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Aerospace Medicine

THERMAL INJURY PREVENTION PROGRAM

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This Air Force Instruction (AFI) implements Air Force Policy Document (AFPD) 48-1, *Aerospace Medicine Enterprise*, and provides supporting guidance for establishing and implementing an effective local Thermal Injury Prevention Program (TIPP) to commanders, supervisors, medical personnel, and individuals at every level. This AFI covers thermal stress education, environmental monitoring, guidance charts, and signs and symptoms of thermal injury. Refer to AFI 33-360, *Publications and Forms Management*, for instructions on processing supplements and variances. Ensure that all records created as a result of processes prescribed in this publication are maintained IAW Air Force Manual (AFMAN) 33-363, Management of Records, and disposed of IAW the Air Force Records Disposition Schedule (RDS) in the Air Force Records Information Management System (AFRIMS). Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*; route AF Forms 847 from the field through channels, to AFMSA/SG3PB, 7700 Arlington Blvd, Falls Church, VA 22042. This publication applies to all Air Force (AF) active duty personnel, civilian employees, Air Force Reserve Command (AFRC) Units and the Air National Guard (ANG). Submit waiver requests through the chain of command to the appropriate Tier waiver approval authority. The authorities to waive Wing/unit level requirements in this publication are identified with a Tier ("T-0, T-1, T-2, T-3") number following the compliance statement, IAW AFI 33-360. This publication may be supplemented at any level, but all direct supplements must be routed to the OPR of this publication for coordination prior to certification and approval. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement of the Air Force.

SUMMARY OF CHANGES

This AFI has been significantly revised incorporating major changes, to include conversion from a non-directive AFPAM to an AFI, creation of Air Force TIPPs, new roles and responsibilities, and Tiering requirements. This AFI expands applicability to deployed operations.

Chapter 1

PROGRAM OVERVIEW

1.1. Overview. Air Force Policy Directive (AFPD) 48-1, Aerospace Medicine Enterprise (AME), emphasizes the need to "optimiz[e] the safety and health of AF personnel in the performance of their duties in any circumstance or location." Moreover, it directs that the Air Force Medical Service will focus on identifying and reducing the risk of injury and illness through appropriate surveillance, prevention and control programs. This AFI supports AFPD 48-1 by providing commanders, supervisors, individuals, and medical personnel with guidance on how to collectively implement an effective TIPP in order to prevent and manage heat and cold injuries and illnesses among Air Force personnel. Failure to prevent and manage heat and cold injuries and illnesses can have disastrous impact on mission capability through degraded human performance and potentially result in the prolonged or permanent incapacitation or death of Airmen and civilian workers.

1.2. Purpose. Thermal stress is a physical hazard to personnel, and as such, falls under the Occupational and Environmental Health (OEH) Program regulated under AFI 48-145, Occupational and Environmental Health Program. AFI 48-145 states "the role of Aerospace Medicine relative to human occupational and environmental health focuses on health risk assessment and associated health monitoring, sampling, and surveillance of actual and potential physical, chemical, biological, and radiological hazards, man-made and naturally occurring, in the workplace and community environment." This AFI is an aid to planning, supporting, and safely executing industrial operations, mission directed operations, field exercises and training, community events, and other installation functions affected by heat or cold stress. This AFI also provides guidance for the prevention of thermal illness and injury. It is beyond the scope of this publication to provide comprehensive guidance for the emergency treatment and aftercare of heat illness and cold injury.

1.3. Focus. The focus of this AFI and the local TIPP is risk assessment and communication, employee education and community awareness.

Chapter 2

ROLES AND RESPONSIBILITIES

2.1. Assistant Secretary of the Air Force for Installations, Environment and Energy (SAF/IE).

2.1.1. Provides oversight of all matters pertaining to the formulation, review and execution of plans, policies, programs and budgets relative to the Air Force TIPP.

2.1.2. Delegates AF TIPP responsibilities to the Deputy Assistant Secretary of the Air Force for Environment, Safety and Infrastructure.

2.2. Deputy Assistant Secretary of the Air Force for Environment, Safety, and Infrastructure (SAF/IEE).

2.2.1. As delegated by the SAF/IE, provides policy, guidance, direction and oversight of all matters pertaining to the formulation, review and execution of plans, policies, programs and budgets relative to the AF TIPP. Oversees implementation of the program.

2.2.2. Conducts periodic program management reviews (PMRs) of the progress of the AF TIPP.

2.3. Air Force Surgeon General (AF/SG).

2.3.1. Provides strategic direction and develops policy to execute the AF TIPP.

2.3.2. Advocates for health risk assessment, surveillance and control requirements associated with AF TIPP through the medical and Line of the Air Force (LAF) Planning, Programming, Budgeting and Execution (PPBE) System.

2.3.3. Reports the status of the AF TIPP annually and on an as-requested basis to SAF/IE through a formal PMR.

2.4. Air Force Medical Support Agency, Aerospace Medicine Policy and Operations Division (AFMSA/SG3P).

2.4.1. Assists AF/SG with developing policy to execute the AF TIPP.

2.4.2. Plans, programs, and budgets for resources and provides oversight for execution of the AF TIPP through the Aerospace Operations (AO) Panel. Supports AF TIPP initiatives by validating requirements and technical needs.

2.4.3. Develops and monitors AF-level performance measures (metrics) to assess AF TIPP effectiveness. Identifies metrics requiring Defense Occupational and Environmental Health Readiness System – Industrial Hygiene (DOEHRS-IH) data quality report development to USAF School of Aerospace Medicine (USAFSAM) to meet metrics reporting requirements.

2.4.4. Reviews thermal injury risk reduction opportunities and makes recommendations to assist LAF in executing effective resource prioritization.

2.4.5. Identifies and prioritizes DOEHRS-IH technical and management issues related to thermal injury to OSD for modification or other appropriate actions.

2.4.6. Establishes Bioenvironmental Engineering (BE) equipment standardization process and ensures consistent utilization in connection with thermal injury prevention.

2.5. USAFSAM Occupational and Environmental Health (USAFSAM/OE).

2.5.1. Provides specialized, technical consultation (including detailed information about models, climate data, and injury mechanisms) to assist in assessing and managing installation TIPPs. (T-1)

2.5.2. Identifies thermal injury risk reduction opportunities with AF-wide significance and evaluates costs/benefits. (T-1)

2.5.3. Analyzes AF-wide, MAJCOM and installation thermal injury data (garrison and deployed locations) to identify significant trends, answer questions/requests and provide annual summary analyses (exposure and outcome based) to the AF/SG, Combatant Command Air Component, MAJCOM and MTF staff. (T-1)

2.5.4. Develops DOEHRS-IH data quality reports identified by AFMSA to meet metrics reporting requirements. (T-1)

2.5.5. Recommends AF-level TIPP metrics to AFMSA/SG3PB. (T-1)

2.6. Major Command Surgeon (MAJCOM/SG).

2.6.1. As needed, establishes AF TIPP medical support priorities and supplements to this AFI to execute MAJCOM mission requirements.

2.6.2. Assists in the PPBE process by identifying and advocating for any AF TIPP requirements.

2.6.3. Supports thermal injury hazard identification, control, mitigation, or elimination considerations in the Air Force operational capability requirements development process.

2.6.4. Ensures AF TIPP management performance monitoring across all bases within their command through the MAJCOM and installation ESOH Councils.

2.6.5. Disseminates information pertaining to policy and new or pending legislation within MAJCOM.

2.6.6. Coordinates with AFMSA/SG3P to identify and resolve AF TIPP programmatic issues.

2.7. Installation Commander.

2.7.1. Provides a safe and healthful workplace and community environment for all Air Force military and civilian personnel IAW DoD ESOH requirements and the AF ESOH Vision and Priorities as established in AFPD 90-8. (T-0)

2.7.2. Implements and directs execution of the installation TIPP through the installation ESOH Council (IAW AFI 90-801) (T-1)

2.7.3. Appoints the installation Bioenvironmental Engineer (or local equivalent) as the TIPP manager. (T-3)

2.7.4. Ensures required TIPP hazard controls are implemented and functioning correctly. (T-0)

2.7.5. Ensures mechanisms for dissemination of thermal risk levels (flag codes) to assigned personnel. (T-3) This can include postings to organizational web sites, use of the commander's access channel, colored flags, signage, or other channels tailored to the installation and mission.

2.7.6. Recognizes the impact of thermal stressors and acclimatization on operations, exercises, training events, ceremonies, and other installation functions, and makes appropriate adjustments and accommodations (T-3), to include:

2.7.6.1. Adjustment of work/rest cycles.

2.7.6.2. Provision of replacement fluids and electrolytes.

2.7.6.3. Provision of suitable clothing, gear, supplies, and equipment; and modifications as required to reduce risk in light of operational requirements.

2.8. Installation Environment, Safety and Occupational Health Council (ESOHC). Provides senior leadership input and direction and senior management review of the installation TIPP IAW the requirements of AFI 90-801 and this AFI. (T-1)

2.9. Military Treatment Facility Commander (MTF/CC) or local equivalent.

2.9.1. Provides TIPP support to the Wing (or local equivalent) and supported units. (T-0)

2.9.2. Directs the installation TIPP and ensures it is supported with adequate resources and staffing to implement the responsibilities outlined in this AFI. (T-0)

2.9.3. Is responsible for the TIPP at supported GSUs or MUNSS sites and ensures appropriate support is provided. (T-1)

2.9.4. Ensures that timely care is provided for thermal-related injuries and illnesses. (T-3)

2.9.5. Ensures all medical staff who examine patients are aware of illnesses and injuries that may have a correlation to thermal injury. (T-2)

2.9.6. At co-located installations (i.e., host Active Duty installation with tenant AF Reserve units), TIPP responsibilities are a joint responsibility between the Active Duty MTF Commander and the Commander of the ground RMU with Unit Type Code (UTC) supporting Aerospace Medicine Functions. (T-0)

2.9.7. At non-co-located ARC installations (i.e., no active duty host installation), TIPP responsibilities are conferred to the full-time Bioenvironmental Engineering/Public Health Office under the Mission Support Group (MSG). A Memorandum of Agreement between the RMU and MSG will describe TIPP responsibilities delivered by the Bioenvironmental Engineering/Public Health Office. On behalf of the installation commander, the RMU Commander is responsible for assuring a comprehensive TIPP is available for Traditional Reserve members to include program elements accomplished by the MSG. (T-0).

2.10. Chief of Aerospace Medicine (SGP) (or local equivalent).

2.10.1. Leads Aerospace Medicine execution of TIPP responsibilities. (T-1)

2.10.2. Provides administrative and technical oversight of the TIPP at supported GSUs and MUNSS sites. (T-1)

2.10.3. Ensures the Occupational and Environmental Health Working Group (OEHWG) addresses TIPP under the direction of the Aerospace Medicine Council. (T-1)

2.10.3.1. The installation TIPP will be reviewed and briefed periodically along with other OEH programs. (T-1)

2.10.3.2. The OEHWG will support the TIPP, including ensuring leadership awareness of issues, investigating injuries, and disseminating information. (T-3)

2.10.4. Trains MTF medical providers on potential thermal injuries/illnesses based on health risks associated with the installation and corresponding International Classification of Disease (ICD) codes. (T-1)

2.10.5. Ensures that cases of thermal injury are communicated to Bioenvironmental Engineering for entry into the DOEHRS Incident Reporting Module. (T-3)

2.11. Weather Flight Commander (or local equivalent).

2.11.1. Supports the TIPP with current weather data and information in accordance with local procedures. At locations without an assigned weather flight, contact the supporting Operational Weather Squadron (OWS) to obtain required weather information. See Air Force Visual Aid 15-137, Operational Weather Squadron Areas of Responsibility, to locate the supporting OWS. (T-3)

2.11.2. Assists the TIPP with obtaining and interpreting historical weather data and information, to include the local installation, future deployed locations, and other operational needs. (T-2)

2.12. Bioenvironmental Engineering (BE) Flight Commander (or local equivalent).

2.12.1. Manages the installation TIPP, subject to appointment by the wing or installation commander per this AFI. (T-3)

2.12.2. Assists commanders and supervisors with integrating thermal injury prevention information into Risk management-based decision processes. (T-1)

2.12.3. Ensures thermal injury risk assessments are accomplished in accordance with AFI 48-145 and AFMAN 48-146. (T-0)

2.12.3.1. Reviews new processes or operations (garrison or deployed) to prevent or control potential thermal injury hazards at the earliest feasible stage. (T-1) Consult with the Weather Flight (or supporting OWS if no weather flight exists) to review historical climate information as well as predictive analyses. (T-3)

2.12.3.2. Investigates proposed changes to existing processes or operations, including equipment and facilities (including but not limited to construction plan reviews, the AF Form 332, *Base Civil Engineer Work Request*, or other base-specific process) for potential thermal injury hazards to AF personnel. (T-1)

2.12.3.3. When a very detailed assessment of the risk of thermal injury is required, conduct an assessment based on the American Council of Government Industrial Hygiene Threshold Limit Values for Physical Agents in the Work Environments processes for Cold Stress and Heat Stress and Strain. (T-3)

2.12.3.4. Recommends, evaluates and determines adequacy of thermal injury hazard controls to include engineering and/or administrative controls and the appropriate use of Personal Protective Equipment (PPE) when other options fail to mitigate the hazard. (T-0)

2.12.3.5. Reviews site health and safety plans for thermal injury risks. (T-0)

2.12.3.6. Effectively communicates thermal injury risks and recommended controls and/or corrective actions to organizational leadership, affected individual(s) and members of a related Similar Exposure Group (SEG). (T-1)

2.12.3.7. Ensures that reported thermal injuries are documented in the DOEHRS Incident Reporting Module. (T-1)

2.12.3.8. When supporting a site with no BE officer assigned, provides technical oversight for all thermal injury risk assessments at the GSUs or MUNSS sites. The level of involvement may range from simple oversight to performing the OEH assessments based on the technical expertise of the available personnel and the host-nation agreements for OCONUS locations. (T-2)

2.12.3.9. Once initiated by Public Health (PH), completes the workplace evaluation page of the occupational illness investigation page in AFSAS.

2.12.4. Completes deployment site-specific OEH exposure documentation in DOEHRS. (T-1)

2.12.5. Provides consultation and technical expertise to workplaces on potential thermal injury hazards, training and regulatory requirements when applicable. (T-1)

2.12.6. As a member of the OEHWG, provides consultation on thermal injury exposures to the OEHWG. (T-1)

2.12.7. Conducts environmental monitoring (heat and cold injury risk assessment) as described in section 3.2 of this instruction. At installations with clear "bubble" canopy aircraft (e.g. fighters and trainers), assesses the Fighter Index of Thermal Stress (FITS) as described in Attachment 3 of this instruction. (T-3)

2.13. Public Health Flight Commander (or local equivalent).

2.13.1. Ensure thermal injuries and illnesses classified as Reportable Medical Events (RMEs) are entered into the Air Force Disease Reporting System Internet (AFDRSi) IAW AFI 48-105, *Surveillance, Prevention, and Control of Disease and Conditions of Public Health or Military Significance*. (T-0)

2.13.2. Ensures thermal injuries and illnesses reported to PH are investigated, initiated in Air Force Safety Automated System (AFSAS) and closed within 30 days IAW requirements in AFI 91-204, Safety Investigations and Reports (T-0).

2.13.3. After the provider makes the final determination on the illness report, and prior to closing an investigation, PH will review each illness record to ensure internal (within individual report) and external (compared with other similar illness reports) consistency and that all supporting data have been captured and documented. (T-1)

2.14. Geographically Separated Unit (GSU) Commander or Delegate (Medical Aid Station).

2.14.1. Ensures that Medical Aid Station staff provides TIPP support as defined in this AFI to the extent possible within the scope of training, manpower and equipment available. (T-3)

2.14.2. Coordinates with the supporting MTF/SGP for OEH Program support as needed to fulfill the requirements of this AFI. (T-3)

2.15. Aerospace and Operational Physiology.

2.15.1. Provides aircrew members training on thermal risk and prevention IAW AFI 11-403. (T-3)

2.15.2. When requested, and in conjunction with BE and PH, provides training to supervisors and affected individuals regarding prevention strategies and performance effects of temperature extremes. (T-3)

2.16. Base Civil Engineer (BCE). Establishes and maintains processes to ensure design and construction lead personnel involve BE in all design review stages (conceptual, intermediate and final), pre- construction meetings, pre-final and final inspections to identify and address potential thermal injury concerns related to new construction and facility modification projects. (T-1)

2.17. Unit/Organizational Commander.

2.17.1. Provides workers a safe and healthy work environment that complies with all OEH program requirements, including thermal injury prevention. (T-0)

2.17.2. Incorporates weather conditions, PPE/clothing, and anticipated workload into planning for new operations, changes to existing processes or operations, equipment and facilities in coordination with BE. (T-1)

2.17.3. Supports installation and organizational level TIPP objectives and targets. (T-0)

2.17.4. Implements corrective actions for identified TIPP discrepancies to organizational facilities and processes. (T-1)

2.17.5. Ensures unit personnel are trained on applicable components of the TIPP program as described in this AFI. (T-0)

2.17.6. Ensures unit personnel are provided with appropriate PPE/clothing in accordance with the potential for thermal injury. (T-0)

2.18. Workplace Supervisor.

2.18.1. Ensures all thermal injury hazards are abated and that all Airmen and civilian workers comply with TIPP requirements. Understands the impacts of acclimatization (see A2.2) on the risk of thermal injury. (T-0)

2.18.2. Ensures required TIPP hazard controls are implemented and functioning correctly, that PPE is available and used correctly in the workplace, and instructs personnel on care/hygiene of their PPE. (T-0)

2.18.3. Ensures workplace compliance with applicable TIPP regulatory and policy requirements. (T-0)

2.18.4. Informs TIPP manager of proposed changes to workplace equipment, practices and/or procedures that may impact exposure to thermal hazards. (T-1)

2.18.5. Conducts workplace-specific thermal hazard training, per regulatory or policy requirements; documents training in accordance with AFI 91-202. (T-0)

2.18.6. Consults with appropriate SMEs to ensure thermal hazard training meets or exceeds minimum requirements. (T-2)

2.18.7. Notifies PH of any occupationally-related thermal injuries or illnesses. (T-1)

2.19. Employee.

2.19.1. Understands the thermal risk aspects of work performed and complies with all risk mitigation strategies and program requirements, including training, work practices and the proper use, maintenance and storage of PPE. Understands the impacts of acclimatization (see A2.2) on the risk of thermal injury. (T-0)

2.19.2. Reports changes that may impact exposure to thermal hazards to the appropriate supervisor; actively participates in workplace health hazard identification and health risk assessments, to include wearing sampling/monitoring equipment. (T-0)

2.19.3. Reports any thermal injuries or illnesses to workplace supervisor. If medical care is obtained through civilian sources, then notify supervisor and primary care physician.

Chapter 3

THERMAL INJURY PREVENTION PROGRAM ELEMENTS

3.1. Thermal Injury Prevention for Airmen in Training. Thermal injury prevention, particularly heat injury prevention, is a high priority for Basic Military Training, and in the preparation and training of Battlefield Airmen (BA) and Security Forces (SF). In order to overcome the inherent training restrictions created by exclusively following the work/rest cycle, the Training Wing (TRW)/Training Group (TRG)/Special Tactics Training Squadron (STTS) will work in partnership with TRW Safety and Preventive Medicine physicians to produce a strategic, comprehensive set of heat injury prevention countermeasures. The heat injury prevention will be targeted to the unique needs of each training objective/course, and will be taught and integrated into risk management aspects of each TRG course. A defined risk management (RM) matrix will be developed for each high-risk training event in the TRW/TRG/STTS. This approach provides a level of heat injury prevention that far exceeds the work/rest cycle while assuring training standards and mission goals are accomplished. Thermal injury prevention elements of the TRG RM matrix will be reviewed and approved by preventive medicine physicians upon initial development and re-reviewed in the event of any heat injuries.

3.2. Occupational and Environmental Monitoring. The risk of thermal injury can be approximated by an assessment of environmental conditions, such as air temperature, wind speed, humidity, and radiant heat. There are other environmental factors affecting thermal injury risk, however, this AFI recommends environmental monitoring techniques that can be easily applied, measured and interpreted when conducting both deployed or home base operations; namely Wet Bulb Globe Temperature (WBGT) and Frostbite Risk Level (FRL). Although it does not correlate directly with WGBT, the Heat Index (HI) can be utilized for risk assessment purposes where no BE personnel are on site.

3.2.1. Environmental monitoring is an approximation of the risk of injury and should not be used as a replacement for strong education, training, and awareness components of the local TIPP.

3.2.2. Environmental monitoring should be accomplished periodically to mark transition from one thermal injury risk stage to another. The data collected should be compared to reference values in **Table 3.1** and **3.2**. and when necessary, used to determine administrative and personnel procedures to directly reduce thermal strain and subsequent thermal stress at the work place. Monitoring at the installation level should take place at a location representative of the highest risk, typically near the flight line. At the workplace level, monitoring should be conducted in close approximation to the conditions in which the process of concern will be occurring.

3.2.3. The WBGT. Detailed analysis of the influence of the environment on thermal stress requires knowledge of the following four basic parameters: air temperature, mean radiant temperature, air speed and absolute humidity. The WBGT combines the measurement of two derived parameters, natural wet-bulb temperature (T_{nwb}) and the black globe temperature (T_g), and, in some situations, the measurement of the basic parameter, dry-bulb (air) temperature (T_{db}). The WBGT formulae can utilize either ^{o}F or ^{o}C, as long as usage is consistent; the equations are as follows:

3.2.3.1. *WBGT = 0.7(Tnwb) + 0.2(Tg) + 0.1(Tdb) (outdoors).*

3.2.3.2. *WBGT = 0.7(Tnwb) + 0.3(Tg) (with no radiant load).*

3.2.4. During periods of hot weather, the WBGT is calculated and the appropriate Heat Stress Risk and Flag Color can be determined using **Table 3.1**.

3.2.5. During periods of cold weather, the air temperature and wind speed can be applied to **Table 3.2** and **3.3** to determine the FRL.

3.2.6. Modifications to the WBGT for clothing. Normal duty-type uniforms, overalls, and long-sleeved civilian work clothes do not drive any adjustment to the WBGT. Wearing a second layer of clothing, such as chemical protective gear or firefighting bunker gear adds +6°C/+10°F to the WBGT measurement for light work, and +12°C/+20°F for moderate / heavy work. Additionally, wear of body armor adds an additional +3°C/+5°F to the WBGT measurement. This can, potentially, drive a shift from low or moderate to extreme risk of heat injury.

3.2.7. Heat Index. When operations are taking place at locations where no BE personnel are on site, the HI may be used for risk assessment purposes. HI uses different assumptions and end states than WBGT, and so the two cannot be directly compared. The primary measure of heat stress for the Air Force remains the WBGT. The HI is devised for shady, light wind conditions. Exposure to full sun can increase HI values by up to 15 °F. The advantage of the HI formulation, despite its complex appearance, is that it requires only a temperature and relative humidity (RH) for calculation. The base formula for HI is:

3.2.7.1. *HI = -42.379 + 2.049Tdb + 10.143RH - 0.2248TdbRH – 0.00684(Tdb2) – 0.0548(RH2) + 0.00123 (Tdb2)RH + 0.000853Tdb(RH2) – 0.00000199(Tdb2) (RH2)*

3.2.7.2. Adjustment for RH less than 13% and 80 < T_{db} <112 °F:

3.2.7.2.1. *- [(13-RH)/4] * SQRT{[17-ABS(Tdb-95.)]/17}*

3.2.7.2.2. where ABS and SQRT are the absolute value and square root functions, respectively.

3.2.7.3. Adjustment for RH > 85% and 80 < T_{db} <87 °F:

3.2.7.3.1. *+ [(RH-85)/10] * [(87-Tdb)/5]*

3.3. Communication. The thermal injury risk should be displayed around the installation using a color-coded system, such as flags or boards, or communicated to the base via intranet or radio networks. Tables 3.1 and 3.3 display the risk-based colors for both heat and cold stress, respectively. For reference, Table 3.4 shows the Equivalent Chill Temperature ("Wind Chill").

3.4. Workplace Education and Training. Education and training are fundamental to an effective TIPP. This AFI recommends annual education and training on the signs and symptoms of thermal strain and first aid procedures, work/rest and work/warming cycles, the additive effects of personal protective equipment, and the importance of good hydration.

Table 3.1. Heat Stress Risk Colors.

WBGT Range (oF)	WBGT Range (oC)	Severity	Color
82 - 84.9	27.8 - 29.4	Low	Green

85 - 87.9	29.4 - 31.1	Moderate	Yellow
88 - 89.9	31.1 - 32.2	Severe	Red
>90	>32.2	Extreme	Black

Table 3.2. Cold Stress Risk Determination (Table values indicate time in minutes to frostbite).

Wind Speed (mph/kph)	Air Temperature (°F/°C)											
	10/-12	5/-15	0/-21	-5/-21	-10/-23	-15/-26	-20/-29	-25/-32	-30/-34	-35/-37	-40/-40	-45/-43
5/8	>120	>120	>120	>120	31	22	17	14	12	11	9	8
10/16	>120	>120	>120	28	19	15	12	10	9	7	7	6
15/24	>120	>120	33	20	15	12	9	8	7	6	5	4
20/32	>120	>120	23	16	12	9	8	8	6	5	4	4
25/40	>120	42	19	13	10	8	7	6	5	4	4	3
30/48	>120	28	16	12	9	7	6	5	4	4	3	3
35/56	>120	23	14	10	8	6	5	4	4	3	3	2
40/64	>120	20	13	9	7	6	5	4	3	3	2	2
45/72	>120	18	12	8	7	5	4	4	3	3	2	2
50/81	>120	16	11	8	6	5	4	3	3	2	2	2
Note: Time in minutes until the occurrence of cheek frostbite in the most susceptible 5 percent of personnel; wet skin could significantly decrease the time for frostbite to occur												

Table 3.3. Frostbite Risk Level (FRL) Colors.

Severity	Color	Description
Low	Green	Freezing possible but unlikely
Moderate	Yellow	Freezing could occur in 10-30 minutes
Severe	Red	Freezing could occur in 5-10 minutes
Extreme	Black	Freezing could occur in <5 minutes

Table 3.4. Equivalent Chill Temperature.

WIND SPEED (mph)	TEMPERATURE (°F)											
	10	**5**	**0**	**-5**	**-10**	**-15**	**-20**	**-25**	**-30**	**-35**	**-40**	**-45**
	EQUIVALENT CHILL TEMPERATURE											
5	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
Note: Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$; T = Air Temperature (°F) and V = Wind Speed (mph)												

MARK A. EDIGER, Lt General, USAF, MC, CFS
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

DoDI 6055.05, *Occupational and Environmental Health,* November 11, 2008

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Abbreviations and Acronyms

AEA—Aircrew Equipment Assembly

ABU—Airman Battle Dress Uniform

AME—Aerospace Medicine Enterprise

BE—Bioenvironmental Engineering

BEE—Bioenvironmental Engineer

CBRN—Chemical, Biological, Radiological, Nuclear

DOEHRS-IH—Defense Occupational and Environmental Health Readiness System – Industrial Hygiene

ESOHC—Environment, Safety and Occupational Health Council

FCI—Freezing Cold Injury

FITS—Fighter Index of Thermal Stress

FRL—Frostbite Risk Level

ICD—International Classification of Disease

IPE—Individual Protective Equipment

ISO—International Organization for Standardization

MOPP—Mission-Oriented Protective Posture

NFCI—Non Freezing Cold Injury

OEH—Occupational and Environmental Health

OEHWG—Occupational and Environmental Health Working Group

OSHA—Occupational Safety and Health Administration

PH—Public Health

PMR—Program Management Review

RH—Relative Humidity

SEG—Similar Exposure Group

TLV—Threshold Limit Values

TIPP—Thermal Injury Prevention Program

UCHS—Uncompensable Heat Stress

USAFSAM—USAF School of Aerospace Medicine

USARIEM—US Army Research Institute of Environmental Medicine

UV—Ultra-violet Radiation

WBGT Index—Wet Bulb Globe Thermometer Index

Terms

Acclimatization—Acclimatization is the physiological adaptation of an individual to changes in climate or environment, such as temperature, humidity, or altitude.

Black Globe Temperature (T_g)—This is a measurement that integrates radiant (or direct sunlight) heat exchange and convective heating or cooling into one value. The WBGT index is based on the response of the six inch diameter globe. This measurement uses a six inch diameter hollow copper sphere painted matte black on the outside and containing an unshielded dry-bulb thermometer in the center of the sphere. Note that some current meters use a smaller sphere that is correlated to a six inch sphere.

Cold Injury—Cold environments pose a threat to the individual if they exceed the capacity of the body's thermo-regulatory response mechanisms. The main hazards are hypothermia associated with a fall in the body's core temperature and/or tissue damage that falls under the broad headings of FCI and NFCI (Non-freezing Cold Injury). For the purpose of this AFI the term 'Cold Injury' is all encompassing and applies to an individual who becomes incapacitated as the result of a drop in core body temperature, FCI or NFCI.

Conduction—The transfer of heat between two materials that are in contact with each other, with heat passing from the warmer material to the cooler material.

Convection—The heat transfer between molecules directly adjacent to each other, such as between the body and the surrounding air. The rate of heat exchange is a function of the difference in temperature between the skin and the surrounding air and the rate of air movement over the skin. As the temperature of the air decreases, the amount of heat loss due to convection increases. Increasing air movement increases convective heat loss.

Diuresis—Unusually large urine output. Increased excretion of urine caused by excessive intake of fluids, a drug, or a disease.

Dry—Bulb (air) Temperature (Td)—This is the temperature measured with an ordinary alcohol-in glass, or mercury-in-glass thermometer whose bulb is kept dry and shielded from direct sun radiation.

Evaporation—The process of liquid water converting to a vapor. Evaporation produces a cooling effect on the skin. Evaporative heat loss is a function of the rate of air movement over the skin and the water vapor pressure difference between the surrounding air and the wet skin. As the rate of air movement increases, the rate of evaporation increases, resulting in a cooling effect. However, as humidity increases, evaporative heat loss decreases.

Exercise-associated Collapse—Inability to stand or walk as a result of lightheadedness or syncope occurring immediately after completing a workout due to abrupt decrease in venous return.

Exertional Heat Stroke—The two main criteria for diagnosing exertional heat stroke (EHS) are a core temperature above 104°F (40°C), measured immediately following collapse during strenuous activity, and central nervous system dysfunction (disorientation, headache, irrational behavior, irritability, emotional instability, confusion, altered consciousness, or seizure).

Heat Exhaustion—Heat exhaustion is characterized by collapse due to the inability to maintain adequate cardiac output due to strenuous physical exercise and environmental heat stress. Core temperature is usually 101 to 104 degrees Fahrenheit and no significant central nervous system dysfunction is present at the time of collapse.

Heat Illness—Traditionally heat illness has been divided into heat exhaustion and (exertional) heat stroke. In practice the division is difficult to define; thus, for the purpose of this AFI the

term ‘Heat Illness’ is all encompassing and applies to an individual who collapses as the result of a rise in core body temperature.

Heat Index (HI)—An alternative measure of heat risk that combines dry bulb temperature and relative humidity. Used in the AF for risk assessment when the preferred method (WBGT) is unavailable. See **3.2.7**.

Heat Strain—The physiological or psychological response to heat stress, which is manifested in specific cardiovascular, thermoregulatory, respiratory, renal, endocrine, and other bodily functions, which differ from acceptable human norms.

Heat Stress—The combination of factors which result in heat gains or losses relative to the body, or which prevent the body’s regulatory mechanisms from working efficiently.

Heat Stroke—See ‘Exertional Heat Stroke.’

Heat Syncope—See ‘Exercise-associated Collapse’ and ‘Non-exertional Heat Syncope.’

Humidity—An expression of the quantity of water vapor mixed with the other atmospheric gases.

Hypo-hydration—Dehydration of the human or animal body.

Natural Wet—Bulb Temperature (Tnwb)—This is the temperature measured with a thermometer, with a wet wick fitted closely over the bulb or electronic sensor.

Non-exertional Heat Syncope—Transient loss or near-loss of consciousness due to the indirect effects of high ambient temperatures. Heat induced vasodilation can cause non-exertional syncope prior to acclimatization in the first few days of new exposure to high temperatures with prolonged standing or sudden standing.

Radiant Heat—Radiant heat loss occurs when surrounding objects have lower surface temperatures than the body. Radiant heat gain occurs when surrounding objects have higher surface temperatures than the body. Heat exchange due to radiation is independent of air movement.

Vasodilation—Widening of blood vessels, which increases heat removal but also lowers blood pressure.

Wet-Bulb Globe Temperature (WBGT)—This is an empirical index of heat that provides an index that corresponds to the behavior of the human body under heat strain. $WBGT = 0.7(T_{nwb}) + 0.2(T_g) + 0.1(T_{db})$

Attachment 2

THERMAL INJURY PRINCIPLES AND TRAINING INFORMATION

A2.1. Basic Heat Exchange Principles. Heat illness and cold injury are caused respectively by an excessive rise or fall in core human body temperature. Control of human body temperature can be simplified in the following heat balance equation:

A2.1.1. *Heat storage = Heat Gained - Heat Lost*

A2.1.2. The human body gains heat from metabolism, shivering, and physical exertion. It may either gain or lose heat from the external environment via radiant energy (e.g., sunlight), convection (e.g., air passing against the skin), conduction (e.g., direct contact with a solid body or immersion), and evaporation (e.g., sweating). Some heat can be lost through exhalation. Enclosure in confined spaces and wearing impermeable individual personal equipment (IPE) may prevent heat loss. A more in-depth discussion of metabolic load and heat balance can be found in TB MED 507, *Heat Stress Control and Heat Casualty Management*.

A2.2. Acclimatization. The process of acclimatization is characterized by a series of physiological adjustments that occur when an individual is exposed to a target climate. Acclimatization must be specific for the destination environment and it produces beneficial physiological changes to the individual that minimize the risk of thermal injury. A period of acclimatization is required for all personnel regardless of each individual's physical condition. An individual is considered acclimatized if he or she has undertaken at least two continuous hours of work or exercise in five of the last seven days, or 10 of the last 14 days in the same environmental conditions as the proposed activity. However, adaptation is lost within a few weeks unless the exposure to heat is repeated regularly at intervals of four days or less. If exposure to the targeted environment has followed a substantial period of travel or crossing time zones, the acclimatization time must be assumed to be longer than 10 days. In general, one extra day should be allowed for each time zone crossed.

A2.3. Heat Strain and Performance. In a heat strain situation (where the core body temperature is elevated), individual fatigue and time-to-exhaustion are directly related to the rate of heat gain, and are inversely related to the initial core body temperature.

A2.3.1. Heat stress can reduce mental performance, which is probably mediated by thermal discomfort (from high skin temperature, very wet skin, and cardiovascular strain). However, a very incomplete database exists relating mental performance degradation relative to graded levels of heat stress and strain. Mental performance degrades the most in boring, monotonous and repetitive tasks. In addition, tasks that require attention to detail, concentration, and short-term memory and are not self-paced may degrade from heat stress. Heat stress slows reaction time and decision times. Routine tasks are done more slowly. Errors of omission are more common. Vigilant task performance will degrade slightly after 30 minutes and markedly after 2 to 3 hours of exposure to elevated temperatures.

A2.3.2. Dehydration (>2 percent body weight loss) adversely affects mental function (for example, serial addition, response time and word recognition) during heat exposure. These performance decrements probably increase with the level of dehydration.

A2.3.3. Individual and collective risk of aircrew and ground crew error exists in thermal environmental extremes. Research clearly demonstrates a significant increase in the risk of rotary aircrew errors associated with rising ambient temperatures.

Table A2.1. Effects of Acclimatization to Heat.

Increase in:	Decrease in:
Work output	Heart rate
Endurance	Pulse pressure
Plasma volume	Basal oxygen consumption
Sweat production	Sweat electrolyte concentration
	Skin and core temperature

A2.4. Cold Strain and Performance. Cold stress that does not cause a decrease in core body temperature of more than 0.9 °F or allow muscle temperatures to go below 97 °F does not alter most physiological performance. However, for every 1.8 °F fall in core or muscle temperature, maximal endurance exercise capability is lowered by about 5 percent, exercise endurance time is lowered by 20 percent, and maximal strength and power output is lowered by 5 percent.

A2.4.1. Pain sensations increase when skin temperatures decrease to 68 °F and manual dexterity declines after finger-skin temperatures decrease to 60 °F because of cooling of tissues and decreases in joint mobility. Tactile sensitivity is reduced as skin temperatures drop below 43 °F. These changes are due to decreased tissue temperatures, so that an individual can have a normal body core temperature but still have a significant decline in performance of gross and fine motor skills because the hands and fingers are cold.

A2.4.2. The relationship between finger temperature and performance changes is not linear; rather, there is a clear breakpoint in performance at skin temperatures below 60 °F as hand performance drops off by 10 to 20 percent, and a second sharp decline occurs at a skin temperature less than 43 °F when tactile sensitivity is lost.

A2.4.3. Duration of cold exposure also has a role because underlying tissues will cool more with longer exposures, leading to greater declines in performance as muscles and nerves will both cool. Immersion of the hands and forearms in 50 °F water for as short as 5 minutes can lower manual dexterity by 20 to 50 percent.

A2.4.4. Cold strain can degrade mental performance on complex thinking tasks by 17 to 20 percent. Memory registration for newly presented information is impaired when core temperature falls between 94 and 95 °F, and short-term memory declines up to 20 percent with significant peripheral cooling with no change in core body temperature. A person's ability to remain vigilant declines when the core body temperature is decreasing. Activities that require continuous, rapid and accurate responses are impaired by 13 percent at low ambient temperatures that cause skin temperatures to fall.

A2.5. Individual Risk Factors for Heat Injury. There is wide variation in human tolerance to heat stress. Nevertheless, it is possible to identify factors that cause particular individuals to become heat casualties. The following personal factors must be considered when assessing individual heat injury risk:

A2.5.1. Obesity.

A2.5.2. Lack of physical fitness.

A2.5.3. Lack of sleep.

A2.5.4. Recent alcohol intake.

A2.5.5. Concurrent mild illness e.g., diarrhea, viral illness, fever.

A2.5.6. Dehydration.

A2.5.7. Medications including but not limited to antiepileptic agents, antihistamines, decongestants, tricyclic antidepressants, amphetamines, stimulants, lithium, diuretics, beta blockers, calcium channel blockers, neuroleptics, and thyroid receptor agnoists, or illegal drugs.

A2.5.8. Lack of acclimatization.

A2.5.9. Ephedra-containing nutritional supplements.

A2.5.10. Sickle-cell trait or sickle-cell anemia.

A2.6. Individual Risk Factors for Cold Injury. Systematic review of accidental cold injury has identified the following individual risk factors in a cold environment and must be considered:

A2.6.1. Recent alcohol intake.

A2.6.2. Medications including but not limited to beta blockers, amphetamines, antihistamines, decongestants and caffeine.

A2.6.3. Insufficient clothing.

A2.6.4. Wetness from either the environment or sweat.

A2.6.5. Lean body mass.

A2.6.6. Physical exhaustion.

A2.6.7. Two or more illnesses occurring at the same time.

A2.7. Heat Stress Guidelines. The tables below provide workload, heat stress stages, temperature ranges, flag colors, recommended work/rest cycles and water intake for easy, moderate, and hard work, both for acclimatized and unacclimatized individuals.

Table A2.2. Guide to Determination of Workload.

Easy Work	Moderate Work	Hard Work
Walking on hard surface @ 2.5 mph with < 30 lb load Guard duty Drill and Ceremony	Walking on hard surface @ 3.5 mph with < 40 lb load Walking on loose sand @ 2.5 mph with no load Light maintenance work Construction equipment operation	Walking on hard surface @ 3.5 mph with > 40 lb load Walking on loose sand @ 2.5 mph with load Loading and unloading pallets Dragging hoses or lines

Table A2.3. Heat Guidelines for Average Acclimatized Individuals.

Flag Color	WBGT (°F)	Easy Work		Moderate Work		Hard Work	
		Work / Rest Cycle	Water Intake Qt/hr	Work / Rest Cycle	Water Intake Qt/hr	Work / Rest Cycle	Water Intake Qt/hr
No Flag	78 - 81.9	No Limit	0.5	No Limit	0.75	40/20 min	0.75
Green	82 - 84.9	No Limit	0.5	50/10 min	0.75	30/30 min	1.0
Yellow	85 - 87.9	No Limit	0.75	40/20 min	0.75	30/30 min	1.0
Red	88 - 89.9	No Limit	0.75	30/30 min	0.75	20/40 min	1.0
Black	> 90	50/10 min	1.0	20/40 min	1.0	10/50 min	1.0

Table A2.4. Heat Guidelines for Average Unacclimatized Individuals.

Flag Color	WBGT (°F)	Easy Work		Moderate Work		Hard Work	
		Work / Rest Cycle	Water Intake Qt/hr[a]	Work[b] / Rest[c] Cycle	Water Intake Qt/hr	Work / Rest Cycle	Water Intake Qt/hr
No Flag	78 - 81.9	No Limit	0.5	50/10 min	0.75	30/30 min	0.75
Green	82 - 84.9	No Limit	0.5	40/20 min	0.75	30/30 min	1.0
Yellow	85 - 87.9	No Limit	0.75	30/30 min	0.75	20/40 min	1.0
Red	88 - 89.9	50/10 min	0.75	20/40 min	0.75	10/50 min	1.0
Black	> 90	40/20 min	1.0	10/50 min	1.0	Not allowed	N/A

A2.7.1. For all work rates, individual water requirement may vary by +/- 0.25 qt/hr. (1 qt is roughly equal to 1 liter (0.95L))

A2.7.2. Rest means minimal physical activity, i.e. sitting or standing, accomplished in the shade if possible.

A2.7.3. **Table A2.2** should be used to determine what work category to use when assessing heat stress.

A2.8. Cold Stress Guidelines. Use **Table A2.5** to determine preventative measures for various frostbite risk levels.

Table A2.5. List of recommended preventive measures to decrease frostbite risk.

Frostbite Risk Level	Preventive Measures
Low	• Recommended work/rest (W/R) cycle: 50 minutes work/10 minutes warming• Increase surveillance with self and buddy checks.• Wear appropriate layers and wind protection for the work intensity.• Cover exposed flesh if possible.• Wear Vapor Barrier (VB) boots below 0 °F.• Provide warming facilities below 20 °F.• Avoid sweating.
High	• Recommended W/R cycle: 40 minutes work/20 minutes warming• Mandatory buddy checks every 20–30 minutes.• Wear appropriate layers and All Purpose Environmental Clothing System (APECS). Protect head, face and hands.• Cover exposed flesh.• Wear VB boots below 0 °F.• Provide warming facilities.• Avoid sweating.
Severe	• Recommended W/R cycle: 30 minutes work/30 minutes warming• Mandatory buddy checks every 10 minutes.• Wear appropriate layers and APECS or cold weather parka. Protect head, face and hands.• Wear VB boots.• Provide warming facilities.• Work groups of no less than two personnel.• No exposed skin.• Stay active.• Avoid sweating.
Extreme	• Mission critical work only due to extreme risk.• Keep task duration as short as possible.• Wear appropriate layers, cold weather parka, wind protection. Protect head, face and hands.• Wear VB boots.• Provide warming facilities.• Work groups of no less than two personnel.• No exposed skin.• Stay active.• Avoid sweating.

A2.9. Elements of Heat Injury Prevention. A comprehensive heat weather injury prevention and management program will follow the principles of risk management by identifying hazards, assessing the hazards in terms of severity, probability, and implementing appropriate controls to abate the hazards. Spot checking and supervision by supervisors must be employed to ensure control measures are being implemented. Units train using risk-management principles; therefore commanders and leaders will apply the same framework to prevent heat weather injuries. Heat-casualty prevention is a command responsibility.

A2.9.1. Identifying and Assessing Hazards. Hot weather may present a hazard if any one of the following is present:

A2.9.1.1. High heat category, especially on several sequential days. The WBGT should be measured when ambient temperature is over 75° F.

A2.9.1.2. High-exertion level of training, especially on several sequential days.

A2.9.1.3. Lack of acclimatization (at least 10 to 14 days for new arrivals to become acclimated) and other individual risk factors, such as:

A2.9.1.3.1. Lack of quality sleep.

A2.9.1.3.2. Poor fitness.

A2.9.1.3.3. Overweight.

A2.9.1.3.4. Minor illnesses such as cold symptoms.

A2.9.1.3.5. Prescribed or over-the-counter medications/supplement/dietary aids.

A2.9.1.3.6. Use of alcohol within the last 24 hours.

A2.9.1.3.7. Prior history of heat illness (any heat stroke or more than two episodes of heat exhaustion).

A2.9.1.3.8. Skin disorders such as heat rash and sunburn.

A2.9.1.4. High temperatures at night/rest overnight.

A2.9.2. Developing Controls. Heat casualties can be controlled through:

A2.9.2.1. Establishing standard operating procedures.

A2.9.2.2. Posting heat casualty prevention information where it is easily accessible.

A2.9.2.3. Planning operations and events, to include:

A2.9.2.3.1. Minimizing consecutive days of heavy physical training when heat stressors exist.

A2.9.2.3.2. Providing medical and evacuation support.

A2.9.2.3.3. Providing adequate hydration.

A2.9.2.3.4. Choosing the appropriate time of day – morning is cooler, location, clothing apparel, and location or training/work event.

A2.9.2.3. Knowledge of standardized guidelines for warm weather working conditions fluid replacement and work/rest cycles.

A2.9.3. Implementing Controls. Heat casualty controls can be implemented through the following actions.

A2.9.3.1. A decision to accept risk at the appropriate level.

A2.9.3.2. Hydration standards.

A2.9.3.3. Food intake.

A2.9.3.4. Random checks.

A2.9.3.5. Clothing recommendations.

A2.9.4. Supervising and Evaluating. The final step in the risk-management process is the supervision and evaluation of the controls taken to prevent heat casualties. Examples are:

A2.9.4.1. Enforcing SOPs.

A2.9.4.2. Delegating responsibilities ensure control measures have been implemented.

A2.9.4.3. Monitoring the adequacy/progress of implementation of control measures.

A2.9.4.4. Performing spot-checks of Airmen.

A2.10. Elements of Cold Injury Prevention. A comprehensive cold weather injury prevention and management program should follow the principles of risk management by identifying

hazards, assessing the hazards in terms of severity, probability, and implementing appropriate controls to abate the hazards. Spot checking and supervision by supervisors must be employed to ensure control measures are being implemented. Units train using risk-management principles; therefore commanders and leaders will apply the same framework to prevent cold weather injuries. Cold-casualty prevention is a command responsibility.

A2.10.1. Airman and Leadership Education.

A2.10.1.1. Assessing cold stress.

A2.10.1.2. Recognizing and preventing cold injuries.

A2.10.1.3. Limiting the effects of cold through clothing, shelter, and nutrition.

A2.10.1.4. Evaluating the impact of cold on the mission (for example, everything takes longer; Airmen will be more fatigued, more likely to make mistakes).

A2.10.1.5. Experiential learning, to include:

A2.10.1.5.1. Remembering that true effectiveness in cold environments only comes with experience.

A2.10.1.5.2. Practicing the clothing principles of layering and staying dry. These principles must be tailored to the individual, and must be practiced so that Airmen will learn when to dress down (before sweating begins) and when to add layers (before shivering begins).

A2.10.1.5.3. Using equipment in the cold. Everything takes longer, so practice is needed; Airmen also need to be able to identify where special tools or clothing (for example, contact gloves) may be necessary.

A2.10.1.5.4. Planning for longer missions (weather may change quickly and hinder operations, and Airmen fatigue impacts even routine operations).

A2.10.1.6. The posting of cold-casualty prevention information as an ongoing reminder.

A2.10.1.7. Establishing standing operating procedures for most routines.

A2.10.2. Training.

A2.10.2.1. Clothes are to be appropriate and worn properly.

A2.10.2.1.1. Clothing must be kept dry, and wet, damp clothes changed as soon as possible.

A2.10.2.1.2. Clothing is to be worn loose and in layers, and hands, fingers, and the head are to be covered and protected.

A2.10.2.1.3. All clothing must be clean and in good repair (no broken zippers or holes).

A2.10.2.1.4. Proper boots must be worn (dry, and not overly tight).

A2.10.2.1.5. Socks must be clean and dry, an extra pair of socks must be carried, wet or damp socks must be changed as soon as possible, and foot powder will be used on feet and boots.

A2.10.2.1.6. Feet are to be washed daily if possible.

A2.10.2.1.7. Gaiters are to be worn to keep boots dry when necessary.

A2.10.2.1.8. Gloves or mittens are to be worn.

A2.10.2.1.9. Hands must be warmed under clothes before hands become numb.

A2.10.2.1.10. Skin contact with snow, fuel, or bare metal is to be avoided, and proper gloves are to be worn when handling fuel or bare metal.

A2.10.2.1.11. Gloves are to be waterproofed by treating them with waterproofing compounds.

A2.10.2.1.12. Face and ears are to be covered with a scarf, and an insulated cap with flaps over the ears or a balaclava is to be worn.

A2.10.2.1.13. Face and ears are to be warmed by covering them with warm hands, and the face and ears must not be rubbed.

A2.10.2.1.14. Face camouflage will not be used when the air temperature is below 32 ^{o}F.

A2.10.2.1.15. Sunscreen is to be worn.

A2.10.2.1.16. Sunglasses are to be worn to prevent snow blindness.

A2.10.2.2. Health and nutrition must be sustained.

A2.10.2.2.1. Alcohol use is to be avoided (alcohol impairs the body's ability to shiver).

A2.10.2.2.2. Tobacco products are to be avoided (tobacco products decrease blood flow to the skin).

A2.10.2.2.3. All meals are to be eaten to maintain energy.

A2.10.2.2.4. Water or warm nonalcoholic fluids are to be drunk to prevent dehydration.

A2.10.2.2.5. Carbon Monoxide poisoning must be prevented by using only approved heaters in sleeping areas, by not sleeping near the exhaust of a vehicle while the vehicle is running, and by not sleeping in an enclosed area where an open fire is burning.

A2.10.2.4. Airmen will protect each other.

A2.10.2.4.1. Airmen are to watch for signs of frostbite and other cold weather injuries in their buddies.

A2.10.2.4.2. Airmen are to ask about and assist with rewarming of feet, hands, ears or the face.

A2.10.2.5. Leadership initiatives will be practiced.

A2.10.2.5.1. Activities or exercise will be limited or possibly discontinued during very cold weather.

A2.10.2.5.2. Covered vehicles are to be used for personnel transport.

A2.10.2.5.3. Warming tents will be available.

A2.10.2.5.4. Warm food and drink will be on hand.

A2.10.2.5.5. All equipment are to be checked and working properly.

A2.10.3. Supervising and Evaluating. The final step in the risk-management process is the supervision and evaluation of the control taken to prevent cold casualties. Examples are—

A2.10.3.1. Ensuring all Airmen and leaders are educated and experienced in the prevention, recognition, and treatment of cold-weather injuries, as well as effective measures for working in cold environments.

A2.10.3.2. Delegating responsibilities (inspections, buddy checks) to ensure control measures have been implemented.

A2.10.3.3. Monitoring the adequacy/progress of implementation of control measures.

A2.10.3.4. Performing spot-checks of shelters, rewarming facilities, and food and drink supplies.

A2.10.3.5. Recording and monitoring indicators of increasing cold risks, such as:

A2.10.3.5.1. An increase in the number of cold-weather injuries.

A2.10.3.5.2. An increase in the number of complaints/comments about cold.

A2.10.3.5.3. Observations of shivering and signs of cold-weather injuries.

A2.10.3.6. Continuously evaluating current control measures and strategizing new or more efficient ways to keep warm and avoid cold injuries.

Attachment 3

FIGHTER INDEX OF THERMAL STRESS (FITS)

A3.1. Introduction to Fighter Index Thermal Stress (FITS) The FITS was developed in 1979 to provide a measure of the thermal stress experienced by aircrew in fast jet aircraft with canopies and environmental control systems, engaged in combat sorties at low altitudes, direct sunlight or light overcast, and high outside temperatures. The FITS was derived from the WBGT using in-flight data on cockpit environments and assuming a fixed contribution from solar heating. The FITS table uses ground dry bulb temperature and wet bulb temperatures to yield an estimate of cockpit thermal stress.

A3.2. Assessing FITS Reference Values In hot environments, the FITS provides a measure of thermal strain required which can be used to determine risk of aircrew heat stress and injury. The calculated values assume an Aircrew Equipment Assembly (AEA) thermal insulation of 1.5-2.0 clo, roughly equivalent to light, summer AEA; therefore, the index is not appropriate for cold weather, immersion suit or other types of individual protective equipment.

A3.2.1. The FITS equation utilizes T_{pwb} and T_{db}, the ground psychometric wet bulb and dry bulb temperatures, respectively.

A3.2.1.1. In Fahrenheit, the equation is: $FITS = 0.83T_{pwb} + 0.35T_{db} + 9.14°F$

A3.2.1.2. In Celsius, the equation is: $FITS = 0.83T_{pwb} + 0.35T_{db} + 5.08°C$

A3.2.2. BE personnel determine the FITS zones shown at **Table A3.1** (Fahrenheit) and **A3.2** (Celsius). Aircrews have a responsibility to monitor their physical condition and not to exceed their capability to safely accomplish the mission.

Table A3.1. FITS Reference Values (Fahrenheit).

			T_{pwb} (°F)					
T_{db} (°F)	60	65	70	75	80	90	100	110
70	83	87	92	96	100	108	117	125
75	85	89	93	98	102	110	118	127
80	87	91	95	99	103	112	120	128
85	89	93	97	101	105	113	122	130
90	90	94	99	103	107	115	124	132
95	92	96	100	105	109	117	125	134
100	94	98	102	106	110	119	127	135
105	96	100	104	108	112	120	129	137
110	97	101	106	110	114	122	131	139
115	99	103	107	112	116	124	132	141
120	101	105	109	113	117	126	134	142
FITS Normal Zone			**FITS Caution Zone**			**FITS Danger Zone**		

Table A3.2. FITS Reference Values (Celsius).

	T_{pwb} (°C)							
T_{db} (°C)	10	15	20	25	30	35	40	45
20	20	25	29	33	37	41	45	49
25	22	26	30	35	39	43	47	51
30	24	28	32	36	40	45	49	53
35	26	30	34	38	42	46	51	55
40	27	32	36	40	44	48	52	56
45	29	33	37	42	46	50	54	58
50	31	35	39	43	47	52	56	60
FITS Normal Zone			**FITS Caution Zone**			**FITS Danger Zone**		

A3.3. FITS Actions. FITS reference values and their associated zones are not exact demarcations, but represent the temperatures and humidities at which aircrews begin to experience heat-stress-related effects. These effects may vary with the individual, the particulars of the ground and flight aspects of the mission, the particular clothing worn, and so forth. The following FITS Action, therefore, are guides, rather than directives.

A3.3.1. FITS Normal Zone. The Normal Zone is subjectively hot, but normally safe, and generally covers FITS Reference Values under 90 °F (32 °C) The following procedures should be implemented:

A3.3.1.1. Be alert for symptoms of heat stress.

A3.3.1.2. Ensure adequate fluid intake.

A3.3.2. FITS Caution Zone. The Caution Zone includes conditions that are tolerable if adequate precautions are taken, and generally covers FITS Reference Values between 91 °F and 101 °F (33 °C and 37 °C) The following procedures should be implemented:

A3.3.2.1. Be alert for symptoms of heat stress.

A3.3.2.2. Drink plenty of non-caffeinated fluids.

A3.3.2.3. Avoid exercise 4 hours prior to take off.

A3.3.2.4. Limit ground operations time outside an air-conditioned environment to 90 minutes.

A3.3.3. FITS Danger Zone. The Danger Zone represents conditions that induce progressive heat storage and dehydration sufficient to affect crew performance during normal low-level missions, and comprise FITS Reference Values over 102 °F (38 °C). When the FITS Reference Value is over 115 °F (42 °C), consider limiting or cancelling non-essential flight operations, as the thermal stress constitutes a serious drain on physiological reserves. The following procedures should be implemented:

A3.3.3.1. Minimum recovery time is two hours (landing time to next take off.)

A3.3.3.2. Limit ground operations time outside air-conditioned environment to 45 minutes.

A3.3.3.3. If possible, wait in a cool shaded area if the aircraft is not ready to fly.

A3.3.3.4. Complete a maximum of two aircraft inspections, two exterior inspections on initial sorties, and one exterior inspection on subsequent sorties for fighters and trainers.

A3.3.3.5. Undergraduate Flying Training solo students should be limited to one exterior aircraft inspection per sortie.