THE NATION'S URANIUM PROCESSING FACILITY

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01/13/2020
Effective Date

Implements Quality Requirements

☒ None ☐ BNI ☐ CNS ☐ BNI and CNS

REVISION LOG

Is this revision the result of a periodic review?	☒ Yes ☐ No
Revision 7	☒ Major intent ☐ Minor intent ☐ Non-intent
• These changes are in response to Condition Report 25774-000-GCA-GAM-01861. • An evaluation determination has been performed confirming that this Command Media implements no quality requirements as tracked in the Programmatic Requirements Management System (PRMS). • Because of the extent of changes, revision bars are not shown.	
Revision 6	☒ Major intent ☐ Minor intent ☐ Non-intent
• This revision is a complete re-write; therefore, no revision bars are shown. This revision further establishes guidance and instructions for the protection of workers from heat and cold stress.	
Previous revisions on record	

CONTENTS

1.0 INTRODUCTION

1.1 Purpose

This procedure explains how to protect workers from heat and cold stress and treat the injuries/illnesses that such conditions can cause.

1.2 Scope

This procedure applies to all direct-hire employees and subcontractors/sub-tier subcontractors whose job assignments expose them to thermal stress conditions on the Uranium Processing Facility (UPF) construction site and support areas.

2.0 RESPONSIBILITIES

2.1 UPF Site Manager

The UPF Site Manager is responsible for:

- In conjunction with the Bechtel National, Inc. (BNI) Environmental Safety and Health (ES&H) Manager, ensuring the implementation of this procedure.
- Ensuring that all Project personnel actively follow this procedure.
- Providing worker support, facilities, and other resources necessary to effectively implement this procedure.

2.2 BNI ES&H Manager

The BNI ES&H Manager has the overall authority to interpret the:

- Regulations associated with this procedure.
- Intent and application of this procedure.

2.3 Industrial Hygiene Lead

The Industrial Hygiene Lead is responsible for:

- Overseeing compliance with this procedure via periodic field inspections and heat and cold stress monitoring.
- Providing training to the ESH Advisor related to heat and cold stress monitoring.
- Supplying technical advice for and interpretation of this procedure.

2.4 ESH Advisor

The ESH Advisor is responsible for:

- Assisting the Industrial Hygiene Lead with monitoring activities, when properly trained by the Industrial Hygiene Lead.

2.5 Discipline Superintendent

The Discipline Superintendent is responsible for:

- Being thoroughly familiar with this procedure and his or her individual responsibilities regarding compliance with and implementation of this procedure.
- Pre-planning work activities to identify the appropriate heat and cold stress work/rest cycles for workers to use.
- Ensuring that workers understand the requirements of this procedure.

2.6 Supervisor

The Supervisor is responsible for:

- Ensuring that the applicable safety controls and processes are incorporated into the planning and execution of work.
- Observing workers' performance and physical conditions relative to the temperatures and/or environmental conditions in which they are working.
- Understanding and following the work/rest cycle for his or her appropriate heat/cold exposure work area.
- Identifying newly hired employees who are not acclimatized and allowing them work/rest regiments in accordance with the Action Level curve.

2.7 Subcontract Technical Representative

The Subcontract Technical Representative is responsible for being familiar with:

- This procedure.
- His or her specific responsibilities regarding the implementation and enforcement of subcontractors.

2.8 Worker

Workers are responsible for:

- Understanding how this procedure applies to the work they perform.
- Complying with the requirements of this procedure.
- Identifying emerging heat and cold stress-related illnesses during work activities.

3.0 THERMAL STRESS PREVENTION, EVALUATION, AND CONTROL

This procedure complies with the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs), *Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*, by implementing a comprehensive management program.

3.1 Heat Stress Conditions

This section provide general information related to heat stress determination, heat stress evaluation, and hot weather preparation.

3.1.1 Heat Stress Evaluation and Determination

The detailed decision tree related to evaluating heat stress and strain is located in **Appendix B, *Heat Stress Information***, which also includes information on heat related disorders, signs, and symptoms.

Heat stress evaluation includes, but is not limited to, a combination of the following elements:

- Wet Bulb Globe Temperature (WBGT) level
- Level of clothing or Personal Protective Equipment worn
- Metabolic rate of the work activity
- Location of work (e.g., sun, shade, air-cooled, air-conditioned).

3.1.2 Hot Weather Preparation

When heat stress conditions are expected in upcoming activities, supervision (with assistance from the Industrial Hygiene Lead or Industrial Hygiene Specialist) shall begin planning for hot weather by taking the following steps:

- Establishing cooling stations (e.g., vehicles, shade structures, or cool rooms) for areas that may implement a work/rest cycle
- Setting up air-moving equipment (e.g., fans, air-conditioners)
- Preparing other materials and equipment, as necessary

NOTE: *The Project prefers that cooling stations are cooled or air-conditioned.*

- Briefing workers on heat-related hazards, symptoms, and work controls (refer to **Appendix B**), encouraging the practice of self-determination
- Beginning the evaluation of potential heat-related conditions/tasks
- Identifying preventative measures in daily and weekly planning meetings.
- Briefing supervisors on Appendix B related to acclimatization.

3.2 Cold Stress Conditions

This section provides information on cold stress factors, cold weather preparation, cold weather controls, and work/rest cycles.

3.2.1 Cold Stress Factors

Both environmental and personal health factors contribute to cold injury. These factors include exposure to cold temperatures, high humidity, high winds, contact with wetness and/or conductive (thermal) materials, and inadequate clothing.

Cold stress is best prevented by employing proper hydration and diet, as follows:

- **Hydration:** Significant water loss from the lungs and skin occurs upon exposure to dry, cold air. Increased fluid intake is essential to ensure proper hydration, which allows adequate blood flow to the extremities. Caffeine intake (i.e., coffee, energy drinks, or caffeinated drinks) should be limited because of its diuretic and circulatory effects.
- **Diet:** A well-balanced diet is important for individuals working in cold environments to ensure adequate stores of energy.

Cold stress can also be prevented by applying engineering controls (e.g., heated work areas), administrative controls (e.g., work/rest cycles, when necessary), and personal protective controls (e.g., proper clothing selection).

3.2.2 Cold Weather Preparation

When cold stress conditions are expected in the upcoming monthly activities, supervisors shall:

- Begin holding discussions regarding the implications of cold stress conditions.
- Brief personnel regarding the signs and symptoms of cold stress (described in detail in **Appendix C, *Symptoms of Cold Exposure***), the factors associated with cold stress, and the applicable work controls to prevent cold stress.
- Be aware of work conditions (e.g., weather forecast) and the physical condition of potentially affected workers.

3.2.3 Cold Weather Controls

When ambient temperatures are expected to reach 20°F or lower (providing consideration for wind chill factor) during the work shift, supervisors shall implement the following engineering and administrative control methods, as appropriate:

- Encourage all workers to use self-determination to:
  - Limit their exposure to cold stress conditions.
  - Recognize changes to their physical condition.
  - Promote awareness of cold stress signs and symptoms (refer to **Appendix C**).
- Make heated warming shelters (e.g., tents, cabins, rest rooms) available in close proximity to work activities.
- Have workers initiate discussions regarding cold-related environmental conditions during the Safety Task Analysis and Risk Reduction Talk (STARRT) card briefing specific to the area where work is performed.
- Promote and implement a buddy system for coworkers to regularly check on one another to look for signs or symptoms of cold stress. If signs or symptoms are observed, then coworkers shall take immediate action to seek heated shelters.
- Cover exposed skin as much as possible and ensure that workers do the same.
- Plan work so that it is performed away from windy, drafty, or unprotected areas as much as possible.
- Arrange work in such a way that sitting or standing still for long periods is minimized.
- Ensuring that the work rate is not so high as to cause heavy sweating that will result in wet clothing unless controls are mandated to rest and dry/change clothes in heated shelters.

3.2.4 Work/Rest Cycle

When the air temperature drops to -15°F (providing consideration for wind chill factor), contact Industrial Hygiene to assist in the implementation of work/warming schedules as outlined in the ACGIH TLVs and BEIs.

4.0 RECORDS

Records generated by this procedure shall be maintained in accordance with Y15-95-800, *UPF Document Management*. Record types for documents submitted to

the UPF Document Management Center (DMC) are identified in ML-PS-801768-A001, *Uranium Processing Facility Project Master Document Type List*. Quality type is listed as Quality-Lifetime (QA-L), Quality-Nonpermanent (QA-NP), or Non-Quality (Non-QA).

Records generated during the performance of this procedure include:

Record or Form Number	Record Title	Record Holder	System/ Location	Quality Type
RP-SH-801768-AXXX	*Heat Stress Data-Log Report*	UPF DMC	InfoWorks	Non-QA

5.0 REFERENCES

5.1 Source References

Bechtel Core Process CP-314, *Heat and Cold Stress Prevention*

Bechtel Manual 4SM-6BH-F0001, *BNI NS&E ES&H Manual*

DI-SH-801768-A007, *Cold Stress Communication Guidance*

Y17-95-64-823, *UPF Safety Task Analysis and Risk Reduction Talk/Job Hazard Analysis Program (STARRT/JHA) Process*

5.2 Interfacing References

ACGIH TLVs and BEIs, *Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*

ML-PS-801768-A001, *Uranium Processing Facility Project Master Document Type List*

Y15-95-800, *UPF Document Management*

Y78-001, *Occupational Medicine Program*

6.0 SUPPLEMENTAL INFORMATION

Appendix A, *Acronyms and Definitions*

Appendix B, *Heat Stress Information*

Appendix C, *Symptoms of Cold Exposure and Cold Stress Factors*

APPENDIX A
Acronyms and Definitions

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Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
BEI	Biological Exposure Index
BNI	Bechtel National, Inc.
CTS	Carpal Tunnel Syndrome
ELV	Exposure Limit Value
HAVS	Hand-Arm Vibration Syndrome
PPE	Personal Protective Equipment
STARRT	Safety Task Analysis and Risk Reduction Talk
TLV	Threshold Limit Value
UPF	Uranium Processing Facility
WBGT	Wet Bulb Globe Temperature

Definitions

Acclimatize	A physiological adaptation that improves an individual's ability to tolerate heat stress A person is considered acclimatized if they have worked in a non-air-conditioned environment with an outdoor temperature at or above 85°F for a period that allows them to become accustomed to the temperature.
Acrocyanosis (Cyanosis)	A bluish, purple, or grayish discoloration of the skin (e.g., on the hands and feet) and mucous membranes caused by deficient levels of oxygen in the blood that result from exposure to the cold
Ambient Temperature	The temperature of air measured by a thermometer freely exposed to the air but shielded from radiation and moisture
Buddy System	The buddy system is the practice of organizing workers into work groups so that each worker is in view of or in contact with at least one other worker in the group in order to watch for signs or symptoms of heat/cold stress in their coworkers.
Cold Stress	A condition that arises from exposure to cold temperatures and wind and that can lead to disorders like frostbite and hypothermia
Core Body Temperature	The internal temperature of the central part of the body
Diuretic	A substance or liquid that tends to increase the discharge of urine
Encapsulating Suits	Synonymous with "completely encapsulating suits" (ACGIH TLV uses both terms) The level A Hazardous Materials suit is the most definitive example of totally-encapsulating personal protective equipment (PPE). However, a wide range of PPE and respiratory protection ensembles approach this circumstance wherein a micro-climate created within the PPE will invalidate workplace environmental characterizations such as WBGT. Where PPE substantially restricts air or water vapor movement, either physiological monitoring or detailed analysis by the project industrial hygienist is necessary.
Frostbite	Damage to skin and subcutaneous tissues resulting from exposure to extreme cold; symptoms include numbness, itching, tingling, or a burning sensation upon cooling of the skin
Heat Stress	Heat stress is a condition that arises from a variety of factors among the most important of which are the ambient temperature, the relative humidity, the level of effort required by the job, and the clothing being worn by a worker. An individual who is experiencing heat stress will tend to exhibit an array of measurable symptoms that can include an increased pulse rate, a greater rate of perspiration (except for heat stroke), and an increase in the individual's body temperature. The body's response to heat stress is sometimes referred to as heat strain.
Hypothermia	A condition in which the body loses heat more quickly than it can be produced and the core body temperature drops dangerously low (95°F or lower)

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Acronyms and Definitions

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Impermeable Clothing	Coveralls, for example Coverall materials are available in a huge variety of materials and range of permeability, marketed using adjectives such as vapor-permeable, semi-permeable, microporous, breathable, splash resistant, fluid-resistant, and splash-proof, among many others. Virtually all these PPE choices will inhibit evaporation from the skin surface to some extent and consequently have some impact on heat stress
Rest Period	A period in which the worker moves or is moved from a hot or cold work environment to a more benign environment to allow recovery from the effects of extremely hot or cold temperatures
Self-Determination	The method by which an individual may begin to recognize the early warning signs of heat/cold-related disorder and seek relief from the heat/cold stress exposure; may shorten assigned work times
SMS	Spunbonded polypropylene/Meltblown polypropylene, a layered PPE material
Sustained Heart Rate	For the purposes of this procedure, a sustained peak heart/pulse rate is present when the measured rate spends several minutes (~ 4 or more minutes) at or above a value equal to 180 minus the individual's age in years, expressed in BPM.
Wet Bulb Globe Temperature (WBGT)	A measurement that approximates "effective temperature" and takes into account virtually all the commonly accepted mechanisms of heat transfer (i.e., radiant, evaporative, conductive, etc.). Because of its simplicity, WBGT has been adopted by the ACGIH as its principal index for use in specifying a heat stress related TLV. The WBGT is computed according to the following algebraic sums: • WBGT Outdoors = 0.7 [natural wet bulb] + 0.2 [globe temperature] + 0.1 [dry bulb temperature] • WBGT Indoors = 0.7 [natural wet bulb] + 0.3 [globe temperature]
Wind Chill	The apparent temperature felt on exposed caused by the combination of air temperature and wind speed
Work/Rest Cycle	The amount of time between a period of work and rest (up to two hours) that allows the body to recover from the heat or cold stress

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Heat Stress Information
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Evaluating Heat Stress and Strain

The process indicated in **Figure 1** for evaluating heat stress and strain shall be initiated if:

1. A qualitative exposure assessment indicates the possibility of heat stress.
2. There are reports of discomfort due to heat stress.
3. Professional judgment indicates heat stress conditions.

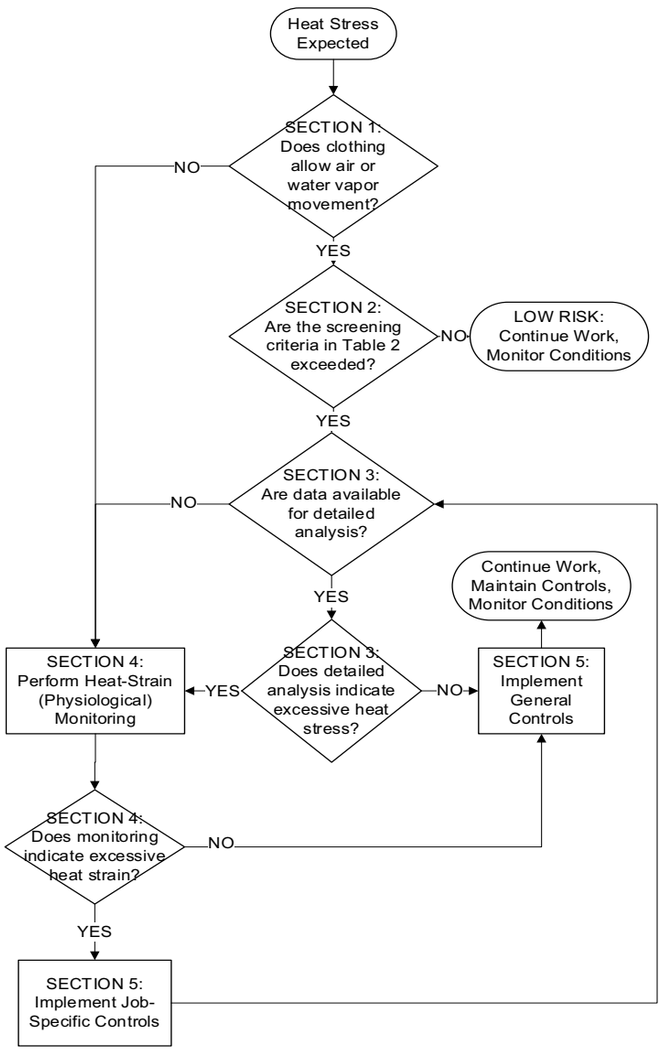

Figure 1. Decision tree for evaluating heat stress and strain.

Section 1—Clothing

The free movement of cool, dry air over the skin's surface maximizes heat removal via evaporation and convection.

The predominant heat removal mechanism for the body is the evaporation of sweat from the skin. Water-vapor-impermeable, air-impermeable, and thermally-insulating clothing (including encapsulating suits and multiple layers of clothing) severely restrict heat removal from the body. When heat removal is hampered by clothing, metabolic heat may produce excessive heat strain even when ambient conditions are considered cool.

The first section of the decision process (refer to **Figure 1**) is the selection of clothing adjustment values, if applicable.

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Table 1 lists some example clothing adjustment values based on the WBGT-based heat exposure assessment. This assessment applies to the traditional work uniform of a long-sleeve shirt and pants. If work clothing for a specific task deviates from the traditional work uniform, then add the clothing adjustment value to the environmental WBGT and proceed to **Section 2** of this appendix.

Table 1. Clothing Adjustment Values for Standard Clothing

Clothing Type	Addition to WBGT (in °F)
Work Clothes (long sleeve shirt and pants)	0
Cloth (woven material) Coveralls	0
Double Layer Woven Clothing	5.4
SMS Polypropylene Coveralls	0.9
Polyolefin Coveralls	1.8
Limited-Use Vapor-Barrier Coveralls	19.8

Section 2—Screening Threshold Based on WBGT

The WBGT is a first-order index of environmental contributions to heat stress. It is influenced by air temperature, radiant heat, air movement, and humidity. **Table 2** provides the WBGT criteria suitable for screening purposes only. To determine the degree of heat stress exposure, consider the work pattern and demands. When the work (and rest) is performed in more than one location, use the time-weighted average WBGT and compare it with the limits in **Table 2**.

Table 2. Screening Criteria for TLV and Action Limit for Heat Stress Exposure

	TLV (WBGT values in °F)				Action Limit (WBGT values in °F)			
Allocation of Work in a Cycle of Work and Recovery	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75%-100%	87.8	82.4	-	-	82.4	77.0	-	-
50%-75%	87.8	84.2	81.5	-	83.3	78.8	75.2	-
25% to 50%	89.6	86.0	84.2	82.4	85.1	80.6	77.9	76.1
0 to 25%	90.5	88.7	86.9	86.0	86.0	84.2	82.4	80.6

After calculating the time-weighted average WBGT and adding the clothing adjustment value (if applicable), use **Table 3** to determine the work rate category for the given activity. Based on the metabolic rate category for the activity and the approximate proportion of work within an hour, a WBGT criterion can be found in **Table 2** for the TLV and for the Action Limit, for screening purposes only.

Table 3. Metabolic Rate Categories and Representative Metabolic Rate with Example Activities

Category	Metabolic Rate (W)	Examples
Rest	115	Sitting
Light	180	Sitting with light manual work with hands or hands and arms, and driving. Standing with some light arm work and occasional walking
Moderate	300	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling; normal walking
Heavy	415	Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at fast pace
Very Heavy	520	Very intense activity at fast to maximum pace

If the measured time-weighted average WBGT adjusted for clothing is less than the table values for the Action Limit, then follow the “NO” branch of the “Section 2” shape in **Figure 1**. This means that there is little to no risk of excessive exposure to heat stress, and work can continue.

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If conditions are above the Action Limit but below the TLV, then implement the necessary general controls listed in **Table 4**. If there are reports of the symptoms of heat-related disorders such as fatigue, nausea, dizziness, and lightheadedness, then the Industrial Hygiene Lead or designee will reconsider the initial evaluation.

Table 4. Elements of Heat Stress Management Program

*Monitor heat stress (e.g., results from the detailed analysis) or heat strain [refer to **Table 5**] to confirm adequate control.*
General Controls
Provide accurate verbal and written instructions, annual training programs, and other information about heat stress and strain
Encourage drinking small volumes (approximately 1 cup) of cool, palatable water (or other acceptable fluid replacement drink) about every 20 minutes and provide multiple water stations
Encourage employees to report symptoms of heat-related disorders to a supervisor or ES&H representative
Encourage self-limitation of exposure
Encourage co-worker observation to detect signs and symptoms of heat strain in others
Counsel and monitor those who take medications that may compromise normal cardiovascular, blood pressure, body temperature regulation, renal, or sweat gland functions; or those who are not acclimatized; and those who are recovering from the abuse of alcohol or other intoxicants
Encourage healthy lifestyles, ideal body weight and electrolyte balance
Adjust expectations of those returning to work after absence from hot exposure situations
Perform pre-placement medical screening to identify those susceptible to systemic heat injury, per Y78-001.
Monitor the heat stress conditions and reports of heat-related disorders
Job-Specific Controls
Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water vapor release, and shielded radiant heat sources
Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain
Consider personal protection that is demonstrated effective for the specific work practices and conditions at the location

If the work conditions are above the TLV screening-criteria in **Table 2**, then follow the “YES” branch of the “Section 2” shape in **Figure 1** and complete a detailed analysis as described in **Section 3** of this appendix.

Section 3—Detailed Analysis

Table 2 is only intended for screening. It is often possible that a condition may be above the TLV or Action Limit criteria provided in **Table 2** and still not represent an exposure above the TLV or the Action Limit. To make this determination, perform a detailed analysis in accordance with the manual method described in the *ACGIH Background Documentation regarding Heat Stress and Strain*.

Work-rest cycles are designed to bring an exposure to the TLV by prescribing what portion of the work cycle should be spent in recovery. The manual method described by **Equation 1** for determine the amount of recovery time (tr) is expressed as the fraction of a cycle time (tc) after a period of work (tw) follows. The basis of this equation is formed by plotting the work conditions (WBGTw and Mw) and recovery conditions (WBGTr and Mr) on the TLV graph. The WBGTw and WBGTr values for all applicable work areas will be measured.

$$\text{Given the following: } TWA = \frac{(WBGT_w \times t_w) + (WBGT_r \times t_r)}{(t_w + t_r)}$$

$$\text{and } t_c = t_w + t_r$$

$$\text{Then: } \frac{t_r}{t_w} = \frac{(TWA - WBGT_w)}{(WBGT_r - WBGT_w)}$$

Equation 1. Manual method to determine the amount of recovery time (t_r).

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The TLV is the value of WBGT at the intersection of the TLV curve and the line connecting the work and recovery locations, as illustrated in **Figure 2**.

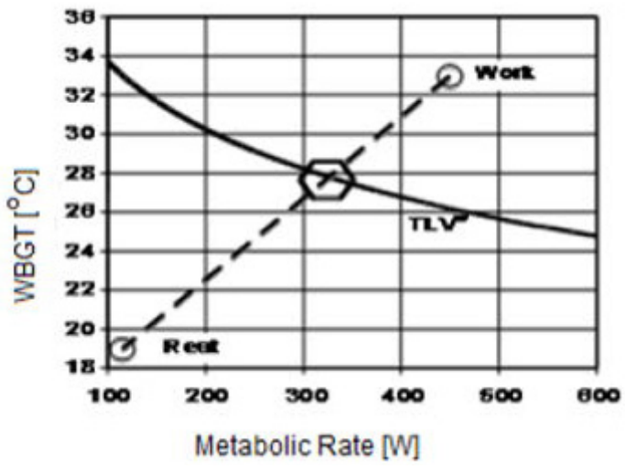

Figure 2. Illustration of the method for finding a TLV for a combination of work and rest conditions.

Using **Equation 2** for the TLV, a computer-based implementation method may be developed to streamline the calculations.

$$TLV\ [℃ - WBGT] = REL[℃ - WBGT] = 56.7 - 11.5 \log_{10} M\ [W]$$

$$AL[℃ - WBGT] = RAL[℃ - WBGT] = 59.9 - 14.1 \log_{10} M\ [W]$$

Equation 2. Action Limit and TLV curve fitting equation.

If the exposure determined by the detailed analysis does not exceed the criteria for the Action Limit, then follow the “NO” branch of the “Section 3” shape in **Figure 1**.

If the Action Limit criteria are exceeded but the criteria for the TLV in the detailed analysis are not exceeded, then implement the necessary general controls listed in **Table 4** and continue to monitor the conditions.

If the exposure from the detailed analysis exceeds the TLV limits, then follow the “YES” branch of the “Section 3” shape in **Figure 1** to monitor physiological conditions in order to demonstrate that adequate protection is provided.

If the data ($WBGT_w/M_w$ and $WBGT_r/M_r$, clothing adjustment values, etc.) required for the detailed analysis is not available, then follow the “NO” branch of the “Section 4” shape in **Figure 1** to assess the degree of heat strain by evaluating physiological conditions.

Section 4—Physiological Monitoring

General site activities will be planned and executed in environmental conditions that keep the workforce exposure below the TLV. To date, the project has not required physiological monitoring. However, some high-risk activities may require physiological monitoring to assess the exposure to heat strain. The normal physiological responses to heat stress provide an opportunity to monitor heat strain among Project personnel. This information should further be used to assess the level of heat strain present in the workforce, control exposures, and assess the effectiveness of implemented controls. **Table 5** provides guidance for acceptable limits of heat strain.

Table 5. Guidelines for Limiting Heat Strain

One or more of the following measures may mark excessive heat strain, and an individual’s exposure to heat stress should be discontinued when any of the following occur:
Sustained (several minutes) heart rate is in excess of 180bpm (beats per minute) minus the individual’s age in years (180 – age) for individuals with assessed normal cardiac performance; or
Body core temperature is greater than 38.5°C (101.3°F) for medically selected personnel and acclimatized personnel; or greater than 38°C (100.4°F) in unselected, unacclimatized workers; or
Recovery heart rate at one minute after a peak work effort is greater than 120bpm; or
There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness.

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Table 5, cont.
An individual may be at greater risk of heat-related disorders if:
Profuse seating is sustained over hours; or
Weight loss over a shift is greater than 1.5% of body weight; or
24-hour urinary sodium excretion is less than 50 moles.

If acceptable levels of heat strain are found during physiological monitoring, then follow the “NO” branch of the “Section 4” shape in **Figure 1**.

If heat strain conditions are found during physiological monitoring, then follow the “YES” branch of the “Section 4” shape in **Figure 1** and implement job-specific controls (as listed in **Table 4**), as necessary. After the implementation of job-specific controls, assess their effectiveness and make adjustments, as necessary.

Section 5 – Heat Stress Management and Controls

The elements of a heat stress management program (including general and job-specific controls) are considered based on the local environmental conditions and professional judgement from the Project Industrial Hygienists.

The heat stress management program is initiated when either of the following occur:

1. Heat stress levels exceed the Action Limit.
2. Personnel perform work in clothing that limits heat loss.

In these situations, implement the necessary general controls listed in **Table 4**.

Additionally, job-specific controls are often required to provide adequate protection to Project personnel. During the consideration of job-specific controls, use **Table 1**, **Table 2**, **Table 3**, and **Figure 2** to evaluate the interactions between acclimatization state, metabolic rate, work-rest cycles, and clothing. When physiological monitoring is necessary, refer to **Table 5** for acceptable signs/symptoms and limits.

Acclimatization

Acclimatization is the beneficial physiological adaptations that occur during repeated exposure to a hot environment. These physiological adaptations include:

•Increased sweating efficiency (earlier onset of sweating, greater sweat production, and reduced electrolyte loss in sweat).

•Stabilization of the circulation.

•The ability to perform work with lower core temperature and heart rate.

•Increased skin blood flow at a given core temperature.

To acclimatize workers, gradually increase their exposure time in hot environmental conditions over a 7-14 day period. New workers will need more time to acclimatize than workers who have already had some exposure. Because acclimatization is to the level of the heat stress exposure, a person will not be fully acclimatized to a sudden higher level, such as during a heat wave. The Action Limit curve will be used to prescribe work/rest cycles for all identified unacclimatized worker.

Heat Stress Disorders—Causes and Symptoms

Heat stress may occur whenever work is performed at elevated temperatures or when protective clothing is worn. Heat stress symptoms include fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement. If the body’s physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur, ranging from mild to fatal. Employees must learn to recognize and treat the various forms of heat stress.

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A number of disorders associated with excessive exposure to hot working conditions can pose serious, even life threatening effects on individuals. These are described as follows.

- **Heat Rash**

  Heat rash is caused by continuous exposure to heat and humid air and is aggravated by chafing clothes. This condition decreases a person's ability to tolerate heat.

  - **Symptoms:** The symptoms of heat rash include mild, red rash, especially on areas of the body in contact with protective gear.
  - **Treatment:** Heat rash is treated by decreasing the amount of time workers wear protective gear and by applying powder to affected areas to help absorb moisture and decrease chafing. Immediately report to the UPF Occupational Medical Provider.

- **Heat Cramps**

  Heat cramps are caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a heat exposure situation that can lead to the more serious condition of heat stroke.

  - **Symptoms:** Heat cramps are characterized by acute painful spasms of the typically voluntary muscles (e.g., abdomen and extremities).
  - **Treatment:** Move the victim to a cool area and loosen their clothing. Have the victim drink 250–500 ml of water immediately and every 20 minutes thereafter until symptoms subside. Immediately report the incident to the UPF Occupational Medical Provider.

- **Heat Exhaustion**

  Heat exhaustion is a state of weakness or exhaustion caused by the loss of fluids from the body. This condition, although less dangerous than heat stroke, must be treated.

  - **Symptoms:** The symptoms of heat exhaustion include pale, clammy, moist skin; profuse perspiration; and extreme weakness. Body temperature will be normal, the pulse will be weak and rapid, and breathing will be shallow. The victim may have a headache, may vomit, and/or may be dizzy.
  - **Treatment:** Move the victim to a cool place, loosen their clothing, place the victim in a head-low position, and provide bed rest. Have the victim drink a cup of water immediately and every 20 minutes thereafter until symptoms subside. Immediately report the incident to the UPF Occupational Medical Provider.

- **Heat Stroke**

  Heat stroke is an acute and dangerous reaction to heat stress caused by a failure of the heat-regulating mechanisms of the body (i.e., the temperature control system that causes sweating stops working properly). During an episode of heat stroke, the body temperature can rise so high that brain damage and death may result if the person is not cooled quickly.

  - **Symptoms:** The symptoms of heat stroke include red, hot, dry skin (although the person may have been sweating earlier); nausea; dizziness; confusion; extremely high body temperature; rapid respiratory and pulse rate; and unconsciousness or coma.
  - **Treatment:** Call the Plant Shift Superintendent or 911.

APPENDIX C
Symptoms of Cold Exposure

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Symptoms of Cold Exposure

Exposure to low temperatures may be a factor if work is performed during any of the following:

- Evening hours
- High wind conditions
- Unpredictable weather
- Winter months.

The first physiologic response to cold exposure is constriction of blood vessels, which inhibits sweat gland functions, causes shivering, and releases extra glucose for heat production.

Hypothermia

When the body can no longer maintain its core temperature by constricting blood vessels, it shivers to increase heat production. Maximum severe shivering develops when the core body temperature has fallen to 35°C (95°F). The most critical aspect of hypothermia is the body's failure to maintain its deep core temperature. Lower body temperatures present the following signs and symptoms:

- Persistent shivering (usually starts when core temperature reaches 35°C [95°F])
- Irrational or confused behavior
- Reduced mental alertness
- Poor coordination, with obvious effects on safety
- Reduction in rational decision-making.

In addition, acute exertion in cold temperatures can constrict blood vessels in the heart.

Hypothermia Stages

Early signs of mild hypothermia include:

- Shivering
- Blue lips and fingers
- Pain in the extremities
- Numbness, itching, or burning
- Poor coordination.

Signs of the next stage, moderate hypothermia, include:

- Slurred speech
- Exhaustion
- Mental impairment
- Confusion
- Poor decision-making
- Drowsiness
- Disorientation
- Inability to take precautions from the cold
- Heart slowdown/weak pulse
- Slow breathing.

In severe cases, hypothermia resembles death. However, patients must be treated as though they are alive. Symptoms include:

- Unconsciousness
- Heart slowdown to the point where pulse is irregular or difficult to find
- No shivering
- No detectable breathing.

APPENDIX C
Symptoms of Cold Exposure

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First Aid for Hypothermia

Stop further cooling of the body and provide heat to begin rewarming.

Carefully move the victim to shelter. Sudden movement or rough handling can upset heart rhythm.

Keep the victim awake.

Immediately report the incident to the UPF Occupational Medical Provider.

Frostbite Signs and Symptoms

Frostbite symptoms vary. They are not always painful but often include a sharp, prickling sensation. The first indication of frostbite is skin that looks waxy and feels numb. Workers should observe each other's facial extremities (e.g., ears and nose) and exposed skin for signs of frostbite (e.g., whitening of the skin surface) or acrocyanosis (i.e., a blue, purple, or grayish hue).

Frostbite First Aid

Once frostbite occurs, report the incident immediately to the UPF Occupational Medical Provider to administer treatment.