NIOSH HEALTH HAZARD EVALUATION REPORT:

HETA #2001-0248-2874
Thomson Multimedia, Inc.
Circleville, Ohio

May 2002

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to Federal, State, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Bradley King and Joel McCullough of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Technical assistance was provided by Ann Krake. Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Heat Stress among Glass Panel/Funnel Production Line Workers

This health hazard evaluation was performed in response to a union request at Thomson Multimedia Inc., in Circleville, Ohio. Concerns were expressed regarding heat-related health effects such as heat strain, fatigue, and heat exhaustion for workers on the glass panel and funnel production lines at the facility.

What NIOSH Did

- We monitored work area temperatures.
- We monitored workers' internal core body temperature, heart rate, and the amount of body weight lost during their shift.
- We interviewed workers about health effects they have experienced that could be related to the high temperatures.
- We reviewed workplace illness and injury logs and health records.

What NIOSH Found

- No monitored workers' core body temperature exceeded 101.3 °F for any sustained period of time, a guideline for recognizing heat strain in acclimatized workers.
- No monitored worker had a sustained peak heart rate of 180 minus their age, a guideline for recognizing heat strain.
- Two workers lost more than 1.5% of body weight during the shift, a sign of risk for heat strain.
- A number of workers reported heat-related symptoms in the past including dehydration, fatigue, nausea, and lightheadedness.

What Thomson Multimedia Inc. Managers Can Do

- Emphasize continuing education programs to ensure all employees potentially exposed to hot environments stay current on heat stress and heat stress prevention information.
- Design a program that gets workers used to the heat in a gradual way.
- Maintain accurate records of any heat-related illnesses and note the indoor and outdoor temperatures and work conditions at the time.

What the Thomson Multimedia Inc. Employees Can Do

- Frequently drink small amounts of cool water or other liquid.
- Eat meals during breaks to replace minerals and electrolytes lost in sweat.
- Maintain awareness of and report to management any signs and symptoms of heat-related illness.
- Take breaks in the cooled break room.

CDC Workplace Safety and Health

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National Institute for Occupational Safety and Health NIOSH

Health Hazard Evaluation Report 2001-0248-2874
Thomson Multimedia, Inc.
Circleville, Ohio
May 2002

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SUMMARY

On April 11, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation request from International Brotherhood of Electrical Workers (IBEW) Local 2331 Union officials at Thomson Multimedia, Inc., in Circleville, Ohio. The request described heat strain, heat exhaustion, and worker fatigue among the workers in the facility's television glass panel and funnel forming department.

A NIOSH industrial hygienist and a NIOSH medical officer visited the Thomson facility on July 18 and 19, 2001. Environmental temperatures were recorded at ware handler and press operator areas on three different production lines using wet-bulb globe temperature (WBGT) monitors. To assess workers' physiological effects, personal monitoring was performed, including continuous monitoring of workers' core body temperature (CBT), skin temperature, and heart rate. Workers' pre- and post-shift weights were recorded. During breaks, workers were interviewed about health symptoms they may have experienced as a result of working in a hot environment.

Recorded WBGT readings reached highs of 94.2°, 95.4°, and 102.8°F in various areas of the three forming lines, with average readings of 91.2°, 91.5°, and 98.8°F, respectively. Only one worker exceeded a core body temperature (CBT) of 101.3°F, the American Conference of Governmental Industrial Hygienists (ACGIH®) guideline for medically selected, acclimatized workers. However, the guidelines were exceeded for a few, non-consecutive minutes during the shift. None of the monitored workers had a sustained heart rate in excess of ACGIH's evaluation criteria (180 beats per minute [bpm] minus the individual's age in years). Two of five workers monitored exceeded 1.5% loss of body weight during their shift, a sign of risk for heat strain. Eighty-two percent of interviewed workers reported experiencing dehydration while at work in the past. Other symptoms reported included fatigue, lightheadedness, nausea, and near-syncope.

NIOSH investigators concluded that hazardous heat stress conditions can exist at the facility. However, physiologic data from monitored workers did not show signs of heat strain on the day monitoring occurred. Temperatures in the work environment suggest a need for employees to take full advantage of the workplace controls for prevention of heat strain. The workplace controls include not exceeding the work/rest schedules and using the cooled break room during rest breaks, particularly when environmental temperatures are high during the summer months. Workers' hydration status needs to be maintained. Communication between employees and management needs improvement, particularly in the area of reporting symptoms of heat strain experienced by the employees.

Keywords: SIC 3229 (Pressed and Blown Glass and Glassware, Not Elsewhere Classified) heat stress, heat strain, television, glass panels, glass funnels, forming equipment operators, forming ware handlers, press operators

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INTRODUCTION

On April 11, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at Thomson Multimedia, Inc., in Circleville, Ohio from the International Brotherhood of Electrical Workers (IBEW) Local 2331 Union. The requestor expressed concerns regarding worker exposures to extreme heat during the production of glass screens for televisions. Health concerns included heat exhaustion and worker fatigue.

On July 18 and 19, 2001, a NIOSH industrial hygienist and a NIOSH medical officer visited the facility's forming department to conduct an industrial hygiene and medical survey. Personal sampling for core body temperature (CBT), skin temperature, and heart rate was conducted during 8-12 hour shifts on employees working on Lines A, B, and C. Environmental temperatures were also recorded in these work areas using wet bulb globe temperature (WBGT) monitors. Private interviews were conducted with workers to gather information on pertinent health symptoms and concerns. Additionally, discussions with management were held regarding hazard communication and employee training programs for heat stress awareness as well as the medical response program.

BACKGROUND

The forming department of the 750,000 square foot (ft^2) Thomson Multimedia, Inc., facility manufactures glass funnels and panels for the production of television sets. A total of 500,000 of each product are produced per year by the three forming lines, Lines A, B, and C, in the department. The panel-producing Line A was installed when the facility was built in 1970; the funnel-producing Line B was brought into production afterwards. In 1990, Line C was added to increase production of panels, particularly very large panels (32 inches and greater). Each forming line (A, B, C) is made up of two production lines where the forming occurs; these are named A_1 and A_2, B_1 and B_2, and C_1 and C_2.

Currently, there are 950 employees working at the facility; 150 of these work in the forming department. Eight-hour work shifts are the standard for the employees in this department, although occasionally overtime may be worked, extending the shift to twelve hours. Workers in the forming department include 68 forming equipment operators, 44 press operators, and 36 forming ware handlers. The average age of workers in this department is 42 years, with an average length of service in the facility of 12 years. Operation and maintenance of the forming lines are performed by the forming equipment operators and press operators, who work on Lines A, B, and C. Forming ware handlers only work on Line A because the other two lines are fully automated. These Line A ware handlers manually handle and transfer the formed, heat-radiating glass panels to a location further along the conveyor line which takes the panels to the finishing area.

Lines A, B, and C are each served by separate furnaces, which use a combination of sand, lime, soda ash, lead, strontium, and a number of chemicals to produce the molten glass. Furnace temperatures can exceed 2,100 degrees Fahrenheit (°F), the melting point of the glass. At the start of each production line, molten glass is dropped onto a conveyor belt and pressed into the form of a funnel or panel. When dropped, the molten glass has an approximate temperature of 2,000°F and cools to 300°F to 400°F as it travels along the conveyor belt. When the panels and funnels reach the end of the production line, they are approximately 100°F and reach room temperature in the finishing department where they are viewed for inspection.

Due to the high temperatures, a heat stress management program has been implemented to address the heat stress concerns. A major aspect of this program is the work/rest schedule in place for the employees. Depending on job category, workers have a 66% work-33% rest schedule or

50% work-50% rest schedule to allow the body time to cool. Since 1995, heat stress has also been part of the worker orientation program. The program includes the use of personal protective equipment (PPE) with emphasis on heat strain prevention tactics such as sufficient water consumption. Continuing education using a CD-ROM training program provides awareness of heat stress hazards among the workers. A medical response team composed of 50 members of the workforce is spread over the 4 daily work shifts; 6 to 10 members are on-site per shift. Trained in dealing with heat-stress related medical incidents, these first responders can usually arrive on scene between 30 and 60 seconds after the report is first sent out; within two minutes, medical equipment, such as a heart defibrulator, can be on the scene.

In January 2001, large, garage-size doors near the forming lines were permanently closed for quality control reasons. Workers reported that these doors, which previously remained opened, had allowed outdoor air into the work environment. One result of closing the doors was a reported increase in the indoor environmental temperatures for the area. In March 2001, the decision was made to ventilate the work areas along each of the production lines allowing cooled air to be supplied to the workers during the summer. Ventilation had previously supplied only ambient outdoor air to the work areas. During days of high ambient temperatures, this could result in supplied air temperatures of around 90°F. The target temperature for the supplied, cooled air is now 71°F. Employees are allowed to stand under these vents to cool off between their work activities. Additionally, there is an air-conditioned room located near the forming lines where employees can cool and drink provided liquids during the rest portion of their work/rest schedules.

To gain further knowledge of the extent of the hazards, safety officials of Thomson Multimedia, Inc., management requested the Environmental Training and Research Center of Ohio University-Chillicothe to perform a series of heat stress studies in the months of February to May 2001. Various recommendations included a 30 minute work/30 minute rest schedule (70°F outside ambient conditions were recorded at time of recommendation), and vigilant personal heat stress monitoring and worker training.

METHODS

Industrial Hygiene

The physical effects of exposure to the high temperatures were assessed by personally monitoring five workers stationed in different areas of the three forming lines in the department. Core body temperature, skin temperature, and heart rate measurements were collected throughout the workers' 8-12 hour shifts between the hours of 8 AM - 8 PM. Press operators from lines A_2, B_2, and C_1, an equipment operator from line A_2, and a ware handler from line A_2 were monitored. These workers had performed their assigned activities in this department for years, were monitored nearing the end of the work week, and thus were assumed to be acclimatized.

The CorTemp™ Wireless Core Body Temperature Monitoring System (HTI Technologies, Inc., Palmetto, Florida) was used to monitor employees' body temperatures. The CorTemp Temperature Sensor, a small, 0.9x0.4 inch, silicon-coated electronic device, is swallowed and provides continuous monitoring of CBTs (accurate to within ± 0.2°F). The sensor passes through the gastrointestinal tract and exits the body at the participant's normal transit time, an average of approximately 72 hours. The sensor, intended for one-time use only, runs on a non-rechargeable silver-oxide battery for a week or longer and utilizes a temperature sensitive crystal which vibrates in direct proportion to the temperature of the substance surrounding it. This vibration creates an electromagnetic flux (frequency = 262.144 kilohertz) that continuously transmits through the surrounding substance. A recorder, the CT2000, receives this signal and translates it into digital temperature information, which is then displayed on the unit and stored to memory. The

CT2000 Recorder monitors temperatures of 50°F to 122°F. The recorder operates on a standard nine-volt alkaline battery, weighs approximately seven ounces, and attaches to the user's belt. The employees' CBTs were recorded at 1-minute intervals during their shifts.

Heart rate and skin temperature were also monitored at 1-minute intervals using a Mini-Mitter Mini-Logger® Series 2000 (Mini-Mitter Company, Inc., Bend, Oregon).[a] The workers were asked to wear a skin temperature monitor on their torso as well as a Polar® chest band heart rate monitor. The logger recording this data weighs approximately four ounces and is worn on the user's belt. The skin temperature readings are accurate to within ± 0.18°F and have a range of 86°F to 108°F. The Polar chest band heart rate monitor counts up to 250 beats per minute (bpm) and is accurate to within ±1 heartbeat.

Three RSS-214 WiBGet® instruments (Imaging & Sensing Technology, Horseheads, New York) were placed in worker areas on each line to collect continuous wet bulb globe temperature measurements. These monitors are capable of measuring temperature ranges of 32°F to 150°F and are accurate to within ±0.5°F. The WBGT index accounts for air velocity, temperature, humidity, and radiant heat and is a useful index of the environmental contribution to heat stress. This index is expressed, for purposes of this study, in terms of degrees Fahrenheit. The WBGT is a function of dry bulb temperature (DB) (a standard measure of air temperature taken with a thermometer), a natural wet bulb temperature (WB) (simulates the effects of evaporative cooling), and a black globe temperature (GT) (which estimates radiant (infrared) heat load). The WBGTs were placed in the ware handling area of line A_1, in the press operator area of line B_2, and in the press operator area of C_1 from morning to late afternoon, including during the peak temperatures during the day. Temperature measurements were recorded in 1-minute intervals.

[a] The skin temperature measurements are not included in this report. No evaluation criteria exist for this measurement, and skin temperatures can be influenced by environmental conditions thereby decreasing their usefulness. Thompson management and employees will be provided with the results of any future analyses of these measurements.

Medical

Workers performing "hot jobs" on the day of the NIOSH investigation were sought for interviews. During rest breaks, workers were asked to participate in confidential interviews with the NIOSH medical officer. The job titles of those interviewed included forming ware handler, equipment operator, stud machine operator (the stud machine operator was grouped with the equipment operators because of the similarity of job duties), and students working at the plant for summer jobs. Workers were asked about personal health concerns, symptoms, or medical conditions that they believed to be related to their workplace exposures. They were also asked about their normal habits when working in hot environments. Workers who participated in the monitoring of internal body temperatures were weighed before and after their work shifts using Seca Travelite™ Digital Scales. The scale has a weight capacity of 330 pounds and is accurate to ±0.1 pounds. OSHA Form 200, *Reports of Occupational Injury and Illness,* were reviewed for the previous 3 years to look for evidence of heat-related illnesses.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity. In addition, some hazardous agents may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Finally, evaluation criteria may change over the years as new information on the hazardous effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[1] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[2] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[3] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

Employers should understand that not all hazardous agents, heat stress for example, have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). However, OSHA still requires an employer to furnish for employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)].

Health Effects of Exposure to Hot Environments

A requirement for normal function of the body is that the core body temperature be maintained within an acceptable range of about 98.6°F ±1.8°F. Maintaining this internal body temperature balance requires a constant exchange of heat between the body and the surrounding environment. The total amount of heat that must be exchanged is related to the total heat produced by the body (metabolic heat) and the heat gained from the environment (if any).[4] The rate of heat exchange with the environment is a function of the air temperature and humidity, skin temperature, air velocity, evaporation of sweat, radiant temperature, and the characteristics of the clothing.

There are numerous factors other than the environment and work load that influence the body's ability to cope with heat. These factors may contribute to the onset of a heat-related illness and should be taken into consideration when situating workers and deciding on control measures.[5] Factors include a lack of acclimatization (i.e., the body not having sufficient time to adjust to the heat), and general state of health (i.e., some medical conditions may contribute to heat-related illnesses, or the conditions may be aggravated by heat). Among these conditions are skin disorders which may interfere with normal sweating mechanisms of the skin. Heart and lung diseases may limit the ability to cope with heat and may be aggravated by it. Poorly controlled diabetes may contribute to dehydration and may be aggravated by excessive heat. Obesity requires increased energy to move and the extra insulation reduces heat loss, contributing to the body's overall heat gain. Some illnesses, such as viral infections and diarrhea, may predispose to dehydration and impair regulation of core body temperature. Medications and drugs can also affect the body's responses to heat and may affect acclimatization. Alcohol consumption has been associated with heatstroke because it interferes with nervous system function and hormonal regulation of fluid balance.[4]

Heat disorders and health effects of individuals exposed to hot working environments include (in increasing order of severity) skin disorders (heat rash, hives, etc.), heat syncope (fainting), heat cramps, heat exhaustion, and heat stroke. In heat syncope, fainting results from blood flow being directed to the skin for cooling, resulting in decreased supply to the brain. This disorder often strikes workers who stand in place for extended periods in hot environments. Heat cramps, caused by sodium depletion due to sweating, typically occur in the muscles employed in strenuous work.

Heat cramps and syncope often accompany heat exhaustion. The weakness, fatigue, confusion, nausea, and other symptoms of this disorder generally prevent a return to work for at least 24 hours. The dehydration, sodium loss, and elevated CBT (above 100.4°F) of heat exhaustion are usually due to individuals performing strenuous work in hot conditions with inadequate water and electrolyte intake. Heat exhaustion may lead to heat stroke if the patient is not quickly cooled and re-hydrated.

While heat exhaustion victims continue to sweat as their bodies struggle to stay cool, heat stroke victims cease to sweat as their bodies fail to maintain an appropriate core temperature. Heat stroke occurs when hard work, hot environment, and dehydration overload the body's capacity to cool itself. This thermal regulatory failure (heat stroke) is a life-threatening emergency requiring immediate medical attention. Signs and symptoms include irritability, confusion, nausea, convulsions or unconsciousness, hot dry skin, and a CBT above 106°F. Death can result from damage to the brain, heart, liver, or kidneys.[6]

Acclimatization

When workers are suddenly exposed to hot work environments, they often show signs of heat stress, such as feeling discomfort, headache, cramps, fatigue, nausea, and other symptoms of heat exhaustion. They also may experience increased heart rate and elevation of core body temperature. Upon repeated exposure to hot environments, there is an adaptation of the body function such that workers may work in the heat with decreased risk of heat-related illnesses. This adaptation is called acclimatization.[5] Working at even a moderate rate in a hot environment brings about these physiological changes that can substantially improve comfort and safety for those who are in general good health. Exposure to heat only, however, will not bring about acclimatization; an elevated metabolic rate, such as happens during work activities, for about 2 hours a day is required. Also, acclimatization at a certain temperature is effective only at that temperature; a person exposed to higher levels of heat stress will not be fully acclimatized at that level, only the lower one.[7] Empirical data suggest that fewer than 5% of workers cannot adequately acclimatize to heat stress.[5]

The ability of a worker to tolerate heat stress requires integrity of cardiac, pulmonary, and renal function, the sweating mechanism, the body's fluid and electrolyte balances, and the central nervous system's heat regulatory mechanism. Impairment or diminution of any of these functions may interfere with the worker's capacity to acclimatize to the heat or to perform strenuous work in the heat once acclimatized.[5] Many of the physiological changes that take place as a person becomes acclimatized are associated with cardiovascular and peripheral vascular phenomena. Although the degree to which metabolic responses occur in reaction to hot environments differs per individual, when any human body is exposed to heat and internal body temperatures rise, the body must rid itself of the excess heat. It does this automatically by increasing cardiac output and expanding larger blood vessels to accommodate the increased flow. In turn, the microscopic blood vessels (capillaries) which thread through the upper layers of the skin, begin to fill with blood. This blood circulates closer to the surface of the skin, and excess heat is lost to the cooler environment.[7]

There are three phases of heat acclimatization. Initially, consecutive exposures to heat in the first few days, with the requisite rise in metabolic rate for 2 hours (e.g., doing work, exercising), cause the body to reach 33% of optimum acclimatization by the fourth day of exposure. The intermediate phase is marked by cardiovascular stability, and surface and internal body temperatures are lower, reaching 44% of optimum by day 8. During the third phase, a decrease in sweat and urine osmolality and other compensations to conserve body fluids and restore electrolyte balances are seen, and 65% of optimum is reached by day 10, 93% by day 18, and 99% by day 21.[7]

Although heat acclimatization for most individuals begins early in a period of working in the heat, it is also quickly lost if the exposure is discontinued. The loss of acclimatization begins when the activity under those heat stress conditions is discontinued, and a noticeable loss occurs after four days. This loss is usually rapidly made up so that by Tuesday workers who were off on the weekend are as well acclimatized as they were on the preceding Friday. However, if there is no exposure for a week or two, full acclimatization can require up to three weeks of continued physical activity under heat stress conditions similar to those anticipated for the work.[7] Chronic illness, the use or misuse of pharmacologic agents, a sleep deficit, a sub-optimal nutritional state, or a disturbed water and electrolyte balance may reduce the worker's capacity to acclimatize. In addition, an acute episode of mild illness, especially if it entails fever, vomiting, respiratory impairment, or diarrhea, may cause abrupt transient loss of acclimatization.[5]

Fluids and Electrolyte Replacement

Dehydration is a common problem from working in the heat. It is caused by failure to replace salt and water lost from sweating. Although sweating is necessary to help cool the body, the fluid and salt loss must be replaced. Sweat production of one liter per hour has been recorded frequently in industrial work and represents a large potential source of cooling if all the sweat is evaporated. Large losses of water by sweating also pose a potential threat to successful temperature regulation of the body because a progressive depletion of body water content occurs if the water lost is not replaced; dehydration by itself affects the body's ability to regulate its temperature and results in a rise of core body temperature.[8]

Under high heat and strenuous work conditions, individuals may produce six to eight liters of sweat in a work shift, and replacement of fluid loss under those conditions is usually incomplete. If the degree of dehydration exceeds 1.5 to 2% of the body weight, the body is less able to tolerate working in hot environments. At this degree of dehydration, heart rate and core body temperature increase and work capacity decreases. If the level of dehydration exceeds 5%, the individual is at much greater risk of heat-related illness.[9] The ACGIH reports that an individual may be at greater risk of heat strain if perfuse sweating is sustained over several hours so that weight loss over a shift is greater than 1.5% of body weight.[7] The amount of dehydration can be estimated by measuring body weight at intervals during the day or at least at the beginning and end of the work shift.[5]

Because thirst is a poor guide in fluid replacement, workers in hot jobs should be encouraged to take a drink of water every 15 to 20 minutes. The water should be cool (50 to 60°F). Drinking from disposable cups or personal containers is preferable to fountains. Workers should drink enough to prevent a loss of body weight.[5]

An important element of sweat is salt (sodium chloride). In most circumstances, a salt deficit does not readily occur because our normal diet provides enough salt, and naturally occurring salt in foods is usually enough to replace salt lost through perspiration. Therefore, workers should eat during their shifts to replace the elements lost in their sweat. Workers on a salt-restricted diet should explain their working conditions to their doctor and discuss the need for extra salt, especially if the workers are unacclimatized.[5] Sugary drinks such as soda pop, and fluids containing caffeine and alcohol should be avoided because consumption of these products may result in worsening of dehydration.[10]

Heat Stress and Strain Prevention Guidelines

A number of heat stress guidelines exist that are available to protect against heat-related illnesses such as heat stroke, heat exhaustion, heat syncope, and heat cramps. The objective of any heat stress index is to prevent a person's CBT from rising excessively. The World Health Organization concluded that "it is inadvisable for deep body (core) temperature to exceed 38°C (100.4°F) or for oral temperature to exceed 37.5°C (99.5°F) in prolonged daily exposure to heavy work and/or heat."[11] According to NIOSH, a deep body temperature of 39°C (102.2°F) should be considered reason to terminate exposure even when deep body temperature is being monitored.[5] This does not mean that a worker with a CBT exceeding those levels will necessarily become a heat casualty; however, the risk of occurrence of heat casualties does increase. The number of unsafe acts committed by a worker increases with an increase in heat stress, and increases in unsafe behavior are seen as the level of physical work of the job increases.[5]

In its 1986 revised criteria for occupational exposure to hot environments, NIOSH provides diagrams showing work-rest cycles and metabolic heat versus WBGT exposures that should not be exceeded.[5] NIOSH developed two sets of recommended limits (see Appendix A), one for acclimatized workers (recommended exposure limit [REL]) and one for unacclimatized workers (recommended alert limit [RAL]). When these work/rest regimens are followed, nearly all workers should be able to tolerate the resulting total heat exposures without substantially increasing their risk of acute adverse health effects. (This statement assumes that workers are medically and physically fit for the level of activity required for their job, and are wearing, at most, long-sleeved cotton work shirts and trousers.) Also, no employee shall be exposed to metabolic and environmental heat combinations exceeding the applicable Ceiling Limits (C) shown in the REL and RAL without being provided with and properly using appropriate and adequate heat-protective clothing and equipment, (*Occupational Exposure to Hot Environments, Revised Criteria 1986*).[12]

The ACGIH TLV criteria refer to environmental heat stress conditions in which nearly all adequately hydrated, unmedicated, healthy workers wearing light-weight summer clothing may be repeatedly exposed without adverse health effects. For surveillance purposes, a pattern of workers exceeding the limits is indicative of a need to control the exposures. On an individual basis, the limits represent a time to cease an exposure until recovery is complete. By taking into account workers' sources of heat (work, air temperature, radiant heat [e.g., sunlight]) and the ability of the body to cool itself (clothing insulation value, humidity, wind), a schedule of work/rest regimens can be determined. The ACGIH screening criteria (see Appendix B) are for designing a work/rest regimen that will maintain CBTs below the recommended limits for acclimatized and unacclimatized employees. For clothing other than light-weight summer clothing, the WBGT temperatures in the appropriate work/acclimatization categories must be lowered, depending upon the clothing, and the criteria must not be used for encapsulating suits or garmets that are impermeable or highly resistant to water vapor or air movement. Further assumptions include an 8-hour work day, 5-day work week, two 15-minute breaks, and a 30-minute lunch break, with rest area temperatures the same as, or less than, those in work areas and "at least some air movement." The TLV for heat stress attempts to provide a framework for the control of heat-related disorders only; although accidents and injuries can increase with increasing levels of heat stress, it's important to note that the TLV's are not directed toward controlling these.[7] According to ACGIH, excessive heat strain may be marked by one or more of the following measures, and an individual's exposure to heat stress should be discontinued when any of the following occur: for individuals with normal cardiac performance, sustained heart rate (over several minutes) exceeding 180 bpm minus age; CBT of greater than 38.5°C (101.3°F) for medically fit, heat-acclimatized personnel and 38.0°C (100.4°F) for unselected, unacclimatized personnel; recovery heart rate of greater than 110 bpm at 1 minute after a peak work effort; symptoms of sudden and severe fatigue, nausea, dizziness, lightheadedness, or profuse and prolonged sweating.

Also according to ACGIH, an individual may be at greater risk of heat strain if profuse sweating is sustained over several hours, weight loss over a shift is greater than 1.5% of body weight, or 24-hour urinary sodium excretion is less than 55 millimoles. If a worker appears to be disoriented or confused, or suffers inexplicable irritability, malaise, or flu-like symptoms, the worker should be removed for rest in a cool location with rapidly circulating air and kept under skilled observation. Immediate emergency care may be necessary. If sweating stops and the skin becomes hot and dry, immediate emergency care with hospitalization is essential.[2]

Chronic demands placed on the worker may be evaluated by calculating the average heart rate for the shift. Decreases in physical job performance were observed when the average heart rate exceeded 115 bpm over the entire shift. This level is equivalent to working at roughly 35% of maximum aerobic capacity, a sustainable level for 8 hours.[7]

The OSHA technical manual, Section III, Chapter 4, Heat Stress,[13] provides investigation guidelines that approximate those found in the 1992-1993 ACGIH publication, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. OSHA does not have a specific heat stress standard. However, acceptable exposure to heat stress is enforced by the Secretary of Labor under the General Duty Clause [section 5(a)(1)].[14]

RESULTS

Industrial Hygiene

As shown in Table 1, WBGT readings reached a high of 94.2°F in the ware handling area of line A_2, with an average temperature of 91.2°F. In the press operator area of line B_2, the WBGT instrument recorded a high of 95.4°F, with an average temperature of 91.5°F. The high WBGT temperature recorded in the press operator area of line C_1 was 102.8°F, with an average temperature of 98.8°F. (According to the National Weather Service, the outdoor dry bulb temperature reached a high of 87.8°F.)

Five workers, assumed to be acclimatized to the heat, were monitored for physiologic responses to the high temperatures in the work area. These responses would provide signals if the individuals were experiencing heat strain during their workshifts. As shown in Table 2, one of three workers on line A_2 spent only a small amount of time, approximately 15 non-consecutive minutes, during his workshift with a CBT above 101.3°F (ACGIH TLV). (Unfortunately, because of equipment failure, data from one individual on line A_2 were unusable.) Table 2 also shows results from a worker on line B_2 as well as on C_1. Neither of these two individuals exceeded the 101.3°F mark during their workshifts.

Table 3 shows results of heart rate activity for the five individuals during their work shifts. None of the five individuals monitored exceeded the ACGIH heart rate criterion of '180-age' for any sustained or extended period of time.

Medical

On the day of the NIOSH investigation, all 17 workers who were asked to participate in a confidential interview agreed to one. Those interviewed included five forming ware handlers, two press operators, eight equipment operators, and two summer-help workers. These employees worked on the hot end of lines A_1, A_2, B_1, B_2, C_1, and C_2. The median age of the interviewed workers was 44 years (range of 18 to 57 years), and the median tenure at their current job was 7 years (range of 6 weeks to 21 years).

The forming ware handlers reported that their work/rest schedule is 30 minutes of work followed by 30 minutes of rest throughout the shift (i.e., a 50% work/50% rest schedule). However, when needed for other job duties, such as "pulling glass", they may not get their break until the job duty is complete. The press operators and equipment operators reported that their work/rest schedule is 60 minutes of work followed by 30 minutes of rest for their shift (i.e., a 66% work/33% rest schedule). The forming ware handlers are allowed to drink from water fountains during work periods if the operation is running well and the operator gives permission. The operators can keep water at their station and drink freely.

Of the 17 workers interviewed, only 3 (18%) reported that they regularly monitored their hydration status during the hot weather season. These workers monitored their hydration status by thirst or by the color of their urine. Fourteen workers (82%) reported that they experienced symptoms of dehydration while at work in the past. The most common symptoms reported were as follows: 15 (88%) workers reported excessive thirst at work, 13 (76%) reported fatigue related to working in hot environments, 11 (65%) reported lightheadedness, 4 (24%) reported clammy skin, 4 (24%) reported nausea, and 3 (18%) reported near-syncope. Seven workers (41%) reported poor appetite when they are hot at work. Subsequently, they eat nothing or very little during their work shift.

Other symptoms reported by workers included muscle cramps (65%), heat rash (41%), and disorientation or confusion (24%) related to working in the heat. Only one worker reported heat-related symptoms to the medical department or to management. No workers reported symptoms related to their heat exposure on the day of the NIOSH investigation, other than feeling hot.

Five workers were weighed before and after their shifts. All workers lost weight during the study period. The percent body weight lost for each worker was 0.4%, 0.5%, 1.1%, 1.8%, and 2.5%. The weight loss occurred over an 8-hour shift in 3 workers and over a 12-hour shift in 2 workers. The worker who lost the most weight worked an 8-hour shift.

Review of the OSHA 200 log for the previous 3 years revealed that one heat-related illness was recorded.

DISCUSSION AND CONCLUSIONS

Certain preventive measures, such as the use of engineering controls (the cooled break room and the supply of cooled air to the work stations) and administrative controls (current work/rest schedules) appear to provide protection from excessive signs of heat strain, such as sustained peak heart rates and sustained excessive core body temperatures. However, we noted a measure of increased risk of heat strain in two of five workers who lost greater than 1.5% of body weight over their shift. A majority of workers interviewed reported they had experienced symptoms such as dehydration, lightheadedness, nausea, and heat rash in the past. These data reveal the importance of preventive measures and full use of the controls provided to decrease these risks.

As shown in Appendix A, both the NIOSH Recommended Alert Limits (RALs) for unacclimatized workers and Recommended Exposure Limits (RELs) for acclimatized workers, from NIOSH's *Occupational Exposure to Hot Environments, Revised Criteria 1986*, take into account the combination of WBGT environmental heat and worker metabolic heat to provide recommended guidelines as to the length of time workers should perform certain activities in hot environments. Therefore, worker metabolic heat rates must be estimated for each category of worker, taking into account body position and movement, type of work, and basal metabolism. As shown in Appendix C, metabolic heat calculations were made for ware handlers, and press and equipment operators. Metabolic heat produced was estimated using energy expenditure tables and the guidelines provided in *Occupational Exposure to Hot Environments, Revised Criteria 1986*, and *Threshold Limit Values for Chemical Substances and Physical Agents*.[2,5] Using this method, the average energy expenditure of a "standard" male worker (154 pounds with a body surface of 19.4 ft^2) can be estimated utilizing basal metabolism and specific activity analysis information regarding body position, movement, and type of work. Appendix C lists the average estimated energy requirements for the activity analysis components as well as a sample calculation for metabolic heat production rate for equipment and press operators. Assessment of the metabolic rate demand of the job activity is essential for applying the appropriate WBGT evaluation criteria to the measured environmental conditions. It is important to note, however, that errors in estimating metabolic heat from energy expenditure tables are reported to be as high as 30%.[5]

Ware handlers were calculated to produce approximately 396 kilocalories per hour (kcal/hr), characterized as a heavy workload. Both press operators and equipment operators were calculated to produce approximately 246 kcal/hr, characterized as a moderate workload. WBGT results and metabolic rate estimates for individuals were compared to those listed in NIOSH Recommended Heat Stress Exposure Limits (RELs) (Appendix A). For the categories of press operator and equipment operator, calculated to have similar metabolic heat production of 200-300 kcal/hr, a comparison of this metabolic heat value with the lower of two average WBGT temperatures recorded in these worker areas (91.5°F) yields a recommended work/rest regimen of approximately 15-30 minute/hour work, and resting for the remainder of the hour. For ware handlers, a comparison of an average WBGT temperature taken in this worker area, 91.2°F, to the metabolic heat produced for this activity, approximately 400 kcal/hr, yields a recommended work/rest regimen of no more than 15 minutes work/hour. These recommendations, however, reflect regimens that would be applicable had the workers not had access to a cooled area for their rest breaks and had to take their rest breaks in the temperatures present in the work environment. These work/rest regimens show the importance of the use of the cooled break room by the workers to allow for longer exposure to the work temperatures.

The metabolic rate estimates were also assigned workload categories (light, moderate, heavy, or very heavy) and compared to the screening criteria in the ACGIH® TLVs®. Use of the ACGIH Screening Criteria for Heat Stress (Appendix B) also provides recommendations on work/rest schedules according to WBGT temperatures taken in worker areas. These criteria also suggest a 25% work and 75% rest schedule for acclimatized workers with moderate workloads in environments at or above 87.8°F, applicable to the press operators and equipment operators in an environment with a recorded average WBGT temperature of 91.5°F. The criteria also suggest that acclimatized workers performing heavy workload also have a 25% work and 75% rest schedule in environments at or above 86.0°F, applicable to ware handlers in an environment with recorded average WBGT temperature of 91.2°F. Again, these recommended regimens reflect conditions had the workers rested in the same temperatures as the work environment. However, because workers have access to a rest area with temperatures differing from the work area, an 8-hour TWA of WBGT values of the work and rest environment would provide a more accurate recommendation of work/rest regimens. However, for the highest work WBGT temperatures encountered on the day of monitoring, that of the press operator area on line C_1, a WBGT value of 71°F would be needed in the cooled break room to create conditions for an 8-hour TWA of work and rest temperatures to allow continuance of the 50% work and 50% rest schedule currently in place.

Continued monitoring of WBGT temperatures by Thomson management can determine if these current work/rest regimens need to be modified when environmental temperatures rise above those encountered on the day of monitoring. This is an important step during future activities because, while physiologic monitoring did not show employees in heat strain on the day monitored, the potential for heat stress still exists, particularly on days when high environmental temperatures may increase the temperatures experienced by workers. This potential is further enhanced if workers do not take full advantage of the cooled break room as well as replenish fluids lost through sweating throughout their work activities. Thomson management should be particularly aware of an increased potential for heat stress among those employees who are new and thus unacclimatized, as well as employees who have been absent from the work site for a number of days who would need to be re-acclimatized.

RECOMMENDATIONS

1. Thomson Multimedia management should emphasize continuing education programs to ensure that all employees potentially exposed to hot environments stay current on heat stress and heat stress prevention information. Workers in hot jobs should have continuing education at least yearly. A good heat stress training program should include at least the following components:

- knowledge of the hazards of heat stress

- recognition of predisposing factors, danger signs, and symptoms

- awareness of signs and symptoms of heat-related illness and first-aid procedures for treatment

- employee responsibilities in avoiding heat stress

- medical conditions that may increase the risk of heat-related illnesses

- dangers in using drugs, including therapeutic ones, and dangers of the use of alcohol before or during work in hot environments

- preventive measures that can be taken to reduce heat stress

2. Management should maintain accurate records of any heat-related illness events and note the environmental and work conditions at the time of the illness. Such events may include repeated accidents, episodes of heat-related disorders, or frequent health-related absences. Job-specific clustering of specific events or illnesses should be followed up by industrial hygiene and medical evaluations.

3. Cool (50-59°F) water or any cool liquid (except alcohol and caffeinated beverages) should be made available to workers to encourage them to drink small amounts frequently, e.g., one cup every 15-20 minutes. Although some commercial drinks contain salt, this is not necessary for acclimatized individuals because most people add enough salt to their diets. Drinking from individual containers improves water intake over the use of drinking fountains.

4. Management, union officials and co-workers should encourage workers to eat meals during their breaks. Minerals and electrolytes lost in sweat are most readily replaced with a normal diet.

5. Workers should take advantage of the cooled break room during their breaks. This cooled environment provides an important control in preventing the excessive rising in CBT. Taking breaks outside, particularly during the warm summer months, may not be enough to lower the CBT adequately prior to returning to work.

6. Workers should be able to monitor their weight so that they can be aware that they are becoming dehydrated. Scales should be provided in the break room so that workers can monitor their weight during the shift, and eat and drink more fluids if they begin to loose weight. Pre-shift and post-shift weights should be about the same.

Additionally, workers should be conscious of and monitor physiological responses to heat strain. A useful metric of this is sustained peak heart rate. Workers should be aware of their personal peak heart rate, 180 minus their age, and monitor it during heavy work periods. Additionally, workers should consider instituting a buddy system whereby a worker can encourage another worker to rest, drink plenty of fluids, and call attention should heat strain symptoms become apparent, and vice versa.

7. A written heat alert program (HAP) should be developed by management and union officials as a preventive measure to reduce heat stress when environmental temperatures soar. A state of heat alert is declared to make sure that measures to prevent heat casualties will be strictly observed during a specified time period. HAPs may differ from one workplace to another, but the purpose is the same: to take advantage of the weather forecast of the National Weather Service as a measure to prevent heat-related illnesses. Components of a heat alert program may include the following:

- Establish criteria for the declaration of a heat alert; for example, a heat alert may be declared if the weather forecast predicts a maximum air temperature of 95°F or above or when the daily maximum temperature exceeds 90°F and is 5°F or more above the maximum reached in any of the preceding 3 days.

- Postpone tasks which are not urgent until the hot weather spell is over.

- Increase the number of workers in each team in order to reduce each worker's heat exposure.

- Increase rest allowances by using the ACGIH screening criteria and NIOSH guidelines.

- Remind workers to drink small amounts of water frequently to prevent dehydration and remind workers to weigh themselves to maintain their body weight.

- Check worker's temperature and pulse during their most severe heat exposure period.

8. Thomson management should design an acclimatization program to decrease the risk of heat-related illnesses. Such a program involves exposing employees to work in a hot environment for progressively longer periods. Taking into account the environmental temperatures and types of activities performed, management should consider a work schedule particularly for new workers or those workers absent from the work environment for a considerable period that begins with a 15 minute work/45 minute rest schedule and gradually increase the work time to provide for acclimatization. In general, OSHA recommends that new workers who will be exposed should start with 20% on day one, with a 20% increase in exposure each additional day. The program should also permit self-limitation of exposures.

9. Thomson management should institute pre-placement and periodic medical examinations of persons applying for or working in hot environments. The examination should be performed by a health care provider with knowledge of the health effects associated with work in hot environments. The examinations should be performed to assess the physical, mental, and medical qualifications of the individuals. The health care provider should update the information periodically for people working in hot environments and determine the capability of individuals to work in hot environments.

10. Thomson management and employees should use the chart in Appendix D to help identify heat stress effects and factors, as well as to learn about the treatment and prevention of these conditions.

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Table 1. WBGT Environmental Temperature Data
Thomson Multimedia, Inc. HETA 2001-0248-2874
July 19, 2001

Monitoring Location	*WBGT Temperature Range (°F)*	*Sampling Times*	*Time of Highest Temperature*	*Average Temperature (°F)*
line A2, ware handler area	**85.6° - 94.2°**	**8:37 am - 7:33 pm**	**3:17 pm**	**91.2°**
line B2, press operator area	**80.8° - 95.4°**	**8:43 am - 3:37 pm**	**2:38 pm**	**91.5°**
line C1, press operator area	**92.6° - 102.8°**	**8:53 am - 3:59 pm and 5:27 pm - 7:45 pm***	**3:51 pm**	**98.8°**

* data from 4:00 PM - 5:26 PM excluded because of equipment failure

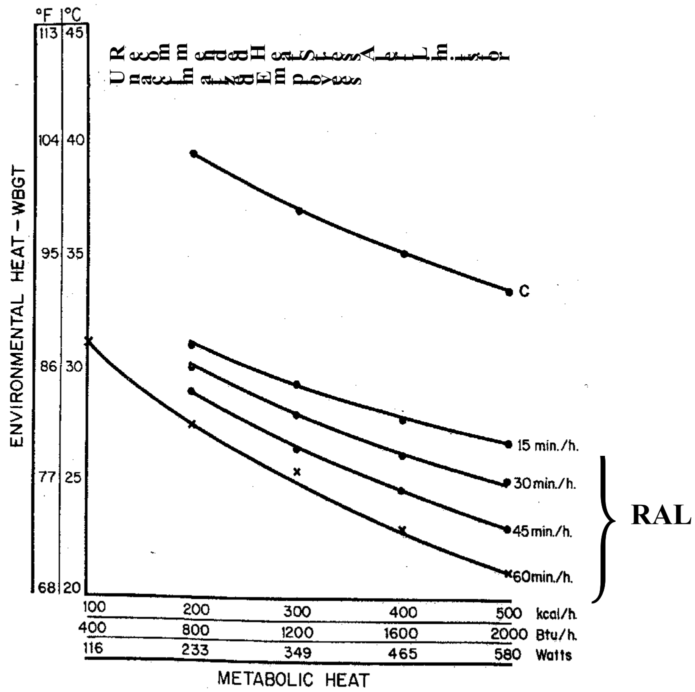
Table 2. Core Body Temperature (CBT) Data
Thomson Multimedia, Inc. HETA 2001-0248-2874
July 19, 2001

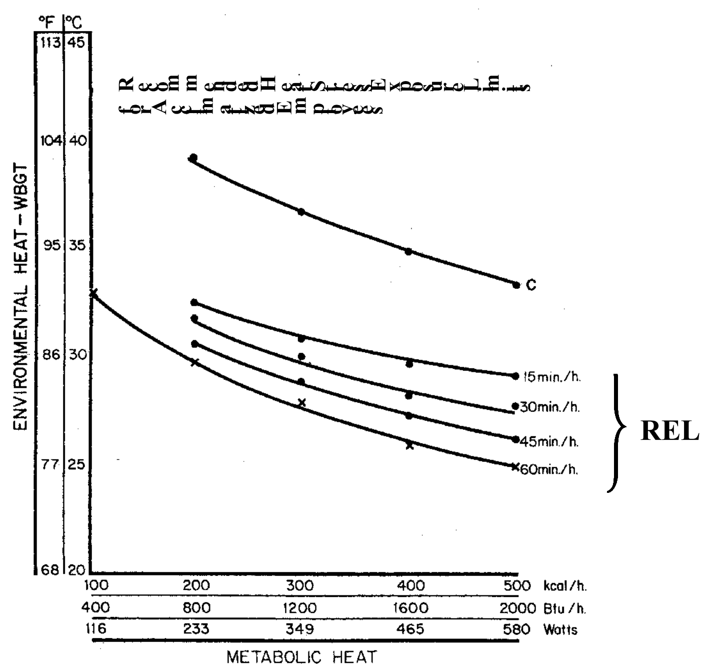
Worker	*Sampling Time*	*Average CBT*	*CBT > 101.3°*
press operator, line A_2	7:50 am - 3:44 pm	99.9°F	did not exceed
equipment operator, line A_2	8:01 am - 7:30 pm	100.2°F	11:43 am-11:47 am; 11:51 am-11:56 am; 6:21 pm-6:25 pm (5% of workshift)
ware handler, line A_2	8:07 am - 3:52 pm	equipment failure	equipment failure
press operator, line B_2	7:55 am - 3:31 pm	98.8°F	did not exceed
press operator, line C_1	8:29 am - 7:32 pm	100.1°F	did not exceed

Table 3. Heart Rate (HR) Data
Thomson Multimedia, Inc. HETA 2001-0248
July 19, 2001

Worker	*Sampling Time*	*Average Heart Rate (beats per minute)*	*HR >180 - age of worker*
press operator, line A_2	7:55 am - 3:46 pm	84	did not exceed
equipment operator, line A_2	8:07 am - 7:28 pm	79	did not exceed
ware handler, line A_2	8:11 am - 3:54 pm	85	did not exceed
press operator, line B_2	8:00 am - 3:33 pm	111	few and inconsistent
press operator, line C_1	8:34 am - 3:22 pm	115	few and inconsistent

Appendix A: NIOSH Recommended Alert Limits (RALs) and Recommended Exposure Limits (RELs) for Heat Stress[5]





Curves indicate recommended work/rest regimens for a combination of external heat (measured as wet-bulb-globe temperatures) and internal (metabolic) heat. The 'C' curve is the Ceiling Limit, indicating that workers should not be exposed to such conditions without adequate heat-protective clothing and equipment.

Appendix B: ACGIH Screening Criteria for Heat Stress Exposure*

	Acclimatized (WBGT values in °F)				Unacclimatized (WBGT values in °F)			
Work Demands	**Light**	**Moderate**	**Heavy**	**Very Heavy**	**Light**	**Moderate**	**Heavy**	**Very Heavy**
100% Work	85.1	81.5	78.8	N/A	81.5	77.0	72.5	N/A
75% Work; 25% Rest	86.9	83.3	81.5	N/A	84.2	79.7	76.1	N/A
50% Work; 50% Rest	88.7	85.1	83.3	81.5	86.0	82.4	79.7	77.0
25% Work; 75% Rest	90.5	87.8	86.0	85.1	87.8	84.2	82.4	79.7

Notes:
- WBGT values 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 assume 8-hour workdays in a 5-day workweek with conventional breaks as discussed in the Evaluation Criteria section of this report.
- 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.

The following work load categories, descriptions of work, and estimated energy expenditures help to estimate a conservative WBGT heat exposure limit for workers conducting these or similar jobs:

Work Categories	Example Activities
Resting	Sitting quietly; Sitting with moderate arm movements
Light (<200 kcal/hr)	Sitting with moderate arm and leg movements; Standing with light work at machine or bench while using mostly arms
Moderate (200-350 kcal/hr)	Scrubbing in a standing position; Walking about with moderate lifting or pushing; Walking on level at 3.7 mph while carrying a 6.6 pound load
Heavy (350-500 kcal/hr)	Carpenter sawing by hand; Shoveling dry sand; Heavy assembly work on a noncontinuous basis; Intermittent heavy lifting with pushing or pulling (e.g. pick-and-shovel work)
Very Heavy (>500 kcal/hr)	Shoveling wet sand

*From American Conference of Governmental Industrial Hygienists (ACGIH®), *2001 TLVs® and BEIs®* and the supplement for *Heat Stress and Strain* from the *Documentation of TLVs® and BEIs®,* 6th Edition. Copyright 2001 and 2000, respectively. Reprinted with permission.

Appendix C: Assessment of Work - Estimated Metabolic Heat Production Rates by Task Analysis[5]

A. Body Position and Movement	kcal/min*	
Sitting	0.3	
Standing	0.6	
Walking	2.0-3.0	
B. Type of Work	**Average (kcal/min)**	**Range (kcal/min)**
Hand work:		
light	0.4	0.2–1.2
heavy	0.9	
Work, one arm:		
light	1.0	0.7–2.5
heavy	1.8	
Work, both arms:		
light	1.5	1.0–3.5
heavy	2.5	
Work, whole body:		
light	3.5	2.5–9.0
moderate	5.0	
heavy	7.0	
very heavy	9.0	
C. Basal Metabolism	1.0	1.0
Sum of A, B, and C equals estimated metabolic production per task		

*For a standard male worker of 70 kg (154 lbs) body weight and 1.8 m^2 (19.4 ft^2) body surface.

Sample calculation for equipment and press operators:

Task	**kcal/min**
A. Standing	0.6 kcal/min
B. Heavy work, both arms	2.5 kcal/min
C. Basal metabolism	1.0 kcal/min
D. Total kcal/min:	4.1 kcal/min
E. Total kcal/hour:	246 kcal/hour

Appendix D: Guide to Heat Stress Effects, Factors, Treatment, and Prevention

Category	*Predisposing factor*	*Underlying disturbance*	*Treatment*	*Prevention*
Heatstroke: 1) Hot dry skin 2) Internal body temperature 104°F or above 3) confusion, loss of consciousness, convulsions 4) fatal if treatment is delayed	1) Sustained exertion in heat by unacclimatized worker 2) Lack of physical fitness and obesity 3) Recent alcohol intake 4) Dehydration 5) Chronic cardiovascular disease	Failure of the drive for sweating leading to loss of evaporative cooling and uncontrolled rise in internal body temperature	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning. Avoid over cooling	Medical screening, selection based on health and physical fitness, acclimatization for 5 to 7 days by graded work and heat exposure, monitoring workers during sustained work in severe heat
Heat Syncope: Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated blood vessels of skin and lower parts of the body	Remove to cooler area, rest in recumbent position	Acclimatization, intermittent activity to assist blood flow to the heart
Heat Exhaustion: 1) Fatigue, nausea, giddiness 2) Skin clammy and moist, pale complexion, or flush 3) May faint on standing 4) Internal body temperature moderately elevated (99.5 to 101.3° F)	1) Sustained exertion in heat 2) Lack of acclimatization 3) Failure to replace water loss in sweat	1) Dehydration 2) Depletion of circulating blood volume 3) Circulatory strain from competing demands for blood flow to skin and to active muscles	Remove to cooler environment, rest in recumbent position, give fluids by mouth, keep at rest, urine volume indicates that water balance has been restored	Acclimatize workers using a break-in schedule for 5 to 7 days, ample drinking water available at all times and water breaks taken frequently during the day
Heat Rash: Profuse tiny raised vesicles (blister-like) on affected areas, pricking sensations during heat exposure	Unrelieved exposure to humid heat with skin continuously wet with unevaporated sweat	Plugging of sweat glands ducts and inflammatory reaction	Mild drying lotions, skin cleansing to prevent infection	Cool sleeping quarters to allow skin to dry between heat exposures

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