



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.