# Annex 4

## Personal Protective Equipment for Cold-Water Survivability

> **Status of this Annex**
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> This Annex is the outcome of a detailed project by the joint working group formed in response to MAIB Recommendation 2026/106, and draws on the research described in A4.3. It forms part of the Code and, like the rest of the Code, may be revised only by the Five Associations. CHAs apply it to their own operations through local risk assessment, recording their decisions in their own documents (A4.2).
>
> Where this Annex is quoted or reproduced, it should be reproduced in full and unaltered, with its edition date, so that the Five Associations' guidance stays distinct from any CHA's local position.

### Purpose and status

**A4.1** This Annex gives non-statutory guidance on personal protective equipment (PPE) to improve the survivability of a Pilot who falls into cold water during transfer, and should be read alongside Annex 2.

**A4.2** The guidance is advisory. It is intended to assist and support the CHA's own risk assessment, which remains the basis for all decisions on PPE (Annex 2, A2.1). Each CHA, working with its Pilots, is best placed to decide what is appropriate for its own operations, and is recommended to record the reasons for its decisions.

**A4.3** This Annex is based on research undertaken by the UKMPA Technical and Training Committee as part of the joint working group (UKMPA, BPA, UKHMA, UKMPG and PSS). The research comprised:

a) a national survey of 103 Pilots, Harbour Masters and marine managers across 40 pilotage districts, recording the PPE currently worn, where opportunities to enhance were identified, and the workforce's views on change;

b) equipment submissions from manufacturers and suppliers, with the certification each stated, mapped to the four protection levels;

c) a practical in-water evaluation of twelve products and configurations assessing donning and doffing, ladder climbing, glove and helmet compatibility, control of water flushing, flotation and self-righting; and

d) a review of BS EN ISO 15027-1:2026 and the published physiology of cold-water immersion.

The in-water evaluation was held in a heated pool, so it assessed handling and fit rather than thermal performance in cold water. Thermal performance rests on certification and test evidence.

**A4.4** UK pilotage areas differ widely in water temperature, distance offshore, pilot boat capability and access to search and rescue. The framework is designed to be applied proportionately across that range.

> **Guiding principle**
>
> Reduce the consequences of accidental cold-water immersion (cold shock, cold incapacitation and hypothermia) as far as reasonably practicable, without a net increase in the overall risk of the transfer, including the risk of a fall from the ladder.
>
> PPE is best judged against both parts together. A garment that performs well in the water is unlikely to be suitable if it makes the climb harder. A garment that is easy to climb in is unlikely to be suitable if it gives little protection in the water.

## The cold-water hazard

**A4.5** Sudden immersion in cold water affects the body in four phases, each on a different timescale. Different items of PPE address different phases.

| Phase | Timescale | Significance for PPE |
|---|---|---|
| **Cold shock** | 0 to 3 min | Involuntary gasp, hyperventilation and cardiac strain. Limiting cold water reaching the skin reduces the response. |
| **Cold incapacitation** | 2 to 15 min | Progressive loss of grip, limb function and swimming ability. Flushing-resistant outer garments and thermal layers extend this window. |
| **Hypothermia** | Over 30 min | Core temperature below 35°C. The main threat only where rescue is significantly delayed. |
| **Post-rescue collapse** | On recovery | Core temperature can continue to fall after recovery. Limiting cooling during immersion reduces this risk. |

**A4.6** UK waters are cold enough to present this hazard at every pilot station in every season. Indicative seasonal sea temperatures are shown below[1]; CHAs are recommended to use local measured data for their own boarding positions where available.

| Region | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|
| **North Sea (Humber, Tees, Tyne, Forth)** | 5–8°C | 7–12°C | 14–18°C | 9–13°C |
| **English Channel (Dover, Southampton, Portsmouth)** | 7–10°C | 10–14°C | 16–20°C | 11–15°C |
| **Irish Sea / West Coast (Liverpool, Bristol, Milford Haven)** | 7–10°C | 9–13°C | 14–18°C | 10–14°C |
| **Scotland / Northern waters (Clyde, Cromarty, Orkney)** | 5–7°C | 7–11°C | 12–15°C | 8–11°C |

**A4.7** **Heat burden (heat strain).** Pilots often report heat, rather than cold, as the main problem with current PPE. Pilots are routinely exposed to heat in the pilot boat cabin, in ship accommodation and on the bridge, and heat fatigue immediately before a ladder climb may increase the risk of a fall. Heat burden is therefore best treated as a transfer-safety risk, and PPE matched to the prevailing air and sea temperatures rather than to the worst case in all conditions.

## Assessing the risk

**A4.8** The framework uses two inputs to suggest a minimum PPE level for each boarding position: water temperature (WT) and expected rescue time (ERT).

**A4.9** **Water temperature.** A seasonal approach is suggested, using the sea temperature for each quarter: winter (December to February), spring (March to May), summer (June to August) and autumn (September to November). Where the range for a quarter spans a band boundary, the lower value gives the more cautious result.

| Band | Water temperature | Indicative risk |
|---|---|---|
| **T1** | 15°C and above | Cold shock mild.<br>Lowest risk. |
| **T2** | 10°C to below 15°C | Significant cold shock.<br>Incapacitation in the order of 20 minutes at 12°C.<br>Elevated risk. |

[1] Source: Met Office and CEFAS, indicative seasonal ranges.

| Band | Water temperature | Indicative risk |
|---|---|---|
| T3 | 5°C to below 10°C | Severe cold shock.<br>Incapacitation in the order of 10 minutes at 5°C.<br>High risk. |
| T4 | Below 5°C | Extreme cold shock.<br>Incapacitation within about 10 minutes, possibly sooner.<br>Very high risk. |

**A4.10** **Expected rescue time.** ERT is the realistic time from a Pilot entering the water to being recovered onto the pilot boat or a rescue asset. The question to ask is: if a Pilot fell in now, how long before they are physically recovered? Factors to consider include:

a) the recovery capability of the pilot boat, including whether a manual backup works without the boat's power;

b) sea state and light conditions (daylight or darkness) at the boarding position, and their effect on recovery time;

c) the availability of a second pilot boat, additional crew, or other nearby rescue assets;

d) the response and transit times of RNLI lifeboats and HM Coastguard helicopters, where these are relied upon *(Coastguard helicopters are airborne within 15 minutes of tasking by day and 45 minutes at night);* and

e) evidence from recovery drills and exercises (Section 14), which gives a more reliable figure than an estimate.

| Band | Typical situation |
|---|---|
| E1<br>under 5 min | Pilot boat immediately alongside with a functioning, tested recovery system. |
| E2<br>5 to 15 min | Pilot boat able to manoeuvre and recover within 15 minutes in normal conditions. |
| E3<br>15 to 40 min | Recovery depends on RNLI or HM Coastguard to complement or replace the pilot boat. |
| E4<br>over 40 min | Remote boarding position, single vessel, or extended rescue response. |

**A4.11** Improving recovery capability is often the most effective control. Because ERT is one of the two inputs, a shorter and more reliable recovery reduces the protection the PPE needs to provide. **PPE is the final measure in the hierarchy of control, applied after vessel, procedural and operational controls have been considered.**

## Indicative PPE level

**A4.12** The matrix below combines the two inputs to give an indicative minimum PPE level.

| ERT / WT | T1 15°C+ | T2 10 to <15°C | T3 5 to <10°C | T4 <5°C |
|---|---|---|---|---|
| E1 <5 min | Level 1 | Level 1 | Level 2 | Level 3 |
| E2 5–15 min | Level 1 | Level 2 | Level 3 | Level 3 |
| E3 15–40 min | Level 1 | Level 2 | Level 3 | Level 4 |
| E4 >40 min | Level 1 | Level 3 | Level 4 | Level 4 |

| Level 1 - Baseline | Level 2 - Enhanced | Level 3 - High | Level 4 - Maximum |
|---|---|---|---|

**A4.13** In applying the matrix, CHAs may wish to note that:

a) the result is an indicative minimum. A CHA may adopt a higher level where its risk assessment shows this reduces the overall risk of the transfer. More protection is not always safer: heavier or bulkier equipment brings heat burden, reduced mobility and, with dry suits, operational risks of its own;

b) before adopting a higher level, it is worth considering whether recovery capability can be improved in the first instance (A4.11);

c) each level keeps the functions of the levels below it (flotation, visibility, alerting, gloves, footwear and flushing control). At Levels 3 and 4 the suit system replaces the Level 1 outer coat and leggings, and its underclothing replaces the Level 2 layers;

d) the level may change with the season, the pilot boat in use and recovery arrangements, and is best reviewed periodically and whenever these change; and

e) the temperature and rescue-time boundaries are a working group judgement drawn from the physiological literature. They have not yet been validated against measured sea temperatures or recorded recovery times, and will be reviewed as that evidence develops.

## Equipment to be considered at each level

**A4.14** The equipment below describes types, not products. Annex 2 applies at all levels: the selection principles in A2.1, and the items it lists as industry best practice where the CHA's risk assessment supports them. For the facial splash guard, see Level 1 below. Any item is best assessed as part of the complete system in which it will be worn (A4.19). At any level, where no equipment evidenced to that level is yet available, the CHA may wish to record the best-evidenced equipment it has adopted and any additional measures to shorten ERT, and review this as products develop.

**Level 1: Baseline**

- Pilot coat and leggings designed for marine use, high-visibility and waterproof, with an integrated or separate lifejacket. Flushing resistance at the wrists and neck should be considered.
- Base clothing that wicks moisture, in place of cotton, suited to the conditions. Thermal insulation added where water temperature, air temperature and operating conditions call for it.
- Full-finger gloves suitable for climbing, keeping grip and feel on wet rungs, chosen by individual fit testing. Grip strength falls quickly once hands are cold, so gloves also help after an immersion.
- A deployable facial splash guard may be considered. A constant-wear facial splash guard is not recommended, as it restricts breathing and speech during the climb.
- Ankle seals are not recommended at Levels 1 and 2: water retained around the legs adds weight at recovery and hinders self-rescue, with no clear thermal benefit at these levels. A hood or balaclava is not usually needed at Levels 1 and 2.

**Level 2: Enhanced** (Level 1, plus)

- Thermal layers that insulate when wet, covering torso and limbs, worn under the flushing-resistant outer: for example, insulated synthetic fabrics, or a close-fitting wetsuit-principle layer. The weight of insulation can be matched to the air temperature to limit heat burden. In the Technical and Training Committee's evaluation, a close-fitting wetsuit-principle layer; controlled flushing well, but was heavy out of the water once saturated.
- Thermal waterproof gloves, such as neoprene, keeping grip on wet rungs, chosen by fit testing.
- No standard currently certifies the immersion performance of thermal layers, so selection rests on stated properties and local testing.

**Level 3: High** (suit system replacing the Level 1 outer and Level 2 layers)

- Either of the following, selected through local risk assessment and compatibility testing (A4.19):
  - a one-piece constant-wear immersion suit meeting BS EN ISO 15027-1:2026 Class D as worn, including underclothing. Some suits carry Class D claims, though not all are certified to the 2026 edition (A4.16); or
  - a two-piece system of robust high-visibility pilot jacket and salopettes, with flushing control at neck, wrists and waist, over defined thermal underclothing. This works on the same principle as a Class D suit: the outer layer limits water entry and flushing, and the underclothing insulates when wet. No two-piece system is certified to Class D, and as it is assembled from separate items it is unlikely to be tested as a complete system. Equivalence is therefore a reasoned judgement, best based on the stated performance of each item (for example the outer garment's flushing control and the underclothing's thermal rating) and on local in-water and compatibility testing (A4.19). The CHA may wish to record the basis for that judgement (A4.14) and keep it under review.
- A thermal hood or balaclava compatible with the pilot helmet in fit and hearing.
- Thermal waterproof gloves, keeping grip on wet rungs, chosen by individual fit testing.
- A SOLAS water-activated light and a personal emergency locating device that can be operated with gloves on.
- A separately selected lifejacket compatible with the suit system, with performance set by local assessment.
- *An insulated dry suit (Class B or above) is not generally recommended at Level 3 where a system meeting Class D as worn is available: its burden is carried on every transfer, while the extra protection is needed only in a long immersion.*

**Level 4: Maximum** (dry suit system replacing the Level 3 suit system)

- A constant-wear dry suit system meeting BS EN ISO 15027-1:2026 Class B or above as worn. An outer shell suit with layered undergarments, and integrated dry socks with separate operational footwear, are preferred to heavily insulated suits with integrated boots, which performed poorly on the ladder.
- A lifejacket always worn with a dry suit, separately selected. Integrated auxiliary buoyancy of the order of 100 N is not a substitute.
- A thermal hood or balaclava as at Level 3.

**Level 4: practical note**

Donning and doffing a dry suit in a pilot boat, or on or near a bridge in darkness, remains difficult, and a workable local procedure should be established before implementation. Residual air in the suit can affect in-water behaviour and is best expelled before the transfer.

Where Level 4 is indicated, CHAs may first wish to consider whether recovery capability can be improved, or the boarding operation modified, for example by using a combination ladder to reduce climb height.

## Selecting and verifying equipment

**A4.15** **Marine use.** Equipment for pilot transfer is best chosen from equipment designed for marine use. General-purpose workwear may be unsuitable.

**A4.16** **Certification.** For Levels 3 and 4, certification to BS EN ISO 15027-1:2026 is the primary evidence of performance. Claims are best checked against the current edition and for the complete configuration as worn. Where a product is not certified, independent test data to ISO 15027-3 may demonstrate equivalent performance, recorded in the PPE specification. Products should also meet Annex 2, A2.1(a). Class D is tested for 2 hours in 10°C water and Class B for 4 hours in

2°C water; Class D performance in colder water is inferred from its insulation value rather than tested. Class durations are measured in calm water and are shorter in wind and waves.

**A4.17** **Off-the-shelf clothing.** Suitability cannot be assumed from general appearance or marketing. Some general marine garments did not seal adequately when tested; others may be entirely suitable once assessed.

**A4.18** **Lifejackets.** Crotch or thigh straps, a spray hood, a light, retro-reflective material and compatibility with any personal emergency locating device, such as a PLB or AIS man-overboard device, all affect survival and recovery time, and are best assessed together with the garment.

**A4.19** **Local compatibility testing.** Compatibility varies by port and is best confirmed locally, by testing the equipment as a complete system, in the actual environment. Pilots who will wear the equipment are best placed to identify problems and should be involved in selection and trials. Testing may confirm that:

a) the garment or suit does not impair lifejacket inflation, self-righting or head-above-water posture;
b) the Pilot can climb a ladder in the complete outfit without significant loss of mobility or grip;
c) gloves give adequate grip on wet rungs when worn with the rest of the PPE;
d) headwear fits under the helmet and stays in place on immersion, the helmet fastens correctly over it, and the headwear, collar and lifejacket do not snag, obscure vision or restrict head movement and upward line of sight when climbing;
e) the equipment performs as intended on the smallest and largest wearers, not only on an average build, with female sizing available where a unisex garment does not fit;
f) the heat burden is manageable, including in warm weather and after boarding; and
g) donning and doffing are practical in the operational setting.

## Use, training and maintenance

**A4.20** **Procedures.** Local procedures may include where PPE is put on and taken off, footwear, air expulsion from dry suits, stowage aboard, heat burden after boarding, and the timing of the Master-Pilot Exchange where transfer PPE is still worn.

**A4.21** **Training and familiarisation.** PPE is the final control measure, and it only reduces risk if it works as intended at the moment it is needed. Training is what makes that more likely: a Pilot who has climbed a ladder, entered the water and self-righted in the equipment is better placed to use it well, and less likely to be put at risk by it. New PPE is best issued with training (Annex 2, A2.2). Before operational use of a Level 4 dry suit, an in-water familiarisation session including ladder climbs, and a period of extended wear in warm conditions with exertion in full PPE, are recommended. Training courses such as the UKMPA Maritime Immediate Emergency Care (MIEC), and UKMPA Marine Pilot Ladder Transfer Safety Training, may also be considered.

**A4.22** **Maintenance.** Suit seals and zips, and lifejackets, benefit from servicing at the manufacturer's intervals, with records kept. Arrangements for provision, maintenance and replacement are best agreed locally and recorded.

## Risk assessment flow chart (example)

**A4.23** **Example.** The flow chart below shows one way of applying the framework at a boarding position. It is an example only, and each CHA may adapt the process to its own risk assessment.

