BY ORDER OF THE COMMANDER
460TH AIR BASE WING

460TH AIR BASE WING INSTRUCTION 48-101

7 MAY 2003

Aerospace Medicine

BASE THERMAL (HEAT AND COLD) STRESS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

NOTICE: This publication is available digitally on the AFDPO WWW site at: **http://www.e-publishing.af.mil.**

OPR: 460 MDS/SGPB
(Capt. Shannon S. McDonald)

Certified by: 460 MDS/CC
(Lt Col Ronald H. Pearson)
Pages: 14
Distribution: F

This instruction implements Air Force Policy Directive (AFPD) 48-1, *Aerospace Medical Program,* to establish responsibilities and procedures to prevent the adverse effects of thermal (heat and cold) stress. This instruction applies to all personnel who are assigned to Buckley Air Force Base. This instruction does not apply to contractor personnel. During mission essential, contingency, or emergency operations, commanders may waive the provisions of this instruction; however, when commanders waive procedures they must ensure all supervisors exercise caution, make certain all subordinate personnel are aware of heat and cold injury symptoms, and take actions to protect the health of personnel. **Attachment 1** contains a glossary of references and supporting information. Maintain and dispose of records created as a result of prescribed processes in accordance with Air Force Manual (AFMAN) 37-139, *Records Disposition Schedule* (will convert to AFMAN 33-322, **Volume 4**). Comply with Air Force Instruction (AFI) 33-332, *Air Force Privacy Act Program*, for documents containing "Privacy Act Information." For "Official Use Only" information comply with Department of Defense Regulation (DoD) 5400.7-R/AFSUP, *DoD Freedom of Information Act Program*, **Chapter 4.**

1. Mandatory, Preferred, and Acceptable Requirements:

1.1. **May.** Indicates an acceptable or satisfactory method of accomplishment.

1.2. **Should.** Indicates a preferred method of accomplishment.

1.3. **Will.** Indicates a mandatory requirement and is also used to express a declaration of intent, probability, or determination.

2. Responsibilities:

2.1. **Host Base Commander will:**

2.1.1. Enforce base and tenant wide participation in this program to ensure the health and safety of all personnel on Buckley AFB.

2.2. **Bioenvironmental Engineering Section (BES) will:**

2.2.1. Measure and provide the heat stress potential throughout the summer months. BES may use the Wet Bulb Globe Temperature (WBGT) meter to measure the heat stress potential.

2.2.2. Obtain temperatures and wind speeds to calculate the cold stress potential throughout the winter months.

2.2.3. Ensure thermal stress readings and guidance are available 24 hours a day during the duty week, and in support of weekend operations/exercises at the request of unit commanders.

2.2.4. Identify all work centers having a medium or high risk for thermal stress. BES will, through routine workplace surveillance, categorize the thermal stress potential for each work center as low, medium or high based on each work center's processes. BES will ensure the medium and high-risk work centers receive routine training and have adequate thermal stress safety procedures.

2.2.5. Investigate all thermal stress illnesses documented on AF Form 190, **Occupational Illness/ Injury Report**.

2.2.6. Where applicable, assist geographically separated units (GSUs) in developing a thermal stress program.

2.3. **Public Health will:**

2.3.1. Provide thermal stress education and training to all work centers having a medium or high risk to thermal stress.

2.3.2. Track all thermal stress illnesses and determine the need for an AF Form 190.

2.4. **Work Center Supervisors will:**

2.4.1. Routinely retrieve the thermal stress index, and implement thermal stress safety procedures accordingly. Procedures on how to retrieve the thermal stress index are identified in paragraph **5.**. Work center supervisors may have to adjust the work rest cycles for operations that require heavy personal protective equipment.

2.4.2. Ensure employees working outside in hot environments increase their fluid intake, and implement appropriate work-rest cycles. (Reference the Work/Rest Cycle in **Attachment 2**.)

2.4.3. Ensure employees working outside in cold environments are properly clothed, and implement appropriate breaks from the cold environment. (Reference the Wind Chill Chart in **Attachment 3** and the Work/Warming Cycle in **Attachment 4**.)

2.4.4. Ensure all employees are trained to recognize thermal stress disorders and first aid treatment, reference **Attachment 5**.

2.4.5. Ensure employees are acclimatized in accordance with paragraph **6.**.

2.4.6. Report all thermal stress illnesses to Public Health.

2.5. **Work Center Employees will:**

2.5.1. Understand the signs and symptoms of thermal stress, and the first aid treatments.

2.5.2. Report all thermal stress illnesses to the work center supervisor.

3. Monitoring Heat Stress:

3.1. BES will monitor heat stress index routinely during the summer months. The summer monitoring period will begin around Memorial Day and end around Labor Day. (The summer monitoring period may be increased or decreased based on seasonal variations.)

3.1.1. When the predicted or forecasted outside temperatures reach 85°F as a daily high, BES will perform heat stress monitoring at least four times during the hottest part of the day. Examples of monitoring schedules might be 1000hrs, 1200hrs, 1400hrs and 1600hrs, or 0900hrs, 1100hrs, 1300hrs and 1500hrs.

3.1.2. When the heat stress index reaches 85°F, BES will initiate heat stress monitoring hourly during normal duty hours, beginning at 0900hrs.

3.1.3. The heat stress index is a tool to provide guidance to workplace supervisors in order to reduce heat stress injuries. The heat stress index should not be used directly for operations requiring heavy personal protective equipment or hot indoor operations. BES will perform baseline heat stress evaluations to establish the normal, expected, and average heat stress for indoor environments where personnel are occupationally exposed to hot environments. The baseline data will be validated on annual surveys. Examples of such environments are steam pits and tunnels, confined spaces heated by radiant exposure to the sun, and boiler rooms and plants.

4. Monitoring Cold Stress:

4.1. BES will monitor the cold stress routinely during the winter months. The winter monitoring period will typically begin around Thanksgiving and end around the first of March. (The winter monitoring period may be increased or decreased based on seasonal variations.)

4.1.1. When predicted or forecasted temperatures fall to 20°F, BES will gather temperature and wind speed data at least five times per day from Weather and calculate the cold stress index (equivalent chill temperature). Examples of monitoring schedules might be 0700hrs, 0900hrs, 1100hrs, 1300hrs and 1500hrs, or 0600hrs, 0800hrs, 1000hrs, 1200hrs and 1400hrs. (The monitoring schedules may be lengthened based on changing or developing weather systems.)

4.1.2. When actual temperatures reach 10°F, BES will calculate the cold stress index hourly during the normal duty day, beginning at 0600hrs.

5. Retrieving Thermal Stress Data:

5.1. BES will post the thermal stress index on a telephone message billboard at extension 7-6391 (on base), or at (303) 677-6391 (commercial). The message will be updated routinely in accordance with the monitoring schedules outlined in paragraphs **4.** and **5.**.

5.2. The workplace supervisors must use the thermal stress index to identify the appropriate work rest cycles in accordance with the tables in **Attachment 2** for heat stress or **Attachment 3** for cold stress. (Heavy personal protective equipment will increase the heat stress on personnel, therefore the work rest cycles must be adjusted to compensate.)

6. Acclimatization:

6.1. Acclimatization is a series of physiological adjustments, which occur when an individual is exposed to a hot climate. A period of acclimatization is required for all personnel regardless of each

individual's physical condition. The better the individual's physical condition, the quicker acclimatization is reached. Acclimatization is achieved through progressive degrees of heat exposure and physical exertion. Acclimatization to heat begins with the first exposure and is usually developed to about 50 percent by the end of the first week. Substantial acclimatization (about 78 percent) should occur by the end of the second week. Full acclimatization is attained quickest by gradually increasing periods of work in the heat.

6.2. For personnel needing acclimatization (see paragraph **6.3.**), supervisors should adjust work schedules. The most strenuous tasks should be performed early in the morning or late in the evening with lighter duty tasks performed during the remainder of the duty day. As personnel become acclimatized, work schedules can be shifted back to normal routines. When unacclimated personnel are exposed to heat, they may experience some discomfort and signs of heat strain, such as high body temperature, increased heart rate and fatigue on the first day. On each succeeding day, personnel's ability to perform at the same level of heat stress improves as signs of discomfort and strain diminish. During the 2 weeks it takes to acclimatize, personnel should be especially aware of the signs and symptoms of heat stress disorders and drink plenty of water. When discomfort and heat stress symptoms occur, personnel should self-pace their activities to perform below maximum physical capacity by adjusting their work speed and interspersing brief, unscheduled and in-place breaks. After a period of 1 to 2 weeks, personnel should be able to perform all tasks without difficulty.

6.3. **The following applies to personnel who need acclimatization:**

6.3.1. Individuals who are routinely and occupationally exposed to strenuous duties or heavy work need acclimatization each year. This may occur during regular duty or work as outside temperatures increase during the spring and summer.

6.3.2. Newly assigned personnel arriving from cooler climates should follow the acclimatization guidelines given above.

6.3.3. Personnel returning to work after 4 days of illness should undergo a 4-day reacclimatization.

6.3.4. Personnel returning to work after 9 or more days away from work should undergo a 4-day reacclimatization.

7. Guidelines for Personnel Wearing the Ground Crew Chemical Defense Ensemble:

7.1. Personnel performing ground crew operations and training while wearing the charcoal-impregnated over-garment and associated protective equipment of the chemical defense ensemble are at increased risk of injury from heat stress. Maximum work times tolerated by personnel while they are wearing the protective ensemble are affected by factors such as an individuals physical condition, state of thermal acclimatization and degree of hydration; the work load associated with a given task; and environmental factors, including air velocity, radiant heat (sunlight), air temperature and humidity. WBGT criteria incorporate many of these variables. While WBGT criteria are useful to experienced medical personnel as an aid in advising commanders concerning the impact of the ensemble under actual operating conditions, they are not readily usable by line supervisors when conducting small unit training exercises.

7.2. Measures to minimize heat casualties in personnel while they are accomplishing their mission are in AFMAN 32-4005, *Personnel Protection and Attack Actions*. Estimates of increases in task performance times, maximum and safe work times and recovery rest times while personnel are wearing

Mission-Oriented Protective Postures (MOPP) equipment are in AFMAN 32-4005. Commanders and supervisors should use this information when planning and conducting exercises to avoid heat injuries in their personnel. Commanders can contact the Bioenvironmental Engineering Section for additional guidance during these operations or exercises.

JAMES A. SANDS, Colonel, USAF
Commander

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFMAN 32-4005, *Personnel Protection and Attack Actions*

AETCI 48-101, *Prevention of Heat Stress Disorders*

American Conference of Governmental Industrial Hygienists

Abbreviations and Acronyms

BES—Bioenvironmental Engineering Services

GSU—Geographically Separated Units. Units not located on Buckley AFB that are the responsibility of Bioenvironmental Engineering

MOPP—Mission Oriented Protective Posture

WBGT—Wet Bulb Globe Temperature. The WBGT is an instrument used to measure heat stress index

Terms

Acclimatization—A series of physiological adjustments, which occur when an individual is exposed to a hot or cold climate. In simple terms, this is considered a break-in period to help personnel slowly adjust to hot and cold environments.

Heat Stress—The net heat load to which a worker may be exposed from the combined contributions of metabolic cost of work, environmental factors (air temperature, humidity, air movement, etc.) and clothing. In simple terms, heat stress is the body burden from the three categories above.

Thermal Stress—The common term used to cover both heat and cold stress.

Work/Rest Cycle—A guidance schedule for personnel to ensure adequate rest breaks are taken to avoid heat stress disorders.

Work/Warming Cycle—A guidance schedule for personnel to ensure adequate warming breaks are taken to avoid cold stress disorders.

Attachment 2

WORK AND REST CYCLES FOR OCCUPATIONAL HEAT EXPOSURES

A2.1. Permissible Heat Exposure Limits. The permissible heat exposure limits are extracted from the American Conference of Governmental Industrial Hygienists Threshold Limit Value booklet. The limits in the table below are based on the following assumptions.

A2.1.1. Personnel are assumed to be acclimated, fully clothed, with average water and salt intake.

A2.1.2. Personnel can take breaks to prevent becoming overheated.

A2.1.3. Exposure limits are based on personnel working in normal work clothing.

Table A2.1. Work Rest Cycle Table (Values given in oF WBGT).

Work/Rest Regimen (per hour)	**LIGHT**	**MODERATE**	**HEAVY**	**VERY HEAVY**
Continuous Work	**< 86.9**	**< 83.2**	**< 81.4**	
75% Work/25% Rest	**87 – 88.6**	**83.3 – 85**	**81.5 – 83.2**	**<81.5**
50% Work/50% Rest	**88.7 – 90.5**	**85.1 – 87.7**	**83.3 – 85.9**	**81.5 – 85**
25% Work/75% Rest	**> 90.6**	**> 87.8**	**>86**	**>85.1**

A2.1.3.1. Continuous Work = No work restrictions.

A2.1.3.2. 25% rest = 15 minute rest each hour.

A2.1.3.3. 50% rest = 30 minute rest each hour.

A2.1.3.4. 75% rest = 45 minute rest each hour.

Table A2.2. Work Level Examples.

Light	Sitting with moderate arm and leg movement
	Standing with light work at machine or bench while using mostly arms
	Using a table saw
	Standing with light or moderate work at machine or bench and some walking about
Moderate	Walking about with moderate lifting or pushing
	Scrubbing in a standing position
	Walking on level at 6 Km/hr while carrying 3 Kg weight load
Heavy	Shoveling dry sand
	Carpenter sawing by hand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (pick and shovel work)
Very Heavy	Shoveling wet sand

A2.2. Personal Protective Equipment Adjustment: Personnel required to wear heavy personal protective equipment (white tyvek suits, respiratory protection, etc.) during normal work center processes have an increase potential for heat stress. Supervisors of personnel who require heavy personal protective equipment should contact BES to identify the appropriate correction factors for **Table A2.1.**.

A2.3. Prevention of Heat Stress Disorders: (The following subjects discuss actions to help prevent heat stress disorders.)

A2.3.1. **Education.** Personnel working and (or) training in hot environments must be educated on the causes, symptoms, first-aid treatment and prevention of heat disorders. Personnel must also be educated on the following factors, which may contribute to heat injury:

A2.3.2. **Water.** Drink large quantities of cool water to make up for water lost through sweating. It is better to drink small amounts of water frequently (a pint every 20 minutes) to replace water than to drink large amounts less frequently. Milk and coffee do not make up for water loss. Carbonated beverages, while containing water, are not as effective as water in keeping the body hydrated because of the tendency to delay gastric emptying.

A2.3.3. **Salt.** Some salt is lost in the sweat. Because the typical North American diet contains so much salt, an individual should season food to taste, but should not make any additional attempts to add excessive salt to the diet. Salt tablets must not be used except under special operating environments when ordered by competent medical authority.

A2.3.4. **Clothing.** Wear loose fitting clothing, especially at the neck and wrist, to allow air circulation. Wear appropriate headgear. When exposed to the Sun’s rays, cover yourself and apply a sun-blocking lotion to prevent sunburn. When not exposed to the sun, consideration should be given to wearing the least allowable amount of clothing.

A2.3.5. **Acclimatization.** Personnel must be acclimated to heat exposures. See paragraph **6.**.

A2.3.6. **Work Schedules.** Modify work schedules to perform the heaviest work in the coolest parts of the day. When working in hot environments, establish work and rest cycles as outlined in **Table A2.1.** Take rest breaks in cool, shaded areas.

A2.3.7. **Food.** Avoid eating greasy, fatty or heavy foods.

Attachment 3

WIND CHILL CHART

Table A3.1. Cold Stress Index (Equivalent Chill Temperature).

WIND SPEED (IN MPH)	ACTUAL TEMPERATURE (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT CHILL TEMPERATURE											
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	3	-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	-124
25	30	15	0	-15	-29	-44	-59	-74	-89	-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	-101	-117	-132	-148
(WIND SPEEDS GREATER THAN 40 MPH HAVE LITTLE ADDITIONAL EFFECT)	LITTLE DANGER (In less than 5 hrs with dry skin. Greatest hazard from false sense of security.)				INCREASING DANGER (Exposed flesh may freeze within 1 minute.)			GREAT DANGER (Exposed flesh may freeze within 30 seconds.)				

NOTE: To determine the wind-chill temperature, enter the chart at the row corresponding to the wind speed and read right until reaching the column corresponding to the actual air temperature.

Attachment 4

WORK/WARMING CYCLE CHART FOR OCCUPATIONAL COLD EXPOSURES

A4.1. Cold stress guidance is intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury, and to describe exposures to cold working conditions under which it is believed nearly all workers can be repeatedly exposed without adverse health effects. The guidance standard objective is to prevent the deep body temperature from falling below 96.8ºF and to prevent cold injury to body extremities.

A4.2. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 96.8 ºF; lower body temperatures will very likely result in reduced mental alertness, reduction in rational decision-making or loss of consciousness with the threat of fatal consequences.

A4.3. Pain in the extremities may be the first early warning sign of danger to cold stress.

A4.4. During exposure to cold, sever shivering develops when the body temperature falls to 95 ºF. This must be taken as a sign of danger to workers and exposure to cold should be immediately terminated for any workers when severe shivering becomes evident.

A4.5. Reference the Work Warming Regimen **Table A4.1.**. below. When entering the warm environment, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change or a change of dry work clothes provided. The onset of heavy shivering, minor frost bite (frost nip), the feeling of excessive fatigue, drowsiness, irritability or euphoria are indications for immediate return to a warm environment.

Table A4.1. TLVs Work/Warm-up Schedule for Four-Hour Shift.

Air Temp	No Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
ºF (approx.) Sunny Sky	Max Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks
-15º to -19º	Normal	1	Normal	1	75 min	2	55 min	3	40 min	4
-20º to -24º	Normal	1	75 min	2	55 min	3	40 min	4	30 min	5
-25º to -29º	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency	
-30º to -34º	55 min	3	40 min	4	30 min	5	Non-emergency		work should cease	
-35º to -39º	40 min	4	30 min	5	Non-emergency		work should cease			
-40º to -44º	30 min	5	Non-emergency		work should cease					
-45º & below	Non-emergency		work should cease							
	work should cease									

NOTE: Schedules apply to 4-hour work periods with moderate to heavy work activities, with warm-up periods of ten (10) minutes in a warm location and with an extended break (i.e. lunch) at the end of the 4-hour work period.)

A4.6. If fine work is to be performed with bare hands for more than 10-20 minutes in an environment below 60.8 ^{o}F, special provisions should be established for keeping the workers' hands warm.

A4.7. To prevent contact frostbite:

A4.7.1. When cold surfaces below 19.4 ^{o}F are within reach, a warning should be given to each worker to prevent inadvertent contact by bare skin.

A4.7.2. If air temperature is 19.4 ^{o}F or less, hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing mittens.

A4.8. Provisions for additional total body temperature in an environment at or below 39.2 ^{o}F. The workers should wear cold protective clothing appropriate for the level of cold and physical activity.

A4.8.1. If the air velocity at the job site is increased by wind, draft or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removed windbreak garment.

A4.8.2. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer should be water repellent, and the outwear should be changed as it becomes wetted. The outer garments should include provisions for easy ventilation in order to prevent wetting of inner layers by sweating.

A4.8.3. Workers handling evaporative liquids (gasoline, alcohol or cleaning fluids) at air temperatures below 39 ^{o}F should take special precautions to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

Attachment 5

COMMON THERMAL STRESS DISORDERS

Table A5.1. Heat Stress Disorders.

Injury	Symptoms	First Aid
Heat Syncope	Fainting when standing erect and immobile in the heat.	Remove to cool area. Allow to recline and provide cool water. Recovery will be prompt and complete.
Heat Cramps	Active sweating, muscle cramps. Spasms, usually in the muscles or arms.	Remove to cool area. Massage extremities. Contact medical facility.
Heat Exhaustion	Profuse sweating, or moist, cool skin. Cramps in abdomen or limbs. Pale face. Dizziness, faintness, weakness, nausea or vomiting. Weak pulse. Normal body temperature.	Treat for shock. Lay person down in cool area and elevate feet. Loosen clothing and cool body by sprinkling with cool water or fanning (not to the point of shivering). Give cool water to drink with conscious. Contact medical facility.
Heat stroke - MEDICAL EMERGENCY	Headache, dizziness, red face/ skin. Hot, dry skin (no sweating), and strong, rapid pulse. High body temperature.	**THIS IS A MEDICAL EMERGENCY. Call 911.** Treat for shock. Lay person down in cool area. Loosen clothing and cool body by sprinkling with cool water or fanning (not to the point of shivering). Give cool water to drink with conscious – add two teaspoons of salt to one canteen if available.

Table A5.2. Cold Stress Disorders.

Injury	Symptoms	First Aid
Chilblain – nonfreezing cold injury. (little or no permanent impairment)	It appears as red, swollen skin, which is tender, hot to the touch, and may itch. This can worsen to an aching, prickly ("pins and needles") sensation, and then numbness.	Move to warm place. Remove wet, constrictive clothing. Wash and dry injured area. Elevate injured area, cover with layers of loose, warm clothing and allow to rewarm (pain and blisters may develop).
Trenchfoot - very serious nonfreezing cold injury, which develops when skin of the feet is exposed to moisture and cold for prolonged periods (12 hours or longer).	The first sign is itching, numbness or tingling pain. Later the feet may appear swollen, and the skin mildly red, blue or black. Red or bluish blotches appear on the skin, sometimes with open weeping or bleeding.	DO NOT pop blisters, apply lotions or creams, massage, expose to heat, or allow personnel to walk on injury.
Frostbite. When freezing extends deeper through the skin and flesh, the injury is frostbite.	Skin will become numb and turn to a gray or waxy-white color. The area will be cold to the touch and may feel stiff or hard.	Move to warm place. Rewarm affected area in warm water (104o-108oF) for 15-30 minutes. (NOT HOT WATER) Cover with several layers of clothing. DO NOT rub affected area. Seek medical attention immediately.
Hypothermia MEDICAL EMERGENCY Untreated, results in death.	**May be difficult to recognize in early stages**. Things to watch for include unusually withdrawn or bizarre behavior, irritability, confusion, slowed or slurred speech, altered vision, uncoordinated movements and unconsciousness. Body is cold under clothing. Even mild hypothermia can cause victims to make poor decisions or act drunk (e.g., removing clothing when it is clearly inappropriate).	**THIS IS A MEDICAL EMERGENCY. Call 911.** Move to warm place. Remove wet clothing. Put on warm clothes or wrap with dry blanket. DO NOT rub body parts. DO NOT give or consume alcohol.