

criteria for a recommended standard

OCCUPATIONAL EXPOSURE TO

TOLUENE DIISOCYANATE

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

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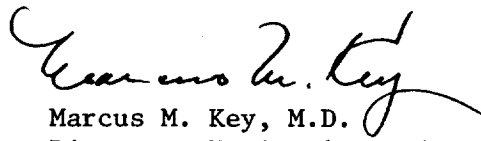
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PREFACE

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. 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 toluene diisocyanate by members of my staff and the valuable constructive comments by the Review Consultants on Toluene Diisocyanate, by the ad hoc committee of the American Industrial Hygiene Association, by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, and by Edwin C. Hyatt on respiratory protection. The NIOSH recommendations for standards are not necessarily a consensus of all of the consultants and professional societies that reviewed this criteria document on toluene diisocyanate. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.



Marcus M. Key, M.D.
Director, National Institute
for Occupational Safety and Health

The Office of Research and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and recommended standard for toluene diisocyanate. Tabershaw-Cooper Associates, Inc. developed the basic information for consideration by NIOSH staff and consultants under contract No. HSM-99-72-128. Keith H. Jacobson, Ph.D., served as criteria manager and had NIOSH program responsibility.

NIOSH REVIEW COMMITTEE ON
TOLUENE DIISOCYANATE

Thomas L. Anania
Division of Technical Services

William M. Johnson, M.D.
Deputy Director,
Division of Field Studies and Clinical Investigations

Denis J. McGrath, M.D.
Special Assistant for Medical Criteria
Office of Research and Standards Development

Patricia M. Quinn
Division of Laboratories and Criteria Development

Lester D. Scheel, Ph.D.
Division of Laboratories and Criteria Development

Robert H. Schutz
Division of Laboratories
and Criteria Development

Ex Officio:

Charles H. Powell, Sc.D.
Assistant Institute Director for Research and
Standards Development

NIOSH REVIEW CONSULTANTS ON
TOLUENE DIISOCYANATE

Hervey B. Elkins, Ph.D.
Division of Occupational Hygiene
Massachusetts Department of Labor and Industries
Boston, Massachusetts 02116

Adrian L. Linch
Chambers Works
E. I. duPont de Nemours and Company
Wilmington, Delaware 19898

John M. Peters, M.D.
Associate Professor of Occupational Medicine
School of Public Health
Harvard University
Boston, Massachusetts 02115

William A. Rye, M.D.
Director of Industrial Health
The Upjohn Company
Kalamazoo, Michigan 49001

Hans Weill, M.D.
Professor of Medicine
School of Medicine
Tulane University
New Orleans, Louisiana 70112

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN
OCCUPATIONAL EXPOSURE STANDARD FOR TOLUENE DIISOCYANATE

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I. RECOMMENDATIONS FOR A TOLUENE DIISOCYANATE STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to toluene diisocyanate (also called tolylene diisocyanate or TDI) in the workplace be controlled by requiring compliance with the following sections. The standard is designed to protect the health and safety of workers for an 8-hour day, 40-hour week over a working lifetime. Compliance with the standard should therefore prevent adverse effects of TDI on the health and safety of workers except in those workers already sensitized to TDI; they should not be exposed to any amount at all. The standard is measurable by techniques that are valid, reproducible, and available to industry and governmental agencies. Sufficient technology exists to permit compliance with the standard. The standard will be subject to review and will be revised as necessary.

"Exposure to toluene diisocyanate" includes work in any area where toluene diisocyanate is stored, transported, or used.

Section 1 - Environmental (Workplace air)

(a) Concentration

Occupational exposure to toluene diisocyanate (TDI) shall be controlled so that no worker shall be exposed to a time-weighted average (TWA) of more than 0.005 ppm (0.036 mg/cu m) for any 8-hour workday or for any 20-minute period to more than 0.02 ppm (0.14 mg/cu m).

(b) Sampling and Analysis

Procedures for sampling, calibration of equipment, and analysis of TDI samples shall be as provided in Appendices I and II, or by methods shown to be equivalent or better in sensitivity, precision, and accuracy.

Section 2 - Medical

(a) Medical Examinations

(1) Preplacement: A comprehensive physical examination for all workers shall be made available to include as a minimum: medical history, a 14" by 17" chest roentgenogram, total white blood cell count with differential, baseline forced vital capacity (FVC) and forced expiratory volume at one second (FEV 1.0). An absolute eosinophil count on capillary blood is recommended as an additional useful baseline measurement. The history should pay particular attention to the presence and degree of any respiratory symptoms, ie breathlessness, cough, sputum production, wheezing, and tightness in the chest. Smoking history should also be elicited.

If a positive personal history of respiratory allergy, previous sensitization to TDI, or chronic obstructive pulmonary disease is elicited, the applicant shall be counseled on his increased risk from occupational exposure to TDI. Chronic bronchitis, emphysema, disabling pneumoconiosis, or cardiopulmonary disease with significantly impaired ventilatory capacity similarly suggest an increased risk from exposure to TDI. If a history of allergy other than respiratory or of other chronic respiratory disease is elicited,

the applicant should be counseled by the physician that he may be at increased risk of adverse health effects from industrial exposure to isocyanates. At the time of this examination, the advisability of the worker's using negative or positive pressure respirators shall be evaluated.

(2) Periodic: The above examinations (with interim history), with the exception of the chest roentgenogram, shall be provided annually, or as otherwise indicated by professional medical judgment, so long as occupational exposure to TDI continues. Repeat white cell counts with differential and absolute eosinophil counts on peripheral blood may also be useful. An estimation of FVC and FEV 1.0 at the beginning and the end of a work shift within the first six months of employment with TDI is recommended as a useful means of surveillance for TDI reaction. Diagnosis of sensitization to isocyanates, for example from the occurrence of acute asthma, nocturnal dyspnea, nocturnal cough, or eosinophilia, at any time including annual periodic evaluations should exclude the worker from further exposure to isocyanates.

Because of seasonal variations in pulmonary function, it is desirable, for comparison of changes in respiratory function, that the periodic examination of an individual worker be performed about the same time each year.

(3) The periodic medical program required in (2) above should be considered a minimal program. In addition, changes in processes or the occurrence of spills or other emergencies that may

cause changes in normal exposure levels, such as brief, high, excursions, should be reported to the responsible physician, who may require additional medical examinations or other medical procedures.

A decrement in FEV 1.0 as measured before commencement of the work-shift and again after completion of the work-shift is a valuable indication of specific reaction to TDI at the operational exposure level. A rise in eosinophil count may also provide evidence of a sensitization phenomenon.

(b) Medical Records

Medical representatives of the Secretaries of Health, Education and Welfare and of Labor, and of the employer, and those physicians designated and authorized by the employee shall have access to medical records, which shall include records of all required examinations. These records shall be kept for 20 years, or, if the employee dies sooner, one year after his death.

Section 3 - Labeling (Posting)

Containers of toluene diisocyanate shall carry a label stating:

TOLUENE DIISOCYANATE

DANGER! HARMFUL IF INHALED

CAUSES BURNS

MAY CAUSE SKIN OR

RESPIRATORY REACTION

Do not breathe vapor.

Do not get in eyes, on skin, on clothing.

Keep container closed.

Use with adequate ventilation.

Wash thoroughly after handling.

First Aid: In case of contact immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician immediately.

If TDI is inhaled, remove the victim to fresh air. If not breathing give artificial respiration; if breathing is difficult, give oxygen. Call a physician immediately.

Work areas where exposure to toluene diisocyanate is likely to occur shall be posted with signs stating:

TOLUENE DIISOCYANATE

(TDI)

DANGER

UNAUTHORIZED PERSONS KEEP OUT

HARMFUL IF INHALED

CAUSES BURNS

MAY CAUSE SKIN

OR RESPIRATORY REACTION

Also, the sign shall give information on the location of respirators.

Section 4 - Personal Protective Equipment and Work Clothing

Subsection (a) shall apply whenever a variance from the standards recommended in Section 1 is granted under the provisions of the Occupational Safety and Health Act or in the interim period during the application for a variance. Until the limits of exposure to TDI

in paragraph (a) of Section 1 are met by limiting the concentration of TDI in the work environment, an employer must utilize, as provided in subsection (a) of this Section, a program of respiratory protection to effect the required protection of every worker exposed.

(a) Respiratory protection

Engineering controls shall be used wherever feasible to maintain TDI vapor or particulate concentrations below the prescribed limits. Appropriate respirators shall be provided and used when a variance has been granted to allow respirators as a means of control of exposure to routine operations and while the application is pending. Administrative controls can also be used to reduce exposure to TDI. Respirators shall be provided and used for nonroutine operations (occasional brief exposures above the limits and for emergencies); however, for these instances a variance is not required but the requirements set forth below continue to apply. In addition, appropriate respirators and protective work clothing shall be provided to and used by employees involved in spray operations, as specified below. Appropriate respirators as described in Table I-1 shall only be used pursuant to the following requirements:

(1) To determine the class of respirator to be used, the employer shall measure the atmospheric concentration of TDI in the workplace when the initial application for variance is made and thereafter whenever process, worksite, climate or control changes occur which are likely to increase the TDI concentration; this requirement shall not apply when only positive pressure respirators

will be used. The employer shall ensure that no worker is being exposed to TDI in excess of the standard either because of improper respirator selection or improper respirator fit.

(2) A respiratory protective program meeting the general requirements outlined in Section 3.5 of the American National Standard for Respiratory Protection, ANSI Z88.2-1969, shall be established and enforced by the employer.

(3) Respiratory protective devices described in Table I-1 shall be either those approved under the following listed regulations or those approved under 30 CFR 11, published March 25, 1972:

Gas mask--30 CFR 13 (Bureau of Mines Schedule 14F)

Type C continuous-flow, supplied air respirator--
30 CFR 12 (Bureau of Mines Schedule 19B)

Self-contained breathing apparatus--30 CFR 11
(Bureau of Mines Schedule 13E)

(4) Workers engaged in spraying material containing TDI and others within 10 feet of the spray unit shall wear Type C continuous-flow, supplied air, positive-pressure, impervious hoods. These shall also be worn in field and construction work where TDI is being used in pour, froth, or insulation operations. Use of such respiratory protective equipment does not eliminate the need for adequate ventilation for vapor control, but is additional protection from mist. Gas masks may be used at distances greater than 10 feet from the spray operations if it is shown that the concentration of TDI

Table I-1

Respirator Selection Guide for Protection Against TDI

Multiple of <u>TWA Limit</u>	<u>Respirator Type</u>
Less than 100 X	Gas mask, industrial size combination canister for organic vapors and with high efficiency filter.
Less than 100 X	Type C demand type (negative pressure) supplied air respirator with full face-piece.
Less than 1000 X	For routine (nonemergency) use: Type C continuous-flow (positive pressure) supplied air respirator with full face-piece
Greater than 1000 X (and at lower concentrations)	For emergency use: Self-contained breathing apparatus, in pressure demand mode (positive pressure).

does not exceed 100 times the time-weighted average for continuous work, or 100 times the ceiling for work of short duration, eg 20 minutes or less.

(5) The employer shall provide respirators in accordance with Table I-1 and shall assure that the employee uses them when required. Employees shall be instructed on the use and cleaning of respirators assigned to them, and how to test for leakage.

(b) Protective Work Clothing

(1) Where there is likelihood of skin contact with liquid TDI the employer shall provide employees with impervious clothing. These garments shall be cleaned inside and out each time they are used. Rubber shoes or rubbers over leather shoes shall be worn where there is possibility of foot contact with liquid TDI. Rubbers shall be decontaminated and ventilated after contamination. Leather shoes which have been contaminated with TDI shall be decontaminated or disposed of.

Workers within 10 feet of spray operations, or at greater distances when there is a greater drift of spray, shall be protected with impervious clothing, gloves, and footwear in addition to a supplied air impervious hood.

(2) Chemical workers' goggles shall be worn where splashes are likely to occur.

Section 5 - Appraisal of Employees of Hazards from Toluene Diisocyanate

Each employee exposed to TDI shall be apprised of the hazards, relevant symptoms, and proper conditions and precautions concerning use or exposure. In addition to the better known symptoms, nocturnal dyspnea or nocturnal cough should be mentioned as less obvious symptoms of TDI reaction. The information shall be kept on file and readily accessible to the worker at all places of employment where TDI is manufactured or used. Information as specified 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 6 - Work Practices and Control Procedures

(a) Containers of toluene diisocyanate shall be examined for leaks upon arrival. The containers shall be properly closed at all times when not in actual use. Workers shall wear chemical safety goggles while handling liquid toluene diisocyanate, and protective clothing where contact is likely.

(b) All spills shall be cleaned up promptly in accordance with the procedures described in Part VI. A supply of materials to facilitate clean-up operations shall be kept on hand in all areas where toluene diisocyanate is regularly used.

(c) Waste materials containing toluene diisocyanate can be removed to an isolated area in the open air or with exhaust ventilation and soaked with 10% ammonia-in-water mixture for 24 hours

before discarding. (Caution: Do not tightly close containers used for decontamination, because of a possible increase in gas pressure.)

(d) All employees working in areas where toluene diisocyanate is regularly used shall be instructed in procedures to be used in the event of spills, and shall be instructed in the types of protective equipment to be used during both normal and emergency conditions.

(e) Individuals not having legitimate reasons to be in the TDI work area shall not be allowed access.

(f) Local exhaust ventilation shall be employed wherever possible in indoor operations where toluene diisocyanate is used. Such ventilation shall be designed to prevent the vapor from reaching the breathing zone of workers and shall be maintained in proper working order.

(g) Procedures including fire-fighting procedures shall be established and implemented to meet foreseeable emergency events. Fire fighters shall be cautioned that toxic products, such as hydrogen cyanide, phosgene, and carbon monoxide can be formed from the pyrolysis of polyurethane products, and be prepared to avoid exposure to such products, as well as to TDI. Respirators shall be available for wearing during evacuation if long distances need to be traversed; supplied air respirators shall be available for use where equipment or operations cannot be abandoned.

Section 7 - Sanitation Practices

(a) Washing Facilities

Emergency showers and eye fountains shall be provided in areas

where there is a potential exposure to toluene diisocyanate. They shall be inspected frequently to make sure that they are in proper working condition.

(b) Food Facilities

Food preparation and eating should be prohibited in toluene diisocyanate areas. Smoking in such areas should also be prohibited.

(c) Clothing

Workers should change into work clothing at the start of work, and remove it at the end of the workday.

Clothing on which toluene diisocyanate has been spilled shall be placed in a tightly sealed container until removal for laundering. The employer shall provide for laundering such clothing. If commercial laundering facilities are used, the employer shall inform the launderer of the precautions required in handling such clothing.

Section 8 - Monitoring and Recordkeeping Requirements

(a) Employers shall monitor environmental exposures to TDI based upon the following sampling schedule:

(1) Monthly requirements: Except as otherwise indicated by a professional industrial hygiene survey, breathing zone samples shall be collected at least monthly to permit construction of a time-weighted average exposure for every operation in which there is a potential for exposure to airborne TDI, so that each employee or employee location is sampled at least once every 6 months.

(2) Weekly requirements: If monthly sampling shows the time-weighted average (0.005 ppm) or ceiling (0.02 ppm) values to

be exceeded at any employee station, immediate steps shall be taken to reduce the exposure. Weekly sampling of that station shall be instituted and continued until all samples for two consecutive weeks meet the standard.

Monitoring shall also be performed weekly whenever there is a change in process or in materials used that could result in increased exposure of workers. Such weekly sampling shall be performed until all samples for two consecutive weeks meet the standard.

(b) Records shall be maintained for all sampling schedules and shall include the type of personal protective devices in use, if any, and the sampling and analytical methods in use. Records shall be classified or readily classifiable by employee, so that each employee has reasonable access to records of his own environmental exposure.

These records (and records of all required medical examinations) shall be maintained for 20 years, or, if the employee dies sooner, one year after his death.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to toluene diisocyanate (TDI). 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 recommended criteria for a 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 and recommended standard for TDI are in a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of TDI products as applicable under the Occupational Safety and Health Act of 1970.

TDI is an irritating material, both in its liquid and airborne forms. It can produce skin and respiratory tract irritation, and can cause sensitization, so that sensitized workers are subject to asthmatic attacks on reexposure to extremely low concentrations of TDI in air.

Environmental limits are recommended to prevent acute and chronic irritation and sensitization of workers but not to prevent a response in already sensitized workers, because available knowledge does not indicate any safe concentration for such persons.

There are conflicts in available epidemiological data. In addition, methods for sampling and analysis of airborne TDI are inadequately sensitive. Thus, further research in these areas is needed in order to demonstrate means by which these recommended standards can be refined.