THE NATION'S URANIUM PROCESSING FACILITY

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REVISION LOG

Revision 9 ☒ Intent ☐ Non-Intent

- These changes are in response to Condition Report 25774-000-GCA-GAM-04029, Action #6, *Revise CP-314, Heat and Cold Stress Prevention, for guidance and utilization of Heat Stress Calculator*
  - Created Appendix D, *Use of WBGT Monitor and Heat Stress Calculator*
- An evaluation determination has been performed confirming that this Procedure does not implement requirements tracked in the Programmatic Requirements Management System (PRMS)
- No forms have been edited as part of this revision
- Other changes include:
  - Added to Section 2.4, *ES&H Advisor*
  - Added new paragraph to Section 3.1.1, *Heat Stress Evaluation and Determination*
  - Updated Section 3.1.3, *Hot Weather Preparation*, first bullet
  - Updated Section 4.0, *Records*, to align with latest UPF template and updated footer note for Records table
  - Updated references
  - Updated acronyms
  - Editorial changes

Revision 8 ☒ Intent ☐ Non-Intent

- These changes are in response to Condition Report 25774-000-GCA-GAM-04029, Action #7, *Revise UPF-CP-314*
  - Added Section 3.1.2, *Heat Stress Communications*
  - Added Section 3.1.4, *Training*
  - Modified Sections 3.1.1, *Heat Stress Evaluation and Determination*; 3.1.2, *Heat Stress Communications*; and 3.1.3, *Hot Weather Preparation*
  - Modified Sections 2.3, *Industrial Hygiene Lead*; 2.4, *ESH Advisor*; and 2.6, *Supervisor*
  - Updated Section 4.0, *Records*
- This revision incorporates the Pen and Ink Change issued on 08/29/2022
- Form changes:
  - UCN-23507, *Work Area WBGT Heat Stress Data* – NEW
  - UCN-23509, *Rest/Cool Down Area Log* – NEW
- An evaluation determination has been performed confirming that this Procedure does not implement requirements tracked in the Programmatic Requirements Management System (PRMS)
- Other changes include:
  - Updated Section 3.2.2, *Cold Weather Preparation*
  - Updated Appendix B, *Heat Stress Information*
  - Updated references
  - Updated acronyms
  - Editorial changes

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 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 ES&H Advisor related to heat and cold stress monitoring to ensure weekend and overnight monitoring is conducted
- Supplying technical advice for and interpretation of this Procedure

2.4 ES&H Advisor

The ES&H Advisor is responsible for:

- Assisting the Industrial Hygiene Lead with monitoring activities, when properly trained by the Industrial Hygiene Lead
- When Industrial Hygiene is not available, ES&H Advisor will have to complete calculations for weekend and night shift operations, when properly trained by the Industrial Hygiene Lead

- Communicating Wet Bulb Globe Temperature readings to the Industrial Hygiene Lead and recording the readings on forms UCN-23507, *Work Area WBGT Heat Stress Data*, and UCN-23509, *Rest/Cool Down Area Log*
- Performing heat stress monitoring, calculating work/rest regiments, and communicating work/rest regiments in accordance with **Appendix B, *Heat Stress Information***, and **Appendix D, *Use of WBGT Monitor and Heat Stress Calculator***

2.5 Discipline Superintendent

The Discipline Superintendent is responsible for:

- Being thoroughly familiar with this Procedure and their 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 workers understand the requirements of this Procedure

2.6 Supervisor

The Supervisor is responsible for:

- Ensuring 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.
- Ensuring workers are using cool down and warm-up areas, as appropriate, for their rest period
- 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 (STR) is responsible for being familiar with:

- The requirements and processes of 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 performed
- 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 provides 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** which also includes information on heat-related disorders, signs, and symptoms. Work/rest regiments will be calculated utilizing the information obtained from the detailed analysis described in **Appendix B** and in accordance with the instructions of **Appendix D**. UCN-23507 will be used to document the work and rest area WBGT and the work/rest regiments prescribed.

The Project heat-stress evaluation includes a combination of the following elements:

- Wet Bulb Globe Temperature (WBGT) level
- Level of clothing, or personal protective equipment (PPE), worn
- Metabolic rate of the work activity
- Location of work (e.g., sun, shade, air-cooled, air-conditioned)
- Education of workforce on process of self-determination

3.1.2 Heat Stress Communications

Heat stress communications include:

- When heat stress conditions are anticipated, ES&H will post advisories for heat stress (Daily Information Sheet and Safely Speaking). Supervisors flowdown this information and advise employees when they are at increased risk of developing heat-related illness
- When a work/rest regimen is in effect, ES&H will communicate the work/rest regimen via radio announcements and text messages. Announcements will be made based upon the conditions observed with the temperatures taken from the work area and will specify which work/rest regimen is in effect
- Supervisors and STRs are responsible for flowdown of work/rest announcements and for understanding in what areas their employees/subcontractors are working
- A repeat radio notification will be sent out five minutes after the first one to ensure all workers affected by the work/rest regimen are notified and have enough time to take their rest period, if applicable

3.1.3 Hot Weather Preparation

When heat stress conditions are expected (ambient air temperature of 80°F) 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, cool rooms) for areas that may implement a work/rest cycle. Cool down areas will be inspected periodically and recorded on UCN-23509. Cooling stations have a target temperature range of 70°F to 76°F WBGT, where the exact temperature shall be up to the discretion of the Lead Industrial Hygienist. It is possible for cool down areas to have different WBGT values; however, areas with higher WBGT values will have longer rest regiments calculated as described in **Appendix D**

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

- Setting up air-moving equipment (e.g., fans, air-conditioners)
- Preparing other materials and equipment, as necessary
- Briefing workers on heat-related hazards, symptoms, and work controls (refer to **Table 4**, **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

3.1.4 Training

All employees will go through the *UPF Heat Stress Awareness* training class on their hire date and through a timely annual refresher of the information before heat stress conditions are anticipated.

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
- Refer to DI-SH-801768-A007, *Cold Stress Communication Guidance*, when project workers are exposed to temperatures 20 degrees Fahrenheit or less

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 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 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 Document shall be maintained in accordance with Y15-95-800, *UPF Document Management*.

The following records generated are:

Record or Form Number	Record Title	System/ Location	Document Type
RP-SH-801768-AXXX[i]	*Heat Stress Data-Log Report*	InfoWorks	RP
UCN-23507	*Work Area WBGT Heat Stress Data*	InfoWorks	WBGT
UCN-23509	*Rest/Cool Down Area Log*	InfoWorks	RCDA

i. Raw data from the WBGT monitors shall be downloaded in a timely manner and uploaded to InfoWorks as RP-SH-801768-AXXX.

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*

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

5.2 Interfacing References

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

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

Y15-95-800, *UPF Document Management*

Y78-001, *Occupational Medicine Program*

5.3 Forms

UCN-23507, *Work Area WBGT Heat Stress Data*

UCN-23509, *Rest/Cool Down Area Log*

6.0 SUPPLEMENTAL INFORMATION

Appendix A, *Acronyms and Definitions*

Appendix B, *Heat Stress Information*

Appendix C, *Symptoms of Cold Exposure*

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.
BPM	Beats Per Minute
ES&H	Environmental, Safety, and Health
PPE	Personal Protective Equipment
STR	Subcontract Technical Representative
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 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 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.

APPENDIX A
Acronyms and Definitions

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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 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).
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 beats per minute (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 (e.g., radiant, evaporative, conductive). 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 skin 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

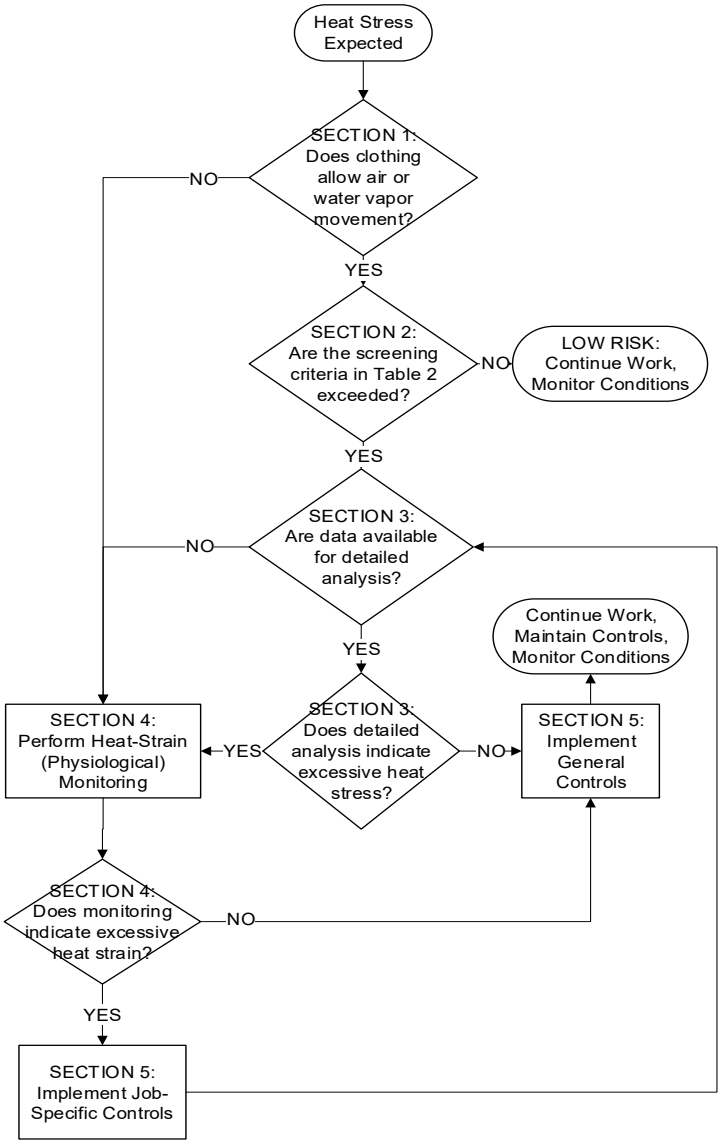

Figure 1. Decision Tree for Evaluating Heat Stress and Strain

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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.

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%–50%	89.6	86.0	84.2	82.4	85.1	80.6	77.9	76.1
0–25%	90.5	88.7	86.9	86.0	86.0	84.2	82.4	80.6

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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 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; 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.

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 one 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; those who are not acclimatized; and/or those who are recovering from the abuse of alcohol or other intoxicants
Encourage healthy lifestyles, ideal body weight, and electrolyte balance

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Table 5. Elements of Heat Stress Management Program (cont.)

*Monitor heat stress (e.g., results from the detailed analysis) or heat strain (refer to **Table 5**) to confirm adequate control.*
General Controls
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, *Occupational Medicine Program*
Monitor heat-stress conditions. Selection of location and number of WBGT monitors is based upon the location of the work fronts being completed. Data will be recorded on UCN-23507, *Work Area WBGT Heat Stress Data*
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 PPE 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, *Heat Stress and Strain*, background documentation.

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** to determine the amount of recovery time (t_r) is expressed as the fraction of a cycle time (t_c) after a period of work (t_w) follows. The basis of this equation is formed by plotting the work conditions ($WBGT_w$ and M_w) and recovery conditions ($WBGT_r$ and M_r) on the TLV graph. The $WBGT_w$ and $WBGT_r$ 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**.

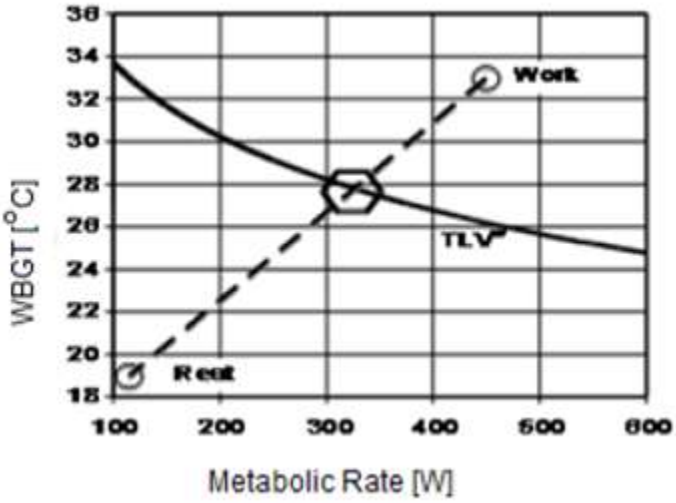

Figure 2. Illustration of the Method for Finding a TLV for a Combination of Work and Rest Conditions

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 (e.g., $WBGT_w/M_w$ and $WBGT_r/M_r$, clothing adjustment values) 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.

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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 6. 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 180 BPM minus the individual's age in years (180 – age) for individuals with assessed normal cardiac performance
• 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
• Recovery heart rate at one minute after a peak work effort is greater than 120 BPM
• There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness
An individual may be at greater risk of heat-related disorders if:
• Profuse sweating is sustained over hours
• Weight loss over a shift is greater than 1.5% of body weight
• 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**.

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Heat Stress Information

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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.

Although ACGIH does not specify a frequency of WBGT readings, the frequency should be sufficient to capture the general site conditions being experienced on the project at a given point in time. Frequency of reading will take into account the following:

- Forecast temperatures for the day
- General conditions throughout the work shift (e.g., cloudy, time of day, wind load)
- Time of day (morning, midday, evening, night)
- Trend of data recorded (Are values increasing at an unusual rate?)

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.

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

APPENDIX B
Heat Stress Information

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- **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

APPENDIX C
Symptoms of Cold Exposure

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- 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

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.

APPENDIX D
Use of WBGT Monitor and Heat Stress Calculator

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This Appendix applies to all Uranium Processing Facility ES&H personnel with responsibility to perform heat stress monitoring and work rest calculations.

Process Description

A detailed decision tree related to evaluating heat stress and strain is located in **Appendix B** of this Core Process. Additional information on heat related disorders, signs, and symptoms can also be found in **Appendix B**. Heat stress evaluation includes, but is not limited to, a combination of the following elements:

- Wet Bulb Globe Temperature
- Level of clothing or PPE worn
- Metabolic rate of work activity
- Location of work (e.g., Outdoors [any work in Balance of Plant], Indoors [Buildings, Designated Cool Down/Rest areas])

Using QuestTemp 34

Use the following link and choose PDF file quest 34. The file is a pre-use check.

H:\SH ESH\00 - ESH Construction\800 - Industrial Hygiene\810 - IH Equipment

Quest User Manual

Use the following link and choose PDF file #M QUESTemp 34_36 User Manual for detailed information on the operation of the WBGT monitor.

H:\SH ESH\00 - ESH Construction\800 - Industrial Hygiene\810 - IH Equipment\IH Monitoring Equipment\3M files

The WBGT meter is placed in direct sunlight as close to the work area as possible. Other high heat areas with no sunlight may need to be evaluated as required. Upon initial set up or when moving from outside to inside locations, wait 10 to 15 minutes for the instrument to stabilize.

Utilizing UCN-23507 or UCN-23509, record the temperature that appears after $WBGT_O$ (Outside) or $WBGT_I$ (Inside) accordingly.

If taking readings during the regular shift, communicate the readings to the UPF BNI Industrial Hygiene Lead or designee. If taking readings during off hours or weekends, use the reading to calculate work rest regimens.

The Heat Stress Calculator may be found at the following link:

H:\SH ESH\00 - ESH Construction\800 - Industrial Hygiene\830- Heat Cold Stress\calc

Input the work area and rest area WBGT values ($WBGT_o$ value for outdoors and $WBGT_i$ value for indoors conditions) and select the "Calculate" button to determine the prescribed work/rest regiment.

APPENDIX D
Use of WBGT Monitor and Heat Stress Calculator

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Announcement

Radio Announcement: Announce calculated Work/Rest Regimen on all radio channels, using the following language:

ATTENTION ATTENTION ATTENTION

We are on a work Rest Regimen. Work (i.e., outdoors - full sun, outdoors - shade, etc. - depending on the work area conditions) is XX minutes on XX minutes off. I repeat, we are on a work rest regimen. Work (i.e., outdoors - full sun, outdoors - shade, etc. - depending on the work area conditions) is XX minutes on XX minutes off. Utilize cool down areas during the rest period. Supervisors confirm you have received the work rest regimen.

NOTE: *Repeat after five minutes to ensure supervisors received the notification.*