



criteria for a recommended standard

OCCUPATIONAL EXPOSURE TO HOT ENVIRONMENTS

Revised Criteria 1986

NIOSH

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Criteria for a Recommended Standard....
Occupational Exposure to Hot Environments
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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

For sale by the Superintendent of Documents, U.S. Government
Printing Office, Washington, D.C. 20402

April 1986

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DHHS (NIOSH) Publication No. 86-113

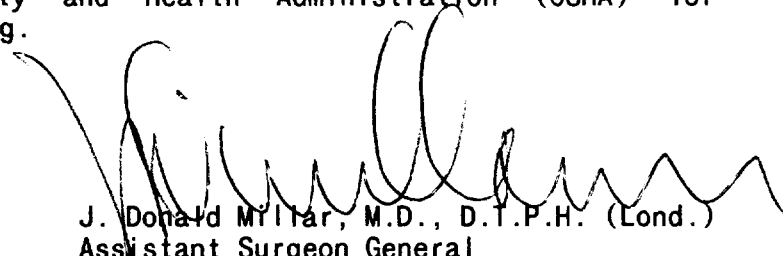
FOREWORD

The Occupational Safety and Health Act of 1970 (Public Law 91-596) states that the purpose of Congress expressed in the Act is "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources...by," among other things, "providing medical criteria which will assure insofar as practicable that no worker will suffer diminished health, functional capacity, or life expectancy as a result of his work experience." In the Act, the National Institute for Occupational Safety and Health (NIOSH) is authorized to "develop and establish recommended occupational safety and health standards..." and to "conduct such research and experimental programs as...are necessary for the development of criteria for new and improved occupational safety and health standards..."

The Institute responds to these mandates by means of the criteria document. The essential and distinguishing feature of a criteria document is that it recommends a standard for promulgation by an appropriate regulatory body, usually the Occupational Safety and Health Administration (OSHA) or the Mine Safety and Health Administration (MSHA) of the U.S. Department of Labor. NIOSH is also responsible for reviewing existing OSHA and MSHA standards and previous recommendations by NIOSH, to ensure that they are adequate to protect workers in view of the current state of knowledge. Updating criteria documents, when necessary, is an essential element of that process.

A criteria document, Criteria for a Recommended Standard...Occupational Exposure to Hot Environments, was prepared in 1972. The current revision presented here takes into account the vast amount of new scientific information on working in hot environments which is pertinent to safety and health. Included are ways of predicting the health risks, procedures for control of heat stress, and techniques for prevention and treatment of heat-related illnesses.

External review consultants drawn from academia, business associations, labor organizations, private consultants, and representatives of other governmental agencies, contributed greatly to the form and content of this revised document. However, responsibility for the conclusions reached and the recommendations made, belongs solely to the Institute. All comments by reviewers, whether or not incorporated into the document are being sent with it to the Occupational Safety and Health Administration (OSHA) for consideration in standard setting.



J. Donald Miller, M.D., D.T.P.H. (Lond.)
Assistant Surgeon General
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control

ACKNOWLEDGMENTS

This revised document was prepared by the staff of the Division of Standards Development and Technology Transfer with assistance from the Division of Biomedical and Behavioral Sciences. The responsibility for the development of the document was that of Austin Henschel, Ph.D., with the assistance of Francis N. Duker-Dobos, M.D., Jay Klemme, M.D., and Nelson A. Leidel, Sc.D. Robert Bernstein, M.D., Ph.D., Paul Caplan, Burt J. Cooper, Jim Ferguson, Jerome Flesch, John Jankovic, Richard Ronk, William D. Wagner, Mary Kay White, Ph.D., and Ralph D. Zumwalde are gratefully acknowledged for their contributions to the critical review of this document. A special appreciation is extended to Carolyn A. Browning and Myrtle Heid for their editorial review, and to Judy Curless and Constance Klinker for their support in typing and finalizing the document for publication.

REVIEW CONSULTANTS

Howard Ayer
Institute of Environmental Health
University of Cincinnati Medical Center
3223 Eden Avenue
Cincinnati, OH 45267

Edward J. Baier, Jr.
Occupational Safety and Health Administration
U.S. Department of Labor
Washington, DC 20210

Louis S. Beliczky
United Rubber Workers
87 High Street
Akron, OH 44308

Thomas E. Bernard
Human Sciences
Research and Development Center
1310 Beulah Road
Pittsburgh, PA 15235

E. R. Buskirk, Ph.D.
Laboratory, Human Performance
The Pennsylvania State University
University Park, PA 16802

Geraldine V. Cox, Ph.D.
Technical Director
Chemical Manufacturers Association
2501 M Street, N.W.
Washington, DC 20037

B. D. Dinman, M.D., Ph.D.
Vice President, Health and Safety
Aluminum Company of America
1501 Alcoa Building
Pittsburgh, PA 15219

F. H. Fuller
E. I. du Pont de Nemours & Company
Engineering Department
Louviere Building
Wilmington, DE 19898

P. A. Gagge, Ph.D.
John B. Pierce Foundation
New Haven, CT 06519

REVIEW CONSULTANTS (CONTINUED)

Ralph F. Goldman, Ph.D.
Multi-Tech Corporation
One Strathmore Road
Natic, MA 01760

John E. Greenleaf, Ph.D.
NASA
Ames Research Center
Moffett Field, CA 94035

Bruce A. Hertig, Ph.D.
306 West High Street
Urbana, Illinois 61801
(the American Industrial Hygiene Association)

Steven M. Horvath, Ph.D.
Institute for Environmental Stress
University of California, Santa Barbara
Santa Barbara, CA 93106

Murray Jacobson
Assistant Director for Health
Office of Technical Support
Mine Safety and Health Administration
U.S. Department of Labor
4015 Wilson Boulevard
Arlington, VA 22203

Herbert H. Jones
Consultant - Occupational Health and Safety
119 Broad Street
Warrensburg, MO 64093

E. Kamon, Ph.D.
The Pennsylvania State University
119 Noll Laboratory
University Park, PA 16802

J. Allen Overton, Jr.
President
American Mining Congress
Suite 300, 1920 N Street, N.W.
Washington, DC 20036

Kent B. Pandolf, Ph.D.
U.S. Army RIEM
Natick, MA 01760

REVIEW CONSULTANTS (CONTINUED)

Jerry Ramsey, Ph.D.
Department Industrial Engineering
Texas Tech University
Lubbock, TX 79409

Manmohan V. Ranadine, M.D.
Chief, Preventive Medicine Consultants Division
Department of Army
Office of the Surgeon General
Washington, DC 20310

Corinne J. Solomon, RN, MPH, COHN
American Association Occupational Health Nurses
Suite 400
3500 Piedmont Road, N.E.
Atlanta, GA 30305

Richard A. Uhlar
International Chemical Workers Union
1655 West Market Street
Akron, OH 44313

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I. RECOMMENDATIONS FOR AN OCCUPATIONAL STANDARD FOR WORKERS EXPOSED TO HOT ENVIRONMENTS

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to heat stress in the workplace be controlled by complying with all sections of the recommended standard found in this document. This recommended standard should prevent or greatly reduce the risk of adverse health effects to exposed workers and will be subject to review and revision as necessary.

Heat-induced occupational illnesses, injuries, and reduced productivity occur in situations in which the total heat load (environmental plus metabolic) exceeds the capacities of the body to maintain normal body functions without excessive strain. The reduction of adverse health effects can be accomplished by the proper application of engineering and work practice controls, worker training and acclimatization, measurements and assessment of heat stress, medical supervision, and proper use of heat-protective clothing and equipment.

In this criteria document, total heat stress is considered to be the sum of heat generated in the body (metabolic heat) plus the heat gained from the environment (environmental heat) minus the heat lost from the body to the environment. The bodily response to total heat stress is called the heat strain. Many of the bodily responses to heat exposure are desirable and beneficial. However, at some level of heat stress, the worker's compensatory mechanisms will no longer be capable of maintaining body temperature at the level required for normal body functions. As a result, the risk of heat-induced illnesses, disorders, and accidents substantially increases. The level of heat stress at which excessive heat strain will result depends on the heat-tolerance capabilities of the worker. However, even though there is a wide range of heat tolerance between workers, each worker has an upper limit for heat stress beyond which the resulting heat strain can cause the worker to become a heat casualty. In most workers, appropriate repeated exposure to elevated heat stress causes a series of physiologic adaptations called acclimatization, whereby the body becomes more efficient in coping with the heat stress. Such an acclimatized worker can tolerate a greater heat stress before a harmful level of heat strain occurs.

The occurrence of heat-induced illnesses and unsafe acts among a group of workers in a hot environment, or the recurrence of such problems in individual workers, represents "sentinel health events" (SHE's) which indicate that heat control measures, medical screening, or environmental monitoring measures may not be adequate [1]. One or more occurrences of heat-induced illness in a particular worker indicates the need for medical inquiry about the possibility of temporary or permanent loss of the worker's ability to tolerate heat stress. The recommended requirements in the following sections are intended to establish the permissible limits of total heat stress so that the risk of incurring heat-induced illnesses and disorders in workers is reduced.

Almost all healthy workers, who are not acclimatized to working in hot environments and who are exposed to combinations of environmental and metabolic heat less than the appropriate NIOSH Recommended Alert Limits (RAL's) given in Figure 1, should be able to tolerate total heat without substantially increasing their risk of incurring acute adverse health effects. Almost all healthy workers, who are heat-acclimatized to working in hot environments and who are exposed to combinations of environmental and metabolic heat less than the appropriate NIOSH Recommended Exposure Limits (REL's) given in Figure 2, should be capable of tolerating the total heat without incurring adverse effects. The estimates of both environmental and metabolic heat are expressed as 1-hour time-weighted averages (TWAs) as described in reference [2].

At combinations of environmental and metabolic heat exceeding the Ceiling Limits (C) in Figures 1 and 2, no worker shall be exposed without adequate heat-protective clothing and equipment. To determine total heat loads where a worker could not achieve thermal balance, but might sustain up to a 1 degree Celsius (1°C) rise in body temperature in less than 15 minutes, the Ceiling Limits were calculated using the heat balance equation given in Chapter III, Section A.

In this criteria document, healthy workers are defined as those who are not excluded from placement in hot environment jobs by the explicit criteria given in Chapters I, IV, VI, and VII. These exclusionary criteria are qualitative in that the epidemiologic parameters of sensitivity, specificity, and predictive power of the evaluation methods are not fully documented. However, the recommended exclusionary criteria represent the best judgment of NIOSH based on the best available data and comments of peer reviewers. This may include both absolute and relative exclusionary indicators related to age, stature, gender, percent body fat, medical and occupational history, specific chronic diseases or therapeutic regimens, and the results of such tests as the maximum aerobic capacity ($\dot{V}O_{2max}$), electrocardiogram (EKG), pulmonary function tests (PFTs), and chest x rays (CXRs).

The medical surveillance program shall be designed and implemented in such a way as to minimize the risk of the workers' health and safety being jeopardized by any heat hazards that may be present in the workplace (see Chapters IV, VI, and VII). The medical program shall provide for both preplacement medical examinations for those persons who are candidates for a hot job and periodic medical examinations for those workers who are currently working in hot jobs.

Section 1 - Workplace Limits and Surveillance

(a) Recommended Limits

(1) Unacclimatized workers: Total heat exposure to workers shall be controlled so that unprotected healthy workers who are not acclimatized to working in hot environments are not exposed to combinations of metabolic and environmental heat greater than the applicable RAL's given in Figure 1.

(2) Acclimatized workers: Total heat exposure to workers shall be controlled so that unprotected healthy workers who are acclimatized to working in hot environments are not exposed to combinations of metabolic and environmental heat greater than the applicable REL's given in Figure 2.

(3) Effect of Clothing: The recommended limits given in Figures 1 and 2 are for healthy workers who are physically and medically fit for the level of activity required by their job and who are wearing the customary one layer work clothing ensemble consisting of not more than long-sleeved work shirts and trousers (or equivalent). The REL and RAL values given in Figures 1 and 2 may not provide adequate protection if workers wear clothing with lower air and vapor permeability or insulation values greater than those for the customary one layer work clothing ensemble discussed above. A discussion of these modifications to the REL and RAL is given in Chapter III, Section C.

(4) Ceiling Limits: No worker shall be exposed to combinations of metabolic and environmental heat exceeding the applicable Ceiling Limits (C) of Figures 1 or 2 without being provided with and properly using appropriate and adequate heat-protective clothing and equipment.

(b) Determination of Environmental Heat

(1) Measurement methods: Environmental heat exposures shall be assessed by the Wet Bulb Globe Thermometer (WBGT) method or equivalent techniques, such as Effective Temperature (ET), Corrected Effective Temperature (CET), or Wet Globe Temperature (WGT), that can be converted to WBGT values (as described in Chapters V and IX). The WBGT shall be accepted as the standard method and its readings the standard against which all others are compared. When air- and vapor-impermeable protective clothing is worn, the dry bulb temperature (t_a) or the adjusted dry bulb temperature (t_{adb}) is a more appropriate measurement.

(2) Measurement requirements: Environmental heat measurements shall be made at or as close as feasible to the work area where the worker is exposed. When a worker is not continuously exposed in a single hot area, but moves between two or more areas with differing levels of environmental heat or when the environmental heat substantially varies at the single hot area, the environmental heat exposures shall be measured at each area and during each period of constant heat levels where employees are exposed. Hourly TWA WBGTs shall be calculated for the combination of jobs (tasks), including all scheduled and unscheduled rest periods.

(3) Modifications of work conditions: Environmental heat measurements shall be made at least hourly during the hottest portion of each workshift, during the hottest months of the year, and when a heat wave occurs or is predicted. If two such sequential measurements exceed the applicable RAL or REL, then work

conditions shall be modified by use of appropriate engineering controls, work practices, or other measures until two sequential measures are in compliance with the exposure limits of this recommended standard.

(4) Initiation of measurements: A WBGT or an individual environmental factors profile shall be established for each hot work area for both winter and summer seasons as a guide for determining when engineering controls and/or work practices or other control methods shall be instituted. After the environmental profiles have been established, measurements shall be made as described in (b)(1), (2), and (3) of this section during the time of year and days when the profile indicates that total heat exposures above the applicable RAL's or REL's may be reasonably anticipated or when a heat wave has been forecast by the nearest National Weather Service station or other competent weather forecasting service.

(c) Determination of Metabolic Heat

(1) Metabolic heat screening estimates: For initial screening purposes, metabolic heat rates for each worker shall either be measured as required in (c)(2) of this section or shall be estimated from Table V-3 to determine whether the total heat exposure exceeds the applicable RAL or REL. For determination of metabolic heat, Table V-3 shall be used only for screening purposes unless other reliable and valid baseline data have been developed and confirmed by the indirect open-circuit method specified in (c)(2) of this Section. When computing metabolic heat estimates using Table V-3 for screening purposes, the metabolic heat production in kilocalories per minute shall be calculated using the upper value of the range given in Table V-3 for each body position and type of work for each specific task(s) of each worker's job.

EXAMPLE:

As shown in Table V-3 (D, Sample calculation), for a task that requires the worker to stand and use both arms, the values to be added would be 0.6 kilocalories per minute (kcal/min) for standing, 3.5 kcal/min for working with both arms, and 1.0 kcal/min for basal metabolism, for a total metabolic heat of 5.1 kcal/min for a worker who weighs 70 kilograms (kg)(154 lb). For a worker that has other than a 70-kg weight, the metabolic heat shall be corrected by the factor (actual worker weight in kg/70 kg). Thus for an 85-kg worker the factor would be $(85/70) = 1.21$ and the appropriate estimate for metabolic heat would be $(1.21)(5.1) = 6.2$ kcal/min for the duration of the task.

(2) Metabolic heat measurements - Whenever the combination of measured environmental heat (WBGT) and screening estimate of metabolic heat exceeds the applicable RAL or REL (Figures 1 and 2), the metabolic heat production shall be measured using the indirect open-circuit procedure (see Chapter V) or an equivalent method.

Metabolic heat rates shall be expressed as kilocalories per hour (kcal/h), British thermal units (Btu) per hour, or watts (W) for a 1-hour TWA task basis that includes all activities engaged in during each period of analysis and all scheduled and nonscheduled rest periods (1 kcal/h = 3.97 Btu/h = 1.16 W).

EXAMPLE:

For the example in (c)(1), if the task was performed by an acclimatized 70-kg worker for the entire 60 minutes of each hour, the screening estimate for the 1-hour TWA metabolic heat would be $(5.1 \text{ kcal/min})(60 \text{ min}) = \text{about } 300 \text{ kcal/h}$. Using the applicable Figure 2, a vertical line at 300 kcal/h would intersect the 60 min/h REL curve at a WBGT of 27.8°C (82°F). Then, if the measured WBGT exceeds 27.8°C, proceed to measure the worker's metabolic heat with the indirect open-circuit method or equivalent procedure.

If the 70-kg worker was unacclimatized, use of Figure 1 indicates that metabolic heat measurement of the worker would be required above a WBGT of 25°C (77°F).

(d) Physiologic Monitoring

Physiologic monitoring may be used as an adjunct monitoring procedure to those estimates and measurements required in the preceding Parts (a), (b), and (c) of this section. The total heat stress shall be considered to exceed the applicable RAL or REL when the physiologic functions (e.g., core or oral body temperature, work and recovery pulse rate) exceed the values given in Chapter IX, Section D.

Section 2 - Medical Surveillance

(a) General

(1) The employer shall institute a medical surveillance program for all workers who are or may be exposed to heat stress above the RAL, whether they are acclimatized or not.

(2) The employer shall assure that all medical examinations and procedures are performed by or under the direction of a licensed physician.

(3) The employer shall provide the required medical surveillance without cost to the workers, without loss of pay, and at a reasonable time and place.

(b) Preplacement Medical Examinations

For the purposes of the preplacement medical examination, all workers shall be considered to be unacclimatized to hot environments. At a minimum, the preplacement medical examination of each prospective worker for a hot job shall include:

(1) A comprehensive work and medical history, with special emphasis on any medical records or information concerning any known or suspected previous heat illnesses or heat intolerance. The medical history shall contain relevant information on the cardiovascular system, skin, liver, kidney, and the nervous and respiratory systems;

(2) A comprehensive physical examination that gives special attention to the cardiovascular system, skin, liver, kidney, and the nervous and respiratory systems;

(3) An assessment of the use of therapeutic drugs, over-the-counter medications, or social drugs (including alcohol), that may increase the risk of heat injury or illness (see Chapter VII);

(4) An assessment of obesity (body fatness), that is defined as exceeding 25% of normal weight for males and exceeding 30% of normal weight for females, as based on age and body build;

(5) An assessment of the worker's ability to wear and use any protective clothing and equipment, especially respirators, that is or may be required to be worn or used; and

(6) Other factors and examination details included in Chapter VII, Section B-1.

(c) Periodic Medical Examinations

Periodic medical examinations shall be made available at least annually to all workers who may be exposed at the worksite to heat stress exceeding the RAL. The employer shall provide the examinations specified in Part (b) above including any other items the examining physician considers relevant. If circumstances warrant (e.g., increase in job-related heat stress, changes in health status), the medical examination shall be offered at shorter intervals at the discretion of the responsible physician.

(d) Emergency Medical Care

If the worker for any reason develops signs or symptoms of heat illness, the employer shall provide appropriate emergency medical treatment.

(e) Information to be Provided to the Physician

The employer shall provide the following information to the examining physician performing or responsible for the medical surveillance program:

(1) A copy of this recommended standard;

(2) A description of the affected worker's duties and activities as they relate to the worker's environmental and metabolic heat exposure;

(3) An estimate of the worker's potential exposure to workplace heat (both environmental and metabolic), including any available workplace measurements or estimates;

(4) A description of any protective equipment or clothing the worker uses or may be required to use; and

(5) Relevant information from previous medical examinations of the affected worker which is not readily available to the examining physician.

(f) Physician's Written Opinion

The employer shall obtain a written opinion from the responsible physician which shall include:

(1) The results of the medical examination and the tests performed;

(2) The physician's opinion as to whether the worker has any detected medical conditions which would increase the risk of material impairment of health from exposure to anticipated heat stress in the work environment;

(3) An estimate of the individual's tolerance to withstand hot working conditions;

(4) An opinion as to whether the worker can perform the work required by the job (i.e., physical fitness for the job);

(5) Any recommended limitations upon the worker's exposure to heat stress or upon the use of protective clothing or equipment; and

(6) A statement that the worker has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

The employer shall provide a copy of the physician's written opinion to the affected worker.

Section 3 - Surveillance of Heat-Induced Sentinel Health Events

(a) Definition

Surveillance of heat-induced Sentinel Health Events (SHE's) is defined as the systematic collection and analysis of data concerning the occurrence and distribution of adverse health effects in defined populations at risk to heat injury or illness.

(b) Requirements

In order to evaluate and improve prevention and control measures for heat-induced effects, which includes the identification of highly susceptible workers, data on the occurrence or recurrence in the same

worker, and distribution in time, place, and person of heat-induced adverse effects shall be obtained and analyzed for each workplace.

Section 4 - Posting of Hazardous Areas

(a) Dangerous Heat-Stress Areas

In work areas and at entrances to work areas or building enclosures where there is a reasonable likelihood of the combination(s) of environmental and metabolic heat exceeding the Ceiling Limit, there shall be posted readily visible warning signs containing information on the required protective clothing or equipment, hazardous effects of heat stress on human health, and information on emergency measures for heat injury or illness. This information shall be arranged as follows:

**DANGEROUS HEAT-STRESS AREA
HEAT-STRESS PROTECTIVE CLOTHING OR EQUIPMENT REQUIRED
HARMFUL IF EXCESSIVE HEAT EXPOSURE OR WORK LOAD OCCUR
HEAT-INDUCED FAINTING, HEAT EXHAUSTION, HEAT CRAMP,
HEAT RASH OR HEAT STROKE MAY OCCUR**

(b) Emergency Situations

In any area where there is a likelihood of heat stress emergency situations occurring, the warning signs required in (a) of this section shall be supplemented with signs giving emergency and first aid instructions.

(c) Additional Requirements for Warning Signs

All hazard warning signs shall be printed in English and where appropriate in the predominant language of workers unable to read English. Workers unable to read the signs shall be informed of the warning printed on the signs and the extent of the hazardous area(s). All warning signs shall be kept clean and legible at all times.

Section 5 - Protective Clothing and Equipment

Engineering controls and safe work practices shall be used to maintain worker exposure to heat stress at or below the applicable RAL or REL specified in Section 1. In addition, protective clothing and equipment (e.g., water-cooled garments, air-cooled garments, ice-packet vests, wetted-overgarments, heat-reflective aprons or suits) shall be provided by the employer to the workers when the total heat stress exceeds the Ceiling Limit.

Section 6 - Worker Information and Training

(a) Information Requirements

All new and current workers, who are unacclimatized to heat and work in areas where there is reasonable likelihood of heat injury or illness, shall be kept informed, through continuing education programs, of:

- (1) Heat stress hazards,
- (2) Predisposing factors and relevant signs and symptoms of heat injury and illness,
- (3) Potential health effects of excessive heat stress and first aid procedures,
- (4) Proper precautions for work in heat stress areas,
- (5) Worker responsibilities for following proper work practices and control procedures to help protect the health and provide for the safety of themselves and their fellow workers, including instructions to immediately report to the employer the development of signs or symptoms of heat stress overexposure,
- (6) The effects of therapeutic drugs, over-the-counter medications, or social drugs (including alcohol), that may increase the risk of heat injury or illness by reducing heat tolerance (see Chapter VII),
- (7) The purposes for and descriptions of the environmental and medical surveillance programs and of the advantages to the worker of participating in these surveillance programs, and
- (8) If necessary, proper use of protective clothing and equipment.

(b) Continuing Education Programs

- (1) The employer shall institute a continuing education program, conducted by persons qualified by experience or training in occupational safety and health, to ensure that all workers potentially exposed to heat stress have current knowledge of at least the information specified in (a) of this section. For each affected worker, the instructional program shall include adequate verbal and/or written communication of the specified information. The employer shall develop a written plan of the training program that includes a record of all instructional materials.
- (2) The employer shall inform all affected workers of the location of written training materials and shall make these materials readily available, without cost to the affected workers.

(c) Heat-Stress Safety Data Sheet

- (1) The information specified in (a) of this section shall be recorded on a heat-stress safety data sheet or on a form specified by the Occupational Safety and Health Administration (OSHA).
- (2) In addition, the safety data sheet shall contain:
 - (i) Emergency and first aid procedures, and

(ii) Notes to physician regarding classification, medical aspects, and prevention of heat injury and illness. These notes shall include information on the category and clinical features of each injury and illness, predisposing factors, underlying physiologic disturbance, treatment, and prevention procedures (see Table IV-1).

Section 7 - Control of Heat Stress

(a) General Requirements

(1) Where engineering and work practice controls are not sufficient to reduce exposures to or below the applicable RAL or REL, they shall, nonetheless, be used to reduce exposures to the lowest level achievable by these controls and shall be supplemented by the use of heat-protective clothing or equipment, and a heat-alert program shall be implemented as specified in (d) of this section.

(2) The employer shall establish and implement a written program to reduce exposures to or below the applicable RAL or REL by means of engineering and work practice controls.

(b) Engineering Controls

(1) The type and extent of engineering controls required to bring the environmental heat below the applicable RAL or REL can be calculated using the basic heat exchange formulae (e.g., Chapters III and VI). When the environmental heat exceeds the applicable RAL or REL, the following control requirements shall be used.

(a) When the air temperature exceeds the skin temperature, convective heat gain shall be reduced by decreasing air temperature and/or decreasing the air velocity if it exceeds 1.5 meters per second (m/sec) (300 ft/min). When air temperature is lower than skin temperature, convective heat loss shall be increased by increasing air velocity. The type, amount, and characteristics of clothing will influence heat exchange between the body and the environment.

(b) When the temperature of the surrounding solid objects exceeds skin temperature, radiative heat gain shall be reduced by: placing shielding or barriers, that are radiant-reflecting or heat-absorbing, between the heat source and the worker; by isolating the source of radiant heat; or by modifying the hot process or operation.

(c) When necessary, evaporative heat loss shall be increased by increasing air movement over the worker, by reducing the influx of moisture from steam leaks or from water on the workplace floors, or by reducing the water vapor content (humidity) of the air. The air and water vapor permeability of the clothing worn by the worker will influence the rate of heat exchange by evaporation.

(c) Work and Hygienic Practices

(1) Work modifications and hygienic practices shall be introduced to reduce both environmental and metabolic heat when engineering controls are not adequate or are not feasible. The most effective preventive work and hygienic practices for reducing heat stress include, but are not limited to the following parts of this section:

(a) Limiting the time the worker spends each day in the hot environment by decreasing exposure time in the hot environment and/or increasing recovery time spent in a cool environment;

(b) Reducing the metabolic demands of the job by such procedures as mechanization, use of special tools, or increase in the number of workers per task;

(c) Increasing heat tolerance by a heat acclimatization program and by increasing physical fitness;

(d) Training supervisors and workers to recognize early signs and symptoms of heat illnesses and to administer relevant first aid procedures;

(e) Implementing a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of heat intolerance such as weakness, unsteady gait, irritability, disorientation, changes in skin color, or general malaise; and

(f) Providing adequate amounts of cool, i.e., 10° to 15°C (50° to 59°F) potable water near the work area and encouraging all workers to drink a cup of water (about 150 to 200 mL (5 to 7 ounces) every 15 to 20 minutes. Individual, not communal, drinking cups shall be provided.

(d) Heat-Alert Program

A written Heat-Alert Program shall be developed and implemented whenever the National Weather Service or other competent weather forecast service forecasts that a heat wave is likely to occur the following day or days. A heat wave is indicated when daily maximum temperature exceeds 35°C (95°F) or when the daily maximum temperature exceeds 32°C (90°F) and is 5°C (9°F) or more above the maximum reached on the preceding days. The details for a Heat-Alert Program are described in Chapter VI, Section C.

Section 8 - Recordkeeping

(a) Environmental Surveillance

(1) The employer shall establish and maintain an accurate record of all measurements made to determine environmental and metabolic

heat exposures to workers as required in Section 1 of this recommended standard.

(2) Where the employer has determined that no metabolic heat measurements are required as specified in Section 1, Part (c)(2) of this recommended standard, the employer shall maintain a record of the screening estimates relied upon to reach the determination.

(b) Medical Surveillance

The employer shall establish and maintain an accurate record for each worker subject to medical surveillance as specified in Section 2 of this recommended standard.

(c) Surveillance of Heat-Induced Sentinel Health Events

The employer shall establish and maintain an accurate record of the data and analyses specified in Section 3 of this recommended standard.

(d) Heat-Induced Illness Surveillance

The employer shall establish and maintain an accurate record of any heat-induced illness or injury and the environmental and work conditions at the time of the illness or injury.

(e) Heat Stress Tolerance Augmentation

The employer shall establish and maintain an accurate record of all heat stress tolerance augmentation for workers by heat acclimatization procedures and/or physical fitness enhancement.

(f) Record Retention

In accordance with the requirements of 29 CFR 1910.20(d), the employer shall retain records described by this recommended standard for at least the following periods:

- (1) Thirty years for environmental monitoring records,
- (2) Duration of employment plus 30 years for medical surveillance records,
- (3) Thirty years for surveillance records for heat-induced SHE's, and
- (4) Thirty years for records of heat stress tolerance augmentation

(g) Availability of Records

(1) The employer shall make worker environmental surveillance records available upon request for examination and copying to the subject worker or former worker or to anyone having the specific

written consent of the subject worker or former worker in accordance with 29 CFR 1910.20.

(2) Any worker's medical surveillance records, surveillance records for heat-induced SHE's, or records of heat stress tolerance augmentation that are required by this recommended standard shall be provided upon request for examination and copying to the subject worker or former worker or to anyone having the specific written consent of the subject worker or former worker.

(h) Transfer of Records

(1) The employer shall comply with the requirements on the transfer of records set forth in the standard, Access to Medical Records, 29 CFR 1910.20(h).

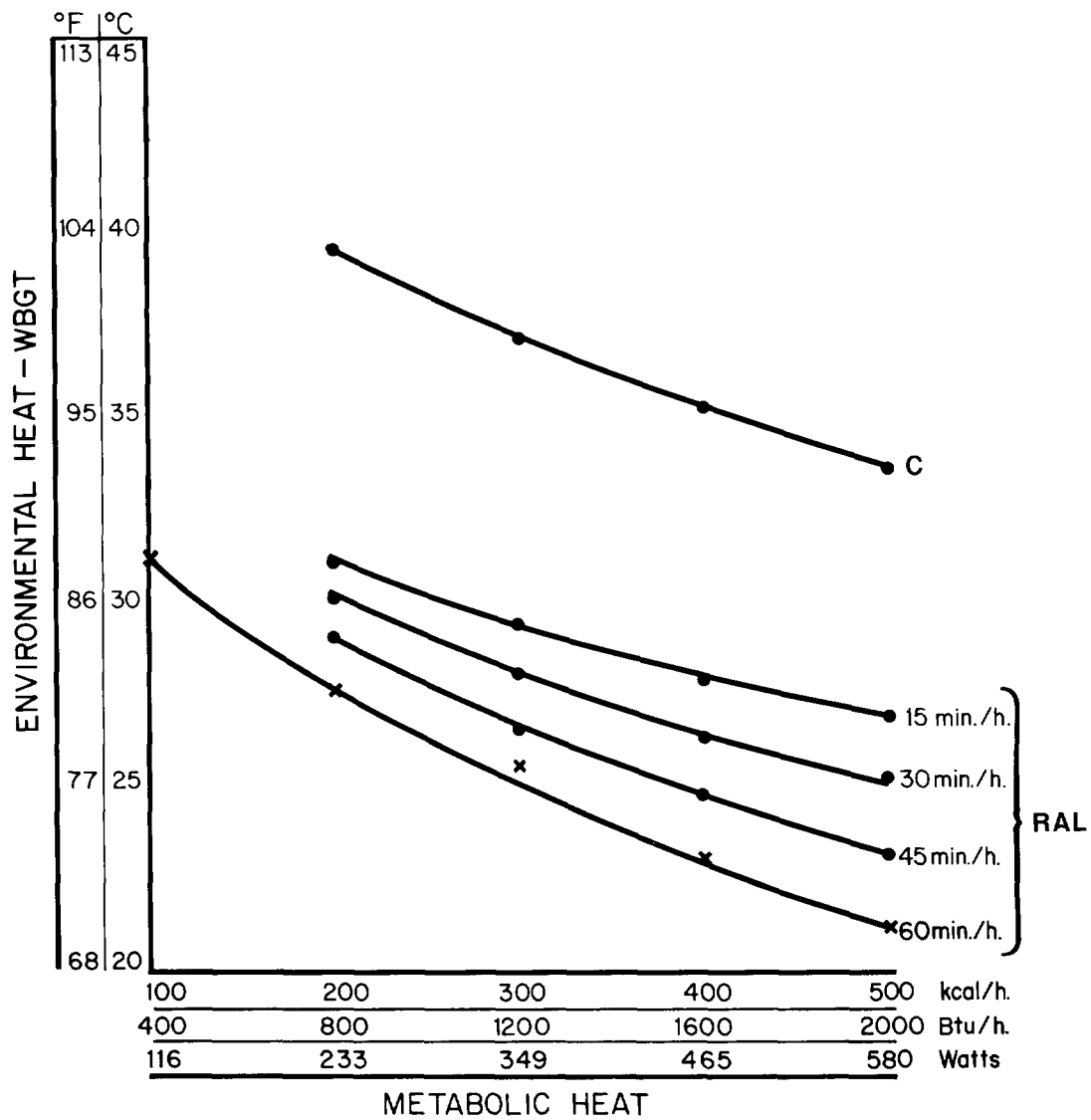


Figure 1. Recommended Heat-Stress Alert Limits
Heat-Unacclimatized Workers

C = Ceiling Limit

RAL = Recommended Alert Limit

*For "standard worker" of 70 kg (154 lbs) body weight and
1.8 m² (19.4 ft²) body surface.

Based on References 2,3,4,5,6,7,8.

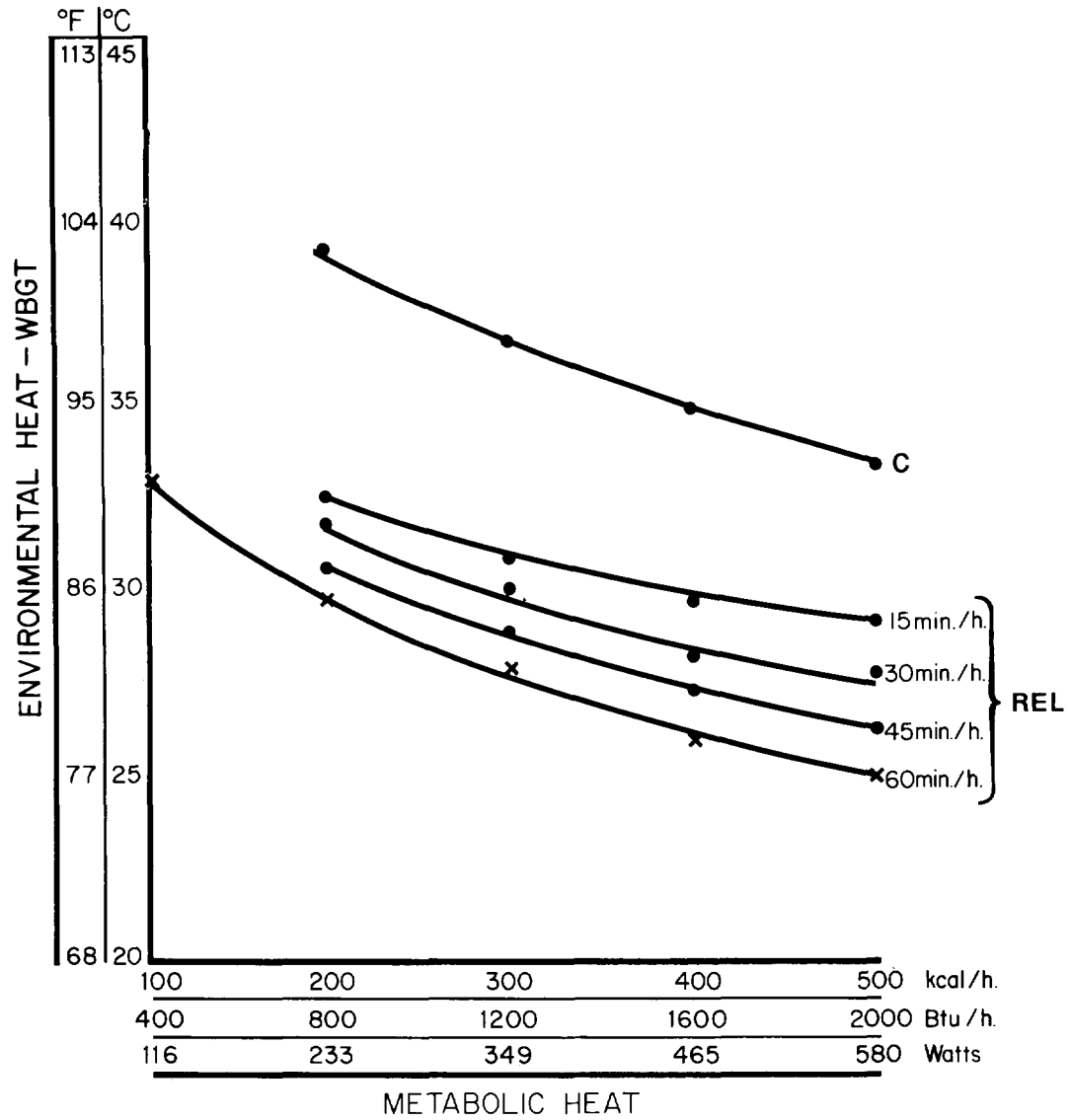


Figure 2. Recommended Heat-Stress Exposure Limits
Heat-Acclimatized Workers

C = Ceiling Limit

REL = Recommended Exposure Limit

*For "standard worker" of 70 kg (154 lbs) body weight and 1.8 m² (19.4 ft²) body surface.

Based on References 2,3,4,5,6,7,8.

II. INTRODUCTION

Criteria documents are developed by the National Institute for Occupational Safety and Health (NIOSH), in response to section 20(a)(3) of the Occupational Safety and Health Act of 1970. In the Act, NIOSH is charged with developing criteria documents for toxic chemical substances and harmful physical agents which will describe exposure levels that are safe for various periods of employment including but not limited to the exposure levels at which no worker will suffer impaired health or functional capacities or diminished life expectancy as a result of any work experience. Environmental heat is a potentially harmful physical agent. This document presents the criteria and recommendations for a standard that were prepared to meet the need for preventing heat-induced health impairment resulting from exposure to occupational heat stress.

This document is an update of the Criteria for a Recommended Standard.... Occupational Exposure to Hot Environments (HSM-10269) published by NIOSH in January 1972 [9]. In June 1972, NIOSH sent the criteria document to the Occupational Safety and Health Administration (OSHA). In January 1973, the Assistant Secretary of Labor for Occupational Safety and Health appointed a 15 member Standards Advisory Committee on Heat Stress to review the NIOSH criteria document and develop a proposed standard. The committee submitted a proposed standard to the Assistant Secretary of Labor, OSHA, in January 1974 [7]. A standard on occupational exposure to hot environments was not promulgated. The updating of this document is based on the relevant scientific data and industry experience that have accrued since the original document was prepared. The document presents the criteria, techniques, and procedures for the assessment, evaluation, and control of occupational heat stress by engineering and preventive work practices and those for the recognition, treatment, and prevention of heat-induced illnesses and unsafe acts by medical supervision, hygienic practices, and training programs.

The recommended criteria were developed to ensure that adherence to them will (1) protect against the risk of heat-induced illnesses and unsafe acts, (2) be achievable by techniques that are valid, reproducible, and available, and (3) be attainable by existing techniques. This recommended standard is also designed to prevent possible harmful effects from interactions between heat and toxic chemical and physical agents. The recommended environmental limits for various intensities of physical work as indicated in Figures 1 and 2 are not upper tolerance limits for heat exposure for all workers but rather levels at which engineering controls, preventive work and hygienic practices, and administrative or other control procedures should be implemented in order to reduce the risk of heat illnesses even in the least heat-tolerant workers.

Estimates of the number of industrial workers who are exposed to heat stress on the job are at best rough guesses. A review of the Statistical Abstracts of the United States, 105th edition 1985, for the number of workers in industries where heat stress is a potential safety and health hazard indicates that a conservative estimate would be 5 to 10 million workers [10].

A glossary of terms, symbols, abbreviations, and units of measure used in this document is presented in XII-A.