



OSHA INSTRUCTION

U.S. DEPARTMENT OF LABOR

Occupational Safety and Health Administration

DIRECTIVE NUMBER: CPL 03-00-017

EFFECTIVE DATE: June 20, 2013

SUBJECT: National Emphasis Program – Occupational Exposure to Isocyanates

****NOTE:** This Instruction has been extended until September 30, 2016.

****NOTE:** As a result of the July 9, 2015, issuance of CPL 02-02-079, Inspection Procedures for the Hazard Communication Standard (HCS 2012), minor changes {in brackets} were made to this directive on January 1, 2016. These changes do not impact this directive's enforcement policy.

ABSTRACT

Purpose: This instruction describes policies and procedures for implementing a National Emphasis Program to identify and reduce or eliminate the incidence of adverse health effects associated with occupational exposure to isocyanates.

Scope: This instruction applies OSHA-wide.

References: OSHA Instruction CPL 02-00-150, [Field Operations Manual](#) (FOM), April 22, 2011;

OSHA Notice 13-01 (CPL 02), [Site-Specific Targeting 2012 \(SST-12\)](#), January 4, 2013.

Cancellations: This instruction supersedes all Regional and Local Emphasis Programs specifically dealing with isocyanates.

State Impact: Notice of intent and adoption required. See Section VII. [[State Adoption Summary](#)]

Action Offices: OSHA National, Regional and Area Offices, State Plan and State Consultation Offices.

Originating Office: Office of Health Enforcement.

those in this instruction. If a State adopts or maintains an emphasis program on isocyanates which differs from the Federal program, the State must identify those differences and either post its policy on the State Plan's website and provide a link to OSHA or provide an electronic copy to OSHA with information on how the public may obtain a copy. If the State's emphasis program is identical to the Federal program, it must provide the date of adoption to OSHA. State adoption must be accomplished within 6 months of the effective date of this instruction, with posting or submission of documentation within 60 days thereafter. OSHA will provide summary information on the State responses to this instruction on its web site.

VIII. Consultation Programs.

When appropriate, consultation programs are encouraged to develop their own strategic approaches for reducing the health effects associated with occupational exposure to isocyanates covered by this NEP.

IX. Significant Changes.

This instruction supersedes all Regional and Local Emphasis Programs specifically addressing occupational exposure to isocyanates.

X. Application.

This instruction applies to all workplaces (General Industry, Construction, and Maritime) under the jurisdiction of Federal OSHA.

XI. Background.

Exposures to isocyanates can have adverse health effects for workers. Organic isocyanates are chemicals which contain one or more isocyanate groups (-NCO) attached to an organic group. The general term "isocyanates" refers to all chemicals with two or more isocyanate groups such as diisocyanates or polyisocyanates. Respiratory disease among workers exposed to isocyanates has been recognized since the 1950s. Exposure limits have been established in the U.S. and other countries for both ceiling and TWA exposures. Isocyanates include compounds classified as potential human carcinogens and known to cause cancer in animals.

"The most widely used compounds are diisocyanates, which contain two isocyanate groups, and polyisocyanates, which are usually derived from diisocyanates and may contain several isocyanate groups. The most commonly used diisocyanates include methylenebis(phenyl isocyanate) (MDI), toluene diisocyanate (TDI), and hexamethylene diisocyanate (HDI). Other diisocyanates include naphthalene diisocyanate (NDI), methylene bis-cyclohexylisocyanate (HMDI) (hydrogenated MDI), and isophorone

diisocyanate (IPDI). Examples of widely used polyisocyanates include HDI biuret and HDI isocyanurate.”¹

Isocyanates are powerful irritants to the mucous membranes of the eyes, nose and throat, and gastrointestinal and respiratory tracts. Irritation may be severe enough to produce bronchitis with bronchospasm. Hypersensitivity pneumonitis (inflammation in the lungs caused by exposure to an allergen) has been reported in isocyanate-exposed workers. Symptoms can continue for months or years after exposure has ceased. Deaths have occurred due to both asthma and hypersensitivity pneumonitis from isocyanate exposure.²

Some isocyanates are also allergic sensitizers. Cross-sensitization, in which a worker is exposed to one isocyanate but reacts adversely to others as well, can occur. Studies indicate that dermal exposure is a significant cause of respiratory sensitization. Thus, workers with skin contact to isocyanates may develop sensitivity, resulting in asthma attacks with subsequent exposures. Sensitization can occur at very low levels of exposure. Dermal sensitization may also result in rash, itching, hives and swelling of the extremities. Because isocyanates are not relatively water soluble, they cannot be easily washed off skin or clothing.

Isocyanates are widely used in the manufacture of flexible and rigid foams, fibers, coatings such as paints and varnishes, and elastomers, and are increasingly used in the automobile industry, auto body repair, and building insulation materials. In addition, spray-on polyurethane products containing isocyanates have been developed for a wide range of retail, commercial, and industrial uses to protect cement, wood, fiberglass, steel, and aluminum, including protective coatings for truck beds, trailers, boats, foundations, and decks.

The National Institute for Occupational Safety and Health (NIOSH) states that “Preventing exposure to isocyanates is a critical step in eliminating the health hazard. Engineering controls such as closed systems and ventilation should be the principal method for minimizing isocyanate exposure in the workplace. Other controls, such as worker isolation and personal protective clothing and equipment may also be necessary. Early recognition of sensitization and prompt and strict elimination of exposures is essential to reduce the risk of long-term or permanent respiratory problems for workers who have become sensitized.”³

The goal of this instruction is to reduce employee exposure to isocyanates shown to potentially cause work-related asthma, sensitization (respiratory, skin) and other occupational health effects. This goal will be accomplished by a combined effort of inspection targeting, outreach to employers, and compliance assistance. By performing activities (enforcement and outreach) related to this hazard, OSHA aims to raise awareness of the occurrence and severity of occupational health hazards related to or associated with isocyanates in all industry sectors.

¹ [NIOSH Safety and Health Topic: Isocyanates](#)

² <http://www.cdc.gov/niosh/docs/96-111/>

³ <http://www.cdc.gov/niosh/topics/isocyanates/>

Occupational illness information may also be obtained during worker interviews. The non-mandatory health surveillance form ([Appendix C](#)) may be used when interviewing workers.

The Office of Occupational Medicine may be contacted if there are questions regarding documentation of cases of occupational illness, including evaluation of the health surveillance forms, review of medical records, interviews with healthcare providers, and analysis of the scientific literature. Area Offices should coordinate through their Regional Office to request assistance of the Office of Occupational Medicine. Additional information on occupational medicine resources are found in [Appendix H](#).

C. Exposure Assessments.

Inspections conducted under this instruction shall include an evaluation of the employer's controls (engineering controls, administrative and work practice controls, and personal protective equipment (PPE)) where potential exposures to isocyanates are present. The CSHO may contact the OSHA Health Response Team (coordinated through their Regional Office) for assistance when evaluating engineering and other controls.

NOTE: *The CSHO shall wear the appropriate personal protective equipment during all inspections, including when taking screening, area and/or personal isocyanate samples (air, skin), and must follow all safety and health precautions as found in the [OSHA Field Safety and Health Manual, ADM 04-00-001](#).*

1. Air Sampling. Personal air samples shall be collected during inspections conducted under this NEP. The CSHO shall be prepared to take samples on the opening day of the inspection. If the process that uses isocyanates is not in operation the day of the inspection, the CSHO shall return at a later date to perform sampling. Where the employer has recent and accurate sampling exposure data (e.g., taken by a State 21(d) consultative service, third party consultant, insurance company), the CSHO shall consult with the Area Director to determine if further sampling is required. When operations using isocyanates are infrequent or unplanned, the CSHO shall consult with the Area Director to determine if sampling is necessary.

Appendix B provides information to the CSHO on sampling protocol, how to order sampling media, and sample shipping instructions. CSHOs should contact the Salt Lake Technical Center (SLTC) laboratory for any questions regarding sampling for isocyanates. All area offices and state plan offices shall follow the air sampling protocol as described in Appendix B. Air samples collected during this NEP will be extracted in the field by CSHOs as described in Appendix B.

Note: See [Appendix B](#) for a listing of OSHA sampling and analytical methods. Individual methods can also be found using the “[Analytical Methods](#)” link (<http://www.osha.gov/dts/sltc/methods/index.html>) on the OSHA public web site.

2. Wipe Sampling. Occupational exposure to isocyanates is a recognized cause of immune sensitization and asthma. Scientific research indicates that dermal exposure to isocyanates is at least as likely as inhalation exposure to induce isocyanate-related asthma. Experiments with laboratory animals have shown that dermal exposure alone to some isocyanates can be sufficient to induce respiratory sensitization. However, OSHA does not currently have any standards setting limits for surface contamination with, or dermal exposure to, isocyanates. Accordingly, if wipe sampling reveals surface contamination or dermal exposure, citations may be issued under the applicable housekeeping standards and/or PPE standards. For housekeeping violations cite 29 CFR 1910.141 (General Industry), 1926.25 (Construction), 1915.81 (Shipyard), or 1918.91 (Longshoring). For PPE violations cite 29 CFR 1910 Subpart I (General Industry), 1926 Subpart E (Construction), 1915 Subpart I (Shipyard), or 1918 Subpart J, (Longshoring).
 - a. Surface sampling. CSHOs should check for surface contamination (e.g., visible foam/coating) on surfaces, tools and equipment near the operation using isocyanates as well as in places where contamination may not be expected such as drinking fountains, telephones, locker rooms, and lunchrooms, to identify potential sources of dermal exposure and evaluate housekeeping and PPE deficiencies. Direct-reading colorimetric wipes can be used to sample surfaces for potential contamination.
 - b. Dermal Sampling. When the CHSO observes contaminated surfaces and equipment, dermal sampling should be conducted. Direct-reading colorimetric wipes can be used to sample dermal exposures.
 - c. PPE Sampling. Gloves are one of the most basic forms of PPE but their resistance to penetration by isocyanates may not be known. Direct-reading colorimetric media can be used to detect permeation of isocyanates through gloves. Other PPE should also be wipe sampled for contamination such as the inside of respirators. See Section C.2 for information on PPE evaluation.
 - d. Methodology. There are two types of direct-reading colorimetric wipe kits available for performing surface, dermal or PPE wipe sampling. One is for aliphatic isocyanates (e.g., Hexamethylene diisocyanate or HDI) and the other is for aromatic isocyanates (e.g., Methylene bisphenyl isocyanate or MDI). The CSHO shall document the results

of any surface, dermal or PPE wipe sampling in the case file. In addition, when a wipe sample is collected the CSHO should add the code "TWIPE" on the OIS form under the Additional Information section. The OSHA Health Response Team can be consulted if the CSHO chooses to conduct surface, dermal, or PPE wipe sampling. Both types of surface, dermal or permeation test kits are available from the Cincinnati Technical Center's (CTC's) agency expendable supplies program.

For general information on wipe sampling, refer to the OSHA Technical Manual, Section II, Chapter 2, subsection V, available at http://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_2.html.

Note: CSHOs should contact the SLTC laboratory for information regarding how to order wipe sampling media, and the wipe sampling and sample shipping procedures.

D. Citation Guidelines.

Where inhalation exposure to an isocyanate exceeds the OSHA PEL set forth at 29 CFR [1910.1000\(a\)](#), [Table Z-1](#), without regard to the use of respiratory protection, citations shall generally be issued as serious, following the citation policy in the FOM. Where an overexposure exists and feasible engineering and/or administrative controls were not utilized or were ineffective, an additional serious citation shall generally be issued under 29 CFR [1910.1000\(e\)](#) and grouped with the overexposure citation.

Where workers are exposed to a particular isocyanate having an established OEL, but no OSHA PEL, a citation for exposure in excess of the OEL may be considered under the General Duty Clause, Section 5(a)(1). See FOM, Chapter 4, Section XIII.B.1. (see [Appendix F](#) for sample General Duty Clause violation language). Any General Duty Clause citation(s) for exposure to an isocyanate under this NEP must be reviewed by the Regional Administrator, in consultation with the Regional Solicitor. If the elements of a 5(a)(1) violation are not met or a decision is made not to issue a citation, a Hazard Alert Letter (HAL) shall then be considered recommending specific actions that would reduce worker exposures to isocyanates. A [sample hazard alert letter](#) is included in Appendix D. When a HAL is issued the code "IHAL" shall be coded on the OIS form under the Additional Information section.

If a worker is exposed to concentrations of a particular isocyanate below the PEL, but in excess of an established occupational exposure limit, citations will not normally be issued (see FOM, Chapter 4, Section XIII.B.1.e). To illustrate:

Appendix A

Industries Where Isocyanate Exposures are Known or Likely to Occur

- Automotive – paints, glues, insulation, sealants and fiber bonding, truck bed lining
- Casting – foundry cores
- Building and construction – sealants, glues, insulation material, fillers
- Electricity and electronics – cable insulation, PUR coated circuit boards
- Mechanical engineering – insulation material
- Paints – lacquers
- Plastics – soft and hard plastics, plastic foam and cellular plastic
- Printing – inks and lacquers
- Timber and furniture – adhesives, lacquers, upholstery stuffing and fabric
- Textile – synthetic textile fibers
- Medical care – PUR casts
- Mining – sealants and insulating materials
- Food industry – packaging materials and lacquers

The tables below provide a construction list as well as primary and secondary lists for general industry and maritime by SIC and NAICS codes. The construction list identifies sectors where construction workers are most likely to have exposures to isocyanates. The primary list includes general industry and maritime industries where exposures to isocyanates are known to occur, exposures have been demonstrated to be above the PEL, and workers have exhibited illnesses associated with exposure to isocyanates. The secondary list for general industry/maritime includes settings where exposures to isocyanates are known to occur, however not all establishments in these listed industries have necessarily documented worker overexposures to isocyanates.

Note: The following are not exhaustive lists. An area office may include an industry sector/code not listed if it falls within their area office's jurisdiction.

Construction

SIC	SIC TITLE	NAICS 2007	NAICS TITLE
1721	Painting and Paper Hanging	238230	Painting and Wall Covering Contractors
1742	Plastering, Drywall, Acoustical, and Insulation Work	238310	Drywall and Insulation Contractors
1752	Floor Laying and Other Floor Work, NEC	238330	Flooring Contractors
1793	Glass and Glazing Work	238150	Glass and Glazing Contractors
1799	Special Trade Contractors, NEC	238150	Glass and Glazing Contractors

General Industry/Maritime (Primary)

SIC	SIC Title	NAICS 2007	NAICS Title
2299	Textile goods, Not Elsewhere Classified	313230	Nonwoven Fabric Mills
2599	Furniture and Fixtures, Not Elsewhere Classified	339950	Sign Manufacturing
2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products	325510	Paint and Coating Manufacturing
3089	Plastics Products, NEC	337215	Showcase, Partition, Shelving, and Locker Manufacturing
3281	Cut Stone and Stone Products	327991	Cut Stone and Stone Product Manufacturing
3442	Millwork/Metal Window and Door Manufacturing	332321	Wood or Metal framed windows and Doors, Manufacturing
3499	Fabricated Metal Products, Not Elsewhere Classified	332999	All Other Miscellaneous Fabricated Metal Product Manufacturing
3721	Aircraft and Parts	336411	Aircraft Manufacturing
3732	Boat Building and Repairing (boat building)	336612	Boat Building
3792	Travel Trailers and Campers	336214	Travel Trailer and Camper Manufacturing
7532*	Top, Body, and Upholstery Repair Shops and Paint Shops	811121*	Automotive Body, Paint, and Interior Repair and Maintenance

* = No target list currently available from DEA/OSA. Area Offices may generate their own list for these SIC/NAICS industries which fall under their jurisdiction.

General Industry/Maritime (Secondary)

SIC	SIC Title	NAICS 2007	NAICS Title
2296	Tire Cord and Fabrics	314992	Tire Cord and Tire Fabric Mills
2396	Misc. Fabricated Textile Products	336360	Motor Vehicle Seating and Interior Trim Manufacturing
2396	Automotive Trimmings, Apparel Findings, and Related Products (textile motor vehicle trimming)	336360	Motor Vehicle Seating and Interior Trim Manufacturing
2431	Millwork	321911	Wood Window and Door Manufacturing

2435	Hardwood Veneer and Plywood	321211	Hardwood Veneer and Plywood Manufacturing
2436	Softwood Veneer and Plywood	321212	Softwood Veneer and Plywood Manufacturing
2493	Reconstituted Wood Products	321219	Reconstituted Wood Product Manufacturing
2531	Public Building and Related Furniture	336360	Motor Vehicle Seating and Interior Trim Manufacturing
2591	Drapery Hardware and Window Blinds and Shades	337920	Blind and Shade Manufacturing
2759	Commercial Printing, NEC	323112	Commercial Flexographic Printing
3052	Rubber and Baskets Hose and Belting	326220	Rubber and Plastics Hoses and Belting Manufacturing
3061	Molded, Extruded and Lathe-Cut Mechanical Rubber Goods	326291	Rubber Product Manufacturing for Mechanical Use
3069	Fabricated Rubber Products, NEC (except rubberized fabric and rubber resilient floor covering)	326299	All Other Rubber Product Manufacturing
3083	Laminated Plastics	326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing
	Plate, Sheet, and Profile Shapes		
3086	Plastics Foam Products (urethane and other foam products)	326150	Urethane and other Foam Product (except Polystyrene) Manufacturing
3088	Plastics Plumbing Features	326191	Plastics Plumbing Fixture Manufacturing
3321	Gray and Ductile Iron Foundries	331511	Iron Foundries
3366	Copper Foundries	331525	Copper Foundries (except Die-Casting)
3479	Coating, Engraving, and Allied Services, NEC	332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers
3491	Industrial Valves	332911	Industrial Valve Manufacturing
3519	Internal Combustion Engines, NEC	333618	Other Engine Equipment Manufacturing
3585	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing

3632	Household Refrigerators and Home and Farm Freezers	335222	Household Refrigerator and Home Freezer Manufacturing
3677	Electronic Coils, Transformers, Other Conductors	334416	Electronic Coil, Transformer, and Other Inductor Manufacturing
3714	Motor Vehicle Parts and Accessories	336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing
3842	Orthopedic, Prosthetic, and Surgical Appliances and Supplies	339999	All Other Miscellaneous Manufacturing
3911	Jewelry, Silverware, and Plated Ware	339911	Jewelry (except Costume) Manufacturing
3999	Manufacturing Industries, NEC	326199	All Other Plastics Product Manufacturing
4449	Water Transportation of Freight, NEC	483211	Inland Water Freight Transportation
4789	Transportation Services, NEC	488999	All Other Support Activities for Transportation
4911	Electric Services	221119	Other Electric Power Generation
4932	Gas, and Other Utility Services Combined	221210	Natural Gas Distribution
7538*	General Automotive Repair Shops	811111*	General Automotive Repair
7539*	Automotive Repair Shops, NEC	811118*	Other Automotive Mechanical and Electrical Repair and Maintenance
7549*	Automotive Services, Except Repair and Carwashes	488410*	Motor Vehicle Towing
		811122	Automotive Glass Replacement Shops
		811191	Automotive Oil Change and Lubrication Shops
		811198	All Other Automotive Repair and Maintenance

* = No target list currently available from DEA/OSA. Area Offices may generate their own list for these SIC/NAICS industries which fall under their jurisdiction.

Appendix E

Publications and Resources

OSHA publications are available online at <http://www.osha.gov/pls/publications/publication.html>. If you are unable to access the online publications and would like to place an order, please contact the OSHA Publications Office at 1-800-321-OSHA (6742).

OSHA Online Resources:

[*Safety and Health Topics Page on Isocyanates*](#)
[*Safety and Health Topics Page on Occupational Asthma*](#)
[*Safety and Health Topics Page on Hazard Communication*](#)
[*Safety and Health Topics Page on Personal Protective Equipment*](#)
[*Safety and Health Topics Page on Respiratory Protection*](#)
[*Safety and Health Topics Page on Spray Operations*](#)
[*Safety and Health Topics Page on Ventilation*](#)

Additional Safety and Health Topics Pages can be found online at [OSHA Safety and Health Topics](#).

OSHA Publications:

- [Chemical Hazard Communication](#) (No. 3084)
- [Hazard Communication Guidelines for Compliance](#) (No. 3111)
- [Job Hazard Analysis Guide](#) (No. 3071)
- [Personal Protective Equipment](#) (No. 3151)
- [Small Business Handbook](#) (No. 2209)
- [Small Entity Compliance Guide for Respiratory Protection Standard](#) (CFR 1910.134), (No. 9071)

[OSHA/NIOSH Spirometry InfoSheet](#) - <http://www.osha.gov/Publications/osha3415.pdf>

[OSHA/NIOSH Spirometry Worker Info](#) - <http://www.osha.gov/Publications/osha3418.pdf>

OSHA Small Business Assistance:

Small business owners who are concerned about the cost of professional help can contact the OSHA Consultation Project Office in their state for free consultation service. Priority is given to businesses with fewer than 250 employees at a worksite, with further consideration given to the severity of the worksite problem. The OSHA Consultation Program can help employers evaluate and prevent hazardous conditions in their workplace that can cause injuries and illnesses, including the hazards associated with exposures to isocyanates. For more compliance assistance information, please visit OSHA's Small Business web page at <http://www.osha.gov/dcsp/smallbusiness/index.html>.

National Institute for Occupational Safety and Health (NIOSH) Resources:

NIOSH [Safety and Health Topics Page on Isocyanates](#)

NIOSH [Safety and Health Topics Page on Asthma and Allergies](#)

NIOSH Preventing Asthma & Death from MDI Exposure During Spray-on Truck Bed Liner and Related Applications, (Sept. 2006), DHHS Pub. No. 2006-149

Other Resources:

Heederik, Derrick, Henneberger, Paul A. and Relich, Carrie A. (2012). "Primary prevention: exposure reduction, skin exposure and respiratory protection." *European Respiratory Review* 21(124), 112-114. Available at: <http://err.ersjournals.com/content/21/124/112.full.pdf>

De Vries, Thomas, Bello, Dhimiter, Stowe, Meredith H., Harari, Homero, Slade, Martin D., and Redlich, Carrie A. (2012). "Transferability of Aliphatic Isocyanates from Recently Applied Paints to the Skin of Auto Body Shop Workers." *Journal of Occupational and Environmental Hygiene*, 9, 699-711. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/23067057>

Arrandale, V.H., Liss, G.M., Tarlo, S.M., Pratt, M.D., Sasseville, D., Kudla, I., Holness, D.L. (2012). "Occupational Contact Allergens: Are They Also Associated With Occupational Asthma?" *American Journal of Industrial Medicine*, 353-60. Available at: www.ncbi.nlm.nih.gov/pubmed/22238032

Bello, Dhimiter, Herrick, Christina A., Smith, Thomas J., Woskie, Susan R., Streicher, Robert P., Cullen, Mark R., Liu, Youcheng, Redlich, Carrie A. (2007). "Skin Exposure to Isocyanates: Reason for Concern." *Environmental Health Perspectives*, 115(3), 328-335. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1849909/>

Appendix G

General Guidance for Employers on Personal Protective Equipment (including Respiratory Protection) for Worker Exposures to Isocyanates

The following information is adapted for this NEP based on information obtained from the Region 2 Isocyanate Local Emphasis Program.

Employers are required to make a hazard assessment of their workplace to determine what kinds of personal protective equipment (PPE) their employees need for protection against isocyanates. The types of PPE selected will be influenced by a number of factors, such as the specific job functions of the worker and the chemical resistance of the PPE. An effective PPE program greatly increases the effectiveness of protective gear. See 29 CFR 1910 Subpart I (General Industry), 1926 Subpart E (Construction), 1915 Subpart I (Shipyard), and 1918 Subpart J (Longshoring).

Specific Job Functions

The nature of the job being performed will greatly influence the selection and features of protective clothing. For example, workers that are analyzing foam samples in a laboratory may require light-duty gloves (at least 5 millimeters in thickness) that are flexible and preserve manual dexterity. The potential for worker exposure is limited to a localized area and may only require gloves and either a lab apron or lab coat, in addition to eye protection. In contrast, a maintenance project, such as repairing a pump line, may require workers to wear thicker gloves that are rugged and durable, as well as hooded chemically-resistant overalls and boots.

General Principles of Personal Protective Equipment Selection

- The item must be suitable for the job the worker is to perform.
- The item must offer a protection time that exceeds potential exposure times.
- The item must be replaced before protection time is exceeded.
- Disposable items are preferable to reusable ones, because of contamination/decontamination issues.

Chemical Resistance of Glove or Clothing

To be effective, the protective clothing must resist permeation and penetration by the chemical or chemicals being handled. Use of disposable gloves and clothing is preferred because proper decontamination of reusable items is often difficult. The employer should request documentation from the manufacturer or distributor specifying if the protective equipment meets the appropriate test standard(s) for the type(s) of chemical(s) used in the workplace. For example, some isocyanates may be part of a solvent mixture, so the gloves must protect against the solvent also.

The protection time of PPE is an important selection consideration. Protection time is the time required for a chemical to permeate or make its way through the chemical protective glove or clothing material, and is the material's maximum use time. Keep in mind that isocyanates are often found as a mixture with other chemicals, especially solvents. Gloves and clothing may be affected by solvents, which can reduce the time it takes for solvents and isocyanates to permeate the glove material. PPE manufacturers are able to provide protection times for their equipment.

It is important for the wearer to understand the need to change gloves and clothing often enough to avoid exceeding manufacturers' stated protection times and to prevent skin contact with isocyanates. The manual dexterity requirements of some jobs require the use of thin, form-fitting gloves. These may offer limited amounts of protection time, so use of such gloves is acceptable only if the gloves are changed with sufficient frequency. For example, if a job requires the use of thin, flexible gloves with a 30-minute protection time for isocyanates, then the wearer should change gloves within 30 minutes from initial contact with the isocyanate-containing compound.

Eye and/or Face Protection

Based on the operation, either safety goggles or a face shield may be required when working with isocyanates.

Respiratory Protection - General

An effective written respiratory protection program must be developed and implemented in accordance with [29 CFR 1910.134](#). Key provisions include assignment of a program administrator, fit testing, medical evaluations, proper use of respirators, training and information (including the need for a user seal check each time the respirator is donned), maintenance and care of respirators, program evaluation and recordkeeping.

Respirator Evaluation and Selection

The employer is required to select the appropriate respirator for each situation in which employees are exposed to isocyanates above the PEL or at any level that poses a recognized hazard of death or serious injury or illness to workers. Some factors that must be included in the evaluation by the employer are as follows.

- A. The concentration of isocyanates in the air to which employees will be exposed must be considered. MDI and TDI have OSHA Ceiling Limits; Methyl Isocyanate has an 8-hour TWA PEL. See [Appendix B](#). Other isocyanates have been evaluated by other organizations and have occupational exposure limits such as the NIOSH REL or ACGIH TLV. Paragraph 1910.134(d)(3)(i) requires the employer to "provide a respirator that is adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements under routine and reasonably foreseeable emergency situations." Therefore, when selecting a respirator for protection against substances that have TWA PEL or Ceiling Limits, the employer must not only consider if exposure levels may be reached or exceeded during routine operations, but also if they may be exceeded during reasonably foreseeable emergency situations. The employer must then select a respirator that would provide adequate protection against these levels.
- B. Negative pressure respirators carry a greater risk of leakage than positive pressure respirators. If the face-to-facepiece seal is compromised (e.g., because of beard growth), more contaminated air is likely to leak in than would be the case with positive pressure respirators.

The protection factor of the respirator needs to be taken into account when selecting a respirator. Paragraph 1910.134(d)(3)(i)(A) discusses the protection factors of the respirators. The respirator

chosen must protect the employee from the concentration of isocyanate to which they are being exposed.

Paragraph 1910.134(d)(1)(i) states, “the employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and the workplace and user factors that affect respirator performance and reliability.”

Paragraph 1910.134(d)(3)(iii)(B) further states that for protection against gases and vapors at levels that are not Immediately Dangerous to Life or Health (IDLH) an air-purifying respirator may be used, provided that:

1. The respirator is equipped with an end-of-service life indicator (ESLI) certified by NIOSH for the contaminant; or
2. If there is no ESLI appropriate for conditions in the workplace, the employer implements a change schedule for canisters and cartridges that is based on information or objective data that will ensure that canisters and cartridges are changed before the end of their service life. The employer shall describe in the respirator program the information and data relied upon and the basis for the change schedule and the basis for reliance on the data.

OSHA anticipates that some employers who perform the required evaluation will determine that air-purifying respirators (APRs) are appropriate for their circumstances. Others may prefer to provide powered-air purifying respirators (PAPRs). APR and PAPR cartridges also need to be changed out. See below on change-out information. Under some circumstances, other employers may determine that Supplied-Air Respirators (SARs) may be the only appropriate type of respirator for these hazards, especially in high-exposure industries like automotive painting.

Respirator Cartridges and Change-out Schedules

OSHA’s Respiratory Protection standard, 29 CFR 1910.134, does not permit the use of warning properties as the sole basis for a cartridge change-out schedule. In addition, isocyanate-containing compounds do not have appropriate sensory warning properties. For atmospheres which are not IDLH, APRs are now considered acceptable as long as appropriate precautions and change-out schedules are in place. See 29 CFR 1910.134(d)(3)(iii)(B).

Currently, there are few respirator cartridges or canisters available on the market with ESLI, and none for isocyanates. An employer must select a cartridge or canister recommended for the chemical(s) against which the cartridge or canister is meant to protect employees. The employer must then implement a change schedule for the canister or cartridges that is based on objective information or data that will ensure that the canister and cartridges are changed before the end of their service life. The data relied upon and the information forming the basis of the determination must be included in the written respirator program. If more information becomes available, an employer would be expected to review and, if necessary, revise the change-out schedule. Further information on change out schedules may be found at

http://www.osha.gov/SLTC/etools/respiratory/change_schedule.html.

The International Isocyanate Institute⁵ sponsored a study to determine the effectiveness of air-purifying respirator cartridges in removing MDI aerosols from air. They concluded that:

- Organic vapor cartridges without a particulate filter were not effective at removing MDI aerosols from air;
- Organic vapor cartridges with dust/mist (DM) or high efficiency (N100) filters effectively removed greater than 99% of MDI aerosol and vapor in all test atmospheres; and
- Formation of MDI aerosols was evident even at very low ($<100\mu\text{g}/\text{m}^3$) total MDI concentrations.

Other PPE Information

Isocyanate vapors are corrosive and severely damaging to the eyes. Contact may cause permanent eye damage. If a half-mask respirator is selected, an employer would also be required under 29 CFR 1910.133(a)(1) to ensure that the employee uses appropriate eye and face protection.

Vapors of isocyanates may cause skin irritation and sensitization. The employer is required under 29 CFR [1910 Subpart I](#) (General Industry), 1926 Subpart E (Construction), 1915 Subpart I (Shipyard), and 1918 Subpart J (Longshoring) to assess the workplace and select appropriate personal protective equipment. Additional personal protective equipment to protect the skin of the face and neck may be required if an employer elects respirators which leave these areas exposed.

Exposure to diisocyanates can cause various respiratory ailments. If an employee using an APR reports any medical signs or symptoms which could be attributed to isocyanate exposure, the employer must take appropriate action. Paragraph 1910.134(e)(7)(i) requires additional medical monitoring if an employee reports medical signs or symptoms related to the ability to use a respirator.

Employee Training on PPE

Personal protective equipment can be effective only if the equipment is selected based on its intended use; employees are trained in its use; and the equipment is properly tested, maintained, and worn.

Teaming the proper personal protective equipment with a good training program can give the worker a large measure of safety where other controls are inadequate or impossible. Train your employees to know:

- Why hand, arm, and body clothing, and respiratory protection are necessary – i.e., why isocyanates are a hazard that require skin and breathing protection;
- How the PPE will protect them;
- The limitations of the protective equipment you have supplied;

⁵ Information on the International Isocyanate Institute, Inc. may be found at www.diisocyanates.org.

- When a worker must wear the protective equipment;
- How to wear the protective gloves, sleeves, and clothing properly;
- How to ensure a comfortable and effective fit;
- How to identify signs of wear, such as cracks, scrapes or lacerations, thinning or discoloration, or break-through to the skin; and
- How to clean and disinfect reusable protective gloves, sleeves, body clothing, and respiratory protection.

Appendix H

General Guidance for Employers on Medical Surveillance Program Information for Worker Exposure to Isocyanates

A medical surveillance program for workers exposed to isocyanates should be developed, supervised and monitored by a physician who is Board Certified/Board Eligible in any of the following:

- Occupational Medicine
- Pulmonology/Pulmonary Medicine
- Internal Medicine
- Family Medicine
- Allergy and Immunology (especially if focused on asthma care)

General recommendations for an isocyanates medical surveillance program include⁶:

- Preplacement, annual and exit general medical examinations with:
 - o Special emphasis on the respiratory tract
 - o A medical history including an extensive work history, history of pre-existing respiratory conditions such as asthma, and a smoking history.
 - o Spirometry (more information for employers and employees can be found on the Spirometry Information sheet (<http://www.osha.gov/Publications/osh3415.html>) and Spirometry Worker Information sheet (<http://www.osha.gov/Publications/osh3418.html>)).
- Workers with a history of respiratory conditions should be informed of the potential for increased health risks associated with exposure to isocyanates.
- Isocyanate-sensitized individuals should be assigned to work in areas where exposure to isocyanates is not expected.

Examples of medical surveillance programs:

1. Michigan State University's "Recommended Medical Screening Protocol for Workers Exposed to Occupational Allergens"
<http://www.oem.msu.edu/userfiles/file/Resources/asthmaprotocol.pdf>
2. Asthma Initiative of Michigan's Recommended Medical Screening Protocol for People Exposed to Work-Related Allergens
<http://www.getastmahelp.org/work-related-asthma-screening.aspx>

General Occupational Medicine Resources:

Association of Occupational and Environmental Clinics (AOEC) - <http://www.aoec.org/>

Workplace Health and Safety Queensland Designated Doctor Program: Isocyanate health surveillance guidelines: www.deir.qld.gov.au/workplace/resources/pdfs/ddp-isocyanateguide.pdf

⁶These recommendations can be found at http://www.michigan.gov/documents/cis_wsh_cet5045_90179_7.doc