

One Team. One Culture.

Administrative Procedure

PRC-PRO-SH-121

Heat Stress Control

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Change Summary

Description of Change

Revised to align physiological monitoring direction with recommend practices identified by the American Conference of Governmental Industrial Hygienists (ACGIH).

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1.0 INTRODUCTION**1.1 Purpose**

This procedure establishes requirements for working in CH2M HILL Plateau Remediation Company (CHPRC) areas where there is a potential for heat stress, and provides a process to mitigate heat strain and prevent heat stroke. This procedure implements some of the CHPRC Worker Safety and Health Program Plan requirements and is in compliance with Title 10, *Code of Federal Regulations (CFR), Part 851, Worker Safety and Health Program.*

1.2 Scope

This procedure applies to all CHPRC activities having a potential for heat stress, and applies to all CHPRC employees, including subcontractors.

1.3 Applicability

This Level 2 procedure is applicable to CHPRC employees and subcontractors who work in areas having a potential for heat stress.

1.4 Implementation

This procedure is effective upon publication.

2.0 RESPONSIBILITIES

All responsibilities associated with this procedure are identified in the process steps.

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3.0 PROCESS

CHPRC's heat stress control program follows the process identified in Figure 1, "CHPRC Decision Logic for Heat Stress Control," and uses information from planning tables that factor in the Wet Bulb Globe Temperature (WBGT) value, clothing ensemble, metabolic work rate, and worker acclimatization status. Figure 1 and planning tables are used by Occupational Safety and Industrial Hygiene (OS&IH) to assess heat stress and strain, evaluate risk to workers, collect physiological screening data, and establish Work-Rest cycles.

3.1 Preparation for Seasonal Heat Stress

Actionee	Step	Action
Responsible Manager (RM)	1.	<p>Prior to the onset of warm weather, or where the heat stress conditions identified in Section 3.2 could occur, PREPARE for anticipated work having the potential for heat stress, to include:</p> <ul style="list-style-type: none"> • Inventory planning and ordering of supplies needed for working in hot conditions and for establishing cool zones, • Ensuring cool zone equipment is maintained and fully operational, • Performing equipment readiness testing and/or preventive maintenance in cooler times of the year, or day, • Planning for start time, and/or shift adjustments.

3.2 Identification of Heat Stress Conditions

The following conditions require consideration for heat stress, and may require a *CHPRC Heat Stress Evaluation* (Site Form A-6007-263) or an *Industrial Hygiene Exposure Assessment (IHEA)*, by the Project IH (PIH):

- a. Predicted air temperatures greater than 85°F outdoors, or 90°F indoors
When working in single-layer cotton clothing (Clothing Adjustment Factor or CAF equal to zero), either outdoors and/or in direct sun, in air temperatures greater than or equal to 85°F, or indoors in air temperatures greater than or equal to 90°F.
- b. Humidity greater than 60%
When relative humidity reaches 60% in the work environment in combination with warm air temperatures, and/or when wearing protective clothing that significantly restricts air movement, such as impermeable clothing.
- c. Sources of radiant heat are present, or work involves contact with hot objects
When working around and/or in direct contact with radiant heat sources such as steam pipes, boilers, heated vessels, welding operations, and heat reflected from or retained in asphalt surfaces or concrete buildings.
- d. Protective clothing is required
When wearing protective clothing with a CAF greater than zero, at air temperatures greater than or equal to 70°F; or wearing impermeable clothing (e.g., water- or vapor-barrier clothing, encapsulating suits, 40 cal/cm² Arc-Rated suit) at any temperature.

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e. High work intensity

Work at light to moderate metabolic levels requires consideration for heat stress if other heat stress factors are present, such as warm temperatures (85°F for single-layer cotton clothing/70°F for protective or double-layer clothing); work at heavy and very heavy metabolic levels requires a *Heat Stress Evaluation* (Site Form A-6007-263) or *IHEA* at any temperature.

f. Work performed inside an enclosure or greenhouse

When working in a greenhouse or other enclosure with minimal air movement that could result in heat build-up, in the presence of other factors such as warm air temperatures (90°F for single-layer cotton clothing/70°F for protective or double-layer clothing).

Actionee	Step	Action
RM	1.	<u>IF</u> heat stress conditions are expected and controls are required to mitigate hazards, <u>THEN REQUEST</u> the PIH prepare a <i>Heat Stress Evaluation</i> or <i>IHEA</i> for the activity.

3.3 Heat Stress Evaluation

The *CHPRC Heat Stress Evaluation* (Site Form A-6007-263) is a hazard assessment that evaluates the following parameters:

- Location/Task Heat Stress Factors
- Metabolic Demands of the Work Activity/Task
- Clothing Ensemble and Clothing Adjustment Factor (CAF)
- Worker Acclimatization Status
- Heat Stress Control set and Monitoring plan

An *IHEA* that addresses the above-listed parameters is an equivalent hazard evaluation and may be used in lieu of the *CHPRC Heat Stress Evaluation* (Site Form A-6007-263).

Actionee	Step	Action
IH Professional	1.	DEVELOP a <i>CHPRC Heat Stress Evaluation</i> (Site Form A-6007-263) or <i>IHEA</i> <u>AND DOCUMENT</u> the following: <ol style="list-style-type: none"> a. Location/Task Heat Stress Factors. b. Metabolic Demands of the Work Activity/Task. <ol style="list-style-type: none"> 1) USE Table 1, "Metabolic Rate Categories and Work Level" or an approved e-tool such as the Metabolic Rate Calculator. 2) <u>IF</u> a Self-Contained Breathing Apparatus (SCBA) will be worn during the work activity, <u>THEN ACCOUNT</u> for the weight of the SCBA when estimating the metabolic load.

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Actionee	Step	Action
IH Professional	c.	<p>DETERMINE the Clothing Ensemble and Clothing Adjustment Factor (CAF) for personal protective equipment (PPE) worn, using Table 2, "Additions to Measured WBGT Values based on Clothing Adjustment Factors."</p> <p>1) <u>IF</u> a CAF for an ensemble is not shown, <u>THEN</u> PERFORM one of the following:</p> <p>a) REFER to IHTE-2017-001, Heat Stress Clothing Adjustment Factor (CAF) Table," for additional information, including adjustments to account for head coverings and impermeable gloves</p> <p>b) WORK with the Heat Stress TA to extrapolate a CAF.</p> <p>c) USE a CAF estimate and PLAN work activity using Physiological Monitoring (Appendix B).</p>

NOTE: According to the American Conference of Governmental Industrial Hygienists (ACGIH): Worker acclimatization is gained incrementally over 1 to 2 weeks in similar heat stress conditions. A rule of thumb for acclimatized status is that the worker has at least 2 continuous hours of similar heat exposure in 5 of the last 7 days, or 10 of the last 14 days.

- 1) Loss of Acclimatization is noticeable after 4 days of not being in similar heat stress conditions. For most healthy adult workers, loss of acclimatization is transitory and quickly made up.
- 2) Unacclimatized status is reserved for:
 - No recent heat stress exposure
 - Those that are not fully acclimatized
 - Recent heat stress exposures that resulted in excessive heat strain.
- d. Worker Acclimatization status to be planned for the activity.
 - 1) USE "Unacclimatized" as the default status.
- e. The Heat Stress Control Set using a graded approach and taking into consideration the hierarchy of controls.
 - 1) IDENTIFY the WBGT value that signals implementation of job-specific heat stress controls from Table 3, "WBGT Screening Criteria for Heat Stress Exposure."
 - a) IDENTIFY the WBGT value(s) initiating Work-Rest Cycles, and/or Physiological Monitoring.
2. IDENTIFY Engineered Controls as the primary means to reduce heat stress, such as those identified in Section 3.5.

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Actionee	Step	Action
NOTE: <i>When indoor work site temperatures are greater than 95°F, air must be cooled before using fans or forced air ventilation.</i>		
IH Professional	3.	<p><u>IF</u> Engineered Controls are not adequate to reduce the potential for causing heat stress, <u>THEN IDENTIFY</u> Administrative Controls, such as those identified in Section 3.5, to further reduce exposure to heat stress, such as:</p> <ul style="list-style-type: none"> • ADJUST the work schedule for cooler times of the day. • ADJUST the work load or rate. • ESTABLISH Work-Rest cycles. • ADJUST the length of the rest period.
NOTE: <i>Use of cooling vests/suits have been shown to significantly limit worker heat retention and storage. Use of cooling suits in a Radiological Controlled Area needs to be planned with RadCon to address the potential for wicking of radionuclides through the Anti-C's and potentially contaminating under-garments and/or the vortex cooling unit. Note that a CAF reduction is not applied to cooling vests/suits. Instead, physiological monitoring must be utilized to validate the effectiveness of the control.</i>		
4.		
	a.	<p>CONSIDER use of personal cooling devices and accessory equipment such as:</p> <ul style="list-style-type: none"> • Heat reflective clothing • Cooling ties and scarves • Cooling vests • Hydration packs • Vortex vest/suit
	1)	<p>VERIFY concurrence with RadCon before identifying cooling devices for activities occurring in radiological-controlled areas.</p>
	b.	<p><u>WHEN</u> work requires the use of protective clothing in a radiological-controlled area, <u>THEN IDENTIFY</u> the clothing ensemble with RadCon support, taking worker heat stress into consideration.</p>
	1)	<p>USE PRC-1209-CDMP-0118, <i>CHPRC Disposable Radiological PPE Selection Criteria</i>, and Table 2 or IHTE-2017-001, "Additions to Measured WBGT Values based on Clothing Adjustment Factors," to determine the appropriate ensemble with the lowest heat stress burden.</p>

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<i>Actionee</i>	<i>Step</i>	<i>Action</i>
IH Professional	5.	IDENTIFY emergency egress and response to be used in the event of excessive heat strain, if not already identified in Project/Work Control documents.
	6.	RETAIN a working copy <u>AND</u> SUBMIT <i>CHPRC Heat Stress Evaluation</i> (Site Form A-6007-263) or <i>IHEA</i> to the SWIHD Administrator.
SWIHD Administrator	7.	ENTER the <i>CHPRC Heat Stress Evaluation</i> or <i>IHEA</i> into SWIHD <u>AND</u> PROCESS the record into the Integrated Document Management System.

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Table 1. Metabolic Rate Categories and Work Level

Work Level Category	Metabolic Rate* [W], 154 lb of weight	Metabolic Rate [W], 200 lb of weight	Metabolic Rate [W], 250 lb of weight	Example Activities
Rest	Up to 115	149	187	<ul style="list-style-type: none"> • Sitting, attending meetings, observing work, taking notes.
Light	180 (115-235)	234	292	<ul style="list-style-type: none"> • Sitting, light manual work with hands and/or arms. • Driving cars, trucks. • Standing and occasional walking with some light arm work, such as: <ul style="list-style-type: none"> ○ Walk-through inspections, rounds and surveillances ○ Reading instruments ○ Using non-powered hand tools ○ Using table saw, bench top machinery ○ Performing routine RCT/IH sampling, data-logging.
Moderate	300 (235-360)	390	487	<ul style="list-style-type: none"> • Sustained moderate hand and arm work, moderate arm, leg work, and trunk work, such as: <ul style="list-style-type: none"> ○ Moderate pushing and pulling, ○ Environmental sampling, ○ Crane and rigging work, ○ Heavy equipment operation, ○ Using portable power tools, 7-15 pounds of force. • Materials handling: installing barricades, moving waste drums/containers with mechanical means. • RO/RO container opening/closing/liner installation. • Normal walking while carrying ≤ 7 pounds, such as walking stick surveys, HPT surveys with reaching.
Heavy	415 (360-470)	539	674	<ul style="list-style-type: none"> • Intense arm and trunk work, such as: <ul style="list-style-type: none"> ○ Carrying/shoveling dry sand/soil, ○ Manual sawing, ○ Pushing and pulling heavy loads, ○ Moving waste or laundry bags, ○ Intermittent heavy assembly work or ○ Heavy lifting/pulling/pushing/carrying ≤ 25 pounds. • Walking at a fast pace. • Hand tool use with >15 pounds of force.
Very Heavy	520	675	844	<ul style="list-style-type: none"> • Very intense activity at fast pace, such as: <ul style="list-style-type: none"> ○ Shoveling wet sand/soil, ○ Heavy assembly work, ○ Heavy lifting/pulling/carrying >25 pounds. ○ Running, ○ Installing T-posts.

Notes:

- The effect of body weight on the estimated metabolic rate may be accounted for by multiplying the estimated rate by the ratio of actual body weight, divided by 154 lb.
- The default Metabolic Rate value* is based on a 154-lb person. The IH should determine the average weight of workers in the crew, to include equipment and gear they carry or wear, to more accurately predict the metabolic load.

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Table 2. Additions to Measured WBGT Values based on Clothing Adjustment Factors for Some Clothing Ensembles (ACGIH, 2016)

Clothing Type	Addition to WBGT, °F
Work Clothes (Long Sleeve Shirt and Pants)	0
Cloth (woven) Coveralls	0
Double-layer woven Clothing	5.4
SMS Polypropylene Coveralls	0.9
Polyolefin Coveralls	1.8
Limited-use Vapor-barrier Coveralls	19.8

Notes: Additions may also need to be made to account for head covers and gloves. For a more complete listing of CAFs, see IHTE-2017-001.

Table 3. WBGT Screening Criteria for Heat Stress Exposure

Allocation of Work in a Cycle of Work and Recovery	TLV® WBGT Values in °F (Acclimatized)				Action Limit WBGT Values in °F (Unacclimatized)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	<87.8	<82.4	PM	PM	<82.4	<77.0	PM	PM
75% Work/ 25% Rest	87.8	82.5-84.2	≤81.5	PM	82.5-83.3	77.1-78.8	≤75.2	PM
50% Work/ 50% Rest	87.9-89.6	84.3-86.0	81.6 - 84.2	≤82.4	83.4-85.1	78.9-80.6	75.3 - 77.9	≤76.1
25% Work/ 75% Rest	89.7-90.5	86.1- 88.7	84.3-86.9	82.5-86.0	85.2 - 86.0	80.7-84.2	78.0-82.4	76.2 - 80.6
PM	>90.5	>88.7	>86.9	>86.0	>86.0	>84.2	>82.4	>80.6

Notes:

- Table 3 is intended as an **initial screening tool** to evaluate if a heat stress situation may exist.
- See Table 1, *Metabolic Rate Categories and Work Level* and/or consult the *2009 Documentation*.
- Thresholds are computed as a TWA-Metabolic Rate, where the metabolic rate for rest is taken as 115W and work is the representative (mid-range) value of Table 1.
- In the table, rest is assumed to occur in the same or similar environment as the work (e.g., WBGT is the same). The metabolic rate for rest is already factored into the screening limit.
- **If work and rest environments are different** (e.g., rest environment has different WBGT), **calculate hourly time-weighted average (TWA)-WBGTs, or utilize the most conservative location as representative.** TWAs for Work Rates should also be used when the work demands vary within the hour. (See *2009 Documentation*, p 22).
 - $TWA-WBGT = [(WBGT_w \times t_w) + (WBGT_r \times t_r)] / t_w + t_r$
 - $TWA-Metabolic\ Rate = [(MR_w \times t_w) + (MR_r \times t_r)] / t_w + t_r$
- Values in the table are applied by reference to the “Work-Rest Regimen” section of the *Documentation* and assume 8-hour workdays in a 5-day workweek with conventional breaks* as discussed in the *Documentation*.
 - *The Hanford 10 hour/day work schedule, for purposes of heat stress TLVs, may be considered as comparable to the standard 8-hour day, when 2 hours/day are spent on administrative tasks such as pre-job briefings, checking out respirators, obtaining work equipment, and dress/undress/shower activities.
 - When workdays are extended, consult the “Application of the TLV” in the *2009 Documentation*.
- Because of the physiological strain associated with Heavy and Very Heavy work regardless of WBGT, criteria values are not provided for continuous work, and for up to 25% rest in an hour for Very Heavy. Instead of using the screening criteria, a detailed analysis and/or **Physiological Monitoring (PM)** should be used.

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3.4 Implement General Heat Stress Controls

Heat stress conditions that are adequately addressed using General Heat Stress Controls, as identified in Table 4 “General Heat Stress Controls,” present a lower risk for heat stroke and may be addressed using a graded approach. Use of a graded approach allows implementation of work-rest regimens, as identified in Table 3, “WBGT Screening Criteria for Heat Stress Exposure.”

Table 4. General Heat Stress Controls

Implement General Heat Stress Controls:

- Monitor heat stress conditions and reported symptoms of Heat-Related Illness;
- Provide oral and written work instructions;
- Provide additional heat stress information in safety bulletins and seasonal initiatives;
 - Include information about the role medications may pose in maintenance of kidney function, cardiovascular health, blood pressure, and body temperature regulation;
- Take regularly scheduled breaks;
- Encourage drinking small volumes of cool water regularly throughout the shift;
- Encourage workers to self-limit exposures and/or report heat-related symptoms;
 - Encourage the buddy system/coworker observations;
- Encourage healthy lifestyles, maintenance of electrolyte balance and ideal body weight;
- Adjust expectations of worker performance and take individual factors into consideration:
 - Those returning to work after absence from hot exposure conditions,
 - Those not acclimatized to wearing specialized PPE.

Actionee	Step	Action
RM/ Field Work Supervisor (FWS)	1.	<p><u>WHEN</u> potential heat stress conditions exist for a work activity having <i>Light to Moderate</i> metabolic demands, performed in clothing with a CAF of zero,</p> <p><u>THEN</u>:</p> <ul style="list-style-type: none"> • CONSULT with OS&IH to determine worker acclimatization. • DETERMINE the WBGT screening value that signals implementation of the Work-Rest Cycle and/or Physiological Monitoring. • DETERMINE if WBGT monitoring should be requested for the project (e.g., work is indoors, or around reflective surfaces, heat sinks like concrete buildings or asphalt, etc.), OR, if Hanford Meteorological Station (HMS) WBGT data may be used.

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Actionee	Step	Action
NOTE:		<i>HMS WBGT readings must be representative of the employee's work area to be used to determine work/rest. Data from the nearest Hanford Meteorological Station (HMS) that records WBGT data may only be used to monitor outdoor work that is located away from buildings/structures and reflective surfaces and heat sinks.</i>
OS&IH/ Designee	2.	As needed, COLLECT, RECORD, <u>AND</u> EVALUATE WBGT data in accordance with PRC-PRO-SH-409, using Hard-copy field-use forms (Site Form A-6004-691, <i>CHPRC WBGT Monitoring Data</i>) or a printed SWIHD field log.
		<u>OR</u>
	3.	EVALUATE WBGT Data from the nearest HMS, in accordance with guidelines identified in Appendix C, "Use of Hanford Meteorological Station for WBGT Measurements."
	a.	DOCUMENT surveys that identify HMS data used to determine work-rest regimens in the "Generic" SWIHD tab.
FWS	4.	REVIEW the General Heat Stress Controls identified in Table 4, "General Heat Stress Controls," <u>AND</u> IMPLEMENT the controls that are within the FWS's authority.
FWS/ Workers	5.	PROVIDE cool water <u>AND</u> ENCOURAGE workers to consume adequate quantities before entering the work area and/or on breaks.
NOTE:	1.	<i>It is anticipated that workers may become warm and/or thirsty while working under general or job-specific heat stress controls. Rest periods may be taken in the work area, or outside of the work area, as needed to maintain adequate hydration.</i>
	2.	<i>When radiological and/or chemical particulate contamination is present, or potentially present, decontamination practices may be required prior to entering the drinking station.</i>
	6.	<u>IF</u> heat stress conditions exist in a radiological-controlled area, <u>THEN</u> PROVIDE water at drinking stations in accordance with PRC-PRO-RP-40196, <i>Drinking Liquids in Contamination Areas</i> .
	7.	IMPLEMENT feasible controls (e.g., a rest area that is shaded and cooler than the work environment).

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Actionee	Step	Action
FWS/ Workers	8.	<p>OBSERVE yourself and co-workers for signs and symptoms of excessive heat strain <u>AND IMMEDIATELY REPORT</u> those who show signs and symptoms to the FWS.</p> <p>a. <u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Sudden and severe fatigue • Nausea • Dizziness • Lightheadedness <p><u>THEN:</u></p> <ol style="list-style-type: none"> 1) REMOVE the worker from the source of heat (e.g., PPE, hot environment). 2) MOVE them to a cool location (shade, air-conditioned, or fans blowing on employee) for a minimum of 15 minutes. 3) PROVIDE water. 4) OBSERVE employee until the signs and symptoms have abated. <p>b. <u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Disoriented or confused • Inexplicable irritability • Malaise • Chills <p><u>THEN RESPOND</u> as a medical emergency.</p> <ol style="list-style-type: none"> 1) CALL 911 (509-373-0911 from a cell phone). 2) COOL, MONITOR, <u>AND</u> ASSIST worker until emergency responders arrive. 3) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077, <i>Reporting, Investigating, and Managing Health, Safety and Property/Vehicle Events</i>.

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3.5 Implement Job-Specific Heat Stress Controls

Heat stress conditions that are NOT adequately addressed using general heat stress controls present a greater risk for heat stroke and require job-specific controls, such as those identified in Table 5, “Job-Specific Heat Stress Controls.”

Table 5. Job-Specific Heat Stress Controls

Implement Job-Specific Controls where heat strain may be excessive:

- **Engineered Controls** that reduce the metabolic work rate, provide general air movement, reduce process heat and water vapor release, and shield radiant heat sources; e.g.,
 - Mechanical assistance with tasks, as feasible
 - Containment tents/enclosures with recirculating or once-through air conditioning, or evaporative cooling
 - Misters (fan-mounted, tubing runs)
 - Fans
 - Designated shaded rest area
 - Portable swamp coolers
 - Heat shielding insulation.
- **Administrative Controls** that set acceptable exposure times, allow sufficient recovery, and limit physiological strain; e.g.,
 - Pre-job briefing on heat stress associated with the work scope
 - Work/rest cycle in accordance with Table 3 or the *Heat Stress Evaluation/IHEA*
 - **Physiological Monitoring** in accordance with Table 3, and/or the *Heat Stress Evaluation/IHEA*
 - Industrial Hygienist control of specific work scope
 - Adjusted shift or start time (work in cooler part of day)
 - Rotate tasks between workers, and/or divide tasks between workers in a manner to reduce metabolic rate.
- **Cooling PPE** demonstrated as effective, with RadCon concurrence (if applicable); e.g.,
 - Cooling suit/vest and accessories (e.g., cool tie/scarf, vortex)
 - Camelback water hydration when wearing PPE, including air-fed hood.

In addition to job-specific controls, a review of the symptoms of excessive heat strain, as presented in Table 6, “Guidelines for Limiting Excessive Heat Strain,” is required.

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Table 6. Guidelines for Limiting Excessive Heat Strain and Controlling Heat Related Medical Emergencies

EXCESSIVE HEAT STRAIN

One or more of the following measures may identify excessive heat strain. An individual's exposure to heat stress should be discontinued when any of the following occur:

- a) Sustained (several minutes) heart rate in excess of 180 beats per minute (bpm) minus the individual's age in years (180-age), for individuals with assessed normal cardiac performance; or
- b) Body core temperature is greater than 100.4°F (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used); or
- c) Recovery heart rate at one minute after a peak work effort exceeds 120 bpm; or
- d) There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness.

HEAT RELATED MEDICAL EMERGENCIES

One or more of the following measures may identify that an employee is potentially experiencing a heat related medical emergency and 911 should be called:

- a) Appears to be disoriented or confused,
- b) Suffers inexplicable irritability,
- c) Malaise,
- d) Or Chills.

Actionee	Step	Action
RM/FWS/IH Professional	1.	<p><u>WHEN</u> potential heat stress conditions exist for a work activity and/or work is performed in clothing with a CAF greater than zero, and/or work may be performed at a heavy or very heavy metabolic level, <u>THEN</u>:</p> <p>a. IMPLEMENT the feasible controls identified Table 5, "Job-Specific Heat Stress Controls," and the control set identified on the <i>CHPRC Heat Stress Evaluation</i> (Site Form A-6007-263), or <i>IHEA</i> (Site form A-6007-296 or equivalent) <u>AND PERFORM one</u> of the following:</p> <ol style="list-style-type: none"> 1) IMPLEMENT Job-Specific Heat Controls using a graded approach, e.g., monitor the WBGT and establish the work/rest regimen identified in Table 3, until Physiological Monitoring is required, or until the work activity is terminated because Physiological Monitoring is not deemed a feasible option. <p><u>OR</u></p> <ol style="list-style-type: none"> 2) IMPLEMENT Physiological Monitoring directly, in combination with other Job-Specific Controls, as identified in the <i>CHPRC Heat Stress Evaluation</i> (Site Form A-6007-263), or <i>IHEA</i>.

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Actionee	Step	Action
RM/FWS/IH Professional	<u>OR</u>	<p>3) IMPLEMENT observation of <u>symptoms of excessive heat strain</u> as a control for short-term activities that are under the direct control of an IH Professional, with concurrence of the Heat Stress TA and/or IH Programs Manager (e.g., such as for a single entry/activity wearing an SCBA in PPE with a CAF greater than zero).</p> <p>2. PROVIDE cool water <u>AND ENCOURAGE</u> workers to consume adequate quantities before entering the work area and/or on breaks.</p>
NOTE:	<p>1. <i>It is anticipated that workers may become warm and/or thirsty while working under general or job-specific heat stress controls. Rest periods may be taken in the work area, or outside of the work area, as needed to maintain adequate hydration.</i></p> <p>2. <i>When radiological and/or chemical particulate contamination is present, or potentially present, decontamination practices may be required prior to entering the drinking station.</i></p>	
FWS/ Workers	3.	<u>IF</u> heat stress condition exist in a radiological-controlled area, <u>THEN PROVIDE</u> water at drinking stations in accordance with PRC-PRO-RP-40196.
FWS/ OS&IH/ Workers	4.	<p>REVIEW the following information at the pre-job briefing:</p> <p>a. Heat stress controls and monitoring for the work activity.</p> <p>b. Information from Table 6, "Guidelines for Limiting Heat Strain and Controlling Heat Related Medical Emergencies," to include a review of symptoms of excessive heat strain.</p>

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Actionee	Step	Action
FWS/ Workers	5.	<p>OBSERVE yourself and co-workers for signs and symptoms of excessive heat strain <u>AND</u> IMMEDIATELY REPORT those who show signs and symptoms to the FWS.</p> <p>a. <u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Sudden and severe fatigue • Nausea • Dizziness • Lightheadedness <p><u>THEN:</u></p> <ol style="list-style-type: none"> 1) REMOVE the worker from the source of heat (e.g., PPE, hot environment). 2) MOVE them to a cool location (shade, air-conditioned, or fans blowing on employee) for a minimum of 15 minutes. 3) PROVIDE water. 4) OBSERVE employee until the signs and symptoms have abated. <p>b. <u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Disoriented or confused • Inexplicable irritability • Malaise • Chills <p><u>THEN</u> RESPOND as a medical emergency.</p> <ol style="list-style-type: none"> 1) CALL 911 (509-373-0911 from a cell phone). 2) COOL, MONITOR, AND ASSIST worker until emergency responders arrive. 3) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077, <i>Reporting, Investigating, and Managing Health, Safety and Property/Vehicle Events</i>.
FWS	6.	<p>COMMUNICATE frequently with the IH Professional during the work activity regarding the workers' performance and WBGT temperatures <u>AND</u> CONTACT the IH Professional when the need for Physiological Monitoring is reached or when the work activity is terminated because Physiological Monitoring is not deemed a feasible option.</p>

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Actionee	Step	Action
OS&IH	7.	<p><u>WHEN</u> using a graded approach to heat stress mitigation, <u>THEN COLLECT AND RECORD</u> WBGT data in accordance with PRC-PRO-SH-409, using hard-copy field-use forms (Site Form A-6004-691, <i>CHPRC WBGT Monitoring Data</i>) or a printed SWIHD field log.</p> <p>a. DOCUMENT surveys that identify WBGT data used to determine work-rest regimens in the “Heat” SWIHD tab.</p>
		<u>OR</u>
		<p>b. EVALUATE WBGT Data from the nearest Hanford Meteorological Station in accordance with guidelines identified in Appendix C, “Use of Hanford Meteorological Station for WBGT Measurements.”</p>
		<p>c. DOCUMENT surveys that identify HMS data used to determine work-rest regimens in the “Generic” SWIHD tab.</p>
	8.	<p><u>WHEN</u> the rest environment is at a lower temperature than the work environment, <u>THEN CALCULATE</u> hourly TWA-WBGT and TWA-Metabolic Rates, and/or Safe Work Times to better estimate the timing of Work-Rest cycles, as feasible, <u>AND COMMUNICATE</u> revised Work-Rest cycle information to the FWS.</p>
	9.	<p>Under the graded approach, <u>WHEN</u> the WBGT value in Table 3 reaches the point where Work-Rest cycles are required, <u>THEN IMPLEMENT</u> Work-Rest cycles in accordance with Table 3.</p> <p>a. <u>WHEN</u> the WBGT value in Table 3 reaches the point where Physiological Monitoring is required, <u>THEN IMPLEMENT</u> Physiological Monitoring in accordance with Section 3.6, “Implement Physiological Monitoring,” and Appendix B, “Physiological Monitoring.”</p>
		<u>OR</u>
		<p>b. <u>IF</u> Physiological Monitoring is not deemed feasible, <u>THEN TERMINATE</u> the work activity until a different time.</p>
		<u>OR</u>
		<p>c. <u>IF</u> Physiological Monitoring is identified as the primary approach, <u>THEN IMPLEMENT</u> Physiological Monitoring in accordance with Section 3.6, “Implement Physiological Monitoring,” and Appendix B, “Physiological Monitoring.”</p>

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3.6 Implement Physiological Monitoring

Three pathways are identified for physiological monitoring:

- 1) Continuous monitoring wearing a chest-strap that monitors heart rate and estimates core body temperature by use of computer software;
- 2) Intermittent monitoring using a finger pulse oximeter (or taking the pulse manually) to determine *Heart Rate*, and if the Project IH (PIH) deems necessary and appropriate, using a body/ear thermometer to estimate core *Body Temperature*;
- 3) Consult the TA to determine other feasible methods when *Heart Rate* and *Body Temperature* measurements are not feasible for a given work activity and/or other physiological measurements are deemed more appropriate.

For additional information on physiological measurements, refer to Appendix B, "Physiological Monitoring."

3.6.1 Continuous Monitoring

Procedure steps in this section apply to continuous monitoring using a chest-strap heart monitor.

<i>Actionee</i>	<i>Step</i>	<i>Action</i>
IH Professional	1.	DEVELOP HSE/IHSP instructions for the heart-rate monitoring system selected for use that aligns with requirements of the ACGIH TLV® for heat stress <u>AND OBTAIN</u> TA approval prior to implementation.
Heat Stress TA	2.	REVIEW and approve the HSE/IHSP instructions initially, <u>AND VALIDATE</u> the use of the HSE/IHSP instruction annually.

NOTE: *Core body temperature, taken with a rectal thermometer, is a measure of heat exposure that may be directly compared with the TLV®. IH does not collect core body temperature measurements, but instead collects estimates of core body temperature, and heart rate, to be used as screening data for the purpose of establishing appropriate work-rest periods. Screening measures are not considered exposure records (e.g., there is no single value to report) and personal reports are not required for screening data. For more information on exposure records, refer to PRC-PRO-SH-409.*

- a. VERIFY annual instrument acceptance tests are performed and documented (by the line organization) for heart rate and/or body temperature estimates.

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Actionee	Step	Action
OS&IH/FWS/ Workers	3.	<p data-bbox="537 296 1456 365">Before starting work, DISCUSS the following monitoring information with project personnel:</p> <ul style="list-style-type: none"> <li data-bbox="537 394 1456 499">a. Physiological Monitoring data is designated “Official Use Only” (OUO), shared only by OS&IH, the FWS, and the employee during the work evolution, to prevent excessive heat strain. <li data-bbox="537 529 1456 827">b. All workers are monitored. <ul style="list-style-type: none"> <li data-bbox="586 579 1456 709">• Physiological Monitoring data is used for real-time decision-making regarding the timing and length of Work-Rest cycles needed for adequate heart-rate recovery, and is not considered an exposure measurement. <li data-bbox="586 730 1456 827">• Workers are not required to receive an exposure report for Physiological Monitoring but may access monitoring information in accordance with PRC-PRO-SH-409. <li data-bbox="537 848 1456 1320">c. To qualify for a work activity and prior to dressing out in the PPE ensemble, the <i>Baseline Resting Heart Rate</i> <u>cannot</u> exceed 100 beats per minute (bpm). <ul style="list-style-type: none"> <li data-bbox="586 978 1456 1192">• If the <i>Baseline Resting Heart Rate</i> exceeds 100 bpm, the worker cannot dress out and enter the work area. <ul style="list-style-type: none"> <li data-bbox="643 1062 1456 1192">○ If there are morning and afternoon entries into a work area and they do not qualify in the morning, their <i>Baseline Resting Heart Rate</i> may be reassessed for the afternoon entry to determine if they qualify. <li data-bbox="643 1226 1456 1320">○ Workers who do not qualify based on the <i>Baseline Resting Heart Rate</i> should be assigned other duties outside of the heat stress environment.

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Actionee	Step	Action
OS&IH/FWS/ Workers	4.	<p>Before starting work, DISCUSS the flow of communications between the IH surveyor, workers, the FWS, and the IH Professional in the event of excessive heat strain.</p> <p>a. OS&IH directly communicates with the worker and/or FWS during monitoring.</p> <p>b. OS&IH follows up with communications to the FWS and IH Professional, as soon as practicable, to identify workers directed to take the following actions related to Physiological Monitoring results:</p> <ul style="list-style-type: none"> • TAKE a rest period because <i>Sustained Heart Rate</i> measurement criteria are temporarily exceeded; • EXIT the work area when <i>Recovery Heart Rate</i> exceeds 120 bpm and/or <i>Body Temperature</i> estimates exceeds 100.4°F (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used).
FWS/OS&IH	c.	<p><u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Sudden and severe fatigue • Nausea • Dizziness • Lightheadedness <p><u>THEN:</u></p> <ol style="list-style-type: none"> 1) REMOVE the worker from the source of heat (e.g., PPE, hot environment). 2) MOVE them to a cool location (shade, air-conditioned, or fans blowing on employee) for a minimum of 15 minutes. 3) PROVIDE water. 4) OBSERVE employee until the signs and symptoms have abated. <p>After employee has completed cool down/recovery, they may return to activities that are a potential source of heat stress.</p>

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<i>Actionee</i>	<i>Step</i>	<i>Action</i>
FWS/OS&IH	d.	<p><u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Disoriented or confused • Inexplicable irritability • Malaise • Chills <p><u>THEN RESPOND</u> as a medical emergency.</p> <ol style="list-style-type: none"> 1) CALL 911 (509-373-0911 from a cell phone). 2) COOL, MONITOR, AND ASSIST worker until emergency responders arrive. 3) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077, <i>Reporting, Investigating, and Managing Health, Safety and Property/Vehicle Events</i>.
OS&IH	5.	CONTINUOUSLY MONITOR <u>AND</u> EVALUATE the heart monitor and respond to elevated <i>Heart Rates</i> and/or core <i>Body Temperature</i> estimates according to the HSE/IHSP.
	6.	<p><u>IF</u> individuals <i>Heart Rate</i> or <i>Body Temperature</i> criteria are exceeded, <u>THEN DIRECT</u> worker to:</p> <ol style="list-style-type: none"> a. Exit the work area and Remove PPE with a CAF greater than “0.” b. Rest in a cool area and drink water for a minimum of 15 minutes, until RHR is ≤ 100 bpm or temperature is $< 99^{\circ}\text{F}$. c. After employee has completed cool down/recovery, they may return to activities that are a potential source of heat stress. <p><u>AND MAKE</u> comments in the SWIHD survey.</p>
	7.	DOCUMENT Physiological Monitoring measurements using Site Form A-6007-287, <i>Physiological Monitoring</i> , or equivalent. <ol style="list-style-type: none"> a. ATTACH Physiological Monitoring data-log to a SWIHD survey, created in the PM survey tab, <u>AND ADD</u> each individual name in the OUO sub-tab.

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3.6.2 Intermittent Monitoring

Procedure steps described in this section apply to intermittent monitoring using a finger pulse oximeter and/or thermometer.

Actionee	Step	Action
OS&IH/FWS/ Workers	1.	<p>Before starting work, DISCUSS the following monitoring information with project personnel:</p> <ol style="list-style-type: none"> a. Physiological Monitoring data is designated “Official Use Only” (OUO), shared only by OS&IH, the FWS, and the employee during the work evolution, to prevent excessive heat strain. b. All workers are monitored. <ul style="list-style-type: none"> • Physiological Monitoring data is used for real-time decision-making regarding the timing and length of Work-Rest cycles needed for adequate heart-rate recovery, and is not considered an exposure measurement. • Workers are not required to receive exposure reports for Physiological Monitoring but may access monitoring information in accordance with PRC-PRO-SH-409. c. To qualify for a work activity and prior to dressing out in the PPE ensemble, the <i>Baseline Resting Heart Rate</i> <u>cannot</u> exceed 100 bpm. <ul style="list-style-type: none"> • If the <i>Baseline Resting Heart Rate</i> exceeds 100 bpm, the worker cannot dress out and enter the work area. <ul style="list-style-type: none"> ○ If there are morning and afternoon entries into a work area and they do not qualify in the morning, their <i>Baseline Resting Heart Rate</i> may be reassessed for the afternoon entry to determine if they qualify. ○ Workers who do not qualify based on the <i>Baseline Resting Heart Rate</i> should be assigned other duties outside of the heat stress environment. d. <u>IF</u> the PIH deems that <i>Body Temperature</i> is an appropriate measurement (e.g., workers are in Level D PPE), <u>THEN EXPLAIN</u> that <i>Body Temperature</i> may be used in lieu of <i>Heart Rate</i> to qualify for entry into a heat stress environment. <ul style="list-style-type: none"> • <i>Baseline Body Temperature</i> must be normal (e.g., < 99°F). • <u>IF</u> <i>Body Temperature</i> is used as the baseline entry measure, <u>THEN</u> <i>Body Temperature</i> shall be used instead of <i>Heart Rate</i> for additional follow-up physiological measurements when working in the heat stress environment, for that day/entry.

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Actionee	Step	Action
OS&IH/FWS/ Workers	2.	<p>Before starting work, DISCUSS the flow of communications between the OS&IH, workers, the FWS, and the IH Professional in the event of excessive heat strain.</p> <p>a. IH surveyor directly communicates with the worker and/or FWS during monitoring.</p> <p>b. OS&IH follows up with communications to the FWS and IH Professional, as soon as practicable, to identify workers directed to take the following actions related to Physiological Monitoring results:</p> <ul style="list-style-type: none"> • TAKE a rest period because <i>Sustained Heart Rate</i> measurement criteria are temporarily exceeded; • EXIT the work when the <i>Recovery Heart Rate</i> exceeds 120 beats per minute and/or <i>Body Temperature</i> estimates exceed 100.4°F (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used).
FWS/OS&IH	c.	<p><u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Sudden and severe fatigue • Nausea • Dizziness • Lightheadedness <p><u>THEN:</u></p> <ol style="list-style-type: none"> 1) REMOVE the worker from the source of heat (e.g., PPE, hot environment). 2) MOVE them to a cool location (shade, air-conditioned, or fans blowing on employee) for a minimum of 15 minutes. 3) PROVIDE water. 4) OBSERVE employee until the signs and symptoms have abated.

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Actionee	Step	Action
FWS/OS&IH	d.	<p><u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Disoriented or confused • Inexplicable irritability • Malaise • Chills <p><u>THEN</u> RESPOND as a medical emergency.</p> <ol style="list-style-type: none"> 1) CALL 911 (509-373-0911 from a cell phone). 2) COOL, MONITOR, AND ASSIST worker until emergency responders arrive. 3) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077, <i>Reporting, Investigating, and Managing Health, Safety and Property/Vehicle Events</i>.
OS&IH	3.	<p>Where intermittent <i>Heart Rate</i> monitoring is performed using an oximeter or pulse measurement, RECORD data on A-6007-287, <i>CHPRC Physiological Monitoring</i>, or equivalent:</p> <ol style="list-style-type: none"> a. MEASURE <u>AND</u> RECORD each worker's <i>Baseline Resting Heart Rate</i> or <i>Body Temperature</i> <u>before</u> they dress out. <ol style="list-style-type: none"> 1) <u>IF</u> the <i>Baseline Resting Heart Rate</i> exceeds 100 bpm <u>THEN</u> EITHER: <ol style="list-style-type: none"> a) REASSIGN the worker to another task that does not involve heat stress exposure; <p style="text-align: center;"><u>OR</u></p> b) MEASURE <i>Body Temperature</i> (see step 4) if the PIH deems temperature to be an appropriate measurement, to determine if body temperature is normal (<99°F). 2) <u>IF</u> the <i>Resting Heart Rate</i> and/or the <i>Body Temperature</i> exceed the stated criteria, <u>THEN</u> COMMUNICATE to the FWS that the individual does not qualify for work in a heat stress environment. <ol style="list-style-type: none"> b. SET the <u>initial</u> measurement interval to about 30 minutes after work begins for intermittent monitoring <u>AND</u> ADJUST the monitoring interval, as appropriate, not to exceed 1 hour between intermittent measurements. c. MEASURE <u>AND</u> RECORD a <i>Sustained Heart Rate (SHR)</i> in the work area <u>AND</u> COMPARE to the <i>SHR</i> criterion of (180-age).

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Actionee	Step	Action
OS&IH	d.	<p data-bbox="581 300 1128 367"><u>IF</u> an individual's <i>SHR</i> exceeds (180-age), <u>THEN</u> PERFORM the following:</p> <ol style="list-style-type: none"> <li data-bbox="581 394 1421 462">1) SIGNAL the individual to rest in an appropriate location while inside the work area. <li data-bbox="581 489 1421 594">2) MEASURE the <i>Recovery Heart Rate (RHR)</i> 1 minute after a peak work effort or after 1 minute of rest <u>AND COMPARE</u> to the <i>RHR</i> criterion of 120 bpm. <ol style="list-style-type: none"> <li data-bbox="630 621 1071 688">a) <u>IF</u> the <i>RHR</i> exceeds 120 bpm, <u>THEN</u> DIRECT the worker to: <ol style="list-style-type: none"> <li data-bbox="678 716 1421 783">i. Remove PPE with a CAF greater than "0" and Exit the work area following established doffing process, <li data-bbox="678 810 1404 877">ii. Rest in a cool area and drink water for a minimum of 15 minutes, until RHR is \leq 100 bpm, <li data-bbox="678 905 1421 1010">iii. After employee has completed cool down/recovery, they may return to activities that are a potential source of heat stress. <p data-bbox="630 1037 1218 1071"><u>THEN</u> NOTIFY the FWS and IH Professional.</p> <p data-bbox="532 1098 1218 1165">e. <u>IF</u> the <i>RHR</i> does not exceed 120 bpm, <u>THEN</u> ALLOW the individual to continue working.</p> <p data-bbox="487 1192 1356 1260">4. <u>WHEN</u> the PIH deems that <i>Body Temperature</i> is an appropriate measurement for the activity and PPE selection:</p> <ol style="list-style-type: none"> <li data-bbox="532 1287 1421 1354">a. COLLECT a <i>Body Temperature</i> measurement (forehead, axillary, or tympanic membrane) as an alternate screening measurement. <li data-bbox="532 1381 1396 1449">b. APPLY a correction factor to forehead and axillary temperature measurements in accordance with Appendix B. <li data-bbox="532 1476 1356 1543">c. USE the tympanic temperature as a direct measure of Body Temperature.

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Actionee	Step	Action
OS&IH	a.	<p><u>IF</u> the corrected <i>Body Temperature</i> measurement, or actual tympanic membrane temperature exceeds 100.4°F (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used),</p> <p><u>THEN</u> DIRECT the individual to:</p> <ol style="list-style-type: none"> 1) Remove PPE with a CAF greater than “0” and Exit the work area, 2) Rest in a cool area and drink water for a minimum of 15 minutes, until temperature is < 99°F. 3) After employee has completed cool down/recovery, they may return to activities that are a potential source of heat stress. <p><u>AND</u> NOTIFY the FWS and IH Professional.</p>
	5.	<p>DOCUMENT Physiological Monitoring measurements using Site Form A-6007-287, <i>Physiological Monitoring</i>, or equivalent.</p> <ol style="list-style-type: none"> a. ATTACH Physiological Monitoring data to a SWIHD survey, under the “PM” survey tab.

3.7 Employee Information and Training

Actionee	Step	Action
RM	1.	<p>VERIFY that employees working in, or supervising work in hot environments, receive the computer-based training course 620193, <i>CHPRC Temperature Extremes</i>, every 2 years.</p>
RM/FWS	2.	<p>CONDUCT <u>AND</u> DOCUMENT work-specific heat stress training in safety meetings and pre-job briefings.</p> <ol style="list-style-type: none"> a. DISCUSS heat strain prevention and emergency response in pre-job briefings. b. DISCUSS the use of WBGT readings, work-rest cycles, physiological monitoring, and the flow of communication. c. PARTICIPATE in seasonal heat stress campaigns and special safety meetings.
RM/IH Professional	3.	<p>VERIFY the Employee Job Task Analysis (EJTA) is marked for “Work in Hot Environments” and/or “Greenhouse Work,” as applicable, in accordance with PRC-PRO-SH-52755, <i>Employee Job Task Analysis</i>.</p>
OS&IH	4.	<p>As requested, PARTICIPATE in pre-job briefings and safety meetings to discuss heat stress hazards and control methods.</p>

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Actionee	Step	Action
Employees	5.	PARTICIPATE in seasonal heat stress campaigns, safety meetings pre-job briefings, and with Physiological Monitoring efforts.
	6.	RECOGNIZE factors that may contribute to Heat-Related Illness (e.g., medications, inadequate hydration) and those that mitigate (e.g., adequate water consumption, rest, good physical conditioning).
Employees/ FWS	7.	RECOGNIZE the signs and symptoms of <u>excessive</u> heat strain <u>AND IDENTIFY</u> when an emergency situation is occurring.
	8.	RESPOND appropriately to a heat stress situation:
	a.	<u>IF</u> signs and symptoms of <u>excessive</u> heat strain are experienced or observed in co-workers, <u>THEN</u> INFORM the FWS immediately.
	1)	<u>IF</u> worker exhibits any of the following signs and symptoms:
		<ul style="list-style-type: none"> • Sudden and severe fatigue • Nausea • Dizziness • Lightheadedness
	<u>THEN:</u>	<ul style="list-style-type: none"> a) REMOVE the worker from the source of heat (e.g., PPE, hot environment). b) MOVE them to a cool location (shade, air-conditioned, or fans blowing on employee) and rest for a minimum of 15 minutes. c) PROVIDE water. d) OBSERVE employee until the signs and symptoms have abated.

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<i>Actionee</i>	<i>Step</i>	<i>Action</i>
Employees/ FWS	2)	<p><u>IF</u> worker exhibits any of the following signs and symptoms:</p> <ul style="list-style-type: none"> • Disoriented or confused • Inexplicable irritability • Malaise • Chills <p><u>THEN</u> RESPOND as a medical emergency.</p> <p>a) CALL 911 (509-373-0911 from a cell phone).</p> <p>b) COOL, MONITOR, <u>AND</u> ASSIST worker until emergency responders arrive.</p> <p>c) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077, <i>Reporting, Investigating, and Managing Health, Safety and Property/Vehicle Events</i>.</p>
FWS	b.	<p>NOTIFY the Project Safety Manager/RM as soon as practicable <u>AND</u> COMPLETE an Event Report in accordance with PRC-PRO-SH-077.</p> <p>1) PERFORM notification and follow-up actions identified in PRC-PRO-SH-077.</p>
OS&IH	9.	<p>INVESTIGATE cases of heat strain as requested by OS&IH management.</p>

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4.0 FORMS

CHPRC Heat Stress Evaluation, A-6007-263
Industrial Hygiene Exposure Assessment, A-6007-296
CHPRC WBGT Monitoring Data, A-6004-691
Physiological Monitoring, A6007-287

5.0 RECORD IDENTIFICATION

All records are generated, processed, and maintained in accordance with PRC-PRO-IRM-10588, *Records Management Processes*.

Records Capture Table

Name of Record	Submittal Responsibility	Retention Responsibility
<i>CHPRC Heat Stress Evaluation, A-6007-263</i>	SWIHD Administrator	IRM Service Provider

6.0 SOURCES

6.1 Requirements

10 CFR 851, *Worker Safety and Health Program*
 ACGIH, *Threshold Limit Values for Chemical Substances, Physical Agents and Biological Exposure Indices, 2016*
 PRC-MP-SH-32219, *10 CFR 851 CHPRC Worker Safety and Health Program Description*

6.2 References

ACGIH, *Documentation of the Threshold Limit Values® for Physical Agents, 7th edition, Heat Stress and Strain, 2009*
 PRC-1209-CDMP-0118, *CHPRC Disposable Radiological PPE Selection Criteria*
 PRC-PRO-IRM-10588, *Records Management Processes*
 PRC-PRO-RP-40196, *Drinking Liquids in Contamination Areas*
 PRC-PRO-SH-077, *Reporting, Investigating and Managing Health, Safety and Property/Vehicle Events.*
 PRC-PRO-SH-409, *Industrial Hygiene Monitoring, Reporting and Records Management*
 PRC-PRO-SH-17916, *Industrial Hygiene Exposure Assessment*
 PRC-PRO-SH-52755, *Employee Job Task Analysis*
 PRC-PRO-WKM-079, *Job Hazard Analysis*

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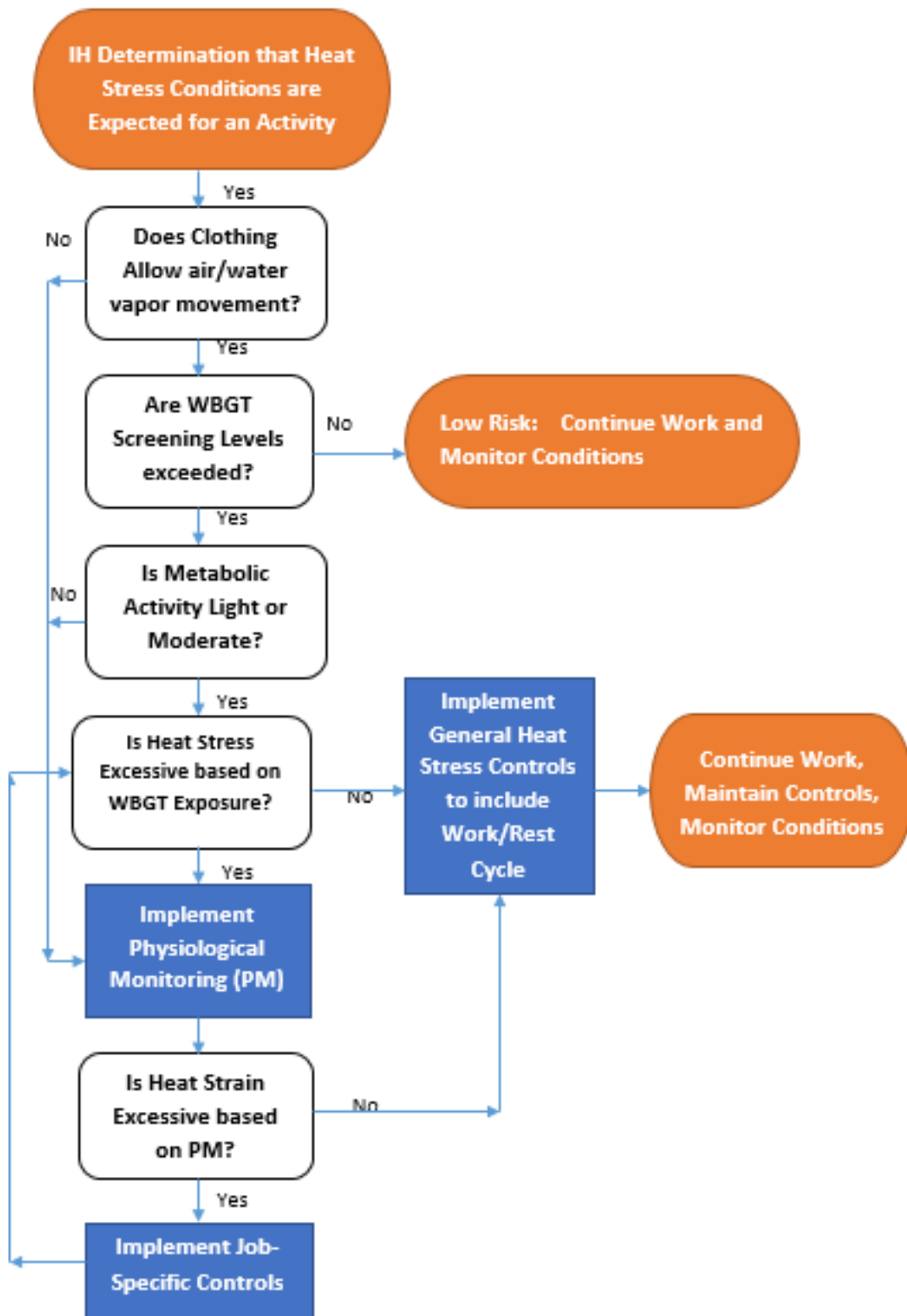
6.3 Bases

TE-2014-003, *Control of Heat Stress and Heat Strain, Establishing a Work-Rest Regimen Based on a Time-Weighted, Wet Bulb Globe Temperature (WBGT)*

TE-2017-001, *Heat Stress Clothing Adjustment Factor Table*

TE-2017-002, *Use of Hanford Meteorological Station for WBGT Measurements*

Figure 1 – CHPRC Decision Logic for Heat Stress Control



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Appendix A - Glossary

Term	Definition
Acclimatization	<p>The temporary adaptation of the body to work in the heat that improves the ability to tolerate heat stress with a reduction of heat strain, that occurs gradually when a person is exposed to it.</p> <p>Acclimatization peaks in most people within four to fourteen days of regular work for at least two hours per day in the heat. 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.</p>
Clothing Adjustment Factor (CAF)	<p>Clothing affects heat stress exposure depending on the amount of insulation, ventilation, and evaporative resistance of the ensemble. Measures to express thermal characteristics of clothing are the WBGT Clothing Adjustment Factor (CAF), assigned through laboratory trials following a heat stress protocol in which temperature and humidity increase until the participant loses the ability to thermo-regulate.</p>
Cool Down Area	<p>A rest area near the worksite where workers periodically enter to cool down after working in a hot environment. Ideally, the cool down area should be shaded and maintained cooler than the work area, and in a radiological low dose area.</p>
(Core) Body Temperature	<p>Core body temperature is found in the blood supplying organs such as the brain and those in the abdominal and thoracic cavities. An internal core body temperature of 101.4°F is the limit for daily prolonged work under heat stress conditions.</p>
Excessive Heat Strain	<p>Excessive heat strain is defined as showing one or more of the following:</p> <ul style="list-style-type: none"> • Core body temperature >100.4°F (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used) • Sustained heart rate >180 beats per minute (minus the person's age) for several minutes • Sudden severe fatigue, nausea, dizziness, lightheadedness
Forehead Temperature	<p>A forehead thermometer may be used to measure body temperature, with application of a correction factor.</p>
General Controls	<p>General controls are implemented BEFORE there is the potential for excessive heat strain. General Controls include: written instructions, annual training, drinking small volumes of water regularly, self-reporting of symptoms, self-limitation of exposures, and use of the buddy-system to report symptoms.</p>
Heart Rate Monitoring	<p>Measurement of an individual's heart or pulse rate to determine the physiological effect from heat stress exposure and determine the individual's recovery rate.</p>
Heat Illness	<p>A serious medical condition resulting from the body's inability to cope with a heat load, and includes heat cramps, heat exhaustion, heat syncope, and heat stroke.</p>
Heat Strain	<p>The overall physiological response resulting from heat stress as recognized by:</p> <ul style="list-style-type: none"> • Increased core body temperature • Increased heart rate • Increased sweating and/or loss of body weight from sweating <p>When physiological responses to heat are not controlled, heat strain may progress to Heat Illness.</p>

Heat Stress Control

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Appendix A - (Cont.) Glossary

Term	Definition												
Heat Stress	The net heat load to which a worker may be exposed from the combined contributions of metabolic heat, environmental factors (air temperature, humidity, air movement, radiant heat), and clothing requirements. Heat stress occurs when the body produces or gains more heat than it is capable of giving off or losing.												
Heat Stroke	Heat stroke is a life-threatening condition requiring IMMEDIATE medical attention and occurs when the core body temperature increases to dangerous levels after the body fails to thermo-regulate.												
Impermeable Clothing	Impermeable means not allowing fluid to pass through. Impermeable clothing are worn to provide the employee protection against a liquid or vapor (e.g., limited-use water- or vapor-barrier clothing), or from an atmosphere/environment (e.g., encapsulating or Level A suit, some electrical protective clothing).												
Job-Specific Controls	Job-specific controls are implemented when there is a potential for excessive heat strain, and include any combination of engineering and administrative controls and use of personal protective equipment that reduces heat stress to an acceptable level.												
Professional Judgment	The process of forming an opinion or evaluation by the application and appropriate use of specialized knowledge gained from extensive academic preparation through formal education, observation, experimentation, inference, and analogy, which is also characterized by conformance with technical and ethical standards within a discipline.												
Recovery Heart Rate (RHR)	After sustained activity at 75% of the maximum heart rate, the heart needs time to recover or return to the normal, resting heart rate. The heart rate is measured 1 minute after a peak work effort. The RHR should not exceed 120 beats per minute (bpm).												
Resting Heart Rate	The baseline heart rate for people at rest, before engaging in a work activity, is identified as less than 100 beats per minute (bpm) for CHPRC.												
Rest Period	Time where the individual ceases engaging in strenuous activity in order to allow the body to dissipate heat, slow the heart, and provide greater blood flow to the skin. When the body is exposed to heat stress, the rest period should allow the individual a place to sit in a cooler, shaded area, and to take water.												
Sustained Heart Rate (SHR)	The heart rate when engaged in a sustained activity and/or in a hot environment, that corresponds to 75% of the maximum heart rate. To calculate the maximum sustained heart rate for an individual, use the formula: 180 bpm - Age (in years). If SHR is temporarily exceeded, a rest period is identified for the individual, then the RHR is measured after 1 minute to determine if the individual is fit to continue working in the heat stress environment.												
Temperature Correction Factor	<i>Body Temperature</i> measurements are taken to estimate the core body temperature, and require a correction factor if they are NOT taken with a rectal or tympanic (ear) thermometer.												
	<table border="1"> <thead> <tr> <th>Forehead T °F</th> <th>Approximate Correction Factor (Multiply)</th> <th>Rectal/Ear T °F</th> </tr> </thead> <tbody> <tr> <td>98.4 - 99.3</td> <td>1.018</td> <td>100.4 - 101</td> </tr> <tr> <td>99.4 - 101.1</td> <td>1.016</td> <td>101.1 - 102.4</td> </tr> <tr> <td>101.2 - 102</td> <td>1.014</td> <td>102.5 - 103.5</td> </tr> </tbody> </table>	Forehead T °F	Approximate Correction Factor (Multiply)	Rectal/Ear T °F	98.4 - 99.3	1.018	100.4 - 101	99.4 - 101.1	1.016	101.1 - 102.4	101.2 - 102	1.014	102.5 - 103.5
Forehead T °F	Approximate Correction Factor (Multiply)	Rectal/Ear T °F											
98.4 - 99.3	1.018	100.4 - 101											
99.4 - 101.1	1.016	101.1 - 102.4											
101.2 - 102	1.014	102.5 - 103.5											

Heat Stress Control

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Appendix A - (Cont.) Glossary

Term	Definition
Threshold Limit Value (TLV)[®] and Action Limit (AL) for Heat Stress	<p>According to the American Conference of Governmental Industrial Hygienists (ACGIH[®]), the Threshold Limit Value (TLV) for heat represents the conditions under which it is believed that nearly all heat acclimatized, adequately hydrated, unmedicated, healthy workers may be repeatedly exposed without adverse health effects.</p> <p>The Action Limit (AL) is similarly protective of unacclimatized workers.</p>
Tympanic Membrane Temperature	An infrared tympanic membrane thermometer may be used to directly estimate core body (e.g., brain) temperature during Physiological Monitoring. For adults, the normal ear temperature is 99.5°F.
Wet Bulb Globe Temperature (WBGT)	The WBGT identifies the environmental temperature index used to assess the potential for heat stress. WBGT values may be measured with integrated equipment or calculated using readings from a globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer. The WBGT factors radiant heat, ambient dry bulb temperature and humidity into a single value. WBGT values measure the environmental heat load exposure but do not predict the micro-climate inside protective clothing. The combined WBGT and CAF is the effective WBGT.
Work-Rest Cycle	The proportion of time spent working and resting during one hour increments, established by the WBGT index, clothing ensemble, activity level (metabolic rate), and acclimatization status.

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Appendix B - Physiological Monitoring**Background Information**

Physiological monitoring provides screening data for work activities having the potential for excessive heat strain, so that the TLV® or Action Limit can be maintained and heat stroke prevented. This appendix provides a process and interpretative guidance when collecting physiological measurements.

The most widely recognized physiological measures for evaluating heat strain are:

- The *Sustained Heart Rate (SHR)* and *Recovery Heart Rate (RHR)*,
- *Body Temperature*,
- Symptoms of excessive heat strain.

Working at the *Sustained Heart Rate (SHR)* identified by the 2016 TLV represents a cardiovascular demand of 75% of the worker's maximum aerobic capacity. For nearly all workers, working at the heat stress TLV, or Action Limit (for unacclimatized), allows individuals to maintain homeostasis, preventing heat stroke.

Baseline Resting Heart Rate

A *Baseline Resting Heart Rate* (≤ 100 bpm) is established before dressing out in the PPE ensemble and entering the work environment.

- IF a *Baseline Resting Heart Rate* ≤ 100 bpm cannot be achieved, and use of temperature as a measure is deemed infeasible by the PIH, THEN the worker does not qualify to perform work in the heat stress environment for that entry and should be reassigned to other work.

Sustained Heart Rate (SHR)

Measurement of the *SHR* varies for intermittent and continuous monitoring:

- 1) Intermittent Monitoring: Measurements are discrete, taken in the work area while the worker is working. The worker stops for a moment and removes the outer work glove for a finger pulse measurement. The results are compared to [180 bpm minus the worker's age].
- 2) Continuous Monitoring: Heart rates are continuously monitored using a chest-strap connected to a computer with software developed for physiological monitoring.

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Appendix B - (Cont.) Physiological Monitoring

NOTE: Some medications could bias Physiological Monitoring measurements, such as heart, migraine, and blood pressure medications (e.g., beta-blockers). The effects of these medications may cause a lowering of the heart rate. For those working in a heat stress environment AND taking medications such as beta-blockers, a rule of thumb regarding heat strain:

“If you reach a point in your work where it is too hard to talk, it is probably too much and you need to rest.”

Sustained Heart Rate (SHR) and Recovery Heart Rate (RHR) Criteria

- A SHR that does not exceed [180 bpm minus the worker’s age], is expected for individuals assessed with normal cardiac performance.
 - Using a chest-strap, SHR is evaluated over several minutes. The worker’s heart rate may exceed (180-age) during the interval, but decisions about the SHR is delayed until the end of the interval.
 - A RHR of less than 120 bpm one minute after a peak work effort indicates that the worker is NOT experiencing heat strain.
 - A RHR one minute after a peak work effort that exceeds 120 bpm indicates the worker is experiencing excessive heat strain and should be removed from the heat stress environment.

Body Temperature

At CHPRC, temperature measurements are considered screening measurements. The rectal thermometer is the only instrument recognized as providing an accurate measure of an individual’s core body temperature and those measurements are not collected by OS&IH.

According to the ACGIH®:

- A core body temperature of $\leq 100.4^{\circ}\text{F}$ (to add a level of conservatism, the screening number for an employee that has not been evaluated by medical for work in hot environments is used) is expected.

There are noted biases with *Body Temperature* measurements that make them problematic in heat stress monitoring. For this reason, the PIH determines if they are an appropriate measure for the work activity and the PPE ensemble worn. Despite their limitations, temperature estimates may still be useful to evaluate trends in an individual’s physiologic response to heat stress.

Estimates of core *Body Temperature* measurements may be taken with a:

- Tympanic membrane (ear) thermometer;
- Body thermometer to measure forehead temperature, or in the depression behind-the ear, or the axillary (underarm) temperature;
- Chest-strap with heart and core body temperature sensor (NOTE: continuous monitors such as the Zephyr™ Bio-Harness 3 has software that estimates core temperature);
- Temperature pill, taken internally, to assess core body temperature (requires special approvals/documentation).

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Appendix B - (Cont.) Physiological Monitoring

Forehead, behind the ear and axillary (underarm) temperature measurements are not direct measures of deep core body temperature and require a variable temperature correction, shown below. Tympanic temperatures are a direct measure of brain temperature, deemed a close estimate of core body temperature. At CHPRC, temperature corrections for tympanic membrane measurements are not required.

Forehead/Behind Ear/Axillary T °F	Correction Factor (Multiply by)
98.4 - 99.3	1.018
99.4 - 101.1	1.015
101.2 - 102	1.014
102.3 - 103.1	1.013

NOTE: A bias on the low side (underestimate) could be seen in both forehead and tympanic measurements for those wearing a respirator hood that provides cool air to the ear/forehead. Scanning too rapidly with a body thermometer can result in a biased measurement. Body temperature measurements may need to be repeated several times to verify the accuracy of the measurement.

Symptoms of Excessive Heat Strain

Symptoms of excessive heat strain may include sudden and severe fatigue, nausea, dizziness, or lightheadedness. Observation of symptoms are an integral part of the heat stress control plan, according to the ACGIH. Although workers showing symptoms of heat stress may voluntarily exit the work area when they recognize their symptoms, the IH is cautioned that individuals who have symptoms may NOT fully recognize them.

The IH should carefully evaluate *Heart Rate* and *Body Temperature* monitoring results:

- It is known that *Heart Rate* increases suddenly and dramatically, for example, when climbing a ladder or set of stairs, but after the short-term high-demand activity is over, their *Heart Rate* should dramatically decrease (e.g., 120 bpm). This is normal recovery.
- When *Heart Rate* does not decrease significantly (e.g., to 120 bpm) after a high-demand activity, and/or does not decrease significantly after resting, then the individual is experiencing potential heat strain.
- If the *Body Temperature* remains stable and below the TLV during an activity in a heat stress environment, the individual is thermo-regulating as expected and is not considered at risk of heat stroke.
- When *Body Temperature* starts to climb above normal and is not reduced significantly by the rest period, the individual is at risk of heat illness.
- When *Body Temperature* exceeds the TLV, the individual should be removed from the heat stress environment.

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Appendix C - Use of Hanford Meteorological Station for WBGT Measurements

Direction to measure WBGT and other heat stress measurements follow the conventions identified by the ACGIH® in *Threshold Limit Values® for Physical Agents*.

While it is true that WBGT heat measurements should be made at, or as close as possible to, the specific work area where the worker is exposed to heat stress, it is also permissible to use measurements from WBGTs that are not on the work site, **provided the readings are representative of the employee's work area.**

According to TE-2017-002, Use of the Hanford Meteorological Station for WBGT Measurements, Data collected by local WBGTs are comparable to data collected by the met station WBGTs; i.e., within the accuracy range of the instruments. Note that it is not uncommon for two WBGT meters to have slightly different readings, up to a difference of a few °F. The use of Hanford Meteorological (Met) Stations with WBGT and weather data for outdoor work is approved, with certain precautions:

- Use of Met station WBGT data is best suited, and may only be applied, to outdoor work, away from buildings and structures, reflective surfaces and heat sinks.
- The Met station does not observe Daylight Savings Time (DST) and all measurements are reported as Pacific Standard Time (PST).
- Met stations that have WBGTs that collect measurements every 15 minutes but post measurements on the hour. A time lag could exist between when the measurement was recorded and when it is posted on the website, such that the data point may no longer reflect current conditions.
 - In this case, one may call the Met Station directly for the current WBGT measurement nearest to the work location.

CHPRC OS&IH does not collect Met Station WBGT information; it is obtained through contact with the Met Station. The data collected by the Met Station is saved under MSA rules. WBGT data is received by the shift office for some CHPRC projects.

The shift office enters WBGT data into the logbook and broadcasts the information to project personnel via a paging system. WBGT data that is received by CHPRC shift offices and transmitted to CHPRC OS&IH, is not required to be entered into SWIHD as a WBGT log; however if WBGT data is used to signal a change in work-rest periods, then that WBGT value and the time would be noted on the SWIHD Field Log or Physiological Monitoring form.