

6 AUGUST 2001



Aerospace Medicine

PREVENTION OF THERMAL STRESS

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OPR: 35 AMDS/SGPB (Major Martin Alexis)
Supersedes 35 FWI 48-105, 21 Apr 01.

Certified by: 35 MDG/CC (Col David E. Geyer)
Pages: 10
Distribution: F

This instruction implements AFD 48-1, Aerospace Medicine Program, and describes procedures designed to protect personnel, who are exposed to severe weather conditions while performing duties at Misawa Air Base (AB), from adverse health effects of heat and cold stress. It applies to all military and civilian personnel assigned or attached to the 35th Fighter Wing (35 FW).

1. References.

- 1.1. AFMAN 32-4005, Personnel Protection and Attack Actions.
- 1.2. Heat Illness: A Handbook for Medical Officers, US Army Research Institute of Environmental Medicine Natick, MA, Report Number TN 91-3, 3 June 1991.
- 1.3. Medical Aspects of Cold Weather Operations: A Handbook for Medical Officers, US Army Research Institute of Environmental Medicine Natick, MA, Report Number TN 93-4, March 1993.
- 1.4. Threshold Limit Values for Chemical Substances and Physical Agents, American Conference of Governmental Industrial Hygienists, 1998.

2. Definitions.

- 2.1. Ambient Temperature—The temperature of the air without regard to the effects of humidity, radiant heat of the sun, or wind.
- 2.2. Heat Stress Condition—A four level advisory based on the risk of injury or illness due to the effects of working in extreme temperatures.
 - 2.2.1. Condition **Green**—The risk of heat-related injury or illness is real, but typical workloads can continue with proper hydration, clothing, and surveillance. All outdoor workers should have current training on the symptoms of overexposure and first aid measures. Implement work and rest cycles as appropriate.

2.2.2. Condition **Yellow**—The risk of heat-related injury or illness is significant. Work practices should be modified to properly manage the risks. Worker surveillance and education should be increased. Enforce water intake. Consider reassigning workers who not acclimatized and are performing moderate and heavy tasks in hot environments to duties protected from extreme temperatures. Implement work and rest cycles as appropriate.

2.2.3. Condition **Red**—The risk of heat-related injury or illness is high. Work practices must be modified to properly manage the risks. Workers should be monitored constantly and education should be conducted at least weekly. Reassign unacclimatized workers performing moderate and heavy tasks in hot environments, to duties protected from extreme temperatures. Implement work and rest cycles as appropriate.

2.2.4. Condition **Black**—The risk of heat-related injury or illness is severe. For heavy work in hot environments, only emergency and mission critical tasks should be conducted outdoors. Implement work and rest cycles as appropriate.

2.3. Wet Bulb Globe Temperature (WBGT)—A method of measuring temperature to more accurately describe how the human body perceives the relative heat of an environment. It adjusts the ambient temperature for the effect of humidity, the cooling effect of evaporation, and the warming effect of the radiant heat from the sun. The following method will be used for determining the WBGT index at Misawa Air Base:

2.3.1. **With solar load**— {WBGT (°F) = 0.7 x Natural Wet Bulb (°F) + 0.2 X Globe Temperature (°F) + 0.1 x Dry Bulb (°F)}

2.3.2. **Without solar load**— {WBGT (°F) = 0.7 x Natural Wet Bulb (°F) + 0.3 x Globe Temperature (°F)}

3. Concept.

3.1. This instruction provides unit commanders and supervisors with information and guidance to operate continuously in a severe hot or cold environment. This instruction is to be applied in peacetime, contingency, and exercise operations.

3.2. This instruction provides guidance beyond that supplied in AFMAN 32-4005, Personnel Protection and Attack Actions. AFMAN 32-4005 outlines work cycle guidance which can lead commanders and supervisors to place personnel in a situation where they must remove Chemical Warfare Defense Equipment (CWDE) to reduce body heat to a safe level.

4. Responsibilities.

4.1. 35th Aerospace Medicine Squadron, Bioenvironmental Engineering Flight (BEF) (35 AMDS/SGPB) will:

4.1.1. Establish recommended heat stress and cold injury prevention guidelines for personnel occupationally exposed to extreme temperature environments and document the evaluations in the work area's routine Industrial Hygiene Survey.

4.1.2. Conduct health risk assessments in workplaces at the request of the supervisor or commander.

- 4.1.3. Upon request, provide commanders and supervisors with risk assessments and guidelines for conducting tasks not addressed in this instruction.
- 4.1.4. Conduct regular, four times per day, Wet Bulb Globe Temperature (WBGT) readings during the summer season, 1 June through 1 October, when ambient air temperature exceeds 85°F and provide 35 Operations Support Squadron, Weather Flight (35 OSS/OSW) and 35 FW Command Post (35 FW/CP) with current WBGT readings and heat stress conditions.
- 4.2. 35th AMDS Public Health (35 AMDS/SGPM) will:
 - 4.2.1. Provide training information on the effects and risks of heat stress and cold injury for workers routinely exposed to extreme temperature environments.
 - 4.2.2. Provide training to supervisors, upon request, for workplaces without routine, occupational exposure to extreme temperature environments.
- 4.3. 35 OSS/OSW will:
 - 4.3.1. Notify 35 AMDS/SGPB whenever the ambient air temperature crosses the threshold of 85° F during the summer season as defined in paragraph 4.1.4. During winter season, provide wind chill temperature information at or below -7°C (19.4°F) to the 35 FW Command Post (35 FW/CP) for dissemination of frostbite warnings.
 - 4.3.2. Upon notification, disseminate changes of heat stress condition (as determined by 35 AMDS/SGPB) to all units connected to the New Tactical Forecast System (N-TFS) and the non-operational weather channel.
- 4.4. 35 FW Command Post (35 FW/CP) will:
 - 4.4.1. Emergency Action Controllers will notify 35 FW Maintenance Operations Center (MOC), group commanders, Base Operations, main base fitness center, and will post heat conditions on the Commander Access Channel (CAC).
 - 4.4.2. 35 FW Maintenance Operations Center will broadcast appropriate heat stress conditions and frostbite warnings to flightline production supervisors via the Land Mobile Radios (LMR).
- 4.5. Supervisors will:
 - 4.5.1. Make drinking water readily available to the workers during times where the heat condition is Yellow or above.
 - 4.5.2. Monitor workers for signs of heat stress and intervene when appropriate.
 - 4.5.3. Implement work and rest cycles in accordance with [Attachment 1](#) of this instruction.
 - 4.5.4. Ensure proper facilities are available for rest periods as well as protection from excessive cold weather.
 - 4.5.5. Ensure workers are trained on the following safety and health procedures concerning cold stress:
 - 4.5.5.1. Proper re-warming procedures and appropriate first aid treatment.
 - 4.5.5.2. Proper eating and drinking habits (warm sweet drinks and soups should be available. Coffee should be limited because of the diuretic and circulatory effects).
 - 4.5.5.3. Recognition of impending frostbite or hypothermia.

4.5.5.3.1. In addition to the above training, ensure workers are trained annually on heat and cold stress symptoms and prevention. All training should be documented in AF Form 55, Employee Safety and Health Record.

5. Heat Stress.

5.1. Controlling Heat Stress.

5.1.1. Follow the rest and work regime as specified in **Attachment 1** of this instruction.

5.1.2. During the summer season or when the worker is exposed to artificially generated heat, drinking water should be made available to the workers. Water should be kept reasonably cool, but not cold.

5.1.3. Reference **Attachment 1** for recommended water intake. Urine should be clear and free of odor if proper hydration is occurring.

5.1.4. Personnel working in hot environments should be encouraged to salt their food. Do not take salt tablets unless directed by a physician.

5.1.5. Light, loose clothing made of breathable material should be worn during outdoor activities in hot conditions. If special clothing is required for performing a particular job and it impedes sweat evaporation or has a high insulation value (firefighters, chemical warfare), the workers heat tolerance is reduced.

5.1.6. Acclimatization and Fitness:

5.1.6.1. Acclimatization to heat involves both physiological and psychological adjustments, which occur in an individual during the first week of exposure to a hot environment. Workers arriving from colder climates during the hot weather should be given light duty for the first week to allow for acclimatization.

5.1.6.2. Workers who are not fit or have medical condition may be more susceptible to the effects of extreme heat. If the member or the supervisor has any questions about fitness for duty in extreme heat, contact the member's physician.

5.2. Symptoms of Heat Related Conditions:

5.2.1. Heat Cramps. Symptoms include painful cramps of the voluntary muscles following exposure to heat. Heat cramps result primarily from excessive sweating which results in the loss of essential salts and water in the body. Body temperature is normal unless heat cramps are accompanied by heat exhaustion.

5.2.2. Heat Exhaustion. Symptoms of heat exhaustion include cool, clammy, moist skin, and profuse sweating. Breathing will usually become shallow and quiet, and the pulse rate will be weak. The pupils will remain normal.

5.2.3. Heat Stroke. Symptoms include extreme rise in body temperature, shivering, and lack of sweating. If continued for a period of time, it can result in kidney failure, pulmonary edema, and liver damage. Heat stroke is a severe medical emergency.

5.2.4. If any of the symptoms listed above persist after normal re-hydration procedures, seek medical advice and/or support immediately.

6. Cold Stress (Hypothermia)

6.1. The single most important aspect of life-threatening hypothermia is a fall in the deep core temperature of the body. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F); lower body temperatures will likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

6.2. Warning Signs.

6.2.1. Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body temperature has fallen to 35°C (95°F). This should be taken as a sign of danger to the workers when severe shivering becomes evident. Unless there are unusual or extenuating circumstances, cold injury to other than hands, feet, and head is not likely to occur without the development of the initial signs of hypothermia.

6.3. Protection from hypothermia and frostbite.

6.3.1. Adequate insulation and dry clothing to maintain core temperatures above 36°C (96°F) must be provided to workers if work is performed in air temperatures below 4°C (40°F). Continuous skin exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C (-25°F). To prevent contact frostbite, the workers should wear anti-contact gloves. When cold surfaces below -7°C (19.4°F) are within reach, a warning should be given to each worker to prevent inadvertent contact by bare skin. If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items should be supplied in auxiliary heated versions. If work is performed continuously in the cold at an equivalent chill temperature (ECT) of below -7°C (19.4°F), heated warming shelters (tents, hanger, etc.) should be made available nearby. The worker should be encouraged to use the shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, minor frostbite (frostnip), the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to shelter.

6.3.2. Special caution should be exercised when working with toxic substances and when workers are exposed to vibration. Cold exposure may require reduced exposure limits. Workers handling evaporative liquid (gasoline, alcohol or cleaning fluids) at air temperatures below 4°C (39.2°F) should take special precautions to avoid soaking of clothing or gloves with liquids because of the added danger of cold injury due to evaporative cooling. For work practices at or below -12°C (10.4°F) ECT, the following should apply:

6.3.2.1. The worker should be under constant protective observation (buddy system or supervision).

6.3.2.2. The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods should be taken in heated shelters and the opportunity for changing into dry clothing should be provided.

6.3.2.3. New workers should not be required to work fulltime in the cold during the first days of duty, until they become accustomed to the working conditions and required protective clothing.

6.3.2.4. The work should be arranged in such a way that sitting still or standing for long periods is minimized.

7. Non-Freezing Cold Injury (NFCI)

7.1. Non-freezing cold injury is the result of prolonged (many hours) exposure of the lower extremities to temperatures above freezing but below 65⁰F. The feet are the most common area of injury, which is reflected in the common names of the two principal types of non-freezing injury: trench foot and immersion foot. Trench foot occurs during ground operations and is due to the combined effects of sustained cold exposure and restricted circulation. Immersion foot is caused by continuous immersion of the extremities in cold water.

7.2. Warning Signs.

7.2.1. The injured tissue is pale, anesthetic, pulseless, and immobile, but not frozen. Trench foot or immersion foot (depending on the environmental medium causing the injury) can be diagnosed when these signs **DO NOT CHANGE AFTER WARMING**. In addition, the skin is frequently macerated and slightly edematous. The degree of the injury is usually not completely apparent early.

7.3. Protection from NFCI

7.3.1. Like frostbite, the first essential of management is detection. Foot inspection and care every eight hours under cold-wet condition will prevent most cases and allow detection of early injury.

7.3.2. Dry boots and socks should not be replaced on the feet until the feet are warm and have normal feeling.

7.3.3. If NFCI is suspected seek medical advice and/or support immediately.

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Commander

Attachment 1

HEAT STRESS TABLES

Table A1.1. Heat Stress Prevention Recommended Work/Rest Cycles For Daily Operations (Normal Duty Uniform) Acclimatized Workers

Heat Category/ Flag Color	Temperature Range WBGT (°F)	Easy Work		Moderate Work		Hard Work	
		Work/Rest	Water Intake Qt/hr	Work/Rest	Water Intake Qt/hr	Work/Rest	Water Intake Qt/hr
1 (White)	78 – 81.9	No Limit	½	No Limit	¾	40/20 min	¾
2 (Green)	82 – 84.9	No Limit	½	50/10 min	¾	30/30 min	1
3 (Yellow)	85 – 87.9	No Limit	¾	40/20 min	¾	30/30 min	1
4 (Red)	88 – 89.9	No Limit	¾	30/30 min	¾	20/40 min	1
5 (Black)	> 90	No Limit	1	20/40 min	1	10/50 min	1
NOTES				EXAMPLE OF WORKLOAD CATEGORIES		CLOTHING ADJUSTMENTS	
<p>* Work/rest cycles recommendations are based on personnel who are fully acclimatized, optimally conditioned, hydrated and rested</p> <p>* Rest means minimal physical activity (sitting or standing) and should be accomplished in the shade if possible</p> <p>* Drink small amounts of water throughout the work period, not all at once</p> <p>* WBGT is NOT air temperature. WBGT (outdoors)={0.7 Natural Wet-Bulb+0.2 Globe Temp. + 0.1 Dry bulb</p> <p>* References: AFPAM 48-151</p>				<p>Light: Standing or sitting to control machines, performing light hand or arm work</p> <p>Moderate: Cleaning floor, hammering nails, moderate lifting</p> <p>Heavy: Digging ditches by hand, sandbags filling and moving</p>		<p>Cotton Coverall: Add 2°F to WBGT index</p> <p>MOPP gear (all levels and equivalent coverall Suits): Add 10°F to the WBGT index</p>	

Table A1.2. Use When in BDUs Plus IPE Gear or Any Level MOPP with IPE but NO BDUs

IPE ONLY *(w/BDUs) OR NO BDU OPTION (w/GCE)					
Heat Condition	White Below 82	Green 82 – 84	Yellow 85 – 87	Red 88 – 89	Black 90 or Above
Workload Category	Work/Rest Cycle for 1 Hour Intervals (Min/Min)				
Light	50/10	50/10	50/10	50/10	45/15
Moderate	50/10	50/10	45/15	30/30	20/40
Heavy	45/15	30/30	20/40	10/50	Mission Essential Only
Water Intake (Quarts/Hour)	½	½ - 1	1 – 1 ½	1 ½ - 2	> 2

*IPE includes flack vest and web gear only.

Table A1.3. Use When in MOPP Level 1 or 2 with IPE Gear and BDUs

MOPP LEVELS 1 & 2					
Heat Condition	White Below 82	Green 82 – 84	Yellow 85 – 87	Red 88 – 89	Black 90 or Above
Workload Category	Work/Rest Cycle for 1 Hour Intervals (Min/Min)				
Light	50/10	50/10	50/10	45/15	45/15
Moderate	50/10	45/15	30/30	20/40	10/50
Heavy	45/15	30/30	20/40	10/50	Mission Essential Only
Water Intake (Quarts/Hour)	½	½ - 1	1 – 1 ½	1 ½ - 2	> 2

Table A1.4. Use When in MOPP Level 3 or 4 with IPE Gear and BDUs

MOPP LEVELS 3 & 4					
Heat Condition	White Below 82	Green 82 – 84	Yellow 85 – 87	Red 88 – 89	Black 90 or Above
Workload Category	Work/Rest Cycle for 1 Hour Intervals (Min/Min)				
Light	50/10	50/10	45/15	45/15	30/30
Moderate	45/15	30/30	20/40	10/50	Mission Essential Only
Heavy	30/30	20/40	10/50	Mission Essential Only	Mission Essential Only
Water Intake (Quarts/Hour)	½	½ - 1	1 – 1 ½	1 ½ - 2	> 2

Attachment 2

WIND CHILL CHART

A2.1. The “wind chill” temperature is an estimate of the still air temperature that causes the same skin cooling as each of the particular combinations of wind and temperature listed. For example, air at -10°F blowing on the skin at 10 mph has about the same cooling effect as -33°F still air. The risk of freezing is based on the estimated cooling rate and stratified into three zones of ascending risk.

Table A2.1. Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)

		Actual Temperature Reading ($^{\circ}\text{F}$)										
Estimated Wind Speed (in mph)	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature ($^{\circ}\text{F}$)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-22	-37	-53	-69	-85	-100	-116	-132	-148
(Wind Speeds greater than 40 mph have little additional effect.)	LITTLE DANGER (If exposure < 5 hrs to dry skin. Greatest hazard from false sense of security)				INCREASING DANGER (Exposed skin may freeze within one minute)				GREAT DANGER (Exposed skin may freeze within 30 seconds.)			
	Trench foot and immersion foot may occur at any point on this chart.											

A2.2. The wind chill temperature provides roughly quantitative index of the risk of freezing injury to exposed skin. The estimates in this table are based on the effect of wind and cold on dry skin in healthy individuals with normal skin. Wet skin or restricted circulation will increase the susceptibility to freezing.

The table is adapted from the Wind Chill Chart at Appendix A of USARIEM Technical Note 92-2: Sustaining Health and Performance in the Cold.