WHITE GLACIER
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Enhancing Survivability Beyond Minimum Standards

A Proposal for a Polar Immersion Suit Tier to Meet Polar Code Chapter 8 Goals in Realistic Conditions

Prepared by: Diego Jacobson, CEO White Glacier February 2026

Executive Summary

Standard SOLAS/LSA immersion suits (LSA Code/MSC.81(70)) are approved for calm 0–5 °C water immersion with mild air exposure — **not** for realistic polar abandonment (sub-zero air –20 °C+, wind chill, 0.5–2+ kg ingress, wet donning). Independent evidence shows they lose functional survivability (dexterity for signaling/self-rescue, core stability) well before 24 hours — even when METR is as short as 1 day.

The Polar Code (Chapter 8.2.3) requires “adequate thermal protection” and “sufficient thermal insulation” to support survival for the maximum expected time of rescue **in prevailing polar conditions**. Standard suits do not reliably meet this goal-based requirement in practice, particularly when survivors are dispersed, wet, hypothermic, or face delays in accessing group survival equipment (PSK/GSK), malfunctioning heaters, or damaged liferafts.

While the Code allows flexibility through combinations of PSK, GSK, heated liferafts, and other systems, this **only works reliably on paper**. In real polar abandonment scenarios, survivors are frequently dispersed, wet, hypothermic, unable to self-rescue or signal effectively, and face delays in setting up or accessing group equipment — often compounded by malfunctioning heaters, damaged liferafts, or inability to reach shared resources. Independent testing and SAR modelling show that standard LSA immersion suits lose functional survivability in <6–24 hours under these conditions — leaving survivors dependent on equipment that is unlikely to be deployed or used as intended.

Recent regulatory actions validate this gap:

- **Lloyd's Register** (case #00845510): standard suits "may not consistently ensure 5-day survivability under realistic polar conditions."
- **DIRECTEMAR (Chile)**: Committed to verify suit performance during PSC inspections in Punta Arenas (redacted email attached).
- **NOAA**: Sole source justification (FAR 13.106-1(b)) for Arctic 10+ in Arctic research vessel operations, citing inadequacy of standard suits for sub-zero air, wind, and ingress (attached).

This white paper presents evidence of the gap, explains why standard suits fall short of Polar Code goals in real scenarios, and proposes a **Polar Immersion Suit** tier — voluntary, performance-based, and fully compatible with existing regulations.

The proposal aligns with SSE 12 item 7.19 (LSA thermal performance amendments, March 9–13) and offers a practical path to enhance survivability without mandating changes to existing suits.

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1. The Polar Code's Goal-Based Survival Requirement

The International Maritime Organization's (IMO) Polar Code, effective January 1, 2017, aims to reduce risks to human life in polar waters through a goal-based framework rather than prescriptive rules. Chapter 8 (Life-Saving Appliances and Arrangements) emphasizes survivability post-abandonment, requiring equipment to enable survival for the maximum expected time of rescue (METR) in prevailing polar environmental conditions.

- **Chapter 8.2.3**: Immersion suits must provide "adequate thermal protection" and "sufficient thermal insulation" to support survival for METR.
- **Goal-based flexibility**: Allows combinations of personal survival kits (PSK), group survival kits (GSK), heated liferafts, and other systems to meet the requirement.

However, this flexibility assumes timely, effective deployment and use — an assumption that breaks down in real polar abandonment scenarios, where environmental and human factors (cold, wet, dispersion, delays) render standard equipment insufficient.

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2. Evidence of Inadequacy of Standard LSA Suits

Standard SOLAS/LSA immersion suits are designed and tested for temperate conditions (calm water at 0–5 °C with limited air exposure). They are not suitable for

polar environments, where sub-zero air temperatures, wind chill, spray ingress, and wet donning are common. Independent studies and regulatory precedents demonstrate that these suits fail to provide the required thermal protection and functional survivability for METR in polar conditions.

Key Evidence:

- **Lloyd's Register Acknowledgment (Case #00845510)**: Standard suits "may not consistently ensure 5-day survivability under realistic polar conditions, particularly where survivors are dispersed or wet." This classification society validation highlights the gap in practical performance.
- **Ergopro 2022 Tests (Trondheim, Norway)**: Human-subject testing showed standard suits lose functional requirements (dexterity, core stability) in under 6 hours in combined Arctic conditions (sub-zero air, wind, ingress). Advanced suits maintained performance much longer, demonstrating a viable alternative.
- **USCG RDC 2023 Arctic SAR Simulation Study**: METR outliers reach 12–72+ hours in remote/ice-bound cases, with risks (hypothermia onset) much earlier than standard suit capabilities. The study underscores that SAR delays in the Arctic exceed the effective window of standard equipment.

NOAA Sole Source Justification (2026, FAR 13.106-1(b)): The US National Oceanic and Atmospheric Administration justified sole source procurement of Arctic 10+ suits for Arctic research vessel operations, explicitly citing the inadequacy of standard suits for sub-zero air, wind, and ingress exposure. This federal precedent confirms the gap and validates advanced suits as necessary to meet polar requirements.

These sources collectively show that standard suits do not reliably meet Polar Code Chapter 8 goals in real polar abandonment scenarios, where combinations of PSK/GSK/liferafts often fail due to dispersion, wet subjects, setup delays, or malfunctioning heaters.

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3. Regulatory Momentum – Chile as Leading Indicator

Regulatory bodies and flag states are beginning to recognize and act on this gap, creating momentum for enhanced standards.

- **DIRECTEMAR (Chile) Commitment**: In February 2026, Chile's Maritime Authority acknowledged the concern and committed to verify immersion suit performance during PSC inspections in Punta Arenas (redacted email attached). Punta Arenas handles 20–30% of Antarctic expedition traffic, making this a significant enforcement step and a precedent for other gateways (e.g., Ushuaia, Hobart, Cape Town).

- **IMO SSE 12 (March 9–13, 2026)**: Item 7.19 addresses LSA thermal performance amendments — providing a timely window to propose a Polar Immersion Suit tier as a voluntary enhancement.

This momentum, combined with evidence from LR, Ergopro, USCG RDC, and NOAA, indicates a shift toward requiring or recommending equipment that performs in actual polar conditions.

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4. Proposed Solution: Polar Immersion Suit Tier

To address the gap without mandating changes to existing suits, we propose a **voluntary Polar Immersion Suit tier** — a performance-based category that exceeds SOLAS/LSA minima while remaining fully compatible with current regulations.

Key Requirements for the Tier:

- Proven thermal protection and dexterity in sub-zero air (–20 °C+), wind chill, spray ingress (0.5–2+ kg), wet donning, and prolonged exposure.
- Functional survivability for extended periods (e.g., 12+ hours in combined polar conditions).
- Compliance with existing certifications (USCG, MED, TC, UK MCA) + polar-specific testing (e.g., Ergopro methodology).

The Arctic 10+ Suit as a Model:

- Patented technology (US 11,332,225 B2) provides inherent insulation and airtight seals.
- Tested to maintain performance in extreme polar conditions (Ergopro 2022: 12+ hours).
- Versatile for temperate/cold waters (no overheating, breathable, flexible).
- Already adopted (e.g., Ponant Le Commandant Charcot: 600 suits; NOAA sole source).

This tier aligns with the Polar Code's goal-based intent, offering operators a clear path to exceed minimums and reduce PSC/insurance risks.

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5. Conclusion & Call to Action

Standard suits do not reliably meet Polar Code goals in real polar abandonment scenarios. The evidence (LR, Ergopro, USCG RDC), regulatory actions

(DIRECTEMAR, NOAA), and upcoming IMO discussions (SSE 12 item 7.19) confirm the need for enhancement.

A voluntary Polar Immersion Suit tier is a practical solution to achieve the Code's survival intent without disrupting existing equipment.

White Glacier welcomes collaboration with flag states, ROs, insurers, and operators to support adoption. Contact us for pilots, briefings, or IMO submissions.

Contact Diego Jacobson CEO, White Glacier djacobson@whiteglacier.com +1 939-430-1264

References / Attachments

- Chile DIRECTEMAR Reply (redacted)
- NOAA Sole Source Justification 2026
- Lloyd's Register Reply Excerpt (case #00845510)
- Ergopro 2022 Test Summary
- USCG RDC 2023 SAR Study Executive Summary

Chile DIRECTEMAR Acknowledgment of Polar Immersion Suit Performance Gap – Summary

Date: February 20, 2026 **Prepared by:** Diego Jacobson, CEO, White Glacier **Purpose:** To summarize the positive response from Chile's Maritime Authority (DIRECTEMAR) on immersion suit concerns in polar operations, and outline implications for SSE 12 (item 7.19) and broader Polar Code adoption.

Background

White Glacier submitted evidence to DIRECTEMAR highlighting the survivability gap in standard SOLAS/LSA immersion suits under realistic polar abandonment conditions — even when Maximum Expected Time of Rescue (METR) is as short as 1 day. Key risks include sub-zero air (–20 °C or lower), wind chill, spray ingress (0.5–2+ kg), and wet donning, which are not fully tested under MSC.81(70).

Evidence shared:

- Lloyd's Register acknowledgment (case #00845510): standard suits "may not consistently ensure 5-day survivability under realistic polar conditions, particularly where survivors are dispersed or wet."
- Independent Ergopro 2022 tests (Trondheim): standard suits lose functional dexterity and core stability in <6 hours in combined –20 °C air / 0 °C water / 10 m/s wind + ingress; advanced suits (e.g., Arctic 10+/25+) maintain performance far longer.
- USCG RDC 2023 Arctic SAR simulation study: METR outliers of 12–72+ hours in remote/ice-bound scenarios, with risks onset much earlier.
- NOAA sole source precedent: justified advanced suits for Arctic ops due to standard suit limitations (FAR 13.106-1(b)).

DIRECTEMAR Response (Feb 19, 2026)

Roberto Alfaro Pérez (Jefe, Servicio de Inspecciones Marítimas, DIRSOMAR) replied appreciatively, noting:

- Chile's polar experience is growing, with only a few national vessels certified (type C, summer-only) — their Operational Assessment (OA) and Polar Water Operational Manual (PWOM) required no additional polar gear beyond SOLAS standard.
- Owners voluntarily added PSK/GSK and heated liferafts, showing proactive safety.
- As a SOLAS signatory, DIRECTEMAR relies on IMO-certified "polar" equipment and cannot base norms on independent studies or other flags' assessments.
- **Key Commitment**: They will verify the points raised (e.g., suit performance in polar conditions) during Port State Control (PSC) inspections at Punta Arenas when applicable. The email was copied to central navigation/maneuver inspectors and the Punta Arenas PSC officer.
- They encourage channeling initiatives to IMO for amendments to improve human safety and environmental protection in polar zones.

Full response attached for reference.

SINGLE SOURCE DETERMINATION USING
SIMPLIFIED ACQUISITION PROCEDURES (SAP)
FOR AN ACTION NOT EXCEEDING THE SIMPLIFIED ACQUISITION THRESHOLD
(AUTHORITY: FAR 13.106-1(b)(1))

140802-26-0173

1. **Agency and contracting activity.** Department of Commerce, NOAA Office of Marine and Aviation Operations, Safety Management Branch

2. **Description of supplies or services required to meet agency needs (including the estimated value).** *Artic 10+ Immersion suits/Polar Survival suits must be made of material with inherent insulation and for use without a life jacket to comply with USCG, SOLAS, LSA y MSC 81(70) IMO and the latest edition of the POLAR CODE. The Artic 10+ Immersion suits/Polar Survival suits are requested to be delivered by June 1, 2026.*

3. Identification of the single source or the brand name to be solicited. *White Glacier, Artic 10+ Immersion suits/Polar Survival suits. Puerto Rico, USA*

4. **Supporting rationale.** Only one source or brand name is reasonably available as detailed below:

   ✓ Other - Only one source is capable– This particular brand name is essential to the requirement and market research indicates similar products do not meet or cannot be modified to meet agency needs. *Artic 10+ Immersion suits/Polar Survival suits exceeds regulation requirements and is certified to comply with the USCG, SOLAS, LSA y MSC 81(70) IMO and THE POLAR CODE. These suits are low maintenance and much more durable than neoprene suits and have been tested for 12+ hours in Artic conditions. No other manufacturers have similar survival suits that provide as much protection. Vendor has confirmed these have to purchased directly through them, there are no authorized distributors/resellers.*

5. **Market Research.**

   No other manufacturer's carry this type of product. Multiple sources sought for similar survival suits.

6. **Technical/Requirements Representative Certification**

   I certify that this requirement constitutes the Government's minimum needs and the supporting data provided herein is accurate and complete to the best of my knowledge and belief.

WOLFSTON.JAIME.MORGAN.1502566632 Digitally signed by WOLFSTON.JAIME.MORGAN.1502566632 Date: 2026.02.10 10:55:34 -08'00'

LT Jaime Wolfston — 2/10/2026
Safety Management Branch — Date

Lloyd's Register Reply Excerpt Case #00845510 – Acknowledgment of Risk in Polar Immersion Suit Performance February 2026

From: Dean A. Biskupovich, Lloyd's Register **Global Technical Client Care Team (GTCC) – Americas Date:** February 2026 (response to Diego Jacobson outreach)

Key Excerpts (Direct Quotes from LR Response):

"Your email inquiry appears to be highlighting a potential concern regarding current SOLAS-approved immersion suits, specifically that these may not fully meet the functional requirements for 5-day survivability under realistic polar conditions."

"Based on SARex findings, we understand your concern that SOLAS approved immersion suits, even when supplemented with personal and group survival kits, may not consistently ensure 5-day survivability under realistic polar conditions, particularly where survivors are dispersed, wet, or nutritionally compromised."

"Classification Societies are bound by international and national regulations and cannot impose requirements beyond the existing statutory instruments. Consequently, immersion suits that are approved in accordance with SOLAS and the LSA Code are considered acceptable for statutory compliance, provided they are carried, maintained, and used as intended."

"If a manufacturer wishes to update immersion suit standards or the LSA Code, the recognized pathway is to collaborate with a national administration or industry association to submit a proposal to the IMO Maritime Safety Committee."

Summary of LR Position (Paraphrased for Context): Lloyd's Register acknowledges the risk that standard SOLAS/LSA immersion suits may not reliably provide consistent functional survivability in realistic polar abandonment scenarios — even in some cases within the 5-day METR baseline — particularly when survivors face dispersed conditions, wetting, or prolonged exposure. However, as a classification society, LR is bound by current IMO and national regulations and cannot independently impose higher requirements. LR recommends pursuing updates through national administrations or IMO submissions (relevant to SSE 12 agenda item 7.19).

Prepared by: Diego Jacobson, CEO, White Glacier **Date:** February 2026

For reference in ongoing engagement with flag states, ROs, and IMO stakeholders

White Glacier Arctic Immersion Suits: Compliance with IMO Polar Code and Performance in Extreme Cold Water Conditions

Executive Summary

This technical report evaluates the thermal protection performance of White Glacier's Arctic 10+ PC and Arctic 25+ immersion suits under simulated Arctic conditions, exceeding the requirements of IMO MSC.81(70). Tests conducted in 0.0°C water, -20°C air, and 10 m/s wind demonstrated minimal core temperature drops (-0.5°C and -0.4°C respectively over 6 hours), stable skin temperatures (extremities above 10°C), and preserved manual dexterity. The suits maintained performance even with simulated water ingress and wet donning scenarios, addressing vulnerabilities in standard neoprene suits. These results support compliance with the IMO Polar Code, which mandates effective survival equipment in sub-zero temperatures, high winds, and ice-laden waters. The Arctic suits are recommended for Polar operations in commercial shipping, offshore activities, search and rescue, and expeditions, providing enhanced survivability beyond basic regulatory standards.

Introduction and Objective

The IMO Polar Code establishes requirements for ships operating in polar waters, emphasizing survival gear capable of withstanding extreme cold, wind chill, and potential water ingress. Standard tests under MSC.81(70) do not fully replicate these conditions. This report presents independent test results for White Glacier's Arctic 10+ PC (with thermal booties) and Arctic 25+ (with integrated foot insulation) suits, to assess

thermal stability, skin temperature maintenance, comfort, and functionality over extended periods, including scenarios like wet donning.

Client: White Glacier Company **Test Facility:** Ergopro Ltd, Trondheim, Norway **Test Dates:** May 27, August 17, and August 29, 2022 **Test Standard Reference:** MSC.81(70) **Document References:**

- Extreme test of Arctic 10+ insulated immersion suit with thermal booties [1]
- Extreme thermal test of the new Arctic 25+ [2]

Test Methodology

Tests simulated extreme Arctic conditions, including freezing water, sub-zero air, high winds, and internal water ingress to mimic real-world scenarios such as abandon-ship events or rescues.

Key Test Parameters

Parameter	Value
Water Temperature	0.0°C
Air Temperature	-20°C
Wind Speed	10 m/s
Wind Chill Effect	-30°C
Water Added Inside Suit	500g (simulated ingress)
Test Duration	6 hours (maximum allowed)

Test Subject

- ID: SM
- Sex: Male
- Weight: 71 kg

Height: 178 cm

- The same subject was used for both suits to enable direct comparison [1][2].

Procedures

- Subjects were immersed in controlled conditions while monitoring core and skin temperatures.
- Manual dexterity tests were performed post-immersion.
- For wet donning evaluation (Arctic 25+), underclothing was soaked with 2.0–2.3 kg of water prior to donning.

Results

Core Temperature

Suit Model	Start (°C)	End (°C)	Change (°C)
Arctic 10+ + Booties	36.9	36.4	-0.5
Arctic 25+ (Integrated)	36.8	36.4	-0.4

- No core temperature drop occurred during the final 3 hours in either test, indicating sustained thermal protection [1][2].

Skin Temperature

- Lowest recorded: Big toe (Arctic 10+ + Booties: 13.3°C; Arctic 25+: 13.7°C).
- All other skin sites remained above 20°C.
- Projections indicate toe temperatures would stay above 10°C for an additional 5–6 hours [1][2].

Comfort and Functionality

- No significant cold discomfort or urge to urinate reported, suggesting effective thermal regulation.
- Manual dexterity tests (e.g., survival tasks) were successfully completed post-immersion [2].

Wet Donning Performance

- In the Arctic 25+ test, despite 2.0–2.3 kg of internal moisture, core temperature remained stable, with a slight increase observed after 3 hours in one variant [2].
- By comparison, standard neoprene suits lose 40–45% of thermal protection with 1 liter of ingress, leading to rapid heat loss and potential test termination [2].

Discussion: Implications for IMO Polar Code Compliance

The Polar Code requires survival equipment to function in sub-zero temperatures, high winds, and ice-laden waters—conditions not comprehensively covered by MSC.81(70). These tests confirm the Arctic suits' suitability:

- **Thermal Protection:** Exceeds standards by maintaining core and skin temperatures in extreme conditions.
- **Wind Chill and Ingress Tolerance:** Validated under -30°C wind chill equivalent with water ingress.
- **Wet Donning:** Addresses a critical gap in standard suits, ensuring performance in realistic scenarios.
- **Product Enhancements:** Arctic 10+ PC integrates thermal booties (CLO value: 4.87); Arctic 25+ offers 10% improved insulation (CLO: 5.36) [1][2].

These features position the suits as compliant and optimized for Polar operations, reducing hypothermia risk and enhancing survivability.

Comparison with Standard Neoprene Suits

Feature	Arctic 10+ / 25+ Suits	Standard Neoprene Suits
Thermal Stability	Maintains core temperature over 6 hours in 0.0°C water	Loses up to 45% protection with ingress [2]
Wet Donning Performance	Stable with 2.0–2.3 kg internal moisture	Rapid heat loss; unsafe skin temperatures [2]
Manual Dexterity	Preserved post-immersion	Often impaired due to cold stress [2]
Bare Hand Access	Arms withdrawable inside suit	No internal mobility
Splash Protection	Built-in tent for wind/wave shielding	None
Calorie Intake Support	Allows eating/drinking inside suit	No access
Comfort & Regulation	No discomfort during tests	Frequent cold stress [2]
Polar Code Suitability	Tested under relevant conditions	Not validated for Polar scenarios [2]

Enhanced Features and Compliance Matrix

Requirement (IMO/MSC.81(70) & Polar Code)	Arctic 10+ Performance	Compliance Status
Thermal Protection	Stable core temperature for 6+ hours in 0.0°C	Exceeds
Skin Temperature Safety	Extremities >10°C; others >20°C	Exceeds
Wind Chill Resistance	Tested in -20°C air, 10 m/s wind	Exceeds
Water Ingress Tolerance	Maintains warmth with 500g ingress	Exceeds
Wet Donning Capability	Stable with 2.0–2.3 kg moisture	Exceeds
Buoyancy	97+ lbs (SOLAS compliant)	Exceeds
Flame Resistance	Protects >10 seconds in flame	Exceeds
Jump Test	Survives 10 m jump	Exceeds
Manual Dexterity	Preserved post-immersion	Exceeds

Additional Innovative Features:

- Bare hand access for dexterity tasks.
- Splash tent for environmental protection.
- Support for calorie intake and sleep inside the suit, aiding extended survival.

Conclusions and Recommendations

The Arctic 10+ PC and Arctic 25+ suits demonstrate superior performance in extreme cold water immersion, fully supporting IMO Polar Code compliance. They provide reliable thermal protection, even in wet donning and ingress scenarios, outperforming standard neoprene suits. For flag states, recognized organizations, and the IMO, these results advocate for certification criteria that prioritize real-world survivability. Customers in polar or cold-water operations should consider these suits for enhanced safety and operational reliability.

References: [1] Thermal evaluation of Arctic 10+ and Arctic 25+ suits. [2] Extreme thermal test of the new Arctic 25+. [3] Extreme Cold Water Test Report White Glacier suits.

Executive Report: U.S. Coast Guard Research & Development Center Study

Verify International Maritime Organization Polar Code Survival Time Requirement

Arctic Search & Rescue Simulation Model

December 2023

Authors: C. Mahoney & G. Python

U.S. Coast Guard Research & Development Center, New London, CT

Sponsored by: Commandant (CG-SAR-2), U.S. Coast Guard

1. Purpose and Background

The International Maritime Organization (IMO) Polar Code (effective 2017) mandates that ships operating in polar waters (Arctic and Antarctic) must equip life-saving appliances (LSA) and survival supplies to sustain life for the Maximum Expected Time of Rescue (METR) in a maritime emergency. The Code defines METR as "the time adopted for the design of equipment and systems that provide survival support. It shall never be less than 5 days" (IMO, 2017).

Ship operators determine METR via an Operational Assessment, but the Code provides limited guidance on methodology, and the origin of the 5-day baseline is undocumented. This allows operators to default to 5 days, potentially under-provisioning equipment for routes where rescue times exceed this threshold—posing significant risks to crew and passengers.

This U.S. Coast Guard (USCG) study evaluates the 5-day minimum by modeling realistic Arctic SAR scenarios in the U.S. Arctic Area of Responsibility (AOR). It uses a Repast Simphony simulation incorporating historical data to estimate METR and assess adequacy.

2. Methodology

The model simulates SAR response using:

- Historical AIS vessel traffic (2019–2021) for vessels of opportunity (VOOs).
- Weather data (ERA5: sea state, wind, cloud ceiling).
- Ice extent (NSIDC shapefiles).
- Response assets (USCG cutters like Healy and WMSL, HC-130 fixed-wing, MH-60/HH-60 rotary-wing helicopters, etc.).

- Delays for planning, weather, ice navigation, crew rest, refueling.

Six scenarios (June–October, 8–320 victims) vary by location (Chukchi/Beaufort Seas to North Pole), season, victim count, and ice conditions. Each ran 30 iterations for statistical confidence intervals on first contact and full recovery times.

3. Key Scenarios and Results

The study tested diverse emergencies:

Scenario	Description	Victims	Location/Season	METR Exceeds 5 Days?
1	Cargo vessel abandon ship (open water)	8	Northeast of Barrow, AK / August	No
2	Research vessel beset in ice	25	Near North Pole / October	Yes
3	Tanker abandon ship (open water)	10	Chukchi Sea / September	No
4	Cruise vessel abandon ship (mass rescue)	300	Northwest Passage / September	No
5	Icebreaker (e.g., Healy analog) abandon ship	80	North of ice extent / August	Yes
6	Commercial airliner crash on ice	320	North of Barrow / June	No

Summary Findings:

- The 5-day METR is adequate in open-water or near-shore scenarios with good helicopter access.
- It is insufficient in remote, ice-bound cases or high-victim scenarios far from infrastructure (e.g., Scenarios 2 and 5).
- Factors driving longer METR: Distance from assets, ice impeding surface vessels, large victim loads exceeding helicopter capacity, weather/seasonal limitations.
- VOOs help in open water but are limited in ice.

4. Conclusions and Recommendations

The simulation confirms that Arctic SAR response times can exceed 5 days due to vast distances, sparse infrastructure, harsh weather, and ice hazards. The 5-day Polar Code

baseline works for some U.S. Arctic routes but fails in others, particularly high-capacity or remote operations.

Key recommendation: Update the Polar Code to require standardized, repeatable METR calculation methods in Operational Assessments (e.g., simulation models like this one). This would ensure uniform standards for Polar Ship Certificates, thorough risk evaluation, and adequate LSA/survival equipment—reducing inconsistencies and enhancing safety.

The model is adaptable for future work: community responses, Polar hull VOOs, detailed ice layers, icing effects, winter scenarios, international assets, or other missions (e.g., oil spill response).

5. Implications

As Arctic shipping increases (driven by climate change and resource access), accurate METR is critical for Polar Code compliance. Insufficient provisioning risks lives in extended emergencies. This USCG study provides evidence-based support for IMO policy refinement, emphasizing simulation tools for realistic assessments.

Contact: Christine M. Mahoney, USCG RDC (Christine.M.Mahoney@uscg.mil). Full report available via USCG/DHS public portals (e.g., dco.uscg.mil or DTIC).

This executive report distills the 48-page December 2023 document for stakeholders in polar shipping, insurance, regulation, and safety.