CHAPTER 11

Ice and Cold Water Diving Operations

11-1 INTRODUCTION

11-1.1 Purpose. This chapter explains the special requirements for ice and cold water diving.

11-1.2 Scope. Polar regions and other cold weather environments are uniquely hostile to divers, topside support personnel, and equipment. Diving where ice cover is present can be extremely hazardous and requires special equipment as well as appropriate operating and support procedures. Awareness of environmental conditions, personnel and equipment selection, and adequate logistical support are vital to mission success and dive team safety.

11-2 OPERATIONS PLANNING

Normal diving procedures generally apply to diving in extremely cold environments. However, there are a number of significant equipment and procedural differences that enhance the diver's safety.

11-2.1 Planning Guidelines. The following special planning considerations relate to diving under/near ice cover or in water at or below a temperature of 37°F:

- The task and requirement for ice diving should be reviewed to ascertain that it is operationally essential.
- Environmental conditions such as ice thickness, water depth, temperature, wind velocity, current, visibility, and light conditions should be determined. Ideally, a reconnaissance of the proposed dive site is performed by the Diving Supervisor or a person with ice-covered or cold water diving experience.
- The type of dive equipment chosen must be suited for the operation.
- Logistical planning must include transportation, ancillary equipment, provisioning, fuel, tools, clothing and bedding, medical evacuation procedures, communications, etc.

NOTE **The water temperature of 37°F was set as a limit as a result of Naval Experimental Diving Unit's regulator freeze-up testing. For planning purposes, the guidance above may also be used for diving where the water temperature is above 37°F.**

11-2.2 Navigational Considerations. Conditions in cold and ice-covered water affect diver underwater navigation in the following ways:

- The proximity of the magnetic pole in polar regions makes the magnetic compass useless.

- The life of batteries in homing beacons, strobes, and communication equipment is shortened when used in cold water.

- Surface light is so diffused by ice cover that it is nearly impossible to determine its source.

- Direct ascent to the surface is impossible when under the ice and determining return direction is often hindered.

- In shallow ice-covered waters, detours are often required to circumvent keels or pressure ridges beneath the ice.

- With an ice cover, there are no waves and therefore no ripple patterns on the bottom to use for general orientation.

11-2.3 **Scuba Considerations.** Scuba equipment has advantages and disadvantages that should be considered when planning a cold water dive.

The advantages of using scuba are:

- Portability
- Quick deployment
- Minimal surface-support requirements

The disadvantages of using scuba are:

- Susceptibility of regulator to freezing
- Depth limitations
- Limited communications
- Severely limited ability to employ decompression diving techniques
- Duration limitations of CO_2 removal systems in closed-circuit UBA

11-2.4 **Scuba Regulators.** Refer to the ANU for selection of proper regulator. The single-hose regulator is susceptible to freezing. The first and/or second stage of the single-hose regulator may freeze in the free-flow position after a few minutes of exposure in cold water. The single-hose regulator should be kept in a warm place before diving. It is important that the diver test the regulator in a warm place, then refrain from breathing it until submerging. When returning to the surface, the regulator should remain submerged and the diver should refrain from breathing from the regulator until resubmerging. The diver's time on the surface should be kept to a minimum. Once under the water, chances of a freeze-up are reduced. However, if a regulator is allowed to free-flow at depth for as little as five seconds, freeze-up may occur. The diver should therefore avoid purging the second stage of the regulator when diving in cold water. If water needs to be purged from the mouthpiece, the diver should do so by exhaling into it (Figure 11-1).

Figure 11-1. Ice Diving with Scuba. Divers in Typhoon dry suits and Aga/Divator FFM Scuba with approved cold-water regulators.

11-2.4.1 **Special Precautions.** Single-hose regulators should be equipped with an anti-freeze cap, which is a special first-stage cap that can be filled with liquid silicone available from the manufacturer. Correct maintenance and application of an approved lubricant to the appropriate points are also essential. Extra precautions must also be taken to make sure that scuba cylinders are completely dry inside, that moisture-free air is used, and that the regulator is thoroughly dried prior to use.

11-2.4.2 **Octopus and Redundant Regulators.** Where water temperature is at or below 37°F, a redundant scuba system (twin scuba bottles, each having a K-valve and an approved cold water regulator) or twin scuba bottles with one common manifold and an approved cold water regulator (with octopus) shall be used.

11-2.5 **Life Preserver.** The use of life preservers is prohibited only when diving under ice. The accidental inflation of a life preserver will force the diver upward and may cause a collision with the undersurface of the ice. Should the diver be caught behind a pressure ridge or other subsurface ice structure, recovery may be difficult even with tending lines. Also, the exhaust and inlet valves of the variable volume dry suit will be covered if a life preserver is worn. In the event of a dry suit blow-up, the inability to reach the exhaust dump valve could cause rapid ascent and collision with the surface ice.

11-2.6 **Face Mask.** The diver's mask may show an increased tendency to fog in cold water. An antifog solution should be used to prevent this from occurring. Saliva will not prevent cold water fogging.

11-2.7 **Scuba Equipment.** The minimum equipment required by every Navy scuba diver for under-ice operations consists of:

- Wet suit/variable volume dry suit
- Open-circuit scuba with cold water modification or closed-circuit UBA
- Face mask
- Weight belt and weights as required
- Knife and scabbard
- Swim fins
- Wrist watch
- Depth gauge
- Submersible scuba bottle pressure gauge
- Harness such as an Integrated Divers Vest (IDV), MK 12 jocking harness, etc.
- Lifelines

A variety of special equipment, such as underwater cameras and lift bags, is available to divers [see the NAVSEA/00C Authorized for Navy Use (ANU) list for specific identification of authorized equipment]. However, the effect of extreme cold on the operation of special equipment must be ascertained prior to use.

11-2.8 **Surface-Supplied Diving System (SSDS) Considerations.** Using SSDS in ice-covered or cold water requires detailed operations planning and extensive logistical support. This includes thermal protection for an elaborate dive station and recompression chamber and hot water heating equipment. In addition, dive equipment may require cold climate modification. Because of logistical considerations, scuba is used in most ice diving situations. However, SSDS may be required because of prolonged bottom times, depth requirements, and complex communications between topside and diver. When diving in cold water that is not ice covered, logistic and equipment support requirements are reduced; however, very cold water poses many of the same dangers to the surface-supplied diver as ice diving.

11-2.8.1 **Advantages and Disadvantages of SSDS.**

The advantages of using SSDS are:

- Configuration supports bottom-oriented work.
- Hot water suit and variable volume dry suit offer diver maximum thermal and environmental protection.
- Communications cable offers audio communications.
- Gas supply allows maximum duration to the maximum depth limits of diving.

The disadvantages of using SSDS are:

- Manifold/panel may freeze up.
- Low-pressure compressors do not efficiently remove moisture from the air which may freeze and clog filters or fracture equipment. This is more likely when the water is very cold and the air is warm. Banks of high-pressure cylinders may have to be used.
- Buildup of air or gas under the ice cover could weaken and fracture thin ice, endangering tenders, other topside personnel, and equipment.
- Movement of ice could foul or drag diver's umbilical.
- Battery life of electronic gear is severely reduced.
- Carbon dioxide removal recirculator components may have to be heated.
- Decompression under extreme cold conditions may be dangerous due to water temperature, ice movement, etc.

11-2.8.2 **Effect of Ice Conditions on SSDS.** Ice conditions can prevent or severely affect surface-supplied diving. In general, the ice field must be stationary and thick enough to support the dive station and support equipment. If the dive must be accomplished through an ice floe, the floe must be firmly attached to land or a stable ice field. Severe ice conditions seriously restrict or prohibit surface-supplied diving through the ice (i.e., moving, unstable ice or pack ice and bergs, and deep or jagged pressure ridges could obstruct or trap the diver). In cases where a diver is deployed from a boat in a fixed mooring, the boat, divers, and divers' umbilicals must not be threatened by moving ice floes.

11-2.9 **Suit Selection.** Custom wet suits designed for cold water diving, variable volume dry suits, and hot water suits have all been used effectively for diving in extremely cold water. Each has advantages and disadvantages that must be considered when planning a particular dive mission. All suits must be inspected before use to ensure they are in good condition with no seam separations or fabric cuts.

11-2.9.1 **Wet Suits.** Custom wet suits have the advantages of wide availability, simplicity and less danger of catastrophic failure than dry suits. Although the wet suit is not the equipment of choice, if used the following should be considered:

- The wet suit should be maintained in the best possible condition to reduce water flushing in and out of the suit.
- Wearing heavy insulating socks under the boots in a wet suit will help keep feet warm.

CAUTION **In very cold water, the wet suit is only a marginally effective thermal protective measure, and its use exposes the diver to hypothermia and**

restricts available bottom time. The use of alternative thermal protective equipment should be considered in these circumstances.

11-2.9.2 **Variable Volume Dry Suits.** Variable volume dry suits provide superior thermal protection to the surface-supplied or scuba diver in the water and on the surface. They are constructed so the entry zipper or seal and all wrist and neck seals are waterproof, keeping the interior dry. They can be inflated orally or from a low-pressure air source via an inlet valve. Air can be exhausted from the suit via a second valve, allowing excellent buoyancy control. The level of thermal protection can be varied through careful selection of the type and thickness of long underwear. However, too much underwear is bulky and can cause overheating, sweating, and subsequent chilling of the standby diver. Dry suit disadvantages are increased swimmer fatigue due to suit bulk, possible malfunction of inlet and exhaust valves, and the need for additional weights for neutral buoyancy. Furthermore, if the diver is horizontal or deployed with the head below the rest of the body, air can migrate into the suit lower extremities, causing overinflation and loss of fins and buoyancy control. A parting seam or zipper could result in a dramatic loss of buoyancy control and thermal shock. Nevertheless, because of its superior thermal protection, the dry suit is an essential component of extremely cold water diving.

CAUTION **Prior to the use of variable volume dry suits and hot water suits in cold and ice-covered waters, divers must be trained in their use and be thoroughly familiar with the operation of these suits.**

11-2.9.3 **Extreme Exposure Suits/Hot Water Suits.** Hot water suits provide excellent thermal protection. If their use can be supported logistically, they are an excellent choice whenever bottom times are lengthy. They are impractical for use by standby divers exposed on the surface.

A hot water system failure can be catastrophic for a diver in very cold water since the hot water is a life support system under such conditions. Hot water temperature must be carefully monitored to ensure that the water is delivered at the proper temperature. When using the hot water suit, wet suit liners must be worn. The hose on the surface must be monitored to ensure it does not melt into the ice. When not in use, the heater and hoses must be thoroughly drained and dried to prevent freezing and rupture.

11-2.10 **Clothing.** Proper planning must include protecting tenders and topside support personnel from the environment. However, bulky clothing and heavy mittens make even routine tasks difficult for topside personnel. Waterproof outer gloves and boots may also be considered. Regardless of the type of clothing selected, the clothing must be properly fitted (loosely worn), and kept clean and dry to maximize insulation. In planning operations for such conditions, reduced efficiency resulting in longer on-site time must be considered. Refer to the *Polar Operations Manual* for complete information on thermal protection of support personnel and equipment.

11-2.11 **Ancillary Equipment.** A detailed reconnaissance of the dive site will provide the planner with information that is helpful in deciding what ancillary equipment is required. Diving under ice will require special accessory equipment such as a line with lights for underwater navigation, ice-cutting tools, platforms, and engine protection kits.

The method of cutting the hole through the ice depends on ice thickness and availability of equipment. Normally, two or more of the following tools are used: hand ice chipper, ice handsaw, ice auger, chain saw, thermal ice cutter or blasting equipment. In addition, equipment to lift the ice block, remove the slush, and mark the hole is required. Sandbags, burlap bags, or pallets for the tenders to stand on are also needed. Ladders should be in place in case a tender falls into the hole.

If there is a possibility of surface support personnel falling through the ice, floatable work platforms, such as an inflated Zodiac boat, should be used. With such flotation equipment, the operation could be continued or safely concluded if the ice breaks up.

Gasoline and diesel engines must be cold-weather modified to prevent engine freeze-up. Vibrations of engines running on the ice can be a problem and vibration dampening platforms may be required.

11-2.12 **Dive Site Shelter.** Tent equipment including framing and flooring material may be required to construct a dive site shelter and a windbreak. Depending on the severity of the climate, remoteness of the site, and duration of the mission, shelters can range from small tents to steel sea-land vans and elaborate insulated huts transported to the site and erected from kits. Dive site shelters should have storage areas for dry items and a place for drying equipment. Benches should be provided for dressing divers, flooring should be installed for insulation, and heating and lighting should be adequate. In an extremely cold and dry climate, fire and inadequate ventilation are ever-present dangers. A carbon monoxide detection kit should be available and periodic checks made of all living and working spaces. Fire extinguishers shall be available in each shelter.

11-3 PREDIVE PROCEDURES

11-3.1 **Personnel Considerations.** The supervisor of the dive must ensure that all personnel required to make the dive have been properly trained in ice diving techniques and are physically fit. No diver may be allowed to make the dive if, in the opinion of the Diving Supervisor, the diver is suffering from the psychological stress of an ice dive (anxiety, claustrophobia, or recklessness).

11-3.2 **Dive Site Selection Considerations.** The selection of the dive site will depend upon the purpose of the dive and the geographical environment of the area (ice thickness, ice surface conditions, etc.). Additionally, the diving method chosen, safe access routes, shelter location, emergency holes, and exposure of divers and required support personnel will also have a bearing on site selection.

11-3.3 **Shelter.** When ice diving is conducted, a shelter must be erected as close as possible to the diving site to reduce the probability of frostbite and equipment freeze-up. Normally, tents are not placed over the dive hole because they would restrict the movement of tenders and light available to the diver. However, a windbreak should be constructed. A shelter of modular tents and space heaters is ideal; although precautions must be taken to ensure that the ice beneath the shelter is not weakened. Extreme caution must be used when diving for objects, such as downed aircraft, that have fallen through the ice; the area around the original hole may be dangerously weakened.

11-3.4 **Entry Hole.** Proper equipment should be used to cut a suitable hole or holes through the ice in order to leave a clean edge around the hole. Using a sledgehammer to break through the ice is not recommended as it will weaken the surrounding ice. The hole should be a rectangle 6 feet by 3 feet, or a triangle with six-foot sides as shown in Figure 11-2. The triangular hole is easier to cut and is large enough to allow simultaneous exit by two divers. Slush and ice must be removed from the hole, not pushed under the ice surface, as it could slip back and block the hole. To assist exiting divers and improve footing for other team members on the ice surface, sand or burlap bags should be placed on the ice around the hole. Upon completing the dive, the hole must be clearly marked to prevent anyone from falling in accidentally. When possible, the pieces cut from the ice should be replaced to speed up the refreezing process.

11-3.5 **Escape Holes.** Escape holes provide alternative exit points and aid in searching for a lost diver. Downstream escape holes or emergency exit holes must be cut in the ice when diving in a river or bay where there is a current or tidal stream.

11-3.6 **Navigation Lines.** A weighted line should be hung through the hole to aid the diver in retaining his bearing and sense of direction. Suspending a light at the end of the line may be helpful, as well as attaching a series of strobe lights to indicate depth. After locating the work site, a distance line should be laid from the weighted line to the work site. Another method of aiding the diver in keeping his bearings in clear water is to shovel off the snow cover on the ice around the dive site in the form of a spoked wheel (see Figure 11-2). When the ice and snow cover is less than 2 feet thick, the diver should be able to see the spokes leading to the dive hole located at the center of the wheel. The wheel should have a minimum diameter of 60 feet.

11-3.7 **Lifelines.** Diver tending lines are mandatory when diving under ice to help the diver relocate the entrance hole. A polypropylene braided or twisted line has proven to be the best lifeline. It has the advantage of floating up and away from the diver and is available in yellow, white, and orange for high visibility. A bowline or a D-ring and snap hook spliced into the lifeline is the easiest method of attaching the lifeline to the diver. The attachment of the lifeline on both ends must be absolutely secure. Do not tie the line to a vehicle, shovel, first-aid box, or other portable equipment. A 4-inch by 4-inch by 2-foot board placed under the ice several yards away from the dive hole can be used to secure the bitter end of the lifeline (see Figure 11-2). The D-ring and snap hook allow the quickest transfer of

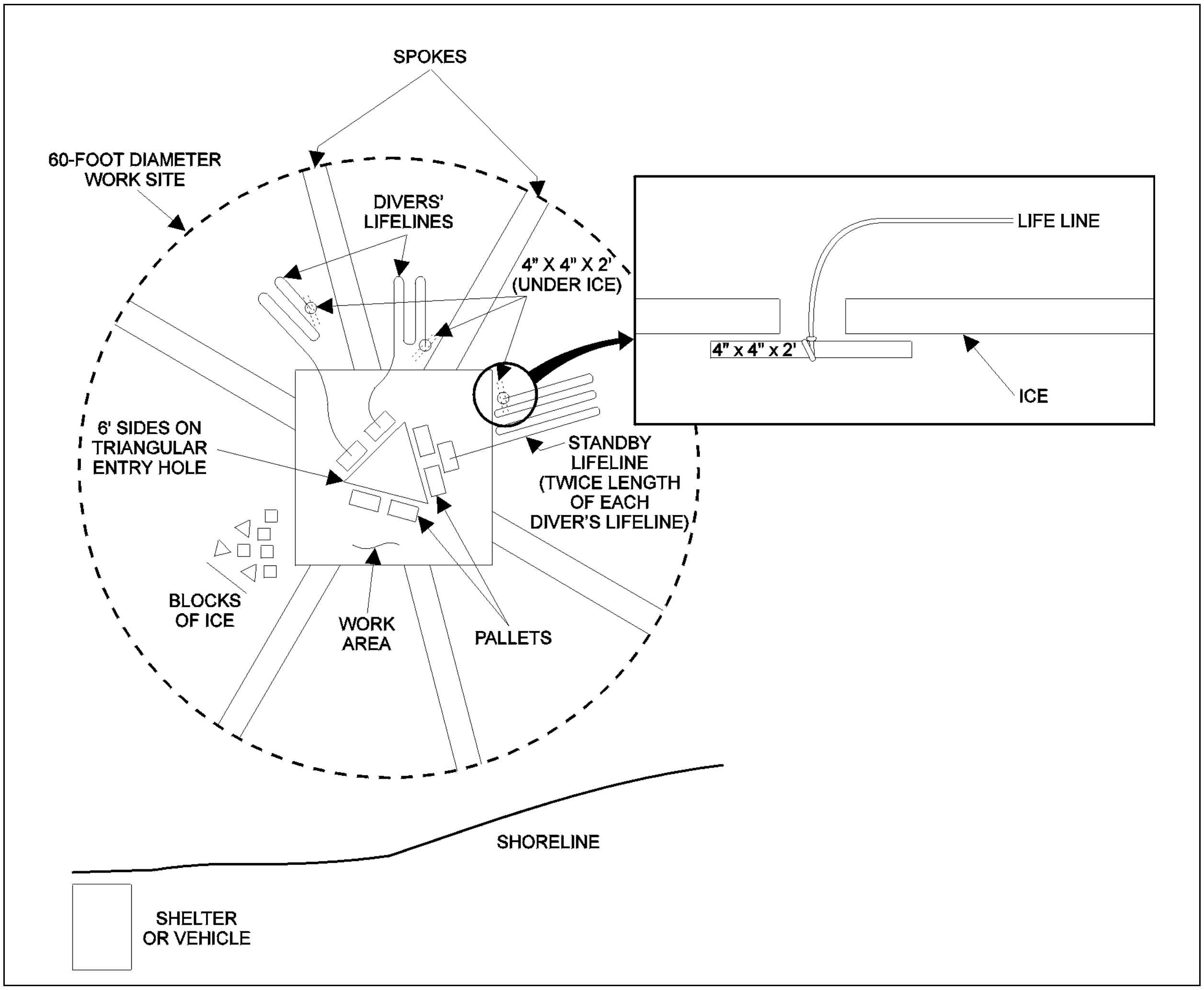

Figure 11-2. Typical Ice Diving Worksite.

the lifeline from diver to diver on the surface, provided the snap hooks are not frozen shut. The snap hooks should be checked for corrosion at frequent intervals. A wet lifeline must be kept off the bare ice to prevent it from freezing to the surface.

11-3.8 **Equipment Preparation.** The diver must wear a distress light that should be turned on upon entering the water. Divers should not be encumbered with unnecessary equipment during cold water dives. Snorkels should be removed and knives worn on the inside of the leg to help prevent the lifeline from snagging on the diver's equipment. Personnel, divers, and tenders must handle rubber accessories such as masks and fins carefully; extreme cold causes them to become brittle.

11-4 UNDERWATER PROCEDURES

11-4.1 **Buddy Diving.** Diving under the ice or in extremely cold waters requires the use of paired dive partners. Buddy diving is required, despite the fact that each diver must be surface tended. When diving through the ice, divers shall always be surface tended. The life-threatening consequences of suit failure, regulator freeze-up or other equipment problems make a solitary tended scuba diver particularly vulnerable. Divers must practice buddy breathing prior to the operation because of the increased possibility that buddy breathing will be required. Proficiency in the process will minimize loss of valuable time during an emergency. Using approved cold water scuba equipment will minimize or eliminate freeze-up problems (see paragraph 11-2.3).

11-4.2 Tending the Diver. The lifeline is to be held by the tender at all times. As an additional safety measure during ice diving, the end of the lifeline must be secured to a stationary object to prevent it from falling into the entry hole should it be dropped by the tender (see Figure 11-2). It is recommended that the lifeline be marked at 10-foot intervals to allow the tender and Diving Supervisor to estimate the diver's position. However, the diver's radial position can only be roughly estimated. The dive team must be thoroughly familiar with the procedures for lifeline tending in Chapter 8.

Tending line sensitivity and awareness of the diver's position by tenders may be difficult with the added factors of lifeline drag on subsurface ice formations, line drag over the lip of the under-ice hole, tending through heavy mittens, and the lack of surface bubbles.

11-4.3 Standby Diver. The standby diver and tender must be immediately available. The standby diver should be kept warm until the Diving Supervisor determines that the standby diver is needed. If possible a shelter or windbreak at the hole should be used. The lifeline of the standby diver should be twice the length of the diver's lifeline in order to perform a thorough circular search. The standby diver must be dressed with the exception of fins, mask, and tanks. These will be ready to don immediately.

11-5 OPERATING PRECAUTIONS

Normal procedures generally apply to diving in extremely cold environments. However, the increased likelihood of regulator freeze-up calls for total familiarity with the buddy breathing procedures described in Chapter 7. This section outlines some of the precautions for operating in cold and ice-covered water.

11-5.1 General Precautions. General precautions for ice and cold water diving operations include:

- Divers should be well rested, have a meal high in carbohydrates and protein, and should not consume any alcohol. Alcohol dilates the blood vessels in the skin, thus increasing body heat loss.

- Bathing is an important health measure to prevent infectious diseases prevalent in cold environments. If necessary, the body can be sponge-bathed under clothing.

- After bathing, a soothing ointment or lotion should be applied to the skin to keep it soft and protect it against evaporation caused by the dry air.

- Shaving and washing the face should be done in the evening because shaving removes protective oils from the skin. Shaving too close can also remove some of the protective layer of the skin, promoting frostbite.

11-5.2 Ice Conditions. The inconsistency and dynamics of ice conditions in any particular area can make diving operations extremely hazardous. The movement of ice floes can be very significant over a relatively short period of time, requiring frequent relocation of dive sites and the opening of new access holes in order to work a fixed site on the sea floor. Diving from drifting ice or in the midst of broken free ice is dangerous and should be conducted only if absolutely necessary.

Differential movement of surface and subsurface pressure ridges or icebergs could close an access hole, sever a diving umbilical, and isolate or crush a diver. The opening of a rift in the ice near a dive site could result in loss of support facilities on the ice, as well as diver casualties.

11-5.3 Dressing Precautions. With a properly fitting suit and all seals in place, the diver can usually be kept warm and dry for short periods in even the coldest water. When dressing for an ice or cold water dive:

- Thermal protection suits should be checked carefully for fabric cuts and separations. Thermal protection suits should expose only a minimum of facial area.

- Mittens, boots, and seals should prevent water entry, while causing no restriction of circulation. Wearing a knitted watchcap under the hood of a dry suit is effective in conserving body heat. With the cap pushed back far enough to permit the suit's face seal to seat properly, the head will be relatively dry and comfortable.

11-5.4 On-Surface Precautions. While on the surface:

- Suited divers should be protected from overheating and associated perspiring before entering the water. Overheating easily occurs when operating from a heated hut, especially if diver exertion is required to get to the dive site. The divers' comfort can be improved and sweating delayed before entering the water by cooling the divers face with a damp cloth and fanning every few minutes. Perspiration will dampen undergarments, greatly reducing their thermal insulating capabilities.

- While waiting to enter the water, divers should avoid sitting on or resting their feet on the ice or cold floor of a hut. Even in an insulated hut, the temperature at the floor may be near freezing.

- Time on the surface with the diver suited, but relatively inactive, should be minimized to prevent chilling of the diver. Surface time can also cool metal components of the diving gear, such as suit valves and scuba regulators, below the freezing point and cause the parts to ice up when the diver enters the water. Dressing rehearsals prior to diving will help minimize surface delays.

- When operating from an open boat, heavy parkas or windbreakers should be worn over the exposure suits.
- When operating at the surface in newly formed ice, care should be taken to avoid cutting exposed facial skin. Such wounds occur easily and, although painless because of the numbness of the skin, usually bleed profusely.
- Diving from a beach and without a support vessel should be limited to a distance that allows the divers to return to the beach if the suit floods.
- Extreme caution must be exercised when diving near ice keels in polar regions as they will often move with tidal action, wind, or current. In doing so, they can foul umbilicals and jeopardize the divers' safety.

11-5.5 In-Water Precautions.

- Because severe chilling can result in impaired judgment, the tasks to be performed under water must be clearly identified, practiced, and kept simple.
- A dive should be terminated upon the onset of involuntary shivering or severe impairment of manual dexterity.
- If the exposure suit tears or floods, the diver should surface immediately, regardless of the degree of flooding. The extreme chilling effect of frigid water can cause thermal shock within minutes, depending on the extent of flooding.
- Divers and Diving Supervisors must be aware of the cumulative thermal effect of repetitive diving. A thermal debt can accumulate over successive diving days, resulting in increased fatigue and reduced performance. The progressive hypothermia associated with long, slow cooling of the body appears to cause significant core temperature drop before shivering and heat production begins.

11-5.6 Postdive Precautions. Upon exiting cold water, a diver will probably be fatigued and greatly susceptible to additional chilling:

- If a wet suit was worn, immediate flushing with warm water upon surfacing will have a comforting, heat-replacing effect.
- Facilities must be provided to allow the diver to dry off in a comfortable, dry and relatively warm environment to regain lost body heat.
- The diver should remove any wet dress, dry off, and don warm protective clothing as soon as possible. Personnel should have warm, dry clothing, blankets, and hot non-alcoholic beverages available to them.

11-6 EMERGENCY PROCEDURES

11-6.1 Lost Diver. A diver who becomes detached from the lifeline and cannot locate the entrance hole should:

1. Ascend to the underside of the ice.
2. Remove weight belt and allow it to drop.
3. Fix the point of the knife into the ice to maintain position.
4. Remain in a vertical position, to maximize vertical profile and thereby snag the searching standby diver's lifeline.
5. Watch for lifeline and the lifeline of the standby diver and wait for the standby diver to arrive. The lost diver MUST NOT attempt to relocate the hole. The diver must remain calm and watch for the standby diver.

11-6.2 Searching for a Lost Diver. As soon as the tender fails to get a response from the diver, the tender must notify the Diving Supervisor immediately. These procedures are to be implemented at once:

1. The Diving Supervisor shall immediately recall all other divers.
2. The Diving Supervisor must estimate the probable location of the lost diver by assessing the diver's speed and direction of travel.
3. As directed by the Diving Supervisor, the standby diver enters the water and swims in the indicated direction, a distance equal to twice that believed to be covered by the lost diver. The distance may be the full extent of the standby diver's lifeline since it is twice as long as the lost diver's lifeline.
4. The tender must keep the standby diver's lifeline taut.
5. The standby diver conducts a circular sweep.
6. When the lifeline snags on the lost diver, the standby diver swims toward the diver signaling the tender to take up slack.
7. Upon locating the lost diver, the standby diver assists the diver back to the hole.
8. If the first sweep fails, it should be repeated only once before moving the search to the most likely emergency hole.

11-6.3 Hypothermia. When diving in cold water, hypothermia may predispose the diver to decompression sickness. Hypothermia is easily diagnosed. The hypothermic diver loses muscle strength, the ability to concentrate and may become irrational or confused. The victim may shiver violently, or, with severe hypothermia, shivering may be replaced by muscle rigidity. Profound hypothermia may so depress the heartbeat and respiration that the victim appears dead. However, a diver should not be considered dead until the diver has been rewarmed and all resuscitation attempts have been proven to be unsuccessful.

Hypothermia demands immediate treatment and prompt evacuation to a medical facility. A hypothermic diver must not be allowed to walk; the diver should be transported in a horizontal position. Improper handling of the diver can cause dangerous rhythms of the heart and a drop in the body core temperature, known as after drop.

11-7 ADDITIONAL REFERENCES

For information on extreme cold weather conditions and the polar environment, refer to:

- *A Guide to Extreme Cold Weather Operations* (Naval Safety Center, July 1986)
- *Polar Operations Manual* S0300-A5-MAN-010 (Naval Coastal Systems Center) (NCSC)
- *Guide to Polar Diving* (Office of Naval Research, June 1976)
- *UCT Arctic Operation Manual* NAVFAC P-992
  (To obtain a copy of this manual, contact NCSC, Code 5110.)