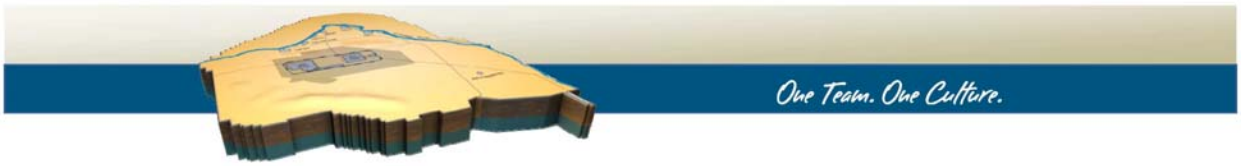


*Administrative Procedure*

# PRC-PRO-SH-121

# Heat Stress Control

**Revision 0, Change 6**

**Published: 01/24/13**
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**Project: CH2M HILL Plateau Remediation Company**
**Topic: Occupational Safety & Industrial Hygiene**

**Administration Use**

CH2MHILL
Plateau Remediation Company

**CHANGE SUMMARY**

**AJHA:** N/A
**HRB Date:** N/A
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**Rev. 0, Chg. 6** **PR#:** PRC- 51740
**USQ Screen Number:**
Editorial per PRC-PRO-NS-062, GCX-2.

**Description of Change**

Rev. 0-6: Corrects an editorial error in the flow chart (figure 1), which currently reads "Are the screening criteria in Table 2 exceeded?" to "Are the screening criteria in Table 3 exceeded?'.

Rev. 0-5: Minor verbiage change on Figure 1 to more accurately describe a step in the flowchart. See below.

- Original Language = Perform heat-strain (physiological) monitoring
- New Language = Analyze heat stress conditions and identify controls
- Changed TA from Mark Jones to Rich Roblee.

Rev. 0-4: Added additional clothing adjustment factors to App. A Table 1 from current TLV and literature articles. Updated TA to MJ Jones and Functional Manager to MT Hughey. Updated guidance provided in Appendix A and D. Added Appendix E. Clarified recordkeeping requirements for IH WBGT data and documentation of work/rest regimens.

Rev.0-3, 8/5/09: Editorial changes to update ACGIH reference from “current edition” to “2005 edition” to conform to 10 CFR 851. Addition of Applicability and Responsibilities sections to match CHPRC PRO template. Corrected section call outs as well as added abbreviation explanations throughout document.

Rev.0-2, 6/24/09: Incorporated editorial changes to update nomenclature of referenced procedures (step 2.2.3.c and section 5.2).

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## 1.0 INTRODUCTION

### 1.1 Purpose

This procedure establishes requirements and processes for working in conditions with the potential for heat stress on the Hanford Site. Following these requirements will assist in compliance with:

- 10 CFR 851, *Worker Safety & Health Program*
- Heat stress exposure limits specified in American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices*, (TLV/BEI) (2005 Edition).
- OSHA 29 CFR 1926.65 and 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*, requirements for control of heat stress conditions during hazardous waste activities.

### 1.2 Scope

This procedure applies to all CH2M HILL Plateau Remediation Company (CHPRC) activities where potential heat stress conditions may be involved.

Certain medical services are not within the scope of this document, including:

- Medical intervention for treatment of heat strain illness by the first aid provider or medical providers.
- Fitness-for-duty protocol or medical certification to perform work in hot environments.

In addition, abnormal or emergency response activities where work planning is not practical (such as fire department and patrol) are not covered by this procedure and will be addressed as part of the emergency response.

### 1.3 Applicability

This Level 2 procedure is applicable to CHPRC Team employees who may work in environments with 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.

## 3.0 PROCESS

### 3.1 Preparation for the Heat Stress Season

| Actionee | Step | Action |
|---|---|---|
| Line Management, Engineering, Maintenance, Safety & Health | 1. | During the spring (January – May), MAKE preparations for the upcoming heat stress season. This includes, inventory supplies, preventive maintenance on equipment that will be used, potential adjustment of start time for shift work, determination of type and supplies needed for cool zones, order additional supplies as needed, and as appropriate, set up cool zones and ensure they are operational. |

**NOTE:** *Appendix E provides information and checklists that can be used as guidance for preparation for the heat stress season.*

### 3.2 Identification and Evaluation of Heat Stress Conditions

| Actionee | Step | Action |
|---|---|---|
| Line Management | 1. | Prior to performing work, EVALUATE whether the potential for heat stress exists.<br>IF necessary,<br>THEN CONTACT the safety and health professional to assist in this evaluation. CONSIDER the following risk factors in this evaluation:<br><br>a. High temperature. |

**NOTE:** *Normally an ambient temperature of 80 $^{0}$F should trigger this evaluation. Certain personal protective clothing ensembles and workloads may require this evaluation to be triggered at a lower ambient temperature.*

b. Humidity.

c. Sources of radiant heat, such as steam pipes, boilers, heated vessels.

d. Use of protective clothing (coveralls, Tyvek coveralls, semi-permeable, or impermeable chemical protective clothing) which can impair the body's ability to regulate heat.

e. Work intensity (workload) and duration.

f. Outdoor operations conducted in hot weather, such as construction, asbestos removal, or hazardous waste activities.

g. Direct physical contact with hot objects.

h. Work performed in greenhouses or other enclosures during conditions that could result in heat buildup or other environments with minimal air movement.

| Actionee | Step | Action |
|---|---|---|
| Line Management | 2. | IF the task is determined to have potential heat stress, THEN PERFORM a job hazard analysis using the Automated Job Hazard Analysis (AJHA) or similar tool. INCLUDE the safety and health professional in this analysis. |

**NOTE:**
- *The safety and health professional will use Figure 1 to help determine the potential heat stress conditions and what engineering and/or administrative controls should be put in place. This will include if physiological evaluation (monitoring) is required. Also the safety and health professional will work with Line Management to determine worker acclimatization.*
- *If a significant amount of time has elapsed between the preparation of the Job Hazard Analysis or work planning documents and the work, re-evaluate the weather conditions to ensure the heat stress hazards are adequately addressed.*

3. IF the safety and health professional determines that heat stress controls are necessary, THEN IMPLEMENT recommended heat stress controls. These controls may include both engineering and administrative controls as well as personal protective equipment.

4. As needed, OBTAIN and USE Wet bulb globe temperature (WBGT) data, the classification of the work activity level (workload), clothing adjustment factor and Appendix A (with safety and health professional involvement) to establish work/rest regimens. The completion of the evaluation and use of work/rest regimens shall be recorded in the work record.

**NOTE:** *The WBGT data can be obtained by taking a WBGT reading at the worksite or using the WBGT reading from the PNNL weather station when appropriate (if work were being done inside it would probably not be appropriate to use the PNNL weather station WBGT).*

| | | |
|---|---|---|
| Safety and Health Professional | 5. | As requested, ASSIST line management in evaluating the risk for heat stress on a task/job via the AJHA or similar hazard analysis process. Using Figure 1, CONDUCT an exposure assessment to determine if physiological monitoring, a work/rest regimen or other engineering and/or administrative controls are needed to reduce the potential for heat stress. WBGT readings taken in the field shall be entered into the PCRIH database with any other pertinent information. |

**NOTE:** *Additional guidance for using Figure 1 can be found in the 2005 edition of TLV/BEI, published by the ACGIH.*

6. IF physiological monitoring is to be used, THEN CONSULT Appendix D.

| Actionee | Step | Action |
|---|---|---|
| Safety and Health Professional | 7. | IF a work/rest regimen is used, THEN CONSULT Appendix A. The WBGT, clothing adjustment factor, workload and acclimatization/unacclimatization status should be used to determine if a work/rest regimen is appropriate and what work/rest time intervals should be established. |
| | 8. | IF work/rest regimens do not provide the proper level of control, THEN the safety and health professional can determine if a more detailed analysis is appropriate or should physiological evaluation (monitoring) be performed. |

### 3.3 Applying Heat Stress Control Strategies

| *Actionee* | *Step* | *Action* |
|---|---|---|
| Line Management | 1. | ENSURE work performed in a hot environment is under the direction of a supervisor who knows the early signs/symptoms of heat illness and who can enforce the permissible work/rest regimen and other established controls. |
| | 2. | IF workers are not acclimatized to the hot working environment, THEN ENSURE that the safety and health professional is informed so that unacclimatized temperatures are used from Table 3, Appendix A. CONSULT the safety and health professional for guidance on worker acclimatization. |
| | 3. | ENSURE water/fluids are accessible in the work area and provided to workers as needed. |
| | | a. ENCOURAGE workers to consume adequate quantities of water and to drink fluids prior to entering the work area. |
| | | b. IF the safety and health professional determines that heat stress conditions exist in a radiological contamination area, THEN PROVIDE fluids in accordance with CHPRC-00073, *CH2M HILL Plateau Remediation Company Radiological Control Manual*. |

**NOTE:**
- *Recommended intake is 8 ounces (1 cup) of cool water (10-15°C or 50-60°F) every 15-20 minutes. Appendix F provides a chart that can be used to track water consumption; this is not mandatory but is included for voluntary personal use only.*
- *Salt tablets are not recommended.*

| Actionee | Step | Action |
|---|---|---|
| Line Management | 4. | Engineering controls should be used as the primary way to reduce heat stress.<br>IF engineering controls are not feasible or not enough,<br>THEN administrative controls should be used to reduce the exposure to heat stress. |

**NOTE:**
- *When temperatures are at or in excess of 35°C (95°F), forced air ventilation should not be used unless the ventilation air is cooled.*
- *Examples of engineering controls include insulation or shielding of hot equipment and surfaces, local exhaust ventilation, shade tents, and forced ventilation of a work area.*
- *Examples of administrative controls include scheduling work for cooler parts of the day, rotating tasks among workers, and applying work/rest regimens.*

5. ADJUST the employee's work schedule, work load, and work/rest regimen as prescribed by the safety and health professional.

6. ESTABLISH worksite-specific heat stress surveillance (see Appendix C) with the safety and health professional when indicated in Section 3.2.

7. PROVIDE a cool-down area adjacent to the hot environment. Adjust the length of the cool-down period in accordance with guidelines for applicable work/rest regimens and ACGIH TLVs. When radiation or IH contaminants may be present in the work area, deconning may be required prior to exit of the work area and entrance into the cooling area.

8. PROVIDE personal protective equipment, cooling devices, and accessory equipment, (such as insulated gloves, reflective clothing, cool ties, ice vests, vortex suits), as recommended by the safety and health professional and with the concurrence of Radcon..

9. ENSURE jobs which require the use of respiratory protection, radiological, or chemical protective clothing are planned with consideration of the stressors that protective clothing can contribute to the overall heat stress potential.

10. IMPLEMENT physiological evaluation (monitoring) strategies when appropriate and as recommended by the safety and health professional. (See Appendix D.)

11. ENSURE that the work record is properly documented regarding the use of engineering and administrative controls or other information regarding heat stress activities.

| Actionee | Step | Action |
|---|---|---|
| Safety and Health Professional | 12. | ASSIST line management in applying heat stress exposure guidelines using Figure 1 to evaluate the potential for heat stress.<br>a. PROVIDE assistance as requested and/or establish the work/rest regimen with respect to temperature, work load, protective clothing, and cooling devices etc.<br>b. IDENTIFY other factors which may alter the interpretation and use of Figure 1, and determine exposure limits accordingly. |
| | 13. | RECOMMEND appropriate environmental monitoring and physiological evaluation (monitoring) methodologies, engineering controls, administrative controls, and personal protective equipment to prevent heat strain. |
| | 14. | COLLECT, INTERPRET, and DOCUMENT worksite-specific heat strain environmental monitoring and physiological evaluation (monitoring) data as appropriate. Methods for physiological evaluation (monitoring) are in Appendix D. |
| | 15. | Based on temperature, work load category, and protective clothing requirements DETERMINE if workers will need cooling devices while performing tasks: ensure Radcon is involved in the decision making process. |
| | 16. | As requested, ASSIST line management in purchase, issue, and use of cooling devices or other protective equipment; ensure Radcon is involved in the decision making process |

### 3.4 Employee Awareness and Training

| Actionee | Step | Action |
|---|---|---|
| Line Management | 1. | ENSURE that employees who are working in or supervising work in hot environments are trained in heat stress recognition, prevention, and control. Training should address:<br>a. Identification of heat stress hazards and potential health effects.<br>b. Predisposing factors and relevant signs and symptoms of heat injury and illness.<br>c. Information on water intake replacement.<br>d. Heat strain control strategies such as work practices and engineering controls, proper acclimatization, and proper use of heat strain personal protective equipment.<br>e. Potential for therapeutic drugs, over-the-counter medications, or social drugs (including alcohol) to increase the risk of heat injury or illness by reducing heat tolerance. |

| Actionee | Step | Action |
|---|---|---|
| Line Management | f. | Other factors that potentially impact heat stress such as lifestyle, age, gender or medical conditions. |
| | 2. | CONDUCT and DOCUMENT this training in a training course, safety meeting, pre-job briefing, or other appropriate forum. |
| | 3. | INCLUDE worksite-specific heat strain prevention information in regular pre-job briefings. Communicate temperature readings, environmental data, and heat stress information to affected employees. |
| Safety and Health Professional | 4. | As requested, PARTICIPATE in pre-job briefings or other processes communicating the hazards associated with heat stress conditions at the work site and the control methods to be used. |
| | 5. | As appropriate, CONTRIBUTE to training of management and employees in heat stress related topics. |
| Employees | 6. | PARTICIPATE in heat strain prevention activities, including training and pre-job briefings. |
| | 7. | BE AWARE of means to avoid heat strain such as adequate water consumption. |
| | 8. | RECOGNIZE the signs and symptoms of heat strain. |
| | 9. | IF signs and symptoms of heat strain develop, THEN INFORM supervisors and take appropriate action, such as immediately exiting the work area. |

### 3.5 Medical Aspects of Heat Strain Control

| Actionee | Step | Action |
|---|---|---|
| Line Management | 1. | RECOGNIZE work conditions that may require employees to be medically evaluated to work in a hot environment. |
| | 2. | ENSURE first aid and emergency procedures for response to heat strain related illnesses are established and communicated to employees. |
| Medical Contractor | 3. | As requested by line management, ASSESS employee's capacity to work in a hot environment and to wear prescribed personal protective equipment in hot environments. |
| | 4. | PROVIDE medical treatment and intervention strategies, as appropriate. |
| Safety and Health Professional | 5. | INVESTIGATE heat strain disorder cases as requested by the Safety Department Injury/Illness Investigation group. PROVIDE results to line management. |

## 4.0 FORMS

None

## 5.0 RECORD IDENTIFICATION

None

## 6.0 SOURCES

### 6.1 Requirements

10 CFR 851, *Worker Safety and Health Program*
10 CFR 851.23(a)(9)
10 CFR 851.25(a)
10 CFR 851, Appendix A, 6.a
29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*
29 CFR 1910.1020, *Access to Employee Exposure and Medical Records*
ACGIH TLV & BEI Booklet (2005), *American Conference of Governmental Industrial Hygienists* (ACGIH), *"Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices"* (2005 edition).
*ACGIH TLV & BEI Booklet* (2007 edition)

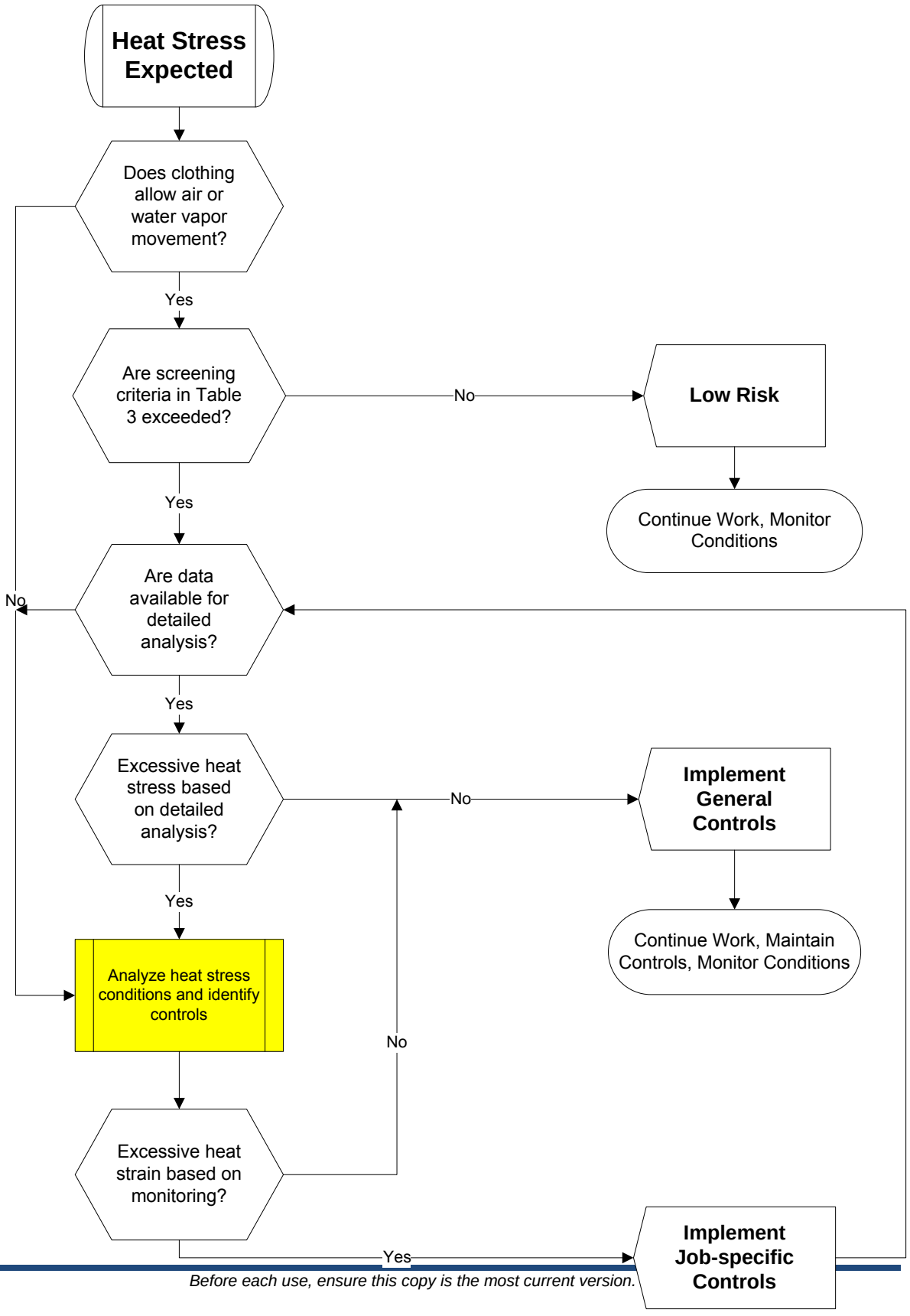
### 6.2 References

CHPRC-00073, *CH2M HILL Plateau Remediation Company Radiological Control Manual*
PRC-PRO-WKM-079, *Job Hazard Analysis*
PRC-PRO-SH-409, *Industrial Hygiene Monitoring, Reporting and Records Management*
*Bernard and Kenney,* 1994, *Standard Operating Safety Guides*, EPA, 1992
NIOSH, 1986, *Revised Criterion, Cincinnati, Ohio*

## 7.0 APPENDIXES

Appendix A -- Establishing Work/Rest Regimens
Appendix B -- Glossary
Appendix C -- Monitoring the Work Environment
Appendix D -- Personal Monitoring
Appendix E – Heat Stress Preparation and Checklists
Appendix F – Hydration Chart

**FIGURE 1 -- Evaluation Scheme for Heat Stress**



## Appendix A -- Establishing Work/Rest Regimens

Appendix A provides guidance for the determination of work/rest regimens if they are to be used as an administrative control to reduce the potential to heat stress. Following Figure 1, determine if Work/Rest regimens can be established. The application of work/rest regimens varies depending on the WBGT indices, clothing, work activity level (workload), and the worker's level of acclimatization. The worksheet below can be used to help establish the work/rest regimens. Table 1, Table 2 and Table 3 are used in this evaluation. Table 3 provides ACGIH heat stress TLVs (work/rest regimens) for several work activity levels. This table assumes that employees do not wear protective equipment to reduce heat exposure. When personal protective equipment is used to reduce heat exposure (e.g., ice vests, vortex suits, etc.), a safety and health professional should be contacted for guidance on how to evaluate this situation.

| | | |
|---|---|---|
| 1. What is the WBGT temperature in the work area? | | |
| 2. What is the WBGT clothing adjustment factor? (Table 1) | | |
| 3. Add the WBGT values from the above two steps. | | |
| 4. Identify the expected work demand category? (Table 2) | Light Moderate Heavy Very Heavy | |
| 5. ☐ Acclimatized | ☐ Unacclimatized | |
| | | ***WORK REST DETERMINATION*** |
| 6. Compare WBGT value from line 3, the work demand category from Line 4 and the acclimatized/unacclimatized status from Line 5 to Table 3 to obtain work/rest times. | | Work Time |
| | | Rest Time |
| **NOTE:** *If WBGT value is greater than those given in Table 3, then the safety and health professional must do a detailed analysis and/or physiological monitoring must be performed.* | | |

This worksheet can be completed by following the steps below:

1. Measure the job site specific WBGT values. The PNNL weather station WGBT may be used to determine the WGBT when appropriate (For example if work were being done inside it would probably not be appropriate to use the PNNL weather station WBGT).

2. Apply the appropriate clothing adjustment factor (CAF) from Table 1 below.

   **NOTE:** *If the clothing worn for this job/task cannot be found in Table 1, the safety and health professional must do additional exposure analysis to determine if engineering or administrative controls are needed.*

3. Add the CAF from Line 2 to the WBGT from Line 1.

4. Establish the estimated work activity level (workload) by referring to Table 2 below.

**NOTE:** *For tasks that involve more than one category, use the most restrictive category unless consultation with a safety and health professional provides other guidance.*

5. Determine whether workers are acclimatized or unacclimatized.

6. Establish a work/rest regimen by applying information obtained from Steps 1 through 5 to Table 3 below.

**NOTE:** *For "Very Heavy Work" for "Work Demands" of 100% work and 75 % work/25 % rest and where the WGBT is off Table 3, the safety and health professional must do a detailed analysis and/or physiological monitoring must be performed.*

7. The establishment of a work/rest regimen shall be documented by the supervisor in the work control document (e.g. work record).

8. Work/rest regimens are normally established in one hour increments and the process should be revisited hourly to determine if the work/rest regimen needs to be altered.

**Table 1 - WBGT clothing adjustment factors (CAF) in $^{o}$F**

.

| Clothing Ensemble | CAF |
|---|---|
| Work clothes (long sleeve shirt and pants)[1] | 0.0 |
| Cloth (woven material) coveralls[1] | 0.0 |
| Double-layer woven clothing[1] | 5.4 |
| Microporous Film Laminate Coveralls with hood[2] (KleenGuard A40) | 4.7 |
| Polyester coveralls with hood[2] (ProTech2000) | 5.4 |
| Polyethylene coated Tyvek with hood[3](Tychem QC) | 18.0 |
| Polyolefin coveralls[3] (Tyvek) | 1.8 |
| OREX Ultra[4] | -1.8 |
| Limited-use vapor-barrier coveralls[1] | 19.8 |

[1] ACGIH 2011 TLV for Heat Stress
[2] O'Conner, D. J., and Bernard, T.E., Continuing the Search for WBGT Clothing Adjustment Factors, Applied Occupational and Environmental Hygiene, Volume 14:119-125, 1999.
[3] Bernard, T., et al, WBGT Clothing Adjustments for Four Clothing Ensembles Under Three Relative Humidity Levels, Journal of Occupational and Environmental Hygiene, 2:251-256, 2005.
[4] OREX Ultra Manufacturers Technical Data Sheet

**Additional Notes:**

1. The 2005 ACGIH TLV for heat stress states "Factors for other clothing ensembles appearing in the literature can be used in a similar fashion following good professional judgment", (page 180). This table lists other clothing adjustment factors found in the literature with the reference cited.

| |
|---|
| 2. Use of respirator hood and/or taping is accounted for in the clothing adjustment factors listed. If not specified as part of the ensemble, subtract 1.0 from all ensembles if the hood is eliminated. (Ashley, C.A., and Bernard, T.E., Effects of Hoods and Flame-Retardant Fabrics on WBGT Clothing Adjustment Factors, Journal of Occupational and Environmental Hygiene, 5: 59-62, 2008) |
| 3. All clothing ensembles include consideration of undergarments (shorts/t-shirt or scrubs). |
| 4. Clothing ensembles not identified within this table should be discussed with the area industrial hygienist for a determination of heat stress controls. |
| 5. The area industrial hygienist has the ability to adjust CAF values as determined necessary. |

**Table 2 - Work Category Guidelines (Workloads)**

| Category | TLV Example Activities |
|---|---|
| Light | Sitting with moderate arm and leg movement<br>Standing w/light work at machine/bench, using mostly arms<br>Using a table saw<br>Standing w/light to moderate work at machine/bench and some walking about |
| Moderate | Scrubbing in a standing position<br>Walking about w/moderate lifting or pushing<br>Walking on level at 6 km/hr while carrying 3 kg weight load |
| Heavy | Carpenter sawing by hand<br>Shoveling dry sand/soil<br>Intermittent heavy lifting with pushing or pulling (e.g., pick-and-shovel work)<br>Heavy assembly work on a noncontinuous basis |
| Very Heavy | Shoveling wet sand/soil |

**Table 3 - Screening Criteria for Heat Stress Exposure**
(WBGT values in °C)

| | Acclimatized | | | | Unacclimatized | | | |
|---|---|---|---|---|---|---|---|---|
| **Work Demands** | **Light** | **Moderate** | **Heavy** | **Very Heavy** | **Light** | **Moderate** | **Heavy** | **Very Heavy** |
| 100% Work | 29.5 (85.1°F) | 27.5 (81.5°F) | 26 (78.8°F) | | 27.5 (81.5° F) | 25 (77.0°F) | 22.5 (72.5° F) | |
| 75% Work; 25% Rest | 30.5 (86.9°F) | 28.5 (83.3°F) | 27.5 (81.5°F) | | 29 (84.2° F) | 26.5 (79.7°F) | 24.5 (76.1° F) | |
| 50% Work; 50% Rest | 31.5 (88.7°F) | 29.5 (85.1°F) | 28.5 (83.3°F) | 27.5 (81.5°F) | 30 (86.0° F) | 28 (82.4°F) | 26.5 (79.7° F) | 25 (77.0° F) |
| 25% Work; 75% Rest | 32.5 (90.5°F) | 31 (87.8°F) | 30 (86.0°F) | 29.5 (85.1°F) | 31 (87.8° F) | 29 (84.2°F) | 28 (82.4° F) | 26.5 (79.7° F) |

**NOTE:**
- *WBGT values are expressed in °C, and represent thresholds near the upper limit of the metabolic rate category.*
- *If work and rest environments are different, hourly time-weighted averages (TWA) should be calculated and used. TWAs for work rates should also be used when the work demands vary within the hour.*
- *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. When workdays are extended, consult the "Application of the TLV" section of the Documentation. Because of the physiological strain associated with Very Heavy work among less fit workers regardless of WBGT, criteria values are not provided for continuous work and for up to 25% rest in an hour. The screening criteria are not recommended, and a detailed analysis and/or physiological monitoring should be used.*

## Appendix B -- Glossary

| TERM | DEFINITION |
|---|---|
| **acclimatization** | The gradual adaptation of an individual to a hot environment. The degree to which a worker is acclimatized to hot environments directly affects how well the body tolerates heat load. Age, gender, and physical fitness affect the period of time for acclimatization to occur; acclimatization can usually be achieved after five to seven days of graduated exposure at the hot job. |
| **apparent temperature** | A temperature and relative humidity index provided by PNNL weather station that relates to potential for various heat syndromes; based on National Weather Association apparent temperature chart. |
| **cool down area** | A rest area normally located as close to the worksite as possible, where workers can periodically enter to cool down after working in hot environments. As a guideline only, areas should be shaded and maintained cooler than the work area. |
| **core body temperature** | Temperature of the internal core body. Both ACGIH and NIOSH cite a core body temperature of 38°C or 100.4°F as the limit for daily, prolonged work under heat stress conditions. Measured in the field either by tympanic, skin, or oral temperature readings. |
| **heat strain** | Physiological response to heat stress recognized by:<br>• Increased core body temperature.<br>• Increased heart rate.<br>• Sweating.<br>If these responses are not controlled, these symptoms may progress and result in increased incidence of heat strain disorders and accident rates. |
| **heat stress** | The total heat load on the body that results from exposure to external sources and from internal metabolic heat production due to physical work. It occurs when the body produces or gains more heat than it is capable of giving off or losing. Contributing environmental factors affecting the potential for heat strain include air temperature, humidity, radiant heat exchange, and air movement. |
| **heat exhaustion** | A heat disorder recognized by profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal, and nausea, vomiting, and unconsciousness may occur. |
| **heat stroke** | A life-threatening heat disorder characterized by diminished or absent sweating. The skin is hot, dry, and flushed. Increased core body temperature, which, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical care is urgently needed. |

| TERM | DEFINITION |
|---|---|
| **hot environment** | A work area where one or more of the following factors may exist, creating the potential for heat strain: high temperature/humidity, sources of significant radiant heat, or use of protective clothing which impedes sweat evaporation. |
| **rest** | A total cessation of work in the hot environment and relocation to a shaded environment to allow for cool-down between work periods. Personal protective equipment (PPE) should be removed and the employee should be seated (as possible) during rest periods. |
| **threshold limit values (TLVs) for heat stress** | ACGIH values incorporate work exertion level, PPE in use, and WBGT temperatures to determine a work/rest regimen that permit nearly all workers to be repeatedly exposed to hot work environments without adverse health effects. TLVs are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and dietary salt intake should be able to function effectively under the given working conditions without exceeding a core body temperature of 38°C (100.4°F). |
| **wet bulb globe temperature (WBGT)** | Environmental temperature index used to assess the potential for heat strain. 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. |
| **work/rest regimen** | The proportion of time that an individual spends working and resting during an hour duration, and is established based on the WBGT index, work activity level (workloads) exertion level, personal protective equipment worn, and acclimatization status. |

## Appendix C -- Monitoring the Work Environment

Thermal stress is a function of air temperature, solar and thermal radiation, relative humidity, air movement, and the physiologic condition of the worker. Where conditions of humidity, sunlight, or radiant heat exist, ***dry bulb measurements alone are inadequate*** as indicators of the proper work/rest regimen. Automated equipment is available that integrates the three temperature measurements and provides a digital readout. If the Project does not have monitoring equipment, it is available through the Industrial Hygiene Equipment Services (IHES - MSA). If equipment is used that provides individual wet bulb, globe, or dry bulb temperature measurements, use one of the two WBGT indices below:

(a) Equation 1 is applicable to outdoor conditions with solar load:

**WBGT = 0.7 (wet bulb temp.) + 0.2 (globe temp.) + 0.1 (dry bulb temp.)**

(b) Equation 2 is applicable to indoor/outdoor conditions without solar load:

**WBGT = 0.7 (wet bulb temp.) + 0.3 (globe temp.)**

Table 3 lists WBGT temperature ranges where heat stress conditions may exist. WBGT readings in these ranges may indicate a need for work/rest regimens to be applied or personal monitoring to be performed. Interpretation of the table depends on the work activity level and specifically defined clothing worn by workers.

At present, the PNNL Weather Station in the 200 area provides WBGT readings during daylight hours, Monday through Friday, between May 1 and October 1, and until 12:00 p.m. on weekends and holidays. These readings are taken between 200 East and 200 West, and can be used as general guidance for most outdoor locations at Hanford. However, depending on specific worksite conditions, they may not be directly applicable for a specific worksite.

As determined by the safety and health professional, supplementary WBGT readings may be necessary when work is performed inside containment tents, greenhouses, other enclosures or at other times of the year.

## Appendix D – Physiological Evaluation (Monitoring)

Physiological evaluation (monitoring) can be used to determine the potential risk to heat stress and can be used under any circumstance to monitor for heat stress. However in certain applications when impermeable clothing is used or the potential for heat stress cannot be controlled by engineering and/or administrative controls, the ACGIH TLV requires physiological evaluation (monitoring) be used. In these situations, engineering and administrative controls shall be used to reduce the potential for heat stress and then physiological evaluation (monitoring) used additionally to monitor heat stress.

This appendix provides guidance on various methods of physiological evaluation (monitoring) for use by safety and health professionals. The American Conference of Governmental Industrial Hygienists (ACGIH) recognizes four measures for evaluating excessive levels of heat strain. These are: sustained heart rate, body core temperature, recovery heart rate and physical symptoms of excessive heat strain.

### Sustained Heart Rate

"Sustained (several minutes) heart rate (SHR) is in excess of 180 beats per minute (bpm) minus the individual's age in years (e.g. 180 – age), for individuals with assessed normal cardiac performance."

1. Prior to starting work where SHR will be used to monitor for heat strain, establish personal monitoring process to be used and the means for identifying the supervisor/employee when the SHR is above 180 bpm minus the employee's age for several minutes and what actions will be taken.

2. Select the equipment (i.e. Nonin Onyx Finger Pulse Rate Monitor, Polar Chest Pulse Rate Monitor) that will be used to monitor heart rate.

3. Establish if the heart rate will be monitored continuously or intermittently (initially intervals should be no longer than 30 minutes until collected data indicates longer intervals are appropriate) and how this will be done.

4. Review the personal monitoring process to be used in the pre-job brief or in another format that ensures supervisors/employees working this task/job are informed of the process.

### Core Body Temperature

"Body core temperature is greater than 38.5°C (101.3°F) for medically selected and acclimatized personnel, or greater than 38°C (100.4°F) in unselected, unacclimatized workers."

If a Project determines that core body temperature is going to be used to monitor for heat strain, notify the TA and review the proposed process with the TA.

**Recovery Heart Rate**

"Recovery heat rate at one minute after a peak work effort is greater than 110 bpm."

1. Prior to starting work where recovery heart rate will be used to monitor for heat strain, establish personal monitoring process to be used and the means for identifying the supervisor/employee when the recovery heart rate is above 110 bpm and what actions will be taken.

2. Select the equipment (i.e. Nonin Onyx Finger Pulse Rate Monitor, Polar Chest Pulse Rate Monitor) that will be used to monitor heart rate.

3. Establish the interval for monitoring recovery heart rate (initially intervals should be no longer than 30 minutes until collected data indicates longer intervals are appropriate) and how this will be done.

4. Review the personal monitoring process to be used in the pre-job brief or in another format that ensures supervisors/employees working this task/job are informed of the process.

**NOTE:** *The "Recovery Heart Rate" may be used in conjunction with the "Sustained Heart Rate" as a means to monitor for heat strain.*

**Physical Symptoms of Excessive Heat Strain.**

"There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness."

If a Project determines that observation of heat strain symptoms is going to be used to monitor for heat strain, notify the TA, review the proposed process with the TA and obtain the TA approval to use the process.

Other methods of personal monitoring for heat strain (i.e. weight loss) may be available. If a Project decides to use one of these other methods, notify the TA, review the proposed process with the TA and obtain TA approval to use the process.

## Appendix E – Heat Stress Preparation & Checklists

In order to be prepared for the heat stress season, various preparations should be made in advance. This appendix provides guidance and checklists that can be used to assist in these preparations and information concerning the reason for cool zones, their set-up, and checklists for them.

The following checklist can be used to begin preparations:

_____ Are containment tents that are equipped with different types of cooling systems available and in working order?

_____ Are misters available and in working order?

_____ Are shade tents available and in good repair?

_____ Are WGBT direct reading instruments readily available and have had maintenance checks?

_____ If physiological monitoring is anticipated, are heart rate monitors (or other devices) available and in working order?

_____ If appropriate, have arrangements been made to work at cooler times of the day?

_____ Is an adequate supply of cooling vest on hand?

_____ Have arrangements been made for having an adequate supply of water at the work site?

The following paragraphs provide information concerning the potential use of cool zones and appropriate checklists for preparation for their use. Industrial hygiene should be consulted with any questions regarding why cool zones are necessary, how to set-up a cool zone, establishing the location of a cool zone, and when a cool zone should be set-up.

*Why do we need cool zones?*

The human body operates within a narrow temperature range. Adverse health effects start to develop when body temperatures begin to rise to the top of this range. Therefore, it is extremely important to provide the means for the body to cool down to normal temperature levels.

Cool down areas, cool zones, assist the body's cooling process and allow for recovery from elevated internal temperatures. Sitting in a cool zone will allow the heart rate to return to normal and give the muscles a chance to rest. This will result in a decrease of the production of internal heat, cooling the body even more. Providing drinking water will replenish the body's lost liquid reserves as well as cooling the core of the body. Taken together, the cool zone and drinking water help protect the worker from adverse health effects due to working in the heat.

*How should the cool zone be set-up?*

A cool zone would ideally be an area with a temperature around 24.4 °C (76 °F), though this might feel too chilly to a worker who is acclimatized to the heat. If such a facility is not available, providing a shaded area with a cool zone fan, benches, and drinking water is an acceptable method to help the worker's body return to a normal temperature.

By the end of March, engineering, with input from operations, should determine the best type of cool zone (closed facility/vehicle with air conditioning or an open cool down area) for the specific tasks to be conducted. For example, "This task requires a cool zone comprised of 1-shade structure, 1-cool zone mister fan, 2- benches, 1-generator, and an adequate supply of cool drinking water."

*Where should cool zones be located?*

The further an employee has to walk to reach the cool zone, the more heat their body will generate from exercising the leg muscles; this is counterproductive. Cool zones should be located as close to the work area as possible to allow for more immediate relief from the heat.

By the end of April, engineering, with input from operations, should complete a drawing specifying the location of the cool zones with an inventory of required equipment (e.g., number of benches, number of fans, number of carports) for all anticipated work for the summer with additional inventory for equipment failures and emergent work.

*When should cool zones be set up?*

When work is going to be conducted in areas where ambient temperatures are greater than or equal to 80°F, cool zones should be set up, tested, and fully functional.

As appropriate during May, operations and maintenance should set up the cool zones, test them, and verify that they are fully functional.

**MARCH:**

Management and craft begin negotiations to adjust the start time of the work shift. Engineering and operations determine the best type of cool zone and supplies needed. Maintenance and operations inventory supplies for cool zone, including but not limited to:

- ☐ Cool zone fans
- ☐ Misting systems
- ☐ Carports: three at 4B, one at 4C, & two at 3A (minimum)
- ☐ Shade tents
- ☐ Generators: 1 per carport
- ☐ Benches: 2 per carport (minimum)
- ☐ Coolers for drinking water bottles

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- ☐ Ice machine or identified supply of ice
- ☐ Filters, nozzles, tubing, and fittings

**APRIL:**

1. Engineering and operations complete drawings for cool zones.
2. Maintenance and operations order all required supplies that are not in stock, including but not limited to:

- ☐ Cool zone fans
- ☐ Misting systems
- ☐ Carports: three at 4B, one at 4C, & two at 3A (minimum)
- ☐ Shade tents
- ☐ Generators: 1 per carport
- ☐ Benches: 2 per carport (minimum)
- ☐ Coolers for drinking water bottles
- ☐ Ice machine or identified supply of ice
- ☐ Filters, nozzles, tubing, & fittings

**MAY:**

By the second week in May, operations and maintenance ensure that the cool zones and misting systems are assembled and fully functional.

**MAY Through End of Hot Season:**

Do not allow water to stand unused in misting system reservoir tanks or water lines for longer than 24-hours. Turn on the units daily, and let run for 15 to 20 minutes even if no work is scheduled. This is done to prevent algae growth in the system, which plugs the spray nozzles. Drain the system (reservoir tanks and lines) if it will not be used for more than 3 days.

### Appendix F – Hydration Chart

**NOTE:** *This appendix is not mandatory.*

| **How much do I need today?** Working in the heat and working at different workloads will add to the minimum water intake. Use this table to determine your minimum requirements. | | **Enter Number of Ounces (oz.)** |
|---|---|---|
| **A. Initial Minimum:** Your weight divided by 20 equals the number of 8-oz. glasses of water that you need to consume. *For example: If your weight is 160 lb., divide that by 20 and you need to drink eight 8-oz. glasses of water today (64 oz.)*. | | |
| | | |
| **B. Today's Expected High Temperature:** | | |
| 29.4 °C (85 °F) | Add 8 oz. | |
| 32.2 °C (90 °F) | Add 16 oz. | |
| 35 °C (95 °F) | Add 32 oz. | |
| 37.7 °C (100 °F) | Add 48 oz. | |
| 40.5 °C (105 °F) | Add 64 oz. | |
| | | |
| **C. Today's Expected Work Activities:** | | |
| Outdoors, light activities: | Add 8 oz. | |
| Outdoors moderate activities (such as carrying 10 lb): | Add 16 oz. | |
| Outdoors heavy activities (such as shoveling or heavy lifting): | Add 24 oz. | |
| **Total Ounces of Water Needed Today Are A + B + C:** | | **Oz.** |

See if you have met your goal; each box is 8-oz. or 1 cup. **Check off** the boxes as you consume water during the day.

| | | | | | |
|---|---|---|---|---|---|
| 8 ☐ | 48 ☐ | 88 ☐ | 128 ☐ | 168 ☐ | 208 ☐ |
| 16 ☐ | 56 ☐ | 96 ☐ | 136 ☐ | 176 ☐ | 216 ☐ |
| 24 ☐ | 64 ☐ | 104 ☐ | 144 ☐ | 184 ☐ | 224 ☐ |
| 32 ☐ | 72 ☐ | 112 ☐ | 152 ☐ | 192 ☐ | 232 ☐ |
| 40 ☐ | 80 ☐ | 120 ☐ | 160 ☐ | 200 ☐ | 240 ☐ |