Appendix 7-A
Guidance on Operations in Environmentally Extreme Conditions
## CONTENTS

1. ENVIRONMENTALLY EXTREME CONDITIONS 2
2. COLD WEATHER OPERATIONS (< -10°C CELSIUS) 2
   2.1 PERSONNEL CONSIDERATIONS 2
   2.2 HUMAN RESPONSE TO COLD EXPOSURE 2
   2.3 WIND CHILL EFFECT 3
   2.4 EFFECT OF COLD EXPOSURE ON COGNITION & REASONING ABILITY 4
   2.5 HEALTH HAZARDS RELATING TO COLD EXPOSURE 4
   2.6 MONITORING ENVIRONMENTAL CONDITIONS 4
   2.7 CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT 4
   2.8 NUTRITIONAL CONSIDERATIONS IN COLD CLIMATES 5
   2.9 WORKSTATION DESIGN AND OPERATIONAL CONSIDERATIONS 5
   2.10 SAFETY SYSTEMS 5
   2.11 FIRE FIGHTING EQUIPMENT 5
   2.12 HULL CONSTRUCTION, ARRANGEMENTS AND EQUIPMENT 6
   2.13 ICE LOADS ON DECKS 6
   2.14 SEA WATER SUPPLIES 6
   2.15 PROTECTION OF DECK MACHINERY, SYSTEMS AND EQUIPMENT 6
3. WARM / HOT (> 35°C CELSIUS) 6
   3.1 ULTRA VIOLET PROTECTION, PERSONNEL 6
   3.2 ULTRA VIOLET PROTECTION, EQUIPMENT 7
   3.3 PRECAUTIONS AGAINST INFECTION 7
   3.4 PRECAUTIONS AGAINST DEHYDRATION 7
4. SAFETY CRITICAL EQUIPMENT IN ENVIRONMENTALLY EXTREME CONDITIONS 7
5. OPERATIONS IN EXTENDED PERIODS OF DARKNESS 8

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1 ENVIRONMENTALLY EXTREME CONDITIONS

This Appendix relates to the following conditions:-

1. Air temperatures of less than -10º Celsius.
   Please note, however, that navigation in ice is NOT included. Guidance in this matter should be sought from other sources.
2. Air temperatures greater than +35º Celsius.
3. Safety-Critical Equipment in Environmentally Extreme Conditions
4. Operations in Extended Periods of Darkness

2 COLD WEATHER OPERATIONS (< -10º CELSIUS)

2.1 PERSONNEL CONSIDERATIONS

Working in cold weather environments has significant implications on human capabilities, and unless proper precautions are made, these can be hazardous to a person’s health. In recognition of these implications on human health and performance due to working in cold climes,

1. Basic information on human performance and health hazards when working in cold conditions
2. Guidance for design or selection of clothing
3. Information that can be used to help generate cold weather operations safety and operating procedures
4. Information that can be used to preserve the health of persons working in cold environments
5. The information that follows is provided for those owners, or operators to consider in the course of ship operation.

2.2 HUMAN RESPONSE TO COLD EXPOSURE

The core (trunk) of the human body should remain within a small temperature range for healthy function. Excessive cooling or excessive heating will result in abnormal cardiovascular and neurological function. The skin is the organ through which a person regulates body temperature. With an average skin temperature of 33°C (91.4°F), conductive heat loss occurs at temperatures below this value, therefore, it is easy to see how cold weather performance can significantly influence normal body function. As a person cools:

Metabolism is increased to generate more body heat – as cooling continues a person will begin to “shiver” – a visible sign that body cooling has progressed beyond a comfortable level. Increased metabolism will reduce the amount of time a person can sustain work.
Safe manual materials handling tasks require the use of sense of touch, hand dexterity, strength, and coordination. Decreases in the ability to produce force, exhibit fine control over objects, and sustain muscular work loads occur in cold working environment.

Work in cold environments is related to an increased risk for musculoskeletal injury. Motor function impairments of the arms and hands will occur long before cognitive or hypothermic-related disabilities occur. Impaired cognitive performance will lead to poor decision-making and increased risk for accident.

Persons suffering from arthritis or rheumatism will generally experience increased levels of pain during cold weather operations.

2.3 WIND CHILL EFFECT

Wind chill is the perceived decrease in air temperature due to the flow of cold air over the body.

Heat is lost from the human body through a variety of processes, including convection, conduction and radiation. In still conditions the air immediately next to exposed skin heats up forming an insulating boundary layer. Air movements disrupt this boundary layer, allowing new, cooler air to replace the warmer air immediately next to the skin, resulting in the apparent cooling effect. This effect is accentuated as the wind speed increases.

The effects of wind chill are illustrated in the diagram below.

![Wind Chill Index](image)

Figure 7 - A - 1 Wind Chill Index

Colour coding in Figure 7 - A - 1 relates to the potential for onset of frostbite in exposed skin, as follows:-

| Frostbite highly likely within 30 minutes, particularly if skin is already cold. |
|------------------|------------------|
| Frostbite will occur within 10 minutes or less, particularly if skin is already cold |
| Frostbite will occur within 2 minutes or less, particularly if skin is already cold |

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2.4 EFFECT OF COLD EXPOSURE ON COGNITION & REASONING ABILITY

Tasks requiring vigilance may be hampered after prolonged exposure to cold. Decision verification procedures should be implemented.

Cold weather operations, coupled with other physical distracters, such as noise or motion environments, will influence the quality of perception, memory and reasoning and compound the risk of decision-making error.

2.5 HEALTH HAZARDS RELATING TO COLD EXPOSURE

The list of potential injuries and issues for occupational work in cold environments is lengthy. Personnel should have adequate training to enhance preparation for work in cold environments. Proper planning and precaution can deter the potential risks of cold work.

2.5.1 Hypothermia

Hypothermia is a rapid, progressive mental and physical collapse due to the body’s warming mechanisms failing to maintain normal body temperatures.

While hypothermia is often associated with immersion in cold water, it can also occur in air when suitable cold weather protection is not employed. Conditions of extremely low dry-ambient temperature or mildly cold ambient temperatures with wind and dampness can lead to a general cooling effect on the body. If metabolic heat production is less than the gradient of heat loss to the environment hypothermia becomes an issue.

2.6 MONITORING ENVIRONMENTAL CONDITIONS

Working in cold environments requires an understanding of the interaction between ambient temperature, wind speed, relative humidity, personnel protective equipment and task being performed. In order to limit the risk during operational activities due to cold stress and further prevent local cold injuries and general freezing, specific preventative measures should be evaluated and introduced during the planning and execution of the daily work activities.

Climatic metrics such as temperature, wind speed, and humidity should be regularly monitored in the locations where outside work is to be performed. Of primary importance is a regular reporting of the wind chill or equivalent temperature.

Regular communications should be maintained regarding allowable time to work outside. Indoor personnel should regularly monitor outside workers so best work-to-rest/warming schedules are maintained.

2.7 CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT

For appropriate protection/isolation against cold climate conditions, adequate clothing should be selected and used onboard during cold periods. Such optimal clothing should be able to mitigate water and humidity during work and at the same time insulate sufficiently to maintain thermal comfort during rest. The insulating effect of the clothing is influenced by different factors including temperature, wind and humidity.
Specific guidance is to be provided covering:

1. Hand Protection
2. Head and Eye Protection
3. Foot Protection

2.8 NUTRITIONAL CONSIDERATIONS IN COLD CLIMATES
The added weight of protective clothing and the limitations in mobility created by protective equipment will increase the mobility demands of the operator, thus increasing the metabolic needs for a given task.

2.9 WORKSTATION DESIGN AND OPERATIONAL CONSIDERATIONS
An analysis of outdoor work situations should be performed early in design/layout development, and should be updated when design changes are made that will influence personnel’s exposure to cold stress.

Outdoor operations analyses (an examination of the tasks to be carried out in cold conditions) should be carried out for open work areas and semi-open work areas. The objective of these analyses is to identify and remedy task performance issues due to overall exposure to temperature, wind, icing and precipitation, including investigation of the weather protection necessary to comply with exposure limits.

2.10 SAFETY SYSTEMS
Cold environments present many significant challenges to the design and use of emergency, evacuation, and rescue devices. Much of the hardware devised for such use is designed for more temperate climates. Fire mains can freeze. Materials (such as used in life vests) become brittle. Working devices (such as sheaves, blocks, and davits) can freeze in place – refusing to move.

2.11 FIRE FIGHTING EQUIPMENT
Significant risks are associated with fire fighting equipment, the most significant being the potential freezing of fluids in lines, thereby depriving crew of the use of the firefighting systems.

Specific risks include:

1. Freezing of fire water hoses, piping, nozzles, etc.
2. Portable fire extinguisher storage may be obstructed or frozen
3. Fire dampers may freeze in the stowage position. (generally closed in temperate climates)

Appliance types include lifeboats, life rafts, rescue boats, launching stations, ice gangways, immersion suits, alarms, escape routes, and access routes.
2.12 HULL CONSTRUCTION, ARRANGEMENTS AND EQUIPMENT
Specific features which should be included when planning operations in cold conditions include:-

1. Ballast Tanks.
   Means must be provided to prevent freezing of the ballast water in tanks and vents

2. Superstructure and Deckhouses.
   External access to the navigation bridge windows is to be provided to facilitate ease of cleaning. Alternating navigation bridge windows are required to be heated.

3. Personnel required to perform external duties such as being a lookout when underway, security at the gangway when in port, or being on deck during loading operations are to be provided with a safe haven.

2.13 ICE LOADS ON DECKS
In particular, one of the potentially significant consequences for any ship in transit through cold weather waters is the concentration of ice on deck.

2.14 SEA WATER SUPPLIES
During navigation and at port in ice-covered waters, attention must be paid to sea water supplies for essential operational systems and safety systems. Sea water supplies are needed for the ballast system, the cooling water system serving propulsion machinery, main and emergency fire pumps supplying the fire and wash deck system and the water spray system.

2.15 PROTECTION OF DECK MACHINERY, SYSTEMS AND EQUIPMENT
Generally, deck machinery and systems are not prepared for freezing temperatures. Essential equipment and systems must be available at all times and in any temperature conditions.

The lubricating oil and hydraulic oil used in rotating machines exposed to the weather must be suitable for low temperatures.

3 WARM / HOT (> 35º CELSIUS)

3.1 ULTRA VIOLET PROTECTION, PERSONNEL
Personnel should be made aware of the risks associated with excessive exposure to ultra violet radiation.

It should be noted that the risk of over-exposure to ultra-violet radiation is not limited to warm / hot conditions, and may also occur in middle or high latitudes.
Operations should be planned or equipment provided so that the risk of personnel being exposed to excessive or extended radiation is minimised.

3.2 ULTRA VIOLET PROTECTION, EQUIPMENT
Certain items of equipment, including some plastics and ropes manufactured using artificial fibres, will quickly degrade when exposed to intense ultra violet radiation, leading to failure in use which may result in a dangerous situation developing.

Arrangements should therefore be made to protect such equipment from exposure to radiation of this type.

It may be inevitable that equipment cannot be protected whilst in use, but every effort should be made to provide adequate protection when not actually deployed.

3.3 PRECAUTIONS AGAINST INFECTION
Operations in certain tropical or equatorial parts of the globe may result in personnel being exposed to the risk of contracting infections or diseases against which their natural immune system will provide little or no defence.

Personnel should therefore be made aware of such risks and the measures to be taken to minimise them.

Where appropriate, barrier arrangements, insect repellents and prophylactic medicines should be provided. Personnel are to be instructed in their use as required.

3.4 PRECAUTIONS AGAINST DEHYDRATION
Dehydration, with its associated risks, may be experienced by personnel engaged in strenuous activities which result in increased perspiration.

Whilst this may occur in temperate climates this risk increases in tropical and equatorial conditions, particularly since even minor levels of activity may give rise to excessive perspiration.

Personnel should therefore be made aware of the risks associated with dehydration, and sufficient drinking water should always be made readily available.

As described in standard medical reference sources urine colour is an easy way to monitor an individual’s hydration status. These should be consulted for further information regarding this matter.

4 SAFETY CRITICAL EQUIPMENT IN ENVIRONMENTALLY EXTREME CONDITIONS
Marine equipment, including that of a safety critical nature, is normally designed and manufactured to operate within a temperature range from -10° to +35° Celsius.

Where there is any likelihood that vessels will be required to operate in conditions outwith this temperature range it should be ensured that all elements of safety
critical systems are designed and manufactured accordingly, or are adequately protected to ensure their continuing operability.

A programme of regular inspection and testing of safety critical systems when operating outwith the normal temperature range should also be implemented to ensure that such systems remain available if required.

5 OPERATIONS IN EXTENDED PERIODS OF DARKNESS

Operations in higher latitudes (north and south) in the winter months will be undertaken in circumstances where the period of natural daylight is restricted or absent altogether and will involve extensive use of artificial illumination.

In such circumstances due recognition should be taken of the risk that personnel will experience depression or other adverse effects due to seasonal affective disorder (SAD).

Clinical advice should be sought to identify the appropriate precautions to be taken to minimise this risk.