

criteria for a recommended standard

OCCUPATIONAL EXPOSURE TO



CARBON MONOXIDE

**U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Health Services and Mental Health Administration
National Institute for Occupational Safety and Health**

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PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health of workers exposed to an ever increasing number of potential hazards at their workplace. To provide relevant data from which valid criteria and effective standards can be deduced, the National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices.

It is intended to present successive reports as research and epidemiologic studies are completed and sampling and analytical methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on carbon monoxide by members of my staff and the valuable constructive comments by the Review Consultants on Carbon Monoxide to NIOSH, the ad-hoc committee of the American Industrial Hygiene Association, and the ad-hoc committee of the American Medical Association. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on carbon monoxide. A list of the Review Consultants appears on pages iv and v. The contributions of others are also acknowledged:

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CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN
OCCUPATIONAL EXPOSURE STANDARD FOR CARBON MONOXIDE

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I. RECOMMENDATIONS FOR A CARBON MONOXIDE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to carbon monoxide (CO) at the workplace be controlled by requiring compliance with the standard set forth in the following eight sections.

Control of employee exposure to CO at his place of employment at the limits stated will (1) prevent acute CO poisoning, (2) protect the employee from deleterious myocardial alterations associated with levels of carboxy-hemoglobin (COHb) in excess of 5 percent and (3) provide the employee protection from adverse behavioral manifestations resulting from exposure to low levels of CO.

The recommended standard is measurable by techniques that are valid, reproducible and currently available to industry and governmental agencies and is attainable with existing technology. The recommended standard is designed to protect the safety and health of workers who are performing a normal 8-hour per day, 40-hour per week work assignment. It is not designed for the population-at-large and any extrapolation beyond the general worker population is unwarranted. Because of the well-defined relationship between smoking and the concomitant exposure to CO in inhaled smoke the recommended standard may not provide the same degree of protection to those workers who smoke as it will to nonsmokers. Likewise, under conditions of reduced ambient oxygen concentration, such as would be encountered by workers at very high altitudes (e.g., 5,000 - 8,000 feet above sea level), the permissible exposure stated in the recommended standard should be appropriately lowered to compensate for loss in the oxygen-carrying capacity of the blood. In

addition, workers with physical impairments that interfere with normal oxygen delivery to the tissues (e.g., emphysema, anemia, coronary heart disease) will not be provided the same degree of protection as the healthy worker population. The criteria and the standard recommended in this document will be reviewed and revised as necessary.

Section 1 - Work Environment

(a) Concentration

(1) Occupational exposure to carbon monoxide shall be controlled so that no worker shall be exposed at a concentration greater than 35 ppm determined as a time-weighted average (TWA) exposure for an 8-hour workday, as measured with a portable, direct reading, hopcalite-type carbon monoxide meter calibrated against known concentrations of CO, or with gas detector tube units certified under Title 42 of the Code of Federal Regulations, Part 84.

(2) No level of carbon monoxide to which workers are exposed shall exceed a ceiling concentration of 200 ppm.

(b) Calibration, Sampling and Analysis

Procedures for calibration of equipment, sampling and analysis of CO samples shall be followed as provided in Appendix I.

Section 2 - Medical Recommendations

Because employees with overt cardiovascular disease may not be protected by an occupational exposure to 35 ppm of CO, a medical program should be instituted consisting of preplacement and periodic examinations with special attention to the cardiovascular system and to medical conditions which could be exacerbated by exposure to CO. Such a medical program could also provide the opportunity for conducting antismoking programs for high-risk employees.

Section 3 - Labeling

- (a) Cylinders and other containers of CO shall carry a label stating:

CARBON MONOXIDE
(CO)

DANGER
COLORLESS ODORLESS GAS
May be fatal if inhaled
Do not breathe gas
High concentrations in air may be explosive

First Aid: Remove victim immediately to an uncontaminated atmosphere. Call a physician immediately. If breathing has stopped, give artificial respiration. Administer oxygen.

- (b) Areas where significant exposure to carbon monoxide is likely to occur shall be posted with a sign stating:

CARBON MONOXIDE
(CO)

DANGER
High concentrations may be fatal
Provide adequate ventilation
High concentrations in air may be explosive

Seek immediate medical attention
if you experience any of the below symptoms:
1 - Severe Headache
2 - Dizziness
3 - Nausea and vomiting

Gas masks are located:
(Specific location to be filled in by employer)

For purposes of this section the term "significant exposure to carbon monoxide" refers to eight-hour TWA exposures exceeding 25 ppm but excludes such exposure as may be self-administered through smoking.

Section 4 - Respiratory Protection

In the event of an emergency or when a variance has been allowed and the use of respiratory protective equipment authorized by the Secretary of Labor, the employer shall provide and insure that the employee wears, as appropriate, one of the following respiratory protective devices approved by NIOSH or the Bureau of Mines as provided in Part 11 of Title 30, Code of Federal Regulations:

(a) Type N Gas Mask (Emergency Situation):

For entry into or escape from an environment containing not over 20,000 ppm, which is not deficient in oxygen, for a total exposure period of not more than 30 minutes.

(b) Demand Type Self-Contained Breathing Apparatus (Variance Situation):

For work in atmospheres containing not over 5,000 ppm carbon monoxide.

(c) Pressure Demand Type Self-Contained Breathing Apparatus (Variance Situation):

For work in atmospheres containing up to 100 percent CO.

(d) Fire Fighting Applications:

A demand or pressure demand type self-contained breathing apparatus.

All respiratory protective equipment shall be selected so as to insure satisfactory face piece fit. Each user shall be instructed and tested in the proper use of respiratory protective devices and each such device shall be used and maintained in accordance with the provisions of the American National Standard Practices for Respiratory Protection ANSI Z-88.2, 1969.

Section 5 - Emergency Procedures

(a) Appropriate measures shall be implemented to assure that the release into the work environment of carbon monoxide in excess of the ceiling value of 200 ppm is prevented.

(b) Massive Release of Carbon Monoxide

Areas in which large amounts of CO are stored, used or emitted, or areas within the workplace through which large amounts of CO are transported, shall be provided with sufficient respiratory protective devices of the types specified in Section 4 and shall be readily accessible to persons who may be located in the area to assure a timely, orderly evacuation of the area by all persons in the event of accidental, massive release of CO. An automatic visual and audible alarm that is set to be activated when the CO concentration reaches 500 ppm should be employed in such areas. Employees working in such areas shall be informed of the hazards and symptoms of acute CO poisoning (see Section 6) and shall be trained to implement an emergency evacuation plan designed for such an occurrence. Periodic drills, held not less frequently than every six months, shall be conducted to assure that such plans are adequate and effective in case of an emergency situation.

(c) Fire Hazards

Adequate fire extinguishing agents shall be readily available in the areas outlined in paragraph (b) of this section since CO will burn when mixed with air and may be explosive when concentrations of between 12.5 percent to 74.2 percent are reached.

Section 6 - Appraisal of Employees of Hazards of Carbon Monoxide

(a) Each employee who receives significant exposure to carbon monoxide [see Section 3(b)] shall be apprised of all hazards, relevant symptoms, appropriate emergency procedures, and proper conditions and precautions for the safe use of CO or safe exposure to CO and shall be instructed as to the location of such information, which shall be kept on file as prescribed in paragraph (b) of this section and shall be readily accessible to all employees at each establishment where CO is involved in industrial processes and operations.

(b) Information as required in Appendix III shall be recorded on U.S. Department of Labor Form OSHA-20, "Material Safety Data Sheet," or on a similar form approved by the Occupational Safety and Health Administration, U.S. Department of Labor.

Section 7 - Work Practices

(a) Each container in which CO is stored shall be examined for leaks upon its arrival at the establishment or upon filling and shall be reexamined periodically at least every three months.

(b) Prior to transferring CO from a storage container, an inspection shall be conducted to detect any gas leaks in the transport system (e.g., cylinder seal with gas regulator, regulator apparatus, regulator seal with transport conduits, conduit system, etc.).

Section 8 - Monitoring and Recordkeeping Requirements

(a) Employers shall monitor environmental exposure of employees to CO as follows:

(1) Personal exposure ("breathing zone") samples* shall be collected in accordance with procedures specified in Appendix I in all workplaces where employees are significantly exposed to CO [see Section 3(b)]. Samples will be collected and evaluated as both TWA and ceiling concentration values.

(2) Frequency of monitoring should be at least annually. It is recognized that more frequent monitoring may be indicated in certain circumstances depending upon the nature of the process, the rate of production, the effectiveness of control measurements, the time of day and seasonal variation, however, more frequent monitoring requirements cannot be recommended until there are extensive studies of specific operations in industry.

(3) Blood analysis for COHb, as specified in Appendix II, shall be performed on all persons employed in work areas when, in the judgment of the OSHA Industrial Hygienist, biologic standards are needed to evaluate borderline exposure to CO (see Chapter V).

(4) Determination of the CO concentration for borderline exposure, as judged by the OSHA Industrial Hygienist, shall be accomplished by continuous monitoring of the workplace environment. Such continuous monitoring shall be accomplished by means of monitoring equipment capable of determining the CO concentration in the workplace environment within 5 percent of the actual value.

*Selected sampling of representative or higher risk workers

(5) Affected employees, or their representatives, shall be given a reasonable opportunity to observe any monitoring required by this section.

(b) Every employer shall maintain records of any personal or environmental monitoring required by this section. Records shall be maintained for a period of at least three years and shall be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health, the Director of the National Institute for Occupational Safety and Health, and to authorized representatives of either. Every employee and former employee shall have reasonable access to any record required to be maintained which indicates the employee's own exposure to CO.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were developed and prepared by the National Institute for Occupational Safety and Health (NIOSH) to meet the need for providing adequate protection for the safety and health of employees exposed to carbon monoxide. The necessary relevant data are made available in accordance with Section 20(a) of the Occupational Safety and Health Act of 1970 that requires the development of criteria by the Secretary of Health, Education, and Welfare on the basis of such research, demonstrations, and experiments and any other information available to him which will assure insofar as practicable that no employee will suffer diminished health, functional capacity, or life expectancy as a result of his work experience.

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultations with others, formalized a system for the development of criteria upon which standards can be established to protect the health of employees from exposure to hazardous chemical and physical agents. It should be emphasized that any criteria documentation for a recommended standard should enable management and labor to develop better engineering controls and more healthful work practices and should not be accepted as a final goal in itself.

In evaluating occupational hazards and setting priorities,¹ it was determined that the potential for exposure of employees at the workplace to CO was greater than that for any other chemical or physical agent. The significance of the CO dose-response relationship in man is attested furthermore by numerous research studies which have been documented in

the scientific literature. In a recent conference on the biological effects of CO sponsored by the New York Academy of Sciences, the findings and views of scientists from the United States, Australia, England, France, and Denmark were presented.²

Background information for this report was obtained from many sources, including those directly cited and listed in the references. In addition there is a bibliography³ of nearly 1,000 references and abstracts on CO prepared by the U.S. Public Health Service as well as the National Air Pollution Control Administration report⁴ of March 1970 on CO exposure in the community.

These criteria for a recommended standard for CO are part of a continuing series of criteria being developed by NIOSH. The criteria and recommended standard apply only to those processes and operations involving the manufacture, emission or use of CO as applicable under the Occupational Safety and Health Act of 1970 (PL 91-596). The occupational safety and health aspects of CO exposure for workers engaged in mining and milling operations are covered by standards promulgated by the Bureau of Mines pursuant to authority granted by the Federal Metal and Nonmetallic Mine Safety Act (30 U.S.C. 725 et seq.). Relevant data, however, bearing on the safety and health hazards resulting from exposure to CO in mining and milling operations were considered in this document.

The criteria contained in this document were developed to assure that the recommended standard based thereon would (1) protect employees against both acute and chronic CO exposure, (2) be measurable by techniques that are valid, reproducible and available to industry and governmental agencies and (3) be attainable with existing technology.

In 1969 the Committee on Effects of Atmospheric Contaminants on Human Health and Welfare, appointed by the Environmental Studies Board of the National Academy of Sciences, reported on the evaluation of current knowledge concerning the effects of CO on man.⁵ While this report deals primarily with the effects on man of exposure to CO from air pollution sources, it is pertinent to note the following statement in the Introduction: "...Today, the two main sources of carbon monoxide appear to be cigarette smoke and the internal combustion engine. And the subject of concern has changed from the acute effects of short-term exposure...to the lasting effects of long-term, low-level exposure, of a duration anywhere from a month to a lifetime, and in the range of CO concentrations that would produce 0.5-10% COHb." Thus, in the case of occupational exposures to CO, a worker's smoking habits must be taken into consideration when evaluating the environment. This factor has not been generally considered until the past few years. It should be emphasized that the above report raised many questions concerning the effects of low-level exposures to CO, and that Committee recommended many additional research studies in this area.

Although important evidence exists which indicates that subtle aberrations may occur in the central nervous system (CNS) during exposure to levels of CO lower than those of the recommended standard, the significance of these changes and their translation to effects upon employee safety and health is not entirely clear. The diversity of opinions and the conflicting experimental evidence existing in this area does not permit the clear-cut assessment of the scientific merit of such data or its extrapolation to the normal working population at this time. If reliable data become available which clearly demonstrate significant impairment of employee

behavior during exposure to very low levels of CO (producing less than 5 percent COHb), then the criteria for the recommended standard will be reassessed on the basis of the additional evidence.