rather than invention from a blank page.

The method was then preliminarily and tentatively tested a step further against two representative technical subjects, deliberately chosen to stress different parts of the framework, confirming that it produces usable, technology-neutral drafting language and not merely a conceptual mapping exercise on paper. The full report walks through both examples in detail, including the reasoning behind each proposed requirement and how it was derived from existing IAEA source material; this summary intentionally leaves that worked, illustrative detail for the full paper, where it can be read alongside the source clauses it is drawn from. Note that these examples are just that: examples of the proposed method; the bulk of the work still remains to be done.

DESIGN PRINCIPLE 01

Consistency

Whatever is produced for maritime use should read as a natural, recognisable compliant extension of the land-based framework rather than a competing one, so that the same underlying safety logic — defence in depth, graded approach to safety, structured safety assessment — applies wherever the reactor happens to sit, afloat or ashore.

DESIGN PRINCIPLE 02

Exhaustiveness

Designers need a genuinely complete set of requirements to build a defensible Safety Case, not a high-level statement of principle that leaves the hard, detailed questions unanswered for later.

A framework that is consistent with land-based practice but incomplete, or complete but inconsistent with it, would fail the industry either way, just for different reasons.

04 Charting the Path Forward

Assuming this mapping approach holds up under wider scrutiny from the organisations that would need to adopt it, two practical routes emerge for turning it into an actual regulatory instrument, rather than leaving it as a well-argued proposal:

ROUTE A

Extend the IAEA Standards themselves

Fold maritime-specific content directly into the existing Requirements and Guides as they come up for periodic revision, keeping a single, unified set of documents for land and sea alike.

ROUTE B PREFERRED

Publish complementary "Standards Addenda"

A dedicated set of addenda for maritime and offshore needs, sitting alongside the existing land-based standards as a companion reference rather than being merged into them.

Both routes preserve exhaustiveness and keep the maritime framework aligned with land-based practice, which is regarded as non-negotiable. On grounds of simplicity and delivery speed, the second option, the Addenda route, is preferred by Nuclear-21: it avoids re-opening every affected land-based standard individually, and it gives the maritime community a dedicated, purpose-built reference it can point to directly, rather than having to trace maritime provisions scattered across many separately revised land-based documents. That said, this is presented as a recommendation for discussion, not a foregone conclusion. The choice between the two routes should be made collectively, by the organisations that will actually have to live with the outcome, IAEA and IMO chief among them.

An analogous logic, building deliberately from existing, trusted IAEA reference material rather than starting from a blank page, should extend naturally, i.e. with the same logic, to security and safeguards aspects of nuclear maritime deployment, which sit outside this report's safety-focused scope but will need equivalent, parallel treatment in due course.

Timing is also part of the picture, and deserves realistic treatment. Harmonisation of the broader regulatory framework is already underway through several parallel initiatives, including the SMR Regulators' Forum, the IAEA SMR Platform, and the Nuclear Harmonization and Standardization Initiative (NHSI), alongside relevant work at WENRA. However, this kind of multilateral harmonisation inherently takes years, and a revised or replaced IMO Code is unlikely to arrive quickly, whichever route is chosen. In the meantime, designers cannot simply wait for the international process to conclude: they need to keep progressing concrete concepts against today's applicable national requirements, while deliberately anticipating where the emerging international consensus is heading, so that early design choices do not become expensive dead ends later. The report situates this proposal explicitly within that transition

period, as one concrete input the IAEA, and its ATLAS programme in particular, can draw on now rather than waiting for a finished international instrument.

05 Whom This Matters To

Although this report was prepared for and addressed to the IAEA in the context of ATLAS, its conclusions speak to a wider set of stakeholders who each have something concrete at stake in how this plays out.

Regulators

Considering their own national position on nuclear maritime applications, they gain a clearer sense of where existing land-based standards can be relied on directly, and where dedicated maritime provisions will genuinely be required.

Reactor and vessel designers

An early, credible signal of the direction international requirements are likely to take, which matters directly for concept selection and design margin decisions made years before any licence application is filed.

Ports, class societies, operators

A preview of the kind of harmonised reference framework that would eventually let a design licensed in one jurisdiction be recognised, with reasonable confidence, in another.

Followers of IAEA ATLAS

Visibility into one concrete technical proposal already on the table for that programme's consideration.

None of these audiences need the full clause-level analysis to find this summary useful. But each of them will find the full report considerably more useful once they are deciding where to place their own effort, or their own investment, over the next few years, which is precisely the point at which the detailed mapping, worked examples and reference requirement lists in the full document start to earn their keep.

06 Why This Matters, and Why It's Worth Reading in Full

Nuclear power at sea will not scale on engineering promise alone. It scales when a regulator in one country can look at a design licensed elsewhere and recognise the safety case behind it, without re-litigating first principles port by port, jurisdiction by jurisdiction. That kind of mutual recognition depends on a shared reference framework, encompassing everything from terminology, to the underlying logic of the approach of the design and safety assessment of the facility. Right now, the only framework dedicated specifically to this purpose is 44 years old, was written for one technology, and was never actually put to commercial use.

The industry does not need to invent that framework from nothing, nor does it need to wait for a lengthy, from-scratch international negotiation before useful, technically grounded answers can be obtained. The IAEA's own standards architecture, extended deliberately and rigorously to maritime and offshore use, can get there considerably faster, while staying anchored throughout to the safety logic that regulators, operators, and the public already understand and trust from land-based nuclear power.

The full Perspective Report goes a good deal further than this summary does by design. It includes the tentative, clause-by-clause review of the 1981 IMO Code against current IAEA Standards and publications; two worked examples showing how the proposed drafting method translates into concrete, technology-neutral requirement language, with the reasoning shown at each step; it recalls the complete reference requirement lists from the key underlying IAEA standards used as the technical foundation for the update, as well as a tracked list of relevant IAEA standards currently under revision that any replacement effort will need to stay aligned with as they are finalised.

Organisations interested in the full report are invited to make contact, so that the complete document can be shared and its proposals discussed directly.

IN THE FULL REPORT — 01

Clause-by-clause review

The 1981 IMO Code mapped, safety function by safety function, against current IAEA Standards.

IN THE FULL REPORT — 02

Two worked examples

The drafting method applied to two technical subjects, with the reasoning shown at each step.

IN THE FULL REPORT — 03

Reference requirement lists

The underlying IAEA standards used as the technical foundation, plus those currently under revision.

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About Nuclear-21

Nuclear-21 is an independent advisory firm specialising in nuclear energy strategy, technology assessment and regulatory policy, working with utilities, developers, regulators and international organisations. Its senior experts bring long-standing experience across nuclear technology, licensing and international policy, including involvement in IAEA initiatives such as the Nuclear Harmonization and Standardization Initiative (NHSI), WNA-CORDEL, and in several nuclear maritime programmes over recent years.

For a copy of the full report, *"A practical and innovative approach towards standards applicable to the maritime uses of nuclear energy,"* or to discuss its proposals, please get in touch.

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This summary is derived from a Nuclear-21 Perspective Report dated 17 July 2026, originally prepared for the IAEA and named ATLAS programme recipients. It is intended to introduce the report's context and conclusions and does not reproduce the full technical analysis, worked examples, or reference requirement lists contained in that report.