

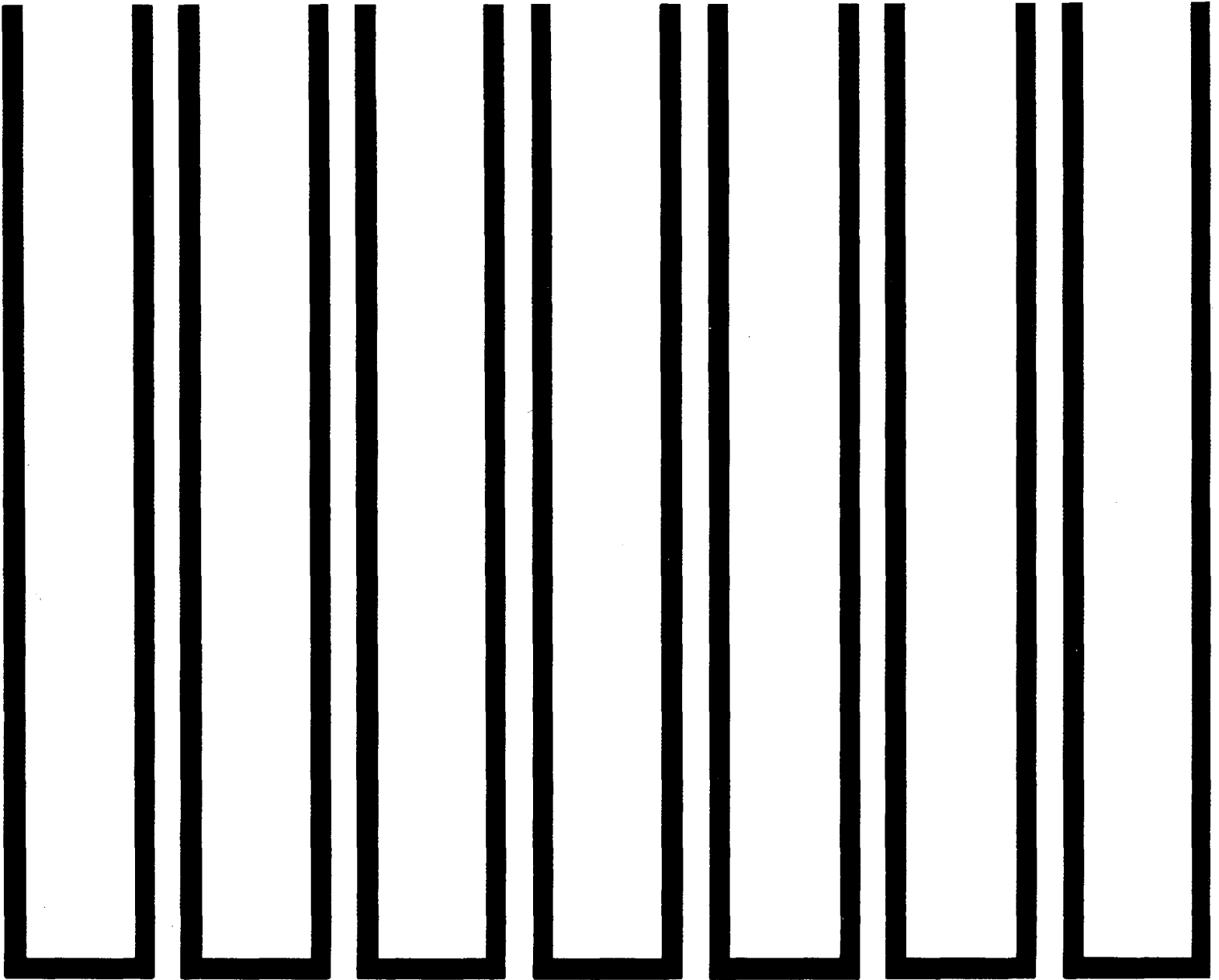
NIOSH

criteria for a recommended standard

occupational exposure to

TUNGSTEN and

CEMENTED TUNGSTEN CARBIDE



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service Center for Disease Control

National Institute for Occupational Safety and Health

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**OCCUPATIONAL EXPOSURE
TO
TUNGSTEN and
CEMENTED TUNGSTEN CARBIDE**



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
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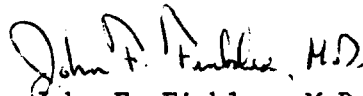
PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. The National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices, to provide relevant data from which valid criteria for effective standards can be derived. Recommended standards for occupational exposure, which are the result of this work, are based on the health effects of exposure. The Secretary of Labor will weigh these recommendations along with other considerations such as feasibility and means of implementation in developing regulatory standards.

It is intended to present successive reports as research and epidemiologic studies are completed and as 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 tungsten and cemented tungsten carbide by members of the NIOSH staff and the valuable constructive comments by the Review Consultants on tungsten and cemented tungsten carbide, by the ad hoc committees of the American Academy of Industrial Hygiene and the American Medical Association, and by

Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on tungsten and cemented tungsten carbide. A list of Review Consultants appears on page vi.



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The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health (NIOSH), had primary responsibility for development of the criteria and recommended standard for tungsten and cemented tungsten carbide. Sonia Berg of this Division served as criteria manager. Stanford Research Institute (SRI) developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31.

The Division review of this document was provided by Richard A. Rhoden, Ph.D. (Chairman), J. Henry Wills, Ph.D., and Howard L. McMartin, M.D., with Gregory Ness (Division of Surveillance, Hazard Evaluations, and Field Studies), and Charles C. Hassett, Ph.D. John J. McFeters and Mary E. Cassinelli (Division of Physical Sciences and Engineering) submitted written comments.

The views expressed and conclusions reached in this document, together with the recommendations for a standard, are those of NIOSH. These views and conclusions are not necessarily those of the consultants, other federal agencies or professional societies that reviewed the document, or of the contractor.

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CRITERIA DOCUMENT:
RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR TUNGSTEN AND CEMENTED TUNGSTEN CARBIDE

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I. RECOMMENDATIONS FOR A STANDARD FOR TUNGSTEN
AND CEMENTED TUNGSTEN CARBIDE

The National Institute for Occupational Safety and Health recommends that employee exposure to elemental tungsten and its compounds and to cemented tungsten carbide dusts in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and provide for the safety of employees for up to a 10-hour work shift, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should prevent adverse effects (except sensitization) of these materials on the health and provide for the safety of employees. The recommended environmental limits for the standard are measurable by techniques that are reproducible and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. Although NIOSH considers the workplace environmental limits to be safe levels based on current information, employers should regard them as the upper boundaries of exposure and make every effort to maintain exposures as low as is technically feasible. The criteria and standard will be subject to review and revision as necessary.

Approximately 70% of US tungsten production is eventually used in the manufacture of cemented tungsten carbide, where tungsten carbide is mixed with cobalt and/or other metals, including nickel, and their oxides or carbides to form a material valued for its hardness and wear resistance. The term "insoluble tungsten," used throughout this document, refers to elemental tungsten and all insoluble tungsten compounds (Table XII-1). The

term "soluble tungsten" refers to those compounds of tungsten which are soluble in water and therefore readily translocated from the lungs, skin, or gastrointestinal tract to internal organs of experimental animals (Table XII-1). For the purpose of compliance with the recommended standards, insoluble tungsten compounds include all those for which water solubility is listed as "insoluble" or less than 0.01 g/100 cc. Soluble tungsten compounds are those listed as "very soluble," "soluble," "slightly soluble," equal to or greater than 0.01/100 cc or "decomposes." Those compounds for which no solubility information is listed should be considered soluble unless it can be demonstrated that they are insoluble in water. As a rough guide for control of airborne concentrations of tungsten compounds, the standard for insoluble tungsten should apply whenever processes within a building or independent structure involve only those stages which produce insoluble tungsten compounds from other insoluble tungsten compounds, eg, starting with ammonium-p-tungstate through tungsten carbide (Figure XII-1). Whenever soluble tungsten compounds are starting, intermediate, or final products, the standard for soluble compounds should apply throughout that building, unless it can be demonstrated through differential sampling and analysis that both limits are being met as appropriate.

The term "cemented tungsten carbide" or "hard metal" refers to a mixture of tungsten carbide (WC), cobalt, and sometimes other metals and metal oxides or carbides. The tungsten carbide content of hard metal is generally 80% or more, and the cobalt content is generally less than 10%, but it may be as high as 25%. When the cobalt content exceeds 2%, its contribution to the potential health hazard is judged to exceed that of

tungsten carbide and all other components, and the recommended standard for such mixtures is based on the current US federal standard for occupational exposure to cobalt, 0.1 mg/cu m. If a future NIOSH recommendation for an occupational exposure limit for cobalt differs from the US federal standard for cobalt, this new recommendation should be considered to replace the current recommendation for an occupational exposure limit for dusts of cemented tungsten carbide containing more than 2% cobalt. If nickel is used as a binder rather than cobalt and the nickel content of the mixture exceeds 0.3%, then the NIOSH recommended occupational exposure limit for nickel of 15 μ g/cu m shall apply. The recommended limits for airborne tungsten are different for "insoluble tungsten," "soluble tungsten," and "cemented tungsten carbide" because of their differing potential biologic effects and inherent toxicities. These criteria and the recommended standards shall apply to places of employment involved in the manufacture, use, storage, or handling of any of the defined materials.

The "action level" is defined as one-half the appropriate recommended time-weighted average (TWA) environmental limit. "Occupational exposure to cemented tungsten carbide, elemental tungsten, or its compounds" is defined as exposure at a concentration greater than the appropriate action level; ie, except for the case of cemented tungsten carbide products in which nickel is the binder, when the NIOSH definition of occupational exposure to nickel shall apply [1]. Exposures to airborne tungsten concentrations equal to or less than one half of the workplace environmental limits, as determined in accordance with Section 8, will not require adherence to the following sections, except for Sections 3(a), 4(b), 4(c), 5, 7, and 8. If exposure to other chemicals occurs, the employer shall also comply with the

provisions of applicable standards for these other chemicals.

The recommended environmental limits are based on data which indicate that insoluble tungsten compounds and cemented tungsten carbide may cause transient or permanent lung damage and skin irritation, while soluble tungsten compounds have the potential to cause systemic effects involving the gastrointestinal tract and CNS. No carcinogenic, mutagenic, teratogenic, or reproductive effects in humans have been reported. Compliance with the appropriate recommended environmental limits should eliminate the hazards associated with tungsten compounds and cemented tungsten carbide, except for a few individuals who may become sensitized to cobalt or nickel and have adverse reactions upon exposure to extremely small amounts of cemented tungsten carbide.

Section 1 - Environmental (Workplace Air)

(a) Concentrations

(1) Occupational exposure to insoluble tungsten shall be controlled so that employees are not exposed to insoluble tungsten at a concentration greater than 5 milligrams, measured as tungsten, per cubic meter of air (mg/cu m), determined as a TWA concentration for up to a 10-hour work shift in a 40-hour workweek.

(2) Occupational exposure to soluble tungsten shall be controlled so that employees are not exposed to soluble tungsten at a concentration greater than 1 milligram, measured as tungsten, per cubic meter of air (mg/cu m), determined as a TWA concentration for up to a 10-hour work shift in a 40-hour workweek.

(3) Occupational exposure to dust of cemented tungsten carbide which contains more than 2% cobalt shall be controlled so that employees are not exposed at a concentration greater than 0.1 milligram, measured as cobalt, per cubic meter of air (mg/cu m), determined as a TWA concentration for up to a 10-hour work shift in a 40-hour workweek.

(4) Occupational exposure to dust of cemented tungsten carbide which contains more than 0.3% nickel shall be controlled so that employees are not exposed at a concentration greater than 15µg of nickel per cu m air determined as a TWA concentration, for up to a 10-hour workshift in a 40-hour workweek as specified in NIOSH's Criteria for a Recommended Standard for Occupational Exposure to Inorganic Nickel.

(b) Sampling and Analysis

Environmental samples shall be collected and analyzed for tungsten as described in Appendices I and II, or for cobalt or nickel, as appropriate. Any methods shown to be at least equivalent in accuracy, precision, and sensitivity to the methods specified may also be used.

Section 2- Medical

Medical surveillance and counselling regarding its importance shall be made available to employees subject to occupational exposure to soluble tungsten, insoluble tungsten, or cemented tungsten carbide.

(a) Preplacement or initial examinations shall include:

- (1) Medical and work histories.
- (2) Physical examinations.
- (3) Specific clinical tests including, but not limited to, a 14- x 17-inch postero-anterior chest roentgenogram and pulmonary function

tests including the forced vital capacity (FVC) and the forced expiratory volume in 1 second (FEV 1).

(4) A judgment of the employee's ability to use positive pressure respirators.

(b) Periodic examinations shall be made available at least annually. These examinations shall include, but not be limited to:

(1) Interim medical and work histories.

(2) A physical examination and special tests as outlined in paragraph (a)(3) of this section.

(c) During or after examinations, applicants or employees having medical conditions which would be directly or indirectly aggravated by exposure to tungsten compounds or cemented tungsten carbide shall be counseled on the increased risk of impairment of their health from working with these materials.

(d) Initial medical examinations shall be made available as soon as practicable after the promulgation of a standard based on these recommendations.

(e) Employers shall ensure that pertinent medical records are kept for all employees exposed to tungsten compounds or cemented tungsten carbide in the workplace for at least 30 years after termination of employment. These records shall be made available upon request to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

All labels and warning signs shall be printed both in English and in the predominant language of non-English-reading workers. Illiterate workers and workers reading languages other than those used on labels and posted signs shall receive verbal information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

(a) Labeling

Containers of soluble tungsten compounds or cemented tungsten carbide shall carry labels which bear the trademarks of the products, the chemical name(s) of the compound(s) contained therein, and information on the effects of the particular product(s) on human health. The trademarks and pertinent information shall be arranged as in the following example:

TRADEMARK
(CHEMICAL NAME)

MAY BE HARMFUL IF INHALED OR SWALLOWED

MAY CAUSE SKIN AND RESPIRATORY TRACT IRRITATION

Avoid unnecessary contact with eyes, skin, and clothing.
Report any suspected skin irritation to your supervisor.
Avoid prolonged or repeated breathing of dust/vapor.
Use only with adequate ventilation.
Wash hands thoroughly after handling, before eating or smoking.

(b) Posting

In areas where soluble tungsten compounds or cemented tungsten carbide are used, a sign containing information on the effects of the specific compounds on human health shall be posted in readily visible locations if employee exposures are above the action level. This information shall be arranged as in the following example.

TRADEMARK
(CHEMICAL NAME)

MAY BE HARMFUL IF INHALED OR SWALLOWED

MAY CAUSE SKIN AND RESPIRATORY TRACT IRRITATION

Avoid prolonged or repeated breathing of dust/vapor.
Avoid unnecessary contact with skin, eyes, and clothing.
Report any suspected skin irritation to your supervisor.
Ventilation should be sufficient to carry away dust or vapor.

Section 4 - Personal Protective Clothing and Equipment

(a) Respiratory Protection

(1) Engineering controls shall be used when needed to keep concentrations of airborne tungsten products at or below the appropriate TWA exposure limits. The only conditions under which compliance with the permissible exposure limits may be achieved by the use of respirators are:

(A) During the time necessary to install or test the required engineering controls.

(B) For operations such as nonroutine maintenance and repair activities causing brief exposure at concentrations above the TWA exposure limits.

(C) During emergencies when concentrations of airborne tungsten products may exceed the TWA exposure limits.

(2) When a respirator is permitted by paragraph (a)(1) of this section, it shall be selected and used in accordance with the following requirements:

(A) The employer shall establish and enforce a respiratory protective program meeting the requirements of 29 CFR 1910.134.

(B) The employer shall provide respirators in accordance with Tables I-1, I-2, and I-3 and shall ensure that employees use the respirators provided. The respiratory protective devices provided in conformance with Tables I-1, I-2, and I-3 shall be those approved by NIOSH or the Mining Enforcement Administration. The standard is specified in 30 CFR 11.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR INSOLUBLE TUNGSTEN COMPOUNDS*

Concentration Range (mg/cu m, as tungsten)	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 25**	(1) Single-use dust respirator (2) Dust respirator with quarter-mask facepiece
Less than or equal to 50**	(1) Half-mask dust respirator (2) Supplied-air respirator with half-mask facepiece
Greater than 50**	(1) Full facepiece dust respirator (2) Supplied-air respirator with full face- piece, hood, or helmet (3) Powered air-purifying respirator (posi- tive pressure) with high efficiency filter*** (4) For abrasive-blasting with tungsten car- bide, supplied-air respirator with hood or helmet operated in pressure-demand or other positive pressure mode or with continuous flow.

*In areas where ammonium-p-tungstate is used, a canister or cartridge which will remove ammonia is needed in addition to a particulate filter.

**When an employee informs the employer that eye irritation occurs while wearing a respirator, the employer shall provide an equivalent respirator with full facepiece, helmet, or hood and ensure that it is used.

***A high-efficiency filter is defined as one having a penetration of less than 0.03% when tested against a 0.3- μ m DOP aerosol.

TABLE I-2

RESPIRATOR SELECTION GUIDE FOR SOLUBLE TUNGSTEN COMPOUNDS*

Concentration Range (mg/cu m, as tungsten)	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 10**	(1) Half-mask dust and mist respirator (2) Supplied-air respirator with half-mask facepiece
Less than or equal to 50**	(1) Full facepiece dust and mist respirator (2) Supplied-air respirator with full facepiece (3) Self-contained breathing apparatus with full facepiece
Greater than 50**	(1) Powered air-purifying respirator (posi- tive pressure) with high-efficiency filter*** (2) Supplied-air respirator with full face- piece, hood, or helmet, continuous-flow or other positive-pressure type (3) Self-contained breathing apparatus with full facepiece in pressure demand or other positive pressure mode

*Tungsten hexachloride in contact with water decomposes to tungsten and chlorine. Therefore, the dust and mist respirator is not satisfactory if the chlorine gas concentration exceeds the permissible level. When this occurs, the minimum acceptable respirator is a full facepiece respirator with a combination dust, mist, and chlorine canister.

**When an employee informs the employer that eye irritation occurs while wearing a respirator, the employer shall provide an equivalent respirator with full facepiece, helmet, or hood and ensure that it is used.

***A high-efficiency filter is defined as one having a penetration of less than 0.03% when tested against a 0.3- μ m DOP aerosol.

TABLE I-3

RESPIRATOR SELECTION GUIDE FOR MIXTURES OF TUNGSTEN AND COBALT

Concentration Range (mg/cu m, as cobalt)	Respirator Type Approved under Provisions of 30 CFR 11
Less than or equal to 1.0*	(1) Any dust respirator, except single-use or quarter-mask respirator* (2) Supplied-air respirator operated with a quarter-mask or half-mask facepiece
Less than or equal to 5.0	(1) Air-purifying respirator with full face- piece and high-efficiency filter** (2) Supplied-air respirator with full facepiece (3) Self-contained breathing apparatus with full facepiece
Less than or equal to 100*	(1) Powered air-purifying respirator, posi- tive pressure, with high efficiency filter** (2) Type C supplied-air respirator contin- uous-flow type, with half-mask facepiece
Less than or equal to 200	(1) Type C supplied-air respirator, contin- uous-flow type, with full facepiece, hood, helmet, or suit (2) Type C supplied-air respirator operated in pressure demand mode with full facepiece
Greater than 200	(1) Self-contained breathing apparatus with full facepiece operated in pressure demand or other positive pressure mode (2) Combination Type C supplied-air respira- tor with full facepiece operated in pressure demand mode with an auxiliary self-contained air supply

*When an employee informs the employer that eye irritation occurs while wearing a respirator, the employer shall provide an equivalent respirator with full facepiece, helmet, or hood and ensure that it is used.

**A high-efficiency filter is defined as one having a penetration of less than 0.03% when tested against a 0.3- μ m DOP aerosol.

(C) Respirators specified for use in higher concentrations of tungsten compounds or cemented tungsten carbide may be used in atmospheres of lower concentrations.

(b) Eye Protection

Eye protection shall be provided in accordance with 29 CFR 1910.133 for operations, such as grinding, which produce and scatter particulates into the air.

(c) Skin Protection

While most workers do not experience skin irritation as a result of exposure to tungsten compounds or cemented tungsten carbide, there are some who develop sensitivity. Fingerless gloves may be used during grinding of hard metal to protect the hands from abrasion. Protective sleeves of dust-proof material may be worn to prevent impact of hard-metal dust on the skin of the arms. In the absence of such gloves and sleeves, creams protective against abrasion may be applied liberally to the hands and arms to minimize contact of the skin with hard-metal dust. When skin irritation occurs, these workers should be referred to a physician for appropriate protective and therapeutic measures. When abrasive dust of tungsten carbide is likely to contact major parts of an employee's body, the employee should wear closely woven coveralls provided by the employer. The coveralls should be laundered frequently to minimize mechanical irritation from dust in the cloth.

Section 5 - Informing Employees of Hazards from Tungsten

(a) Each employee with potential for exposure to tungsten compounds or cemented tungsten carbide shall be informed at the beginning

of employment or assignment to such work areas and periodically thereafter of the hazards, relevant symptoms, appropriate emergency procedures, and proper conditions and precautions for the safe handling and use of these materials. Special mention should be made of possible sensitization to cobalt or nickel. Employees engaged in maintenance and repair shall be included in these training programs.

(b) The employer shall institute a continuing education program, conducted by persons qualified by experience or training, to ensure that all employees have current knowledge of job hazards, proper maintenance and cleanup methods, and proper respirator usage. The instructional program shall include a description of the general nature of the medical surveillance procedures and of the advantages to the employee of participating in these programs. As a minimum, instruction shall include the information in Appendix III, which shall be kept on file, readily accessible to employees at all places of employment where exposure to tungsten compounds and/or cemented tungsten carbide may occur.

(c) Required information shall be recorded on the "Material Safety Data Sheet" shown in Appendix III or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Control of Airborne Tungsten Compounds and Cemented
Tungsten Carbide

Engineering controls, such as process enclosure and/or local exhaust ventilation, shall be used to keep concentrations of airborne tungsten products within the recommended environmental limits. Ventilation systems

shall be designed to prevent the accumulation or recirculation of these materials in the workplace environment and to effectively remove them from the breathing zones of employees. Wet process sharpening of cemented tungsten carbide material may not provide total control of dust, and local exhaust ventilation may also be required. Exhaust ventilation systems discharging to the outside air shall conform to applicable local, state, and federal air pollution regulations and shall not constitute a hazard to employees. Ventilation systems shall be subject to regular preventive maintenance and cleaning to ensure their continuing effectiveness. Continuous airflow indicators, such as water or oil manometers (marked to indicate acceptable airflow), are recommended and should be checked monthly. If such indicators are not used, the efficiency of the ventilation system shall be verified by airflow measurements taken at intervals determined by the documented maintenance history of the system.

(b) Control of Spills and Leaks

Only personnel properly trained in the procedures and adequately protected against the attendant hazards shall be assigned to shut off sources of tungsten, clean up spills, and repair leaks. Dry sweeping should be avoided.

(c) Handling and General Work Practices

(1) Care should be taken in pouring or scooping powdered materials to avoid excessive dust generation. If an employee experiences upper or lower respiratory tract irritation, special attention should be paid to work practices.

(2) Safety precautions are needed in the manufacture of filaments to protect against electrical hazards during high voltage

smelting and against explosion hazards and lacerations from very finely drawn wire.

Section 7 - Sanitation

For insoluble tungsten compounds, appropriate provisions of 29 CFR 1910.141 shall apply. In addition, the following precautions apply to all areas where a potential for exposure to soluble tungsten or cemented tungsten carbide exists:

(a) Eating and food preparation or dispensing (including vending machines) shall be prohibited in work areas containing soluble tungsten or cemented tungsten carbide.

(b) Employees who handle soluble tungsten, cemented tungsten carbide, or equipment contaminated with these materials shall be instructed to wash their hands thoroughly with soap or mild detergent and water before eating or smoking and shall be cautioned not to touch their faces or any other skin surfaces with contaminated fingers.

(c) Waste material contaminated with soluble tungsten or cemented tungsten carbide shall be disposed of in a manner which prevents harm to employees. The disposal method must conform with applicable local, state, and federal regulations and must not constitute a hazard to the surrounding population or environment.

Section 8 - Environmental Monitoring and Recordkeeping

As soon as practicable after the promulgation of a standard based on these recommendations, the employer shall conduct an industrial hygiene

survey at each location where tungsten compounds or cemented tungsten carbide are released into the workplace air to determine whether exposure to airborne concentrations of tungsten products is above the respective action levels. The employer shall keep records of these surveys, including the basis for concluding that air levels are at or below the appropriate action levels. Surveys shall be repeated at least once every 3 years and within 30 days of any process change likely to result in an increase of airborne concentrations of tungsten or its products.

If it has been determined that the environmental concentration of tungsten or its products may exceed the appropriate action level or TWA environmental limit, then the following requirements shall apply:

(a) Personal Monitoring

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of each employee occupationally exposed to any tungsten compound or cemented tungsten carbide. Source and area monitoring may be used to supplement personal monitoring.

(2) Samples representative of the exposure in the breathing zone of the employee shall be collected in all personal monitoring. Procedures for the calibration of equipment, sampling, and analysis of tungsten samples are provided in Section 1(b).

(3) For each TWA concentration determination, a sufficient number of samples shall be taken to characterize the employee's exposure during each work shift. Variations in the employee's work schedules, locations, and duties and changes in production schedules shall be considered in deciding when samples are to be collected. The number of TWA

determinations for an operation or process shall be based on the variations in location and job functions of employees relative to that operation or process.

(4) If an employee is found to be exposed above the appropriate action level, the exposure of that employee shall be monitored at least once every 3 months until the measured concentration is found to be below the action level in two successive analyses of samples taken at least 1 week apart.

(5) If an employee is found to be exposed above the appropriate TWA concentration limit, the exposure of that employee shall be measured at least once every 30 days, and control measures shall be initiated; the employee and others who work in the area while controls are being installed shall be notified of the exposure and of the control measures being implemented. Monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that the employee's exposure no longer exceeds the recommended environmental concentration limit; quarterly or triennial monitoring as applicable may then be resumed.

(b) Recordkeeping

Employers or their successors shall retain records of environmental monitoring for each employee for at least 30 years after the individual's employment has ended. These records shall include the name and social security number of the employee being monitored; job function and location within the worksite at the time of sampling; dates of measurements; sampling and analytical methods used and evidence for their accuracy; number, duration, and results of samples taken and TWA concentrations based

on these samples; and the type of personal protective equipment in use, if any. Records for each employee, indicating the dates of employment with the company and changes in job assignment, shall be kept for the same 30-year period. These records shall be made available to designated representatives of the Secretary of Health, Education, and Welfare and of the Secretary of Labor. Employees or former employees shall have access to information on their own exposures. The employees or their representatives shall be given the opportunity to observe any measurement conducted in accordance with this section and to receive a full explanation of the significance of the measurements.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon that were prepared to meet the need for preventing occupational disease or injury arising from exposure to tungsten, tungsten compounds, and cemented tungsten carbide. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health and to provide for the safety of employees exposed to hazardous chemical and physical agents. The criteria and the recommended standard should enable management and labor to develop better engineering controls and more healthful work practices. Compliance with the recommended standard should not be used as the final goal.

These criteria for a recommended standard for tungsten, tungsten compounds, and cemented tungsten carbide are part of a continuing series of documents published by NIOSH. The recommended standard applies to the processing, manufacturing, use, and handling of these materials in the occupational setting. The standard was not designed for the population-at-large, and any application to situations other than occupational exposures

is not warranted. It is intended to (1) protect against the development of systemic toxic effects and local effects on the eyes and skin, (2) be measurable by techniques that are reproducible and available to industry and government agencies, and (3) be attainable with existing technology.

The major concern in occupational exposure to tungsten, tungsten compounds, or cemented tungsten carbide is the potential for transient or permanent pulmonary damage. Irritation of the skin and upper and lower respiratory tract has also been associated with inhalation of, or skin contact with, these materials and should be considered in any work practices program.

There is little information now available on the toxic effects of tungsten on animals and man which is applicable to the setting of a standard for the industrial environment. Retrospective and prospective epidemiologic studies are needed to assess the potential occupational hazards from tungsten and its compounds. Also, the abilities of various tungsten compounds to irritate the skin and eyes need to be investigated. Additional short- and long-term inhalation studies on animals are necessary to assess the toxic effects of tungsten, particularly on the liver, kidneys, lungs, and central nervous system (CNS). Such studies should aim also to distinguish the effects of exposure to tungsten and its compounds from those produced by mixtures containing cobalt or nickel. Chronic studies are also needed to investigate the carcinogenic, mutagenic, and teratogenic potentials of tungsten.