

NIOSH

criteria for a recommended standard
occupational exposure to
**oxides of nitrogen (nitrogen
dioxide and nitric oxide)**

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

criteria for a recommended standard

**OCCUPATIONAL EXPOSURE
TO
OXIDES OF NITROGEN
(NITROGEN DIOXIDE AND NITRIC OXIDE)**



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Public Health Service

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National Institute for Occupational Safety and Health

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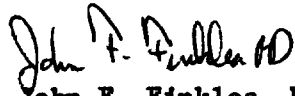
PREFACE

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 the oxides of nitrogen (nitrogen dioxide and nitric oxide) by members of my staff and the valuable constructive comments by the Review Consultants on the Oxides of Nitrogen, by the ad hoc committees of the Society of Toxicology and the American Medical Association, by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, and by William H. Revoir, Jr., on respiratory protection. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies

that reviewed this criteria document on oxides of nitrogen. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.

A handwritten signature in black ink that reads "John F. Finklea MD". The signature is written in a cursive style with a large initial "J".

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The Office of Research and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and the recommended standard for the oxides of nitrogen (nitrogen dioxide and nitric oxide). Tabershaw-Cooper Associates, Inc., developed the basic information for consideration by NIOSH staff and consultants under contract No. HSM 99-73-26. B. Thomas Scheib, served as criteria manager and Douglas L. Smith, Ph.D. had NIOSH program responsibility for development of the document.

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CRITERIA DOCUMENT: RECOMMENDATIONS FOR OCCUPATIONAL EXPOSURE
STANDARDS FOR THE OXIDES OF NITROGEN
(NITROGEN DIOXIDE AND NITRIC OXIDE)

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I. RECOMMENDATIONS FOR A STANDARD FOR THE OXIDES OF NITROGEN
(NITROGEN DIOXIDE AND NITRIC OXIDE)

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to the oxides of nitrogen (nitrogen dioxide and nitric oxide) in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and safety of workers for up to a 10-hour workday, 40-hour workweek over a working lifetime; compliance with the standard is measurable by techniques that are valid, reproducible, and available to industry and government agencies. Sufficient technology exists to permit compliance with the recommended standard. The criteria and standard will be subject to review and revision as necessary.

For the purpose of this standard, "oxides of nitrogen" refers to nitric oxide and nitrogen dioxide. Since nitrogen dioxide in the working environment results, at least in part, from oxidation of nitric oxide, occupational exposures are customarily to mixtures of these gases rather than to either gas alone. "Occupational exposure to the oxides of nitrogen" is defined as exposure to the oxides of nitrogen equal to or above one-half the recommended workroom limit. Adherence only to sections 3, 4(a)(1)(B), 4(a)(1)(C), 4(a)(2)(G), 4(a)(2)(L), 4(a)(2)(M), 4(b)(2), 5, 6(d), 6(e), 6(f), 7(a)(2), 7(a)(3), 7(b)(6), and 7(b)(7) is required when workplace environmental concentrations of oxides of nitrogen are not greater than one-half of the recommended workplace environmental limit. Procedures for identification of exposure areas can be accomplished by determinations using sampling and analytical methods described in

Appendices I and II, or III or by any method shown to be equivalent in accuracy, precision, and sensitivity to the methods specified.

Section 1 - Environmental (Workplace Air)

(a) Nitrogen Dioxide (NO₂)

Occupational exposure to nitrogen dioxide shall be controlled so that workers are not exposed to nitrogen dioxide at greater than a ceiling concentration of 1 ppm by volume (1.8 mg/cu m) as determined by a sampling time of 15 minutes.

(b) Nitric Oxide (NO)

Occupational exposure to nitric oxide shall be controlled so that workers are not exposed to nitric oxide at a concentration greater than 25 ppm of air (30 mg/cu m) determined as a time-weighted average (TWA) exposure for up to a 10-hour workday, 40-hour workweek.

(c) Sampling and Analysis

Procedures for collection and analysis of environmental samples shall be as provided for in Appendices I and II, or by any method shown to be equivalent in precision, accuracy, and sensitivity to the methods specified. Since nitrogen dioxide rarely exists independent of nitric oxide in the workplace air, a sufficient number of samples shall be taken to determine a ceiling concentration for nitrogen dioxide and a TWA for nitric oxide in order to characterize the worker's exposure to the oxides of nitrogen.

Section 2 - Medical

Medical surveillance with particular emphasis on the respiratory system shall be made available as specified below for all workers subject

to "exposure to the oxides of nitrogen."

(a) Preplacement and periodic medical examinations shall be made available to workers occupationally exposed to the oxides of nitrogen. These periodic examinations shall be administered annually or as otherwise indicated by the responsible physician, and shall include as a minimum:

(1) Comprehensive or interim medical and work histories.

(2) Pulmonary function tests including auscultation of the chest, measurement of Forced Vital Capacity (FVC), and Forced Expiratory Volume in the first second (FEV 1).

(3) A judgment of the worker's physical ability to use negative or positive pressure respirators as defined in 29 CFR 1910.134.

In addition to the above, a 14" x 17" posterior-anterior chest X-ray shall be included in the preplacement medical examination. Additional evaluations of pulmonary function, such as tests of pulmonary compliance and diffusion studies, may be found useful in the medical surveillance of workers exposed to nitrogen oxides.

(b) Initial examinations for presently employed workers shall be offered within 6 months of the promulgation of a standard incorporating these recommendations and annually thereafter.

(c) Medical records shall be maintained for persons employed in work involving exposure to the oxides of nitrogen and shall include information on all required medical examinations. X-rays and all pertinent medical records with supporting documents shall be maintained at least 20 years after the individual's employment is terminated. These records shall be available to the medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employee or

former employee, and of the employer.

Section 3 - Labeling (Posting)

Areas where the oxides of nitrogen may be reasonably expected to be present, even occasionally, shall be posted with a clearly legible sign reading:

NITROGEN OXIDES

WARNING

Excessive exposure to these gases is hazardous to health.
Adequate ventilation must be provided.

This sign shall be printed in English and in the predominant language of non-English-speaking workers. All employees shall be informed of the hazardous areas with special instruction given to illiterate workers.

Section 4 - Personal Protective Equipment

Requirements for personal protective equipment shall be as approved under provisions of 29 CFR 1910.134.

(a) Respiratory Protection

(1) Engineering controls shall be used wherever feasible to maintain the concentrations of oxides of nitrogen at or below the prescribed environmental limits listed in paragraphs (a) and (b) of Section 1. While engineering controls are being installed and tested, appropriate respirators shall be provided by employers and used by employees pursuant to the following requirements:

(A) Respirators shall be used for routine operations which result in continuous or frequent exposure to oxides of nitrogen in air at concentrations exceeding prescribed limits only while engineering

controls are being installed and tested.

(B) Respirators shall be used for nonroutine operations of maintenance and repair which result in brief exposure to oxides of nitrogen at concentrations in air exceeding prescribed limits.

(C) Respirators shall be used during emergencies when the concentrations of oxides of nitrogen in air may exceed prescribed limits.

(2) When a respirator is permitted by paragraph (a) (1) of this Section, it shall be selected and used pursuant to the following requirements:

(A) For the purpose of selecting the respirator to be used by employees, the employer shall measure the concentrations of nitrogen dioxide and nitric oxide in the workplace air initially and thereafter whenever control, process, operation, worksite, or climate changes occur which may likely affect the concentrations of oxides of nitrogen. This does not apply during emergencies and during firefighting.

(B) The employer shall ensure that no employee is exposed at concentrations of oxides of nitrogen in excess of prescribed limits because of improper respirator selection, fit, use, or maintenance.

(C) A respiratory protection program meeting the requirements of 29 CFR 1910.134 and 30 CFR 11 shall be established and carried out by the employer.

(D) The employer shall provide employees with respirators in accordance with Table I-1 and shall ensure that employees use the respirators provided in a proper manner.

(E) Respirators described in Table I-1 shall be

those approved under the provisions of 30 CFR 11 as amended.

(F) Respirators specified in Table I-1 for use in atmospheres of higher concentrations of oxides of nitrogen may be permitted for use in atmospheres which contain lower concentrations.

(G) Wherever bulk nitrogen dioxide or nitric oxide is stored or is introduced into an operation or process from a source under pressure, the employer shall store emergency and escape-type respirators so that they are readily accessible to each employee.

(H) The employer shall assign an employee to a job which requires the wearing of a respirator for protection against oxides of nitrogen only with a medical evaluation of the employee's physical ability to safely perform his or her duties while wearing a respirator.

(I) The employer shall instruct the employee in how to don the respirator and how to check its fit and operation.

(J) The employer shall provide the employee with instructions in the proper wearing of the respirator.

(K) The employer shall instruct the employee to use the respirator provided in accordance with instructions and training received, to test the fit of the respirator before entering an atmosphere contaminated with oxides of nitrogen, to guard against damage to the respirator, and to report any malfunction of the respirator to his or her supervisor.

(L) The employer shall instruct the employee in how to recognize and handle emergency situations.

(M) The employer shall establish and carry out a program of cleaning, sanitizing, inspecting, maintaining, repairing, and

storing of respirators to ensure that employees are provided with respirators that are in good operating condition, and shall instruct employees in day-to-day maintenance of respirators.

(N) The employer shall periodically monitor the use of respirators to ensure that the proper type of respirator is being worn in a satisfactory manner.

(O) The employer shall periodically evaluate the effectiveness of the respiratory protection program and eliminate any deficiencies.

TABLE I-1
RESPIRATORS FOR PROTECTION AGAINST INHALATION OF
NITROGEN DIOXIDE AND NITRIC OXIDE*

Maximum Use Concentration	Required Respirator
Less than or equal to 50 ppm of NO ₂ or 1250 ppm TWA of NO	(1) Full facepiece chemical cartridge respirator and NO ₂ cartridges
	(2) A gas mask with a front- or back-mounted NO ₂ canister
	(3) Any supplied-air respirator with a full facepiece, helmet, or hood
	(4) Any self-contained breathing apparatus with a full facepiece
Less than or equal to 100 ppm of NO ₂ or 1250 ppm TWA of NO	(1) Type C supplied-air respirator operated in demand mode (negative pressure) with full facepiece
	(2) Self-contained breathing apparatus operated in demand mode (negative pressure) with full facepiece

TABLE I-1 (CONTINUED)

RESPIRATORS FOR PROTECTION AGAINST INHALATION OF
NITROGEN DIOXIDE AND NITRIC OXIDE*

Maximum Use Concentration	Required Respirator
Less than or equal to 200 ppm of NO ₂ or 1250 ppm TWA of NO	<p>(1) Type C supplied-air respirator operated in continuous-flow mode (positive pressure) with full facepiece, helmet, or hood</p> <p>(2) Type C supplied-air respirator operated in pressure-demand mode (positive pressure) with full facepiece</p>
Unknown or greater than 200 ppm of NO ₂ or 1250 ppm TWA of NO	<p>(1) Combination Type C supplied-air respirator operated in continuous-flow mode (positive pressure) or pressure-demand mode (positive pressure) and auxiliary self-contained breathing air supply operated in pressure-demand mode (positive pressure) with full facepiece</p> <p>(2) Self-contained breathing apparatus operated in pressure-demand mode (positive pressure) with full facepiece</p>
Emergency, Entry (No concentration limit)	<p>(1) Combination Type C supplied air respirator operated in continuous-flow mode (positive pressure) or pressure-demand mode (positive pressure) and auxiliary self-contained breathing air supply operated in pressure-demand mode (positive pressure) with full facepiece</p> <p>(2) Self-contained breathing apparatus operated in pressure-demand mode (positive pressure) with full facepiece</p>

TABLE I-1 (CONTINUED)

RESPIRATORS FOR PROTECTION AGAINST INHALATION OF
NITROGEN DIOXIDE AND NITRIC OXIDE*

Maximum Use Concentration	Required Respirator
Emergency, Escape (No concentration limit)	(1) Self-contained breathing apparatus operated in pressure-demand mode (positive pressure) with full facepiece
Firefighting	(1) Self-contained breathing apparatus operated in pressure-demand mode (positive pressure) with full facepiece

*Respirators equipped with a quarter-mask or half-mask facepiece are not recommended because eye irritation may become significant at low concentrations of nitrogen dioxide in air.

(b) Eye and Face Protection

(1) Eye and face protection shall be achieved by adherence to the requirements of 29 CFR 1910.133.

(2) Chemical safety goggles -- cup-type or rubber-framed goggles, equipped with approved impact-resistant glass or plastic lenses, shall be worn whenever there is danger of eye contact, such as working with pipelines, valves, etc, which might leak and spurt liquid nitrogen dioxide or nitric oxide.

(3) Spectacle-type safety goggles -- metal- or plastic-rim safety spectacles with unperforated side shields, or suitable all-plastic safety goggles may be used where continuous eye protection is desirable.

(4) Face shield -- plastic shields with forehead protection should be worn in addition to goggles.

Section 5 - Informing Employees of Hazards from Oxides of Nitrogen

(a) Workers initially assigned or reassigned to jobs in which the concentrations of the oxides of nitrogen exceed the levels defined for occupational exposure or who will work in areas required to be posted in accordance with Section 3 shall be informed of hazards, relevant symptoms including information on the onset and stages of illness, appropriate emergency procedures, and proper conditions and precautions for safe use, and shall be instructed as to the availability of such information which shall be kept on file, including that prescribed in (c) below. This information shall be accessible to the worker at each place of employment where the oxides of nitrogen are involved in unit processes and operations or evolved as byproducts or contaminants from operations or processes.

(b) A continuing educational program shall be instituted to ensure that all workers have current knowledge of job hazards, proper maintenance procedures, first aid procedures, and cleanup methods, and that they know how to correctly use respiratory protective equipment and eye protective equipment.

(c) Information as required shall be recorded on a "Material Safety Data Sheet" as specified in Appendix IV or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Engineering Controls

(1) The employer shall use engineering controls wherever feasible to prevent or minimize exposure of employees to oxides of nitrogen in the workplace.

(2) A closed process for handling the oxides of nitrogen is the preferred engineering control and shall be used wherever possible to prevent contamination of the work area.

(3) An enclosed process with exhaust ventilation is the next preferred means of engineering control of oxides of nitrogen and shall be used wherever possible if a closed process is not feasible. These systems shall be designed and constructed to prevent the escape of oxides of nitrogen into workplaces. Also, appropriate measures are to be taken to ensure that the discharge of oxides of nitrogen to the outdoor atmosphere is in accordance with applicable federal, state, and local environmental pollution control laws and regulations.

(4) General (dilution) ventilation of the worksite is the least desirable means of engineering control of oxides of nitrogen. It shall be used wherever enclosed processes with exhaust ventilation are not feasible. General (dilution) ventilation systems shall be designed and constructed to ensure that exhaust air containing oxides of nitrogen is not recirculated into the work area.

(b) Enclosed Spaces

(1) Persons who must enter enclosed spaces not known to be safe, such as tanks, reaction vessels, and small rooms which contain oxides of nitrogen or wherein oxides of nitrogen may be liberated, shall wear either a combination type C supplied-air respirator operated in the continuous-flow mode (positive pressure) or pressure-demand mode (positive pressure) and auxiliary self-contained breathing air supply operated in the pressure-demand mode (positive pressure) equipped with a full facepiece, or a self-contained breathing apparatus operated in the pressure-demand mode

(positive pressure) equipped with a full facepiece. At least one standby person, equipped with proper rescue equipment including a self-contained breathing apparatus which operates in the pressure-demand mode (positive pressure) and having a full facepiece, shall be present outside the enclosed space for emergency rescue of persons inside the confined space. Communications (visual, voice, signal line, telephone, radio, or other suitable means) shall be maintained by the standby person with those inside the enclosed space. Persons inside the enclosed space shall be equipped with safety harnesses and safety lines to facilitate their removal.

(c) Agricultural Silos

(1) The silo ventilation blower shall be operated for at least 30 minutes prior to entrance into the silo and continuously while persons are inside the silo.

(2) Persons who must enter a silo in which the concentrations of nitrogen oxides and oxygen are not known to be safe shall be equipped with respirators and safety harnesses as prescribed in paragraph (b) (1) of this Section. At least one standby person as described in paragraph (b) (1) of this Section shall be present outside the silo for emergency rescue of persons inside the silo. Communications as described in paragraph (b) (1) of this Section shall be maintained between persons inside the silo and the standby person.

(d) Emergencies

(1) Written procedures shall be prepared for emergencies, such as a massive release of oxides of nitrogen to the work area, fire, or explosion.

(2) The employer shall ensure that employees are familiar with procedures covering emergencies.

(3) Self-contained breathing apparatus operated in the pressure-demand mode (positive pressure) and equipped with a full facepiece shall be stored so that they are immediately available to persons who need them to escape from an area where an emergency may occur.

(4) Persons who must enter an area where an emergency has occurred to carry out cleanup operations, maintenance, or repair, shall be equipped with respirators and safety harnesses as prescribed in paragraph (b) (1) of this Section. Also, at least one standby person as described in paragraph (b) (1) of this Section shall be present in a safe place near the area where the emergency has occurred for possible rescue of persons inside the hazardous area. Communications as described in paragraph (b) (1) of this Section shall be maintained between persons inside the hazardous area and the standby person.

(5) Only a self-contained breathing apparatus operated in the pressure-demand mode (positive pressure) and equipped with a full facepiece shall be used by a person engaged in firefighting.

(6) Eyewash fountains and drench-type safety showers shall be readily available in areas where liquid forms of the oxides of nitrogen are being handled. This equipment shall be inspected and tested at least every 30 days to insure proper operation.

(e) Preventive Maintenance

(1) The employer shall carry out a preventive maintenance program which shall include regular and periodic inspection of equipment for leakage of oxides of nitrogen into work areas and immediate repair of leaking equipment.

(2) The employer shall ensure that containers of oxides of nitrogen are stored properly to minimize the escape of oxides of nitrogen into work areas.

(3) The employer shall ensure that worksites contaminated by liquid oxides of nitrogen are cleaned up promptly.

(f) Sanitation

General plant housekeeping should be of high standards with emphasis on cleanup, inspection, repair of equipment and leaks, and proper storage of materials. Escape routes and oxides of nitrogen control equipment shall be kept clear. Sanitation practices shall meet the requirements of 29 CFR 1910.141.

Section 7 - Monitoring and Reporting Requirements

(a) No Occupational Exposure to Oxides of Nitrogen

(1) Workers employed in areas where oxides of nitrogen are manufactured, stored, transported, handled, or produced as byproducts of work operations shall not be considered as occupationally exposed to oxides of nitrogen if it has been determined, on the basis of an industrial hygiene survey carried out by the employer or the judgment of a compliance officer, that workers are not exposed to oxides of nitrogen greater than half of the 1-ppm ceiling limit of nitrogen dioxide or half of the 25-ppm TWA limit of nitric oxide.

(2) The employer shall keep records of any industrial hygiene survey including justification of the conclusion that occupational exposure to oxides of nitrogen are not greater than or equal to half of the 1-ppm ceiling limit of nitrogen dioxide or half of the 25-ppm TWA limit of

nitric oxide. The records shall be retained for at least 20 years after termination of an individual worker's employment.

(3) An industrial hygiene survey of the work area shall be made when equipment changes, process modifications, or worksite changes may reasonably be expected to increase the concentrations of the oxides of nitrogen above the levels defining occupational exposure.

(b) Occupational Exposure to Oxides of Nitrogen

(1) If, from the results of an industrial hygiene survey or the judgment of a compliance officer, there is "occupational exposure" to oxides of nitrogen, the employer shall monitor the environmental concentrations of the oxides of nitrogen by the procedures described in Appendix I at least semianually, except as indicated by a professional industrial hygienist, with procedures described in Appendix I.

(2) The first environmental monitoring of the worksite shall be completed within 6 months of the promulgation of a standard incorporating these recommendations.

(3) Environmental monitoring of the workplace shall be carried out by the employer within 30 days after installation of a new process or within 30 days after equipment changes, process modifications, or worksite changes.

(4) If the measurements of the environmental concentrations of oxides of nitrogen in a work area indicate that the levels of either nitrogen dioxide or nitric oxide exceed the prescribed limits listed in paragraphs (a) and (b) of Section 1, the employer shall install appropriate engineering controls and shall monitor the environmental concentrations of oxides of nitrogen in the work area at intervals of 15

days until the results of at least 2 consecutive monitorings have demonstrated that the environmental concentrations of oxides of nitrogen are below the prescribed limits.

(5) The minimum number of representative ceiling determinations for nitrogen dioxide and TWA exposure determinations for nitric oxide for an operation or process shall be based on variations in exposures and production schedules, considering the number of workers exposed as suggested in Table I-2, and as indicated by a professional industrial hygienist.

(6) The employer shall keep records of all environmental monitoring of oxides of nitrogen. The records shall include not only the determined concentrations of oxides of nitrogen but also shall include a description of monitoring and analytical methods. In addition, the records shall include a listing of the type of respirator and other personal protective equipment, if any, worn by employees. The monitoring records shall identify the employees for whom breathing zone air samples were collected, and the employer shall make such records available to representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, and to the employee or former employee.

(7) The employer shall keep the records of all environmental monitoring of the levels of oxides of nitrogen for each employee for whom breathing zone air samples were collected for at least 20 years after the employee's employment is terminated.

TABLE I-2
SAMPLING SCHEDULE

Number of Employees Exposed to Oxides of Nitrogen	Minimum Number of Air Samples to be Collected and Analyzed
1 - 20	50% of the total number of workers
21 - 100	10 plus 25% of the excess over 30 workers
over 100	30 plus 5% of the excess over 100 workers

II. INTRODUCTION

This report presents the criteria and the recommended standards based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to oxides of nitrogen (nitrogen dioxide and nitric oxide). 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 of workers from exposure to hazardous chemical and physical agents. It should be pointed out that any criteria and recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work practices and should not be used as a final goal.

These criteria for standards for oxides of nitrogen are in a continuing series of criteria developed by NIOSH. The proposed standards apply only to the processing, manufacture, and use of the oxides of nitrogen, or to their release as intermediates, byproducts, or impurities therefrom as applicable under the Occupational Safety and Health Act of 1970.

Oxides of nitrogen are important and fairly common hazards of the workplace and are also among the most important and frequently encountered contaminants in the general atmosphere. Produced by processes involving high temperatures, they are important constituents of vehicular exhaust gases, electric power generating plant emissions, agricultural silos, and other operations involving combustion. Recognition of the potential sources of nitrogen oxides is important and is a prerequisite to the design of measures for control of occupational exposures.

The development of the recommended standard for occupational exposure to oxides of nitrogen has revealed deficiencies in data in the following areas:

(1) Carefully controlled cross-sectional epidemiologic studies concerned with chronic pulmonary changes and hematologic changes as well as studies on the incidence of chronic obstructive pulmonary diseases in workers exposed to low concentrations of oxides of nitrogen.

(2) Chronic effects in experimental animals exposed to oxides of nitrogen according to schedules and concentrations of exposure which simulate the occupational environment.

(3) The role of oxides of nitrogen in the production of teratogenic, mutagenic, and carcinogenic changes in animals.

(4) The possible production of neoplasms from exposure to oxides of nitrogen in combination with hydrocarbons, fibrous dusts, and organic solvents at concentrations observed in the occupational environment.