Noise and Temperature Stresses

Los Alamos National Laboratory
Laboratory Implementation Requirements LIR 402-820-01.1
Issue Date: 12/21/99, (Revised 8/20/03) Mandatory Document

1.0 Introduction

1.1 Overview

Note: *Click here* for lessons learned that may apply to the requirements contained in this LIR.

This Laboratory implementation requirements (LIR) document specifies Los Alamos National Laboratory (LANL or the Laboratory) requirements for noise and temperature extremes that shall be implemented for activities that have the potential for causing overexposure to noise and to heat and cold extremes.

This LIR supersedes Administrative Requirement 8-2, "Hearing Conservation," and complements LPR 402-00-00, "Worker Health and Safety," Appendix 12, "General Occupational Safety." The requirements stated in this LIR shall be implemented 6 months after the issue date.

Attachment A consists of tables that give the occupational exposure limits (OELs) that shall be implemented for noise and heat stress based on the 1997 threshold limit values of the American Conference of Governmental Industrial Hygienists. Attachment B contains recommended major implementation criteria for self-assessment of this LIR.

1.2 In This Document

2.0 Purpose

The purpose of this LIR shall be to establish requirements for protecting all workers from the adverse effects of exposure to noise and heat and cold extremes.

3.0 Scope and Applicability

This document shall apply to all LANL employees in which exposures to elevated noise levels and extremes of heat and cold may occur. Visitors, vendors, and subcontractors are excluded from the requirements set forth in this LIR. However, visitors, vendors and subcontractors shall follow the Occupational Health and Safety Administration's requirements for occupational noise and have a program that protects employees from heat and cold stress.

4.0 Definitions

4.1 Acronyms

ESH	Environment, Safety, and Health (Division)
HSR-2	Occupational Medicine Group
HSR-5	Industrial Hygiene and Safety Group
PS-13	ES&H Training Group
HPD	Hearing protection device

LANL	Los Alamos National Laboratory
LIR	Laboratory implementation requirement
OEL	Occupational exposure limit
PPE	Personal protective equipment
TLV	Threshold limit value
TWA	Time-weighted average

4.2 Definitions

Acclimatization—Physiological changes that allow the human body to adapt to heat. After a period of acclimation (fully achieved after approximately 3 weeks), an activity produces fewer cardiovascular demands than it did before acclimation, and the worker sweats more efficiently.

Action level—A term used to express the level of toxicant that requires medical surveillance, usually one-half of the permissible exposure limit, e.g., an 8-h TWA of 82 dB on A-Scale (slow response) or, equivalently, a noise dose of 50% of the permissible OEL.

Audiometric exam—A record of hearing loss or hearing level measured at several different frequencies, which may be presented either graphically or numerically. Hearing level is shown as a function of frequency.

Employee—Any Laboratory worker, including affiliates, who may have the potential to be overexposed to noise and/or thermal stress under normal operating conditions.

Engineering controls—A method of controlling employee exposure to an agent by source modification, process change, substitution, and/or isolation.

Frostbite—Injury to skin and subcutaneous tissues from exposures to extreme cold and, in severe cases, also to deeper tissues.

Heat cramps—Painful muscle spasms—usually occurring on the arms, legs, and abdomen—caused by excessive loss of electrolytes as the result of profuse sweating.

Heat exhaustion—A condition usually caused by loss of body water because of exposure to excess heat. Symptoms include headache, tiredness, nausea, and sometimes fainting.

Heat rash—Profuse tiny raised red vesicles (blisters) on the skin that cause a prickling sensation during heat exposure.

Heat stress—The net heat load on the body from the combined contributions of metabolic heat production and external environmental factors; environmental factors include air temperature and water vapor content, radiant heat exchange, and air movement, as they are affected by clothing.

Heat stroke—A serious disorder resulting from exposure to excess heat that suppresses sweat and increases storage of body heat. Symptoms include hot, dry skin; high temperature; mental confusion; convulsions; and coma. Heat stroke is fatal if not treated properly.

Hearing Conservation Program—A Laboratory program whose goal is preventing or minimizing noise-induced hearing loss by means of noise monitoring, engineering controls, annual audiometric exams, employee training, and hearing protection devices.

Hearing protection devices—PPE for the ears that helps minimize noise exposure. Examples include disposable foam plugs, reusable molded plugs, custom-molded plugs, and earmuffs.

Hypothermia—Decreased body-core temperature resulting from prolonged exposure to freezing or near-freezing temperatures. Hypothermia is the most life-threatening injury caused by cold.

Occupational exposure limit—The TWA exposure level to which nearly all employees may be repeatedly exposed, day after day, without adverse effect. Attachment A lists the OEL values for noise and heat stress.

Personal protective equipment—Devices worn by a worker to protect against hazards in the environment, e.g., insulated gloves.

Qualified person —An employee who has academic credentials or work experience in a relevant discipline, such as industrial hygiene or industrial safety, and who has experience and training in evaluating noise and temperature extremes.

Standard (significant) threshold shift—A change in hearing ability that is used as an indicator of possible noise-induced hearing loss determined by audiometric testing at the 2-, 3-, and 4-kHz frequencies.

Work/rest regimen—The ratio of time spent working to time spent resting in an area designed to relieve heat-related conditions. This ratio is expressed in 1-h periods. **Example**: A work/rest regimen of 75% work and 25% rest corresponds to 45 min of work and 15 min of rest each hour.

5.0 Implementation Requirements

5.1 Responsibilities

Responsible Individual	Shall
Safety-and-Environmentally-Responsible Line Manager	• obtain an HSR-5 or another qualified person to perform evaluations of suspected elevated exposure to noise and/or heat and cold extremes in on-going operations or when significant changes occur; • inform HSR-5 or another qualified person of new or significant changes in operations involving noise and/or heat and cold extremes that may affect employee exposure; • review, approve, and revise hazard control plans or activity hazard analyses that involve noise and temperature extremes and ensure that they are understood and implemented; • implement recommended engineering controls, work practices, postings, PPE, and training to eliminate or reduce the hazards of extremes in noise and temperature to an acceptable level; • provide and maintain required PPE for heat and cold extremes and enforce the use of PPE, when required; • provide HPDs for employees exposed to noise levels at or above the action level; • ensure that HPDs are worn by employees exposed to noise levels at or above the OEL; • ensure that a job-specific briefing on heat and cold stresses is completed, when required;

Responsible Individual	Shall
	• become familiar with the signs and symptoms of heat and cold stress, including heat rash, heat cramps, heat exhaustion, heat stroke, frostbite, and hypothermia for operations where the potential for heat and cold stress exists; and • take action to prevent further hearing deterioration (through engineering controls or increased surveillance, retraining, or removing the employee from the source of the noise) if hearing loss from occupational exposure at the Laboratory is confirmed.
Facility Manager	• maintain facility equipment within its operating parameters to minimize noise and extremes of heat and cold.
Qualified Person	• evaluate operations or areas for physical hazards to determine engineering controls, postings, work practices, PPE, and medical surveillance in accordance with HSR-5 Field Operations Manual; • report the results of evaluations of noise and temperature extremes, including monitoring results, engineering controls, work practices, and PPE to safety- and environment- responsible line managers, employees, HSR-5 (MS K494), and HSR-2 (MS D421); • recommend engineering controls, work practices, and PPE to reduce harmful noise and exposures to extreme heat and cold; • conduct job-specific briefings on heat and cold stresses, when requested; and • recommend those employees who are routinely exposed to noise levels above the action level for placement in the Hearing Conservation Program.
HSR-5	• provide qualified persons for noise and temperature stresses evaluations; • calibrate and maintain equipment used for inspections, tests, monitoring, and data collection per HSR-5's Field Operations Manual; • maintain records of noise and heat and cold stress evaluations and monitoring for the Laboratory; • develop and maintain Field Operations Manual; • determine the effectiveness of the requirements contained in this LIR through assessments and evaluations; • function as a resource for the Laboratory, providing guidance and technical support on issues of noise and temperature extremes; and • evaluate employee additions to or deletions from the Hearing Conservation Program to update the program list; notify HSR-2 (MS D421) in writing of employees' status.
HSR-2	• maintain and administer the audiometric testing program in accordance with the work-smart standard, 29 CFR 1910, Occupational Safety and Health Standards; • schedule and perform initial and annual audiometric exams for employees exposed to noise above the action level; • assist employees with proper fit of HPDs, demonstrate various types of HPDs, and provide an initial set of earplugs to employees; and • request investigations from HSR-5 or another qualified person for employees who have a standard threshold shift or suspected occupational exposure to high noise.
PS-13	• provide the awareness-level self-study course "Thermal Stresses" and • conduct initial and annual refresher training ("Hearing Conservation") for employees who are exposed to noise at or above the action level.
Employees	• report suspected noise and exposure to extreme heat and cold in work areas to immediate supervisors and HSR-5 or another qualified person; • use available engineering controls, work practices, and proper PPE for the work to be performed;

Responsible Individual	Shall
	• participate in training by PS-13 or a job-specific briefing on heat and cold stresses; and • wear HPDs when noise levels are at or above the OEL. **Guidance Note:** Employees should consider wearing HPD when noise levels are at or above the action level.

5.2 Requirements

5.2.1 Evaluation

5.2.1.1 Noise

Sources of noise shall be identified in accordance with Section 5.1 and the need for further evaluation shall be determined.

5.2.1.2 Heat Stress

Situations in which exposure to heat could occur shall be identified in accordance with Section 5.1, and the need for further evaluation shall be determined. If monitoring is warranted, HSR-5 or another qualified person shall conduct the monitoring. Safety- and environment- responsible line managers shall become familiar with the signs and symptoms of heat stress.

If …	Then …
an employee is wearing a respirator and/or an impermeable suit,	• the employee may be in danger of heat stress. Contact HSR-5 or a qualified individual for evaluation. • the employee shall be acclimated to the heat if new to the job task.
an employee is routinely working outside in hot weather,	• the employee may be in danger of heat stress. Contact HSR-5 or a qualified individual for evaluation. • the employee shall be acclimated to the heat if new to the job task.
an employee starts to exhibit symptoms of heat cramps (painful, periodic contractions of the abdominal muscles or other fatigued muscles),	• the employee shall rest in a cool location and drink fluids (lightly salted water or electrolytic drink). He/she shall report to HSR-2 for a medical evaluation.
an employee starts to exhibit symptoms of heat exhaustion (profuse sweating, rapid pulse, pale skin, dizziness, nausea, headaches, or tiredness),	• the employee shall rest in a cool location and drink fluids. He/she shall report to HSR-2 for a medical evaluation.
an employee starts to exhibit symptoms of heat stroke (hot and dry skin, chills, irritability, disorientation, or collapse)	• **a medical emergency exists. Get the employee to a shaded or cool area as quickly as possible, remove PPE that may add to the heat load, and douse the victim in a cool liquid or place him/her in an ice bath. Call 911 immediately.**

5.2.1.3 Cold Stress

Situations in which exposure to cold could occur shall be identified, and the need for further evaluation shall be determined. If monitoring is warranted, HSR-5 or another qualified person shall conduct the monitoring. Safety- and environment-responsible line managers shall become familiar with the signs and symptoms of cold stress. Special precautions shall be exercised when cold and vibration are both present because these stimuli result in similar symptoms.

If …	Then …
an employee is routinely working continuously outdoors in temperatures lower than 39.2°F (4°C),	the employee may be in danger of cold stress. Contact HSR-5 or a qualified individual for evaluation.
an employee shows symptoms of shivering or excessive fatigue,	the employee shall return to a warm location and drink warm, caffeine-free beverages.
an employee shows symptoms of frostbite (numbness or prickly feeling in fingers, face, nose, ears, or other extremity),	the employee shall return to a warm location and remove clothing from affected parts. Do not rub affected area(s). Soak affected areas in warm water and cover with warmed clothes. He/she shall report to HSR-2 for a medical evaluation. **If a part appears to be frozen deeper than the fist layer of skin, or if a whole hand or foot is affected call 911 immediately.**
an employees shows symptoms of hypothermia (intense shivering, slurred speech, confusion, loss of coordination, slow movements),	**a medical emergency exists. Get the employee to a warm and dry area as quickly as possible. Call 911 immediately.**

5.2.2 Engineering Controls

5.2.2.1 Noise

When employees are subjected to noise exceeding the OEL, engineering controls and/or alternative operating conditions shall be implemented when determined jointly by the operating division and HSR-5 to be economically and technically feasible.

Guidance Note: Engineering controls may include

- installing acoustical absorbing materials or barriers,
- designing acoustical enclosures around the noise source, and
- installing mufflers to reduce noise to an acceptable level.

5.2.2.2 Heat Stress

When an employee's heat stress measurement exceeds the OEL, engineering controls and/or work practices, including work/rest regimens, shall be implemented when determined jointly by the operating division and HSR-5 to be economically and technically feasible.

Guidance Note: Engineering controls may include

- using power tools to reduce the physical demands of the work being performed,
- air-conditioned cabs for heavy equipment and vehicles, and
- using fans or blowers.

5.2.2.3 Cold Stress

When employees are subjected to cold exceeding the OEL, engineering controls and/or work practices shall be implemented that have been determined jointly by the operating division and HSR-5 to be economically and technically feasible.

Guidance Note: Engineering controls may include

- minimizing the air velocity in refrigerated rooms so that it does not exceed 1 m/s in the work zone;
- avoiding unprotected metal chairs because they conduct heat away from the body;
- substituting, isolating, relocating, or redesigning equipment and processes to reduce cold stress at the work site; and
- using power tools, hoists, cranes, or other lifting aids to reduce metabolic workload.

5.2.3 Work Practices

5.2.3.1 Noise

Work areas shall be posted when the potential for noise exposure is at or above the OEL. If posting is not feasible, documentation of alternative provisions for notifying employees of the noise hazard shall be provided to HSR-5.

5.2.3.2 Heat Stress

Work practices shall include one or more of the following:

- adjusting work schedules so that the bulk of the work may be done during the cooler parts of the day,
- acclimatizing employees, and
- implementing work/rest regimens as indicated by heat stress monitoring and work load.

5.2.3.3 Cold Stress

The following general work practices and administrative controls shall be implemented to help reduce the risk of cold stress:

- Based on the OELs, safety- and environment-responsible line managers shall implement a work/rest schedule to reduce exposure to cold stress. Scheduled rest breaks shall be enforced.
- Wet clothing shall be replaced immediately.

If the air temperature is at or below,	the following work practices shall be implemented:
39.2°F (4°C),	• Insulating dry clothing shall be provided to employees. • If an employee is performing light work and fine manual dexterity is not required, he/she shall use gloves. • If available clothing does not protect the employee adequately to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve. **Guidance Note:** Employees should avoid soaking clothing or gloves with evaporative liquids (gasoline, alcohol, and cleaning fluids).
30.2°F (-1°C),	• Employees suffering from diseases or taking medication that interferes with normal regulation of body temperature or that reduces tolerance to work in cold environments shall not be required to work in cold. • Gloves shall be worn or metal handles of tools and control bars shall be covered by thermal insulating materials.
19.4°F (-7°C),	• Warming regimens shall be implemented. • Heated shelters shall be provided near the work location. • Warm, sweet, caffeine-free, nonalcoholic liquids or soups shall be available. • If an employee is performing moderate work and fine manual dexterity is not required, he/she shall use gloves.
10.4°F (-12°C),	• Contact HSR-5 for a full description of precautions and measures to be taken.

Guidance Note: Additional work practices may include

- scheduling the coldest work for the warmest part of the day, when feasible;
- moving work to warmer areas whenever possible;
- assigning extra employees to help with highly demanding tasks;
- using the buddy system so that employees can monitor each other's cold stress symptoms;
- giving employees time to adjust to cold conditions;
- minimizing the need to sit or stand in one place for long periods;
- minimizing the amount of work time spent in a cold environment;
- making allowances for the weight and bulk of protective clothing when estimating work performance goals and tasks; and
- asking employees with circulatory problems who work in extreme cold to wear extra insulating clothing and/or to work in the cold for reduced periods.

5.2.4 Personal Protective Equipment

5.2.4.1 Noise

HPDs shall be made available to all employees who are exposed to noise at or above the action level. To provide for individual fit, comfort, and preference, employees shall have a choice of at least two different HPDs. HPDs shall be worn by (1) employees who have not received their baseline audiometric exam for any period exceeding 6 months from the time they are first exposed to noise at or above the action level, (2) employees who have incurred a standard threshold shift, and (3) employees exposed above the OEL. Employees shall be fitted properly for their HPDs and shall be taught how to use and care for them.

5.2.4.2 **Heat Stress**

PPE shall be used along with work/rest regimens to reduce employees' heat stress, when required.

5.2.4.3 **Cold Stress**

PPE shall be provided when conditions indicate air temperatures below 40°F (4°C).

5.2.5 Medical Surveillance

HSR-5 or another qualified person shall recommend employees for medical surveillance based on evaluations of the hazard. Audiometric testing shall be made available to all employees who are routinely exposed to noise at or above the action level. HSR-5 or another qualified person shall recommend employees for medical surveillance based on an evaluation of the hazard. A baseline audiometric exam shall be provided within 6 months of an employee's first exposure to noise at or above the action level and annually thereafter.

5.2.6 Employee Training

5.2.6.1 Noise

Employees exposed to noise at or above the action level shall complete the PS-13 training course, "Hearing Conservation," initially and annually. The training shall include

- the effects of noise;
- the purpose, advantages, and disadvantages of various types of HPDs;
- the selection, fit, and care of HPDs; and
- the purpose and procedures of audiometric testing.

5.2.6.2 Heat Stress

Employees at risk for heat stress, including employees fitted in respirators, impermeable PPE, and employees working outdoors during the hot weather season, shall receive training in

- health effects of hot environments and symptoms of heat-related illness, including heat rash, heat cramps, heat exhaustion, and heat stroke;
- personal risk factors;
- effect of using PPE in heat stress conditions;
- preventive measures;
- adequate fluid intake; and
- actions to take in an emergency.

> **Guidance Note**: These requirements may be accomplished by the self-study course, "Thermal Stresses," offered by PS-13 or by a job-specific briefing on heat and cold stresses conducted by a qualified person.

5.2.6.3 Cold Stress

All employees routinely exposed to the hazards of cold stress [when the air temperature is below 40°F (4°C)] shall be trained in

- the effects of cold stress, including frostbite and hypothermia;

- personal risk factors;
- recognition of symptoms;
- methods employees can use to protect themselves, including engineering controls, work practices, and PPE; and
- first-aid procedures and recognizing medical emergencies.

Guidance Note: These requirements may be accomplished by the self-study course, "Thermal Stresses," offered by PS-13 or by a job-specific briefing on heat and cold stresses conducted by a qualified person.

6.0 References

6.1 Document Ownership

The OIC for this document shall be HSR-5.

6.2 Documents

6.2.1 References

ACGIH (American Conference of Governmental Industrial Hygienists), 1997. "Threshold Limit Values for Physical Agents in the Work Environment," Cincinnati, Ohio.

DiNardi, S. R., Ed., 1997. "The Occupational Environment—Its Evaluation and Control," American Industrial Hygiene Association Press, Fairfax, Virginia.

LANL (Los Alamos National Laboratory). "Safe Work Practices," Los Alamos National Laboratory document LIR 300-00-01, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory). "Documentation of Safe Work Practices," Los Alamos National Laboratory document LIR 300-00-02, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory). "Hazard Analysis and Control for Facility Work," Los Alamos National Laboratory document LIR 402-10-01, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory). "Facility Management Work Control," Los Alamos National Laboratory document LIR 230-03-01, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory). "Worker Health and Safety," Los Alamos National Laboratory document LPR 402-00-0, Los Alamos, New Mexico.

OSHA (Occupational Safety and Health Administration). "Occupational Noise Exposure," Code of Federal Regulations, Title 29, Part 1910.95, Washington, DC.

Plog, B. A., J. Niland, and P. J. Quinlan, 1996. "Fundamentals of Industrial Hygiene," 4th Edition. National Safety Council, Itasca, Illinois.

6.2.2 Required Records

Documentation of assessment of personnel exposures to noise by qualified persons shall be provided to HSR-5 as required by LIHSM Chapters HSR-5-LIHSM-04, "Noise Evaluations" and HSR-5-LIHSM-01, "Worker Protection Qualitative Exposure Assessment." (click here). The following records shall be maintained:

HSR-2	medical surveillance, including audiometric exam records.
HSR-5	monitoring data for noise and heat and cold extremes, equipment calibration data, workplace evaluation data, and reports to HSR-2 recommending employee enrollment in the Hearing Conservation Program.
PS-13	training records for courses related to noise and heat and cold extremes.
Line Organizations	job-specific thermal stresses training records.

7.0 Attachments

Attachment A Occupational Exposure Limits for Noise and Heat Stress

ATTACHMENT A

OCCUPATIONAL EXPOSURE LIMITS FOR NOISE AND HEAT STRESS

1.0 Occupational Exposure Limits for Noise Based on ACGIH 1997 TLVs

The Laboratory's Hearing Conservation Program is based on OSHA 29 CFR 1910.95, "Occupational Noise Exposure," and the 1997 TLVs for noise (OELs) established by ACGIH. The 29 CFR 1910.95 Hearing Conservation Program components adopted include noise monitoring, baseline and annual audiograms, HPDs, employee training, and record keeping. OSHA uses the term "action level" (50% of the OEL) to determine which employees shall enroll in a hearing conservation program, and LANL does the same for its program. The OEL for employee exposure to noise is an 8-h TWA of 85 dBA (slow response, A-weighted, threshold level of 80 dBA, and exchange rate of 3 dB). The 8-h TWA is the average of the sampled sound over an 8-h period. The action level is an 8-h TWA of 82 dBA. The maximum permissible employee exposure to impact/impulse noise is 140 dBC. OELs based on different noise levels and permitted exposure periods are available from HSR-5.

2.0 Occupational Exposure Limits for Heat Stress Based on ACGIH 1997 TLVs

TABLE 1

TLV WET-BULB GLOBE TEMPERATURE CORRECTION FACTORS IN °C FOR CLOTHING

Clothing Type	Clo Value[a]	Wet-Bulb Globe Temp
Summer work uniform	0.6	0
Cotton coveralls	1.0	-2
Winter work uniform	1.4	-4
Water barrier, permeable	1.2	-6

[a] Clo: Insulation value of clothing. One clo unit = 5.55 kcal/m^2/h of heat exchange by radiation and convection for each degree centigrade of temperature difference between the skin and adjusted dry-bulb temperature [the average of the ambient air dry-bulb temperature and the mean radiant temperature, $t_{adb} = (t_a+t_r)/2$].

Guidance Note:

In Figure 1, the Y axis, environmental heat is the wet-bulb globe temperature in degrees Fahrenheit and degrees Celsius. The wet-bulb globe temperature is the combination of the effect of the four main thermal components affecting heat stress: air temperature, humidity, air velocity, and radiation, and measured by the dry-bulb, natural-wet-bulb, and globe temperatures. The X axis, metabolic heat, is listed in kcal/hr, Btu/hr or watts. The metabolic heat is heat generated by the body's physical and chemical processes. The metabolic heat is calculated and categorized in to work load. For example, light work (up to 200 kcal/hr) may be sitting or standing to control machines; moderate work (200-350 kcal/hr) may be walking about with moderate lifting and pushing; and heavy work (350-500 kcal/hr) may be pick and shovel work. When PPE must be worn, the correction values to the wet-bulb globe temperature TLV values must be applied (Table 1).

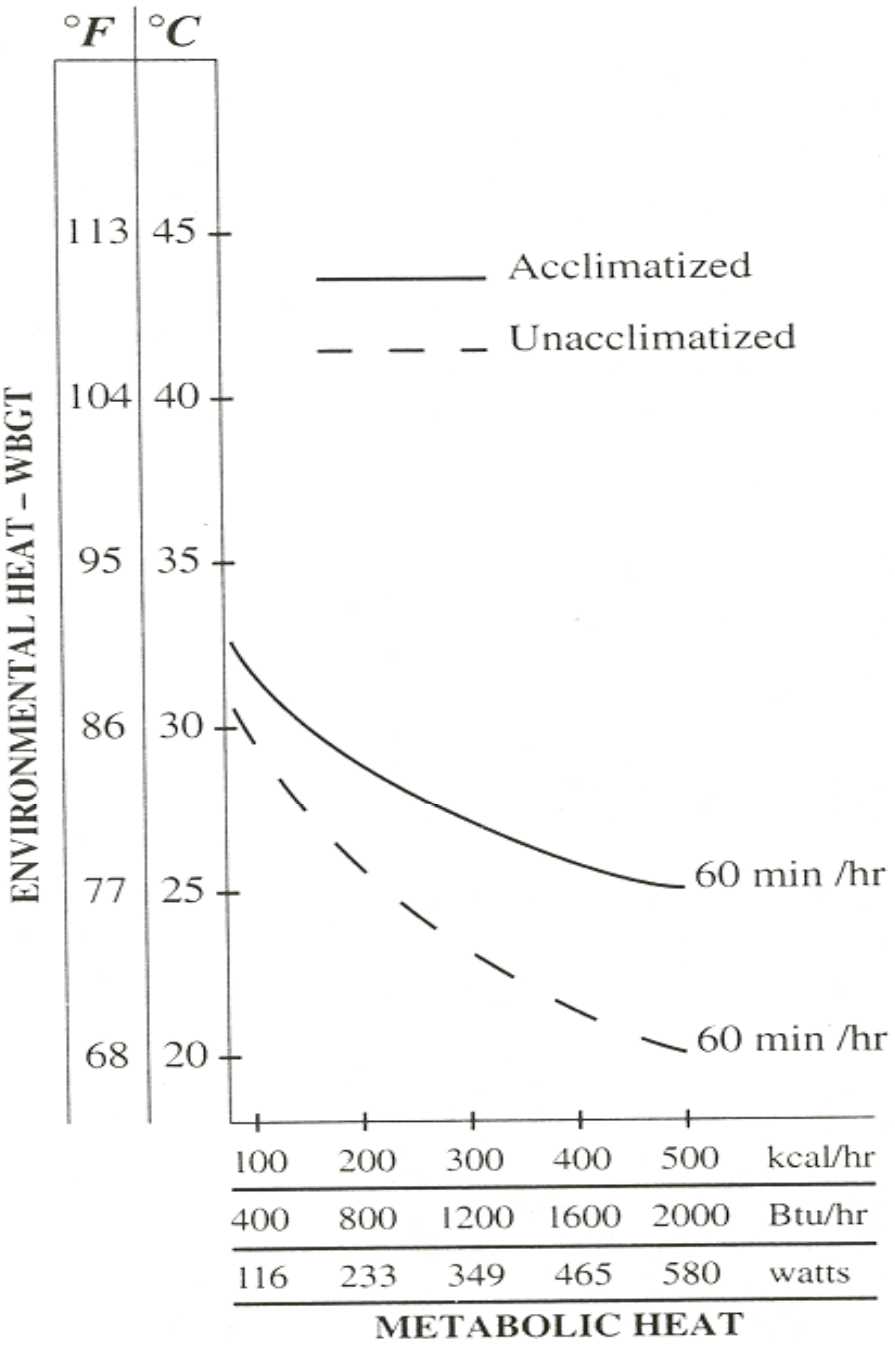

Figure 1. Permissible heat exposure TLVs for heat-acclimatized and unacclimatized workers.