CITY OF PHILADELPHIA RISK MANAGEMENT DIVISION

Safety Directive #P-6

Issue Date: June 2, 2011

Title: HEAT STRESS POLICY

I. PURPOSE

This City's *Heat Stress Policy* has been established to help protect employees who work outdoors or in an indoor industrial setting from the adverse effects of exposure to excessive heat while working.

Outdoor operations conducted in hot weather, and indoor industrial operations involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations. There are no specific laws and regulations governing heat stress. The American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH) publish industry guidelines, which the City has adopted for the assessment of heat exposures.

Outdoor workers are regularly exposed to existing weather elements that may be uncomfortable and need to follow safe work practices to prevent heat-related illnesses. This policy does not provide rationale for employees to stop performing their required work duties. It does however provide some preventive and remedial measures to better protect City workers.

II. RESPONSIBILITIES

A. Department Heads, Managers, and Supervisors

1. Recognize causes of heat stress, signs and symptoms, and controls.
2. Provide work environments that minimize heat stress when possible.
3. Identify employees/positions that may be affected by heat stress.
4. Obtain actual temperature and humidity readings for work environments where heat stress is a concern.
5. Provide a reasonable amount of time for employees to become acclimated to extreme thermal conditions when possible.
6. Provide recovery areas, e.g., air-conditioned enclosures and rooms, for employees where needed.
7. Request the Departmental Safety Officers to evaluate and monitor operations involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, and strenuous physical activities to assess environmental

heat exposures for employees. The Risk Management Division (RMD) may also be contacted for assistance, if internal department resources are not available.

8. Provide information and training to workers about causes of heat stress, signs and symptoms, and controls.
9. Reduce the physical demands of work to the greatest extent possible when hot environmental conditions are involved.
10. Provide intermittent rest periods with water breaks for workers performing moderate to heavy-duty tasks in hot environments.
11. Provide the opportunity for worker pacing when heat stress factors are present.
12. Provide extra workers to lessen physical demands where possible, or limit the number of workers present in an area, especially in confined or enclosed spaces.
13. Provide the use of shifts, e.g., early morning, cool part of the day, or night work.
14. Decide if workers should remain in or be removed from a workplace due to heat stress conditions.

B. **Employees and Visitors**

1. Report heat stress hazards to the appropriate person/supervisor.
2. Adhere to engineering, administrative and work practice controls given by the Department or RMD.

C. **Risk Management Division**

1. General oversight and evaluation of heat stress programs within City departments.
2. Monitor worksites for environmental heat exposures to employees, when needed.
3. Recommend appropriate engineering and administrative heat control measures.

D. **Medical Evaluation Unit**

1. Evaluate potential or present employee medical condition and ability to perform job duties in anticipated thermal work environments.
2. Establish any work restrictions necessary to prevent heat-related illness.

III. DEFINITIONS

A. **Acclimatization** is the ability of the body to undergo physiological adaptations to function in a hot environment.

B. **Conduction** is the transfer of heat between materials that contact each other. Heat passes from the warmer material to the cooler material. For example, a worker's skin can transfer heat to a contacting surface if that surface is cooler, and vice versa.

C. **Convection** is the transfer of heat in a moving fluid. Air flowing past the body can cool the body if the air temperature is cool. On the other hand, air that exceeds 35°C (95°F) can increase the heat load on the body.

D. **Dry bulb (DB) temperature** is measured by a thermal sensor, such as an ordinary mercury-in-glass thermometer, that is shielded from direct radiant energy sources.

E. **Globe temperature** is the temperature inside a blackened, hollow, thin copper globe and represents effects of radiation and wind on the body.

F. **Heat** is a measure of energy in terms of quantity.

G. **Heat Collapse** ("Fainting"). In heat collapse, the brain does not receive enough oxygen because blood pools in the extremities. As a result, the exposed individual may lose consciousness. This reaction is similar to that of heat exhaustion and does not affect the body's heat balance. However, the onset of heat collapse is rapid and unpredictable. To prevent heat collapse, the worker should gradually become acclimatized to the hot environment.

H. **Heat Cramps** are usually caused by performing hard physical labor in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused by both too much and too little salt. Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (±0.3% NaCl), excess salt can build up in the body if the water lost through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

   Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Recent studies have shown that drinking commercially available carbohydrate-electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

I. **Heat Exhaustion**. The signs and symptoms of heat exhaustion are headache, nausea, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment. Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, which is an immediate medical emergency.

J. **Heat Fatigue**. A factor that predisposes an individual to heat fatigue is lack of acclimatization. The use of a program of acclimatization and training for work in hot environments is advisable. The signs and symptoms of heat fatigue include impaired performance of skilled sensorimotor, mental, or vigilance jobs. There is no treatment for heat fatigue except to remove the heat stress before the possibility of a more serious heat-related condition develops.

K. **Heat Rashes** are the most common problem in hot work environments. Prickly heat is manifested as red papules and usually appears in areas where the clothing is restrictive. As

sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

L. **Heat Stroke** occurs when the body's system of temperature regulation fails and body temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict. Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41°C (105.8°F). If body temperature is too high, it can cause death. The elevated metabolic temperatures caused by a combination of workload and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

M. **Natural wet bulb (NWB) temperature** is measured by exposing a wet sensor, such as a wet cotton wick fitted over the bulb of a thermometer, to the effects of evaporation and convection. The term natural refers to the movement of air around the sensor. This sensor represents the effect of humidity, wind and radiation on the body.

N. **Radiation** is the transfer of heat energy through space. A worker whose body temperature is greater than the temperature of the surrounding surfaces radiates heat to these surfaces. Conversely, hot surfaces and infrared light sources radiate heat that can increase the body's heat load.

O. **Wet bulb globe temperature (WBGT)** is the accepted method for determining true temperature that accounts for air currents, relative humidity and solar load. However, this does not take into account chemical protective clothing (i.e. tyvek suits), which prevents evaporative cooling.

For indoor and outdoor conditions with no solar load, WBGT is calculated as:
$WBGT = 0.7NWB + 0.3GT$

For outdoors with a solar load, WBGT is calculated as:
$WBGT = 0.7NWB + 0.2GT + 0.1DB$

IV. HEAT STRESS PROGRAM

A Heat Stress program is necessary for departments that have employees who may perform labor intensive work in high temperature & humidity environments; specifically outdoors or in an indoor industrial setting. A program should include the evaluation of anticipated conditions for workers in hot jobs and monitoring for those workers. Ways of reducing the exposures and associated risks should be considered, including acclimatization, fluid replacement, engineering controls, administrative controls and work practices.

In regards to outside work during extreme hot weather, the National Weather Service (NWS) Heat Index (HI) [see Appendix A] should be utilized to consider preventive measures outlined in this policy to reduce the risk of heat related illnesses. This Heat Index is defined as the temperature the body feels when heat and humidity are combined. The HI chart in Appendix A shows the HI value that

corresponds to the actual air temperature and relative humidity. The City's Department of Public Health uses the HI to issue public heat Advisories, Watches and Warnings for the general population.

When the HI reaches the "Extreme Caution[1]" category (HI = 90 - 105°F) for the Philadelphia area, some preventive measures may be needed to reduce employees' risks of heat related illnesses. The HI values can be directly related to possible heat disorders in high-risk groups. However, normal healthy working individuals are not expected to experience the heat disorders listed in the HI at lower levels, therefore, the City has selected the "Extreme Caution" category as a trigger for additional preventive measures. At this category level, normal healthy individuals may become highly uncomfortable or begin to experience some of the early signs of heat disorders. When the HI reaches the "Danger" category level (HI = 105 - 129°F) for the Philadelphia area, departments must institute some preventive measures as outlined in this policy to mitigate exposures and reduce employees' risks of heat related illnesses.

A. **Employee Monitoring and Exposure Screening**

1. Department heads, managers and supervisors are responsible for monitoring their employees for signs and symptoms of heat-related disorders. Departments can arrange medical evaluations or surveillance for their employees who work in hot environments. Any employee who experiences a heat-related condition or illness that needs medical attention should be referred to the City's designated medical provider for treatment, or nearest hospital for emergencies.

2. Departments and/or RMD will perform heat stress exposure screening that involves assessing occupational workloads and activity levels, measuring environmental wet bulb globe temperatures (WBGT) and assisting in determining workers' acclimatization status. The *ACGIH's "Screening Criteria for Heat Stress Exposure, 2001"* will be used to assess the collected data for suggestion of appropriate work/rest regimens and other recommended controls.

   Employees or their supervisors should contact the department's Safety Office to schedule heat stress exposure screenings if they suspect excessive thermal exposures on the job, or if previously monitored environmental conditions have changed due to modifications to equipment or processes. If desired, employees or their representatives may observe the heat stress exposure screening procedure by arranging with the departmental Safety Office and/or RMD prior to the date of the monitoring. Persons whose heat stress exposures have been monitored will receive written notification of their exposure monitoring results from the departmental Safety Office or RMD.

B. **Acclimatization**

Workers who had previous experience in jobs where heat levels were high enough to produce heat stress or workers returning from an absence of two weeks or more, the regimen should be 50% exposure on day one, 60% on day two, 80% on day three, and 100% on day four. For new workers who will be similarly exposed without the benefit of that experience, the regimen should be 20% on day one, with a 20% increase in exposure each additional day.

[1] The **Extreme Caution** category of the Heat Index chart is defined by the National Weather Service as the category in which the following possible heat disorders may occur with prolonged exposure and/or physical activity for people in high risk groups: sunstroke, muscle cramps and/or heat exhaustion. Those at greatest risk for heat-related illness include infants and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications.

C. **Fluid Replacement**

Water or any liquid (except caffeinated or alcoholic beverages) should be made available to workers to encourage them to drink small amounts frequently, e.g., one cup every 20 minutes. Ample supplies of liquids should be placed close to the work area. Although some commercial replacement drinks contain salt, this is not necessary for acclimatized individuals because most people add enough salt to their summer diets.

D. **Engineering Controls**

1. **General ventilation** is used to dilute hot air with cooler air (generally cooler air that is brought in from the outside). This technique clearly works better during cooler climates than in hot ones. A permanently installed ventilation system usually handles large areas or entire buildings. Portable or local exhaust systems may be more effective or practical in smaller areas.

2. **Air treatment/air cooling** differs from ventilation because it reduces the temperature of the air by removing heat (and sometimes humidity) from the air.

3. **Air conditioning** is a method of air-cooling, but it is expensive to install and operate. An alternative to air conditioning is the use of chillers to circulate cool water through heat exchangers over which air from the ventilation system is then passed; chillers are more efficient in cooler climates or in dry climates where evaporative cooling can be used.

4. **Local air-cooling** can be effective in reducing air temperature in specific areas. Two methods have been used successfully in industrial settings. One type, cool rooms, can be used to enclose a specific workplace or to offer a recovery area near hot jobs. The second type is a portable blower with built-in air chiller. The main advantage of a blower, aside from portability, is minimal set-up time.

5. Another way to reduce heat stress is to increase the airflow or **convection** using fans, etc. in the work area (as long as the air temperature is less than the worker's skin temperature). Changes in air speed can help workers stay cooler by increasing both the convective heat exchange (the exchange between the skin surface and the surrounding air) and the rate of evaporation. Because this method does not actually cool the air, any increases in air speed must impact the worker directly to be effective.

   If the dry bulb temperature is higher than 95°F (39°C), the hot air passing over the skin can actually make the worker hotter. When the temperature is more than 95°F and the air is dry, evaporative cooling may be improved by air movement, although the convective heat will offset this improvement. When the temperature exceeds 95°F and the relative humidity is 100%, air movement will make the worker hotter. Increases in air speed have no effect on the body temperature of workers wearing vapor-barrier clothing.

6. **Heat conduction** methods include insulating the hot surface that generates the heat and changing the surface itself.

7. Simple engineering controls, such as shields, can be used to reduce **radiant heat,** i.e. heat coming from hot surfaces within the worker's line of sight. Surfaces that exceed 95°F (35°C) are sources of infrared radiation that can add to the worker's heat load. Flat black surfaces

absorb heat more than smooth, polished ones. Having cooler surfaces surrounding the worker assists in cooling because the worker's body radiates heat toward them.

With some sources of radiation, such as heating pipes, it is possible to use both insulation and surface modifications to achieve a substantial reduction in radiant heat. Instead of reducing radiation from the source, shielding can be used to interrupt the path between the source and the worker. Polished surfaces make the best barriers, although special glass or metal mesh surfaces can be used if visibility is a problem.

Shields should be located so that they do not interfere with airflow, unless they are also being used to reduce convective heating. The reflective surface of the shield should be kept clean to maintain its effectiveness.

E. Administrative Controls and Work Practices

1. Provide employees with training about heat-induced illnesses (see section F).
2. Schedule the heaviest work to be performed during the coolest part of the day, if possible.
3. Allow employees to build up tolerance to the heat and the work activity slowly (see Section B).
4. Use the buddy system, with people working in pairs.
5. Encourage employees to drink plenty of water, non-alcoholic/non-caffeinated liquids, warm or cool, about a cup every 15 to 20 minutes. Because the body loses fluids in the heat, drinking lots of liquids helps to avoid dehydration.
6. Advise employees to wear light, loose-fitting, breathable clothing, such as cotton.
7. Provide frequent, short breaks in cool, shaded areas to allow the body to cool down. This can be utilized with some approved work/rest regimen appropriate for the department's operations.
8. Instruct employees to avoid eating large meals before working in hot environments.
9. Hot jobs should be scheduled for the cooler part of the day, and routine maintenance and repair work in hot areas should be scheduled for the cooler seasons of the year, where scheduling of duties allows flexibility.
10. Avoid, as much as possible, working in the hot sun or other hot areas.
11. Wear a head covering. A wide brimmed hat or visor will not only protect one's head from intense rays of the sun; it will also provide a shield for one's eyes.
12. Use air conditioners and fans when possible. Open windows to release trapped hot air.
13. Persons taking regular medication should consult with their physician. Some medications cause an adverse reaction in hot weather.

F. Training

Each Department should provide annual training for all employees working in hot environments such as outdoor laborers in summertime, boiler room maintenance personnel,

employees who wear personal protective equipment or apparel that prevents evaporative cooling, etc. This training should cover:

1. Knowledge of the hazards of heat stress;
2. Recognition of predisposing factors, danger signs, and symptoms;
3. Potential health effects of and awareness of first-aid procedures for heat stroke;
4. Employee responsibilities in avoiding heat stress;
5. Dangers of using drugs, including over-the-counter and prescribed therapeutic ones, and alcohol in hot work environments;
6. Use of protective clothing and equipment; and
7. Purpose and coverage of environmental and medical surveillance and the advantages of worker participation in such programs.

Additional training on heat stress hazards and their control may also be available to departments upon request to RMD.

G. **Record Keeping**

Department Safety Offices and RMD will maintain records of all personal exposure monitoring. Exposure monitoring records are maintained for a minimum of five years. These records will be available upon request to employees or designated employee representatives.

H. **Additional Resources**

For additional information on heat stress, controls, or the Heat Stress Policy and Indoor Thermal Comfort Guidance, contact RMD at 683-1704.

REFERENCES

US Department of Labor, Occupational Safety and Health Administration. *OSHA Technical Manual*, Section III: Chapter 4, Heat Stress.

Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. *Working in Hot Environments*, April 1986, Reprinted 1992 with minor changes.

Centers for Disease Control and Prevention, NIOSH, Occupational Exposure to Hot Environments, Revised Criteria, 1986.

American Conference of Governmental Industrial Hygienists (ACGIH), 1998, *Threshold Limit Values and Biological Exposure Indices*.

APPENDIX A

National Weather Service Heat Index

Based on the latest research findings, the NWS has devised the "Heat Index" (HI), (sometimes referred to as the "Apparent Temperature"). The HI, given in degrees F, is an accurate measure of how hot it really feels when effects of the relative humidity (RH) are added to the actual air temperature. HI values were devised for shady, light wind conditions.

HEAT INDEX °F (°C)													
	RELATIVE HUMIDITY as %												
Temp.	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
110 (47)	136 (58)												
108 (43)	130 (54)	137 (58)											
106 (41)	124 (51)	130 (54)	137 (58)										
104 (40)	119 (48)	124 (51)	131 (55)	137 (58)									
102 (39)	114 (46)	119 (48)	124 (51)	130 (54)	137 (58)								
100 (38)	109 (43)	114 (46)	118 (48)	124 (51)	129 (54)	136 (58)							
98 (37)	105 (41)	109 (43)	113 (45)	117 (47)	123 (51)	128 (53)	134 (57)						
96 (36)	**101 (38)**	**104 (40)**	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	132 (56)					
94 (34)	**97 (36)**	**100 (38)**	**103 (39)**	106 (41)	110 (43)	114 (46)	119 (48)	124 (51)	129 (54)	135 (57)			
92 (33)	**94 (34)**	**96 (36)**	**99 (37)**	101 (38)	105 (41)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	131 (55)		
90 (32)	**91 (33)**	**93 (34)**	**95 (35)**	**97 (36)**	**100 (38)**	103 (39)	106 (41)	109 (43)	113 (45)	117 (47)	122 (50)	127 (53)	132 (56)
88 (31)	88 (31)	89 (32)	**91 (33)**	**93 (34)**	**95 (35)**	**98 (37)**	**100 (38)**	103 (39)	106 (41)	110 (43)	113 (45)	117 (47)	121 (49)
86 (30)	85 (29)	87 (31)	88 (31)	89 (32)	**91 (33)**	**93 (34)**	**95 (35)**	**97 (36)**	**100 (38)**	**102 (39)**	105 (41)	108 (42)	112 (44)
84 (29)	83 (28)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	**90 (32)**	**92 (33)**	**94 (34)**	**96 (36)**	**98 (37)**	**100 (38)**	**103 (39)**
82 (28)	81 (27)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	**90 (32)**	**91 (33)**	**93 (34)**	**95 (35)**
80 (27)	80 (27)	80 (27)	81 (27)	81 (27)	82 (28)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	86 (30)	87 (31)

To determine the Heat Index, look at the Heat Index Chart above. As an example, if the air temperature is 96 degrees F (found on the left side of the table) and the RH is 55% (found at the top of the table), the HI - or how hot it really feels - is 112 degrees F. This is at the intersection of the 96 degree row and the 55% column.

Heat Index/Heat Disorders

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130°F or higher (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129°F (41 - 54°C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105°F (32 - 41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90°F (27 - 32°C)	Fatigue possible with prolonged exposure and/or physical activity.