

Appendix A
Information for Heat Illness Prevention

To protect the health and safety of employees from heat-related illnesses, employers should consider using the resources below. Please note that some resources may use temperatures in Celsius instead of Fahrenheit. To convert to degrees Fahrenheit, use this formula: Fahrenheit (°F) = (Celsius x 1.8) + 32

1. Most heat-related illnesses affect workers who do strenuous physical activity. When workers engage in intense work, their bodies create heat. This "metabolic" heat combines with environmental heat (from temperature, sunlight, humidity, etc.) so workers' core temperature can rise to dangerous levels. To prevent a hazardous combination of environmental and metabolic heat, employers should be aware of workers' activity level. Workload can be classified as rest, light, moderate, heavy, or very heavy. See information provided in the tab on Metabolic Heat and Workload (Physical Activity level) for additional detail on estimating worker's workload.

Table 1. Metabolic Heat and Workload (Physical Activity Level)

<u>Level of Workload / Physical Activity *</u>	<u>Examples</u>	<u>Metabolic Rate in Watts, "typical" recognizing that different ways of doing the same task may lead to dramatically different wattage</u>
<u>Rest</u>	<ul style="list-style-type: none">• <u>Sitting</u>• <u>Thinking</u>	<u>115</u>
<u>Light</u>	<ul style="list-style-type: none">• <u>Sitting with minimal hand and arm work</u>• <u>Sewing</u>• <u>Writing or drawing</u>• <u>Driving a car</u>• <u>Occasional or slow walking</u>• <u>Stooping, crouching, or kneeling</u>• <u>Standing watch</u>	<u>180</u>

* Workers who are overweight or obese might produce more metabolic heat than other workers who perform the same tasks. The above table assumes a 70-kg (154-pound) worker.

Table 1 was partially recreated from federal OSHA's guidance on Heat Hazard recognition, which can be accessed at: <https://www.osha.gov/heat-exposure/hazards>.

2. The OSHA-NIOSH Heat Safety Tool app is a useful resource for planning outdoor work activities based on how hot it feels throughout the day. It features real-time heat index and hourly forecasts specific to your location, as well as occupational safety and health recommendations from OSHA and NIOSH. It can be accessed and downloaded at: <https://www.osha.gov/heat/heat-app>

3. Work/rest schedules.

A. Table 2. Work/rest schedules for workers wearing normal work clothing*

<u>Adjusted temperature (°F)†</u>	<u>Light work (minutes work/rest)</u>	<u>Moderate work (minutes work/rest)</u>	<u>Heavy work (minutes work/rest)</u>
90	<u>Normal</u>	<u>Normal</u>	<u>Normal</u>
91	<u>Normal</u>	<u>Normal</u>	<u>Normal</u>
92	<u>Normal</u>	<u>Normal</u>	<u>Normal</u>
93	<u>Normal</u>	<u>Normal</u>	<u>Normal</u>
94	<u>Normal</u>	<u>Normal</u>	<u>Normal</u>
95	<u>Normal</u>	<u>Normal</u>	<u>45/15</u>
96	<u>Normal</u>	<u>Normal</u>	<u>45/15</u>
97	<u>Normal</u>	<u>Normal</u>	<u>40/20</u>
98	<u>Normal</u>	<u>Normal</u>	<u>35/25</u>
99	<u>Normal</u>	<u>Normal</u>	<u>35/25</u>
100	<u>Normal</u>	<u>45/15</u>	<u>30/30</u>
101	<u>Normal</u>	<u>40/20</u>	<u>30/30</u>
102	<u>Normal</u>	<u>35/25</u>	<u>25/35</u>
103	<u>Normal</u>	<u>30/30</u>	<u>20/40</u>
104	<u>Normal</u>	<u>30/30</u>	<u>20/40</u>
105	<u>Normal</u>	<u>25/35</u>	<u>15/45</u>
106	<u>45/15</u>	<u>20/40</u>	<u>Caution‡</u>
107	<u>40/20</u>	<u>15/45</u>	<u>Caution‡</u>
108	<u>35/25</u>	<u>Caution‡</u>	<u>Caution‡</u>
109	<u>30/30</u>	<u>Caution‡</u>	<u>Caution‡</u>
110	<u>15/45</u>	<u>Caution‡</u>	<u>Caution‡</u>
111	<u>Caution‡</u>	<u>Caution‡</u>	<u>Caution‡</u>
112	<u>Caution‡</u>	<u>Caution‡</u>	<u>Caution‡</u>

*With the assumption that workers are physically fit, well-rested, fully hydrated, under age 40, and have adequate water intake and that there is 30% RH [relative humidity] and natural ventilation with perceptible air movement.

†Note: Adjust the temperature reading as follows before going to the temperature column in the table: Full sun (no clouds): Add 13°

Partly cloudy/overcast: Add 7°

No shadows visible/work is in the shade or at night: no adjustment

Per relative humidity:

10%: Subtract 8°

20%: Subtract 4°

30%: No adjustment

40%: Add 3°
 50%: Add 6°
 60%: Add 9°

‡High levels of heat stress; consider rescheduling activities.

Adapted from EPA [1993]

Table 2 above was recreated from the following publication; see page 76 in NIOSH [2016]. *NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments.* By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106.

B. Table 3. Work/rest schedules for those wearing chemical resistant suits.

Air Temp (°F)	Light work			Moderate work			Heavy work		
	Full sun	Partly cloudy	No sun†	Full sun	Partly cloudy	No sun†	Full sun	Partly cloudy	No sun†
75	Normal	Normal	Normal	Normal	Normal	Normal	35/25‡	Normal	Normal
80	30/30	Normal	Normal	20/40	Normal	Normal	10/50	40/20	Normal
85	15/45	40/20	Normal	10/50	25/35	Normal	Caution [§]	15/45	40/20
90	Caution [§]	15/45	40/20	Caution [§]	Caution [§]	25/35	Stop work	Caution [§]	15/45
95	Stop work	Stop work	15/45	Stop work	Stop work	Stop work	Stop work	Stop work	Stop work

*With the assumption that workers are heat-acclimatized, under the age of 40, physically fit, well-rested, fully hydrated, and wearing Tyvek coveralls, gloves, boots, and a respirator. Cooling vests may enable workers to work for longer periods. Adjustments must be made when additional protective gear is worn.

†No shadows are visible or work is in the shade or at night.

‡35 minutes work and 25 minutes rest each hour.

§High levels of heat stress; consider rescheduling activities.

Adapted from EPA [1993]

Table 3 above was recreated from the following publication; see page 77 in NIOSH [2016]. *NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments.* By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106.

4. Acclimatization.

Table 4. Acclimatization in workers

<u>Topics</u>	<u>Additional information</u>
<u>Disadvantages of being unacclimatized</u>	<ul style="list-style-type: none"> • <u>Readily show signs of heat stress when exposed to hot environments.</u> • <u>Difficulty replacing all of the water lost in sweat.</u> • <u>Failure to replace the water lost will slow or prevent acclimatization.</u>
<u>Benefits of acclimatization</u>	<ul style="list-style-type: none"> • <u>Increased sweating efficiency (earlier onset of sweating, greater sweat production, and reduced electrolyte loss in sweat).</u> • <u>Stabilization of the circulation.</u> • <u>Work is performed with lower core temperature and heart rate.</u> • <u>Increased skin blood flow at a given core temperature.</u>
<u>Acclimatization plan</u>	<ul style="list-style-type: none"> • <u>Gradually increase exposure time in hot environmental conditions over a period of 7 to 14 days.</u> • <u>For new workers, the schedule should be no more than 20% of the usual duration of work in the hot environment on day 1 and a no more than 20% increase on each additional day.</u> • <u>For workers who have had previous experience with the job, the acclimatization regimen should be no more than 50% of the usual duration of work in the hot environment on day 1, 60% on day 2, 80% on day 3, and 100% on day 4.</u> • <u>The time required for non-physically fit individuals to develop acclimatization is about 50% greater than for the physically fit.</u>
<u>Level of acclimatization</u>	<ul style="list-style-type: none"> • <u>Relative to the initial level of physical fitness and the total</u>

	<u>heat stress experienced by the individual.</u>
<u>Maintaining acclimatization</u>	<ul style="list-style-type: none"> • <u>Can be maintained for a few days of non-heat exposure.</u> • <u>Absence from work in the heat for a week or more results in a significant loss in the beneficial adaptations leading to an increased likelihood of acute dehydration, illness, or fatigue.</u> • <u>Can be regained in 2 to 3 days upon return to a hot job.</u> • <u>Appears to be better maintained by those who are physically fit.</u> • <u>Seasonal shifts in temperatures may result in difficulties.</u> • <u>Working in hot, humid environments provides adaptive benefits that also apply in hot, desert environments, and vice versa.</u> • <u>Air conditioning will not affect acclimatization.</u>

Adapted from [Moseley 1994; Armstrong and Stoppani 2002; DOD 2003; Casa et al. 2009; ACGIH 2014; OSHA-NIOSH 2011].

Table 4 above was recreated from the following publication; see page 34. NIOSH [2016]. NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments. By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106.

5. Clothing adjustment factors.

Table 5. Clothing adjustment factors exist for various types of clothing.

<u>(°C-WBGT)</u>	<u>Clothing adjustment factors</u>	
	<u>Previous</u>	<u>2006</u>
<u>Clothing</u>		
<u>Work clothing (baseline)</u>	<u>0</u>	<u>0</u>
<u>Cloth coveralls</u>	<u>3.5</u>	<u>0</u>

Double-layer cloth clothing	5	3
Spunbound melt-blown synthetic (SMS) coveralls	-	0.5
Polyolefin coveralls	-	1
Limited-use vapor-barrier coveralls	-	11

Adapted from Bernard TE, Threshold Limit Values for Physical Agents Committee, ACGIH [2014].

Table 5 above was recreated from the following publication; see page 19. NIOSH [2016]. *NIOSH criteria for a recommended standard: occupational exposure to heat and hot environments.* By Jacklitsch B, Williams WJ, Musolin K, Coca A, Kim J-H, Turner N. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 2016-106.