

Progressive Autonomy — Alpha Zulu and the IMO MASS Pathway

Why archipelagic short-sea is the most practical environment for early MASS deployment — and how Alpha Zulu sequences autonomy honestly across 2027–2050 without over-claiming and without removing seafarers

The regulatory framework is now operational

The IMO’s non-mandatory International Code of Safety for Maritime Autonomous Surface Ships (the MASS Code) was adopted at MSC 111 on 22 May 2026 and takes effect on 1 July 2026 — a goal-based framework ensuring that remotely controlled and autonomous ships operate to the safety, security and environmental standards expected of conventional vessels. The mandatory MASS Code is targeted for adoption by 1 July 2030, with entry into force on 1 January 2032, building on the operational data generated during the Experience-Building Phase (EBP) from late 2026 onward. The international regulatory framework for MASS is no longer a future proposition. It is current operational regulation, and Alpha Zulu sequences its autonomy pathway against this real timeline.

The pathway, plainly

Maritime Autonomous Surface Ships are not a single technology; they are a regulatory and engineering pathway across the four IMO Degrees of autonomy. The honest claim of this annex is that Alpha Zulu progresses across that pathway *at its own deliberate pace*, not that it arrives at full autonomy by any specific date. The proposition is **evolution, not revolution**: each Degree of autonomy unlocked when the verification spine, the AI-native operating system, the regulatory framework and the operational confidence together support it — and never before.

This pathway is also **not a labour-saving programme**. Mission Barbados Mission 3 commits the Government of Barbados to building regional maritime jobs, not removing them. The MASS pathway is reframed honestly as the *evolution of seafaring roles* — from larger crews on each vessel toward smaller crews on each vessel *plus* growing skilled shore-based supervisory, engineering and operations roles at the Caribbean Shore Control Centre. The international maritime community’s framing has itself moved from “fully unmanned ships” to a “spectrum of supervised, autonomous and remotely supported operations” that still relies on human involvement — whether on board or ashore. That framing matches the Alpha Zulu pathway exactly. Total maritime employment under the Alpha Zulu programme grows across the 2027–2050 horizon. The mix of roles changes. The total is up, not down.

Why archipelagic short-sea is well-suited to early MASS

Most international MASS development effort has focused on large container ships on deep-sea trans-ocean routes — a context in which the engineering case is strong but the regulatory, labour and operational challenges are substantial. Archipelagic short-sea operation is the opposite profile. Several structural features make the Caribbean inter-island context materially easier for early MASS deployment than container shipping:

- **Short, repetitive, predictable routes.** Bridgetown ⇌ Roseau ⇌ Basseterre is the same passage tomorrow as it was today. The route library matures rapidly with operational voyages; the AZ-Twin Level 3 prediction layer converges to high confidence inside the first year of corridor operation.
- **Limited port congestion and confined regional waters.** The Eastern Caribbean basin carries far less traffic density than European or East Asian short-sea corridors. Collision avoidance, port approach and berthing are all bounded engineering problems at this density. COLREG compliance is genuinely tractable.
- **Strong sovereign motivation.** The economic, climate and food-security case for cost-effective inter-island logistics is stronger here than in any comparable region. The Caribbean has reason to lead on MASS deployment that larger maritime nations do not share.

- **Regulatory coherence under one flag administration.** Vessels under Barbadian flag, on corridors served principally between Barbados and OECS Member States, sit inside a small number of regulatory jurisdictions and a single CARICOM customs framework. The international MASS challenge of operating across many regulators is much reduced.

These features do not make the Caribbean the inevitable first MASS jurisdiction; they make it a *plausible early jurisdiction*, with engineering and regulatory work that is bounded rather than open-ended.

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The IMO four-Degree taxonomy mapped to the Alpha Zulu timeline

The IMO defines four Degrees of autonomy. The Degrees do not represent a hierarchical order — a single voyage may operate at one or more Degrees — and the operational reality is a continuum rather than a step function. Alpha Zulu sequences across them as follows:

Degree	IMO definition	Alpha Zulu period	What is operational
Degree 1	<i>Ship with automated processes and decision support: seafarers on board to operate and control shipboard systems and functions.</i>	From 2027 corridor go-live	Full master and crew aboard; AI voyage planning; digital cargo manifest; predictive maintenance; remote condition monitoring; AZ·MRV+ verification spine. Standard practice across the proving and early industrialisation phases.
Degree 2	<i>Remotely controlled ship with seafarers on board: the ship is controlled and operated from another location; seafarers available on board to take control.</i>	Mid 2030s — early 2040s	Reduced crew aboard; shore-side supervisory functions from the Caribbean Shore Control Centre; automated docking assistance; autonomous energy management; AZ·Twin Level 4 optimisation surfacing routing decisions to the bridge. Builds on operational data from the IMO Experience-Building Phase.
Degree 3	<i>Remotely controlled ship without seafarers on board: the ship is controlled and operated from another location; there are no seafarers on board.</i>	Selectively from late 2030s on fixed routes	Selected high-confidence corridors during favourable weather and traffic conditions only; sequenced inside the mandatory MASS Code (entry into force 1 January 2032) and with insurance acceptance matured. Remote supervision from Shore Control Centre as the default operating mode.
Degree 4	<i>Fully autonomous ship: the operating system of the ship is able to make decisions and determine actions by itself.</i>	Long-horizon option — not committed in the current programme	Held as a long-term possibility for fully fixed, fully verified corridors; subject to mandatory MASS Code operational maturation, insurance acceptance and operational confidence. Conservative posture protects the financing case.

Two disciplines hold the pathway honest. First, **the verification spine is never bypassed** — AZ·MRV+ continues to produce one signed evidence bundle per voyage regardless of autonomy Degree, and the agentic vessel layer reading the bundle never overrides the cryptographic discipline. Second, **sovereign authority is always preserved** — BMTA as flag administration, port authorities at each port of call, NPPOs at each consignment, all retain their authority. The pathway changes how the vessel is operated. It does not change who has authority over it.

The Caribbean Shore Control Centre

The Shore Control Centre is the physical and institutional home of the autonomy pathway. Its location at the Saint Lucy integrated industrial complex is natural: Port Trident as the operational hub of the regional fleet from 2035 onward, Checker Hall as the through-life support precinct, the training campus on site producing the workforce that staffs the Centre. The Centre commissions progressively from the mid-2030s in step with Degree 2 deployment, scaling to Degree 3 selective operations from the late 2030s.

The Centre's staffing model is the place where the labour story lands plainly. Each Shore Control supervisor monitors several vessels simultaneously, intervening only when the agentic vessel layer surfaces an exception. The role is *more skilled, not less skilled*, than the equivalent bridge watch — it integrates navigation judgement, network-wide situational awareness, cybersecurity vigilance and inter-agent arbitration. The pay grade reflects this. The total seafarer-and-shore workforce required to operate a 600-hull RoPAC fleet at 2050 is higher than the equivalent diesel fleet would require, not lower.

The Centre is also the programme's most effective instrument for widening participation. Shore-based supervision is a maritime career that does not require extended absence from home — the six- to nine-month deep-sea contract that has done more than any formal barrier to keep Caribbean women out of seafaring careers. Because these occupations are new to the region they carry no incumbent workforce and no inherited pattern of exclusion, and recruitment, training places and progression can be designed inclusive from the first intake rather than reformed against established custom decades later. The programme's participation floor applies to Shore Control Centre roles as it does to seagoing and shipbuilding positions: not fewer than 40 per cent of positions are held by Caribbean women, certified under the MARIFEM scheme established by Part X of the Merchant Shipping Act, 2024-28 and independently audited. The Centre should be staffed to that standard from commissioning, and the training campus on site recruited to it from its first cohort.

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The honest challenges

International MASS literature consistently identifies two classes of challenge as the most binding: regulation and cybersecurity. Both are present in the Alpha Zulu pathway, and the annex states them plainly rather than understating them.

- **Regulatory acceptance through the EBP.** The non-mandatory MASS Code takes effect on 1 July 2026; the mandatory Code is targeted for adoption by 1 July 2030 with entry into force 1 January 2032. Between those dates the IMO Experience-Building Phase generates the operational data that informs the mandatory regime. Alpha Zulu Degree 1 operations from 2027 sit naturally inside this window; Degree 2 and Degree 3 operations are sequenced so that mandatory-Code acceptance is in hand before deployment, not after.
- **COLREG compliance.** The International Regulations for Preventing Collisions at Sea were written for crewed vessels. MASS interpretation of COLREGs — particularly the duty of the giving-way vessel under Rule 17, the conduct of vessels in restricted visibility under Rule 19, and the lookout requirement under Rule 5 — remains under active IMO work. Degree 3 deployments will face this directly; Degree 2 operations with seafarers aboard avoid it.
- **Cybersecurity regime.** A remotely controlled vessel is exposed to attack surfaces a crewed vessel is not. The agentic vessel layer, the Shore Control Centre communication link, the AZ-MRV+ verification spine and the sovereign-layer interfaces all require cryptographic discipline, key management, intrusion detection and incident response at a standard exceeding current maritime industry practice. The Caribbean Shore Control Centre commissions with this discipline from day one as the cost of the autonomy pathway, not as an afterthought.
- **Search and rescue obligations.** SOLAS Chapter V Regulation 7 places search-and-rescue obligations on every vessel underway. An uncrewed vessel cannot itself rescue a person in distress; the regional Search and Rescue Region coverage — currently shared between the Eastern Caribbean states under their respective IMO arrangements — must absorb this responsibility. Alpha Zulu Degree 3 operations require explicit coordination with the regional SAR framework before they commence.
- **Insurance acceptance.** Marine insurance for autonomous vessels is in early development internationally. Lloyd's Market Association and IUMI work is ongoing. The pathway is sequenced so that the insurance class for each Degree of autonomy is established before deployment, not after; the AZ-MRV+ evidence stream and the AZ-Twin operational record support the underwriting case at each step.

- **Communications reliability.** Remote supervision requires reliable communications between vessel and Shore Control Centre. The Caribbean basin's coverage by maritime VSAT and low-earth-orbit satellite constellations is adequate but not perfect; the pathway includes operational fallback procedures for communications loss at every Degree of autonomy.

The Barbados MASS Sandbox — aligned with the IMO EBP, sovereign under Barbadian statute

The single most consequential sovereign-policy lever Barbados can exercise to accelerate the MASS pathway is the establishment of a **Barbados MASS Regulatory Sandbox** under existing legislation — the Marine Transport (Emissions Control) Act 2024 and the Merchant Shipping Act 2024 — aligned with the IMO's Experience-Building Phase framework and operating in coordination with the IMO Caribbean Cooperation Centre at UTT, Port of Spain.

The *alignment* with the EBP is substantive: the operational data generated inside the Barbados sandbox flows into the international evidence base that the mandatory MASS Code (adoption by 1 July 2030, entry into force 1 January 2032) will be built upon. The *sovereignty* of the sandbox is also substantive: corridor-specific protocols, vessel-class admissibility, operating-condition envelopes and reporting cadence are set by the BMTA under Barbadian statute, not delegated to the IMO. The sandbox is the BMTA's instrument, contributing to the IMO's framework — not subsumed by it. This is the right balance for a small island state with strong sovereign motivation and limited delegatable bandwidth.

The sandbox is also the bridge between Mission Barbados Mission 3, which commits the Government of Barbados to human-capacity-building and gender equality in shipping, and the MARIFEM certification scheme established under Part X of the Merchant Shipping Act, 2024-28 — the statutory instrument by which participation in the Barbadian maritime sector is measured, audited and certified. Inside the sandbox, the regional training campus produces the Shore Control supervisors, the marine engineers and the cybersecurity specialists the pathway requires, recruited to the programme's participation floor of not fewer than 40 per cent Caribbean women: a new generation of skilled maritime jobs that the autonomy programme creates, not removes, and that the region can demonstrate rather than assert.

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How this annex sits in the package

The MASS annex is the second of two forward-architecture annexes in the concept-note package, sitting alongside the AI-Native Architecture annex. The relationship is complementary, not overlapping:

- **AI-Native Architecture covers the network operating system.** The seven-layer agentic stack (producer, buyer, clearing, vessel, verification, network twin, sovereign) is the operating fabric of the network at every Degree of autonomy. AI-Native is what makes the network legible, scalable and verifiable regardless of whether the vessel has a bridge crew or not.
- **MASS / Progressive Autonomy covers the vessel bridge function.** The IMO four-Degree pathway is specifically about the crew envelope on each vessel. It rests on the AI-Native infrastructure but is its own engineering and regulatory work.

Both annexes share the same disciplines: the verification spine is never bypassed; sovereign authority is always preserved; the wall between optimisation and attestation holds; agents propose, signed evidence proves, humans authorise, verifiers attest. Both annexes also share the same physical infrastructure: the Saint Lucy integrated industrial complex (Port Trident + Checker Hall) is the regional home of the AI-Native operating system *and* the Caribbean Shore Control Centre.

What it earns in the package

- **For Team Europe / Global Gateway.** MASS positioning extends the platform-infrastructure framing from the network operating system into the vessel-operating-crew envelope, and aligns the proposition with the IMO MASS Code timeline. It also opens a new financing lane — maritime decarbonisation and digitalisation are increasingly treated as

one programme by EU and EIB instruments, not two. The pathway additionally carries a verified gender-participation standard rather than a declaratory one, which is a condition of several EU external-action instruments and is ordinarily asserted rather than certified.

- **For the IMO.** Alpha Zulu becomes a candidate contributor to the Experience-Building Phase — generating real-corridor data on short-sea autonomy in an archipelagic SIDS context that no current MASS effort serves. The IMO Caribbean Cooperation Centre at UTT is the natural counterpart, and BMTA is the flag administration making the contribution. The pathway also contributes evidence to the IMO's Women in Maritime programme on how autonomy affects participation, a question on which little operational data yet exists.
- **For Mission Barbados Mission 3 and the OECS.** The Shore Control Centre and the regulatory-sandbox infrastructure mean new, high-skilled, regional maritime jobs across the 2030–2050 horizon — supervisory, engineering, cybersecurity, training — held to a floor of not fewer than 40 per cent participation by Caribbean women, certified under MARIFEM and independently audited. The MASS pathway is a skills-up, not a labour-down, programme, and it is a participation-up programme as well.
- **For the verification spine.** Every MASS operation produces a signed AZ-MRV+ bundle exactly as a crewed operation does. The autonomy pathway does not weaken the verification standard; it tests it under the most demanding operational conditions and strengthens it as a result.

Five honest cautions

- **Pacing must not exceed regulatory readiness.** The single biggest risk to the pathway is over-claiming Degree 3 or Degree 4 capability before the mandatory MASS Code is in operational use and before insurance acceptance has matured. The annex sequences Degree 3 conservatively for this reason, holding to fixed routes and favourable conditions until the regulatory and underwriting frameworks support broader operation.
- **Labour engagement begins early.** Caribbean maritime labour and seafarer organisations engage as principals in the pathway design, not as consultees afterwards — and so do the region's maritime gender bodies, among them the Women in Maritime Association of the Caribbean, Barbados Chapter Inc., which is a statutory consultee on the MARIFEM scheme. The job-growth case has to be made to the people whose jobs are changing, not asserted over them; and a participation commitment designed without the organisations representing those it concerns is a commitment made about people rather than with them.
- **Cybersecurity discipline is the binding operational constraint.** The Shore Control Centre, the agentic vessel layer and the regional fleet's communications fabric all require continuous investment in defensive cybersecurity — not a one-time commissioning expense. This is a recurring operational cost across the programme's life.
- **Sovereignty of the regulatory sandbox is non-negotiable.** The sandbox operates under BMTA authority alone. International counterparties (IMO, insurers, class societies) engage with the BMTA as the flag administration; they do not direct the sandbox's operation. This protects both Barbadian sovereignty and the international credibility of the sandbox.
- **Degree 4 remains a long-horizon option.** The annex does not commit to full autonomy on any specific date. The honest posture protects the financing case across the whole pathway by refusing to overclaim the endpoint.

Bottom line. Alpha Zulu progresses across the IMO MASS four-Degree pathway at a deliberate, honest pace from 2027 to 2050. The non-mandatory MASS Code is operational from 1 July 2026; the mandatory Code follows with adoption by 1 July 2030 and entry into force 1 January 2032. Degree 1 operates from corridor go-live; Degree 2 from the mid-2030s as the Saint Lucy Shore Control Centre commissions; Degree 3 selectively from the late 2030s on fixed routes inside a Barbados MASS regulatory sandbox aligned with the IMO Experience-Building Phase but sovereign under BMTA authority; Degree 4 is held as a long-horizon option. The pathway never bypasses the AZ-MRV+ verification spine, never overrides sovereign

authority, and never reduces total maritime employment — it changes the mix of roles between sea and shore while growing the total, and it widens who those roles are open to, under a certification scheme that verifies the claim rather than accepting it. Caribbean short-sea is a plausible early jurisdiction for MASS because the routes are short, the waters are confined, the sovereign motivation is strong and the regulatory geography is coherent. Alpha Zulu is the vessel class to test that proposition, and the BMTA regulatory sandbox is the legal instrument that makes the test sovereign, specific and internationally useful.

Sources: IMO MSC.1/Circ.1638, Outcome of the Regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (3 June 2021); IMO MSC 111 outcome on the adoption of the non-mandatory International Code of Safety for Maritime Autonomous Surface Ships (22 May 2026, effective 1 July 2026); IMO Roadmap to mandatory MASS Code (target adoption by 1 July 2030; entry into force 1 January 2032). The four-degree definitions quoted in this annex are from MSC.1/Circ.1638 verbatim. The Caribbean regulatory-sandbox proposition is framed under the Marine Transport (Emissions Control) Act 2024 and the Merchant Shipping Act 2024 in coordination with the IMO Caribbean Cooperation Centre at UTT, Port of Spain. The MARIFEM certification scheme is established under Part X of the Merchant Shipping Act, 2024-28; certification is issued by the Administration following verification, and references in this annex are to the programme's intention to enter the scheme. Skills, labour and participation figures are project-promoter estimates aligned with Mission Barbados Mission 3 human-capacity-building commitments.