











I. 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.

II. Scope.

This instruction applies OSHA-wide.

III. References.

- A. OSHA Instruction CPL 02-00-150, [Field Operations Manual \(FOM\)](#), April 22, 2011, and subsequent changes.
- B. OSHA Notice 13-01 (CPL 02), [Site-Specific Targeting 2012 \(SST-12\)](#), January 4, 2013.
- C. OSHA Instruction CPL 02-00-025 (CPL 2.25I), [Scheduling System for Programmed Inspections](#), January 4, 1995.
- D. OSHA Instruction CPL 02-00-051(CPL 2-0.51J), [Enforcement Exemption and Limitations under the Appropriations Act](#), May 28, 1998.
- E. OSHA Instruction CSP 03-02-002, [OSHA Strategic Partnership Program for Worker Safety and Health](#), December 9, 2004.
- F. OSHA Instruction CPL 02-00-135, [Recordkeeping Policies and Procedures Manual](#), December 30, 2004.
- G. OSHA Instruction TED 01-00-015, [OSHA Technical Manual](#), January 20, 1999.
- H. OSHA Instruction CPL 02-00-120 (CPL 2-0.120), [Inspection Procedures for the Respiratory Protection Standard](#), September 25, 1988.
- I. { OSHA Instruction CPL 02-02-079 ~~02-02-038 (CPL 2-2.38D)~~, [Inspection Procedures for the Hazard Communication Standard \(HCS 2012\)](#), ~~March 20, 1998~~ July 9, 2015. }
- J. OSHA Instruction CPL 02-01-050, [29 CFR Part 1910, Subpart I, Enforcement Guidance for Personal Protective Equipment in General Industry](#), February 10, 2011.
- K. OSHA Safety and Health Topics, [OSHA Sampling and Analytical Methods](#).
- L. OSHA Instruction CPL 02-00-141, [Inspection Scheduling for Construction](#), July 14, 2006.

- M. OSHA Instruction CPL 02-02-072, [Rules of agency practice and procedure concerning OSHA access to employee medical records](#), August 22, 2007.
- N. OSHA Instruction CPL 02-02-070, [Inspection Procedures for Occupational Exposure to Methylene Chloride Final Rule 29 CFR Part 1910.1052, 29 CFR Part 1915.1052 and 29 CFR Part 1926.1152](#), December 14, 2001.
- O. OSHA Instruction ADM 04-00-001, [OSHA Field Safety and Health Manual](#), May 23, 2011.

IV. Cancellations.

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

V. Expiration.

~~This instruction will expire three (3) years from the issuance date.~~ To be determined.

VI. Action Offices.

- A. Responsible Office.  
Directorate of Enforcement Programs, Office of Health Enforcement.
- B. Action Offices.  
National, Regional and Area Offices; State Plan and State Consultation Offices.
- C. Information Offices.  
OSHA National Offices.

VII. Federal Program Change.

Notice of Intent and Adoption Required. This instruction describes a Federal program change which establishes a new National Emphasis Program (NEP) to identify and reduce or eliminate the incidence of adverse health effects associated with occupational exposure to isocyanates. Because the seriousness and prevalence of this problem is nationwide, state participation in this national emphasis effort is required. A list of relevant industries (by Standard Industrial Classification (SIC)/North American Industry Classification System (NAICS) codes) where isocyanate exposures are known to occur is in [Appendix A](#) of this instruction. Upon request the Directorate of Evaluation and Analysis (DEA), Office of Statistics, will prepare a master inspection list for each State Plan Office. States must code inspections under this NEP as "ISOCYAN8," as described in [Section XIV](#) of this instruction.

The State's notice of intent must indicate whether the State's emphasis program will be identical to or different from the Federal program. If a State is already implementing an emphasis program in this area, or if it adopts a new initiative in response to this Federal program change, its implementing policies and procedures must be at least as effective as

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.”<sup>1</sup>

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.<sup>2</sup>

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.”<sup>3</sup>

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.

<sup>1</sup> [NIOSH Safety and Health Topic: Isocyanates](#)

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

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

## XII. Program Procedures.

### A. Targeting.

Inspections under this NEP will focus on general industry, construction and maritime industries where exposures to isocyanates are known or are likely to occur. Establishments with fewer than 10 workers shall be included in this NEP. Additionally, federal agencies that are subject to inspection and have employees exposed to hazards covered by this NEP shall be included.

#### Identifying Facilities for Inspection.

Exposures to isocyanates are found in many industries, but are not necessarily found in all establishments within those industries. OSHA reviewed extensive information to develop primary, secondary and construction targeting lists for industries with SIC/NAICS codes indicating potential isocyanates exposures.

[Appendix A](#) contains a primary list of general industry and maritime sectors (by SIC/NAICS) where overexposures to isocyanates are known to occur, and exposures have been demonstrated to be above an OSHA permissible exposure limit or an occupational exposure limit<sup>4</sup> (OEL), and workers have exhibited illnesses associated with occupational exposure to isocyanates. A secondary list includes other industries where exposures to isocyanates are also known to occur but where worker overexposures to isocyanates may not have been documented. See Appendix A of this instruction for the primary and secondary lists of industries (by SIC/NAICS code).

Appendix A also contains a list of construction industries (by SIC/NAICS code) where worker exposure to isocyanates are likely to occur. Similar to those contained on the secondary list, not all establishments in the listed construction industries have documented worker overexposures to isocyanates.

If an Area Office knows of industries not included in Appendix A that have demonstrated a pattern of isocyanate exposures, it should notify the Regional Office for possible inclusion in the Appendix. The rationale for including the industry shall be documented, and may include information such as, but not limited to:

1. A history of previous isocyanate overexposures in the industry, based on OSHA inspection histories;

<sup>4</sup> An occupational exposure limit (OEL) is a non-regulatory established airborne exposure limit. An OEL includes National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values® (TLVs®).





























B. Online Materials.

OSHA resources may be of assistance in this outreach effort. A variety of online resources can be accessed through OSHA's public web page, [www.osha.gov](http://www.osha.gov), including an Isocyanates Safety and Health Topics Page (available at <http://www.osha.gov/SLTC/isocyanates/index.html>). See also [Appendix E](#) for additional online resources and publications.

XVIII. Coordination.

A. National Office.

This NEP will be coordinated by the Directorate of Enforcement Programs (DEP) – Office of Health Enforcement (OHE). All questions and comments should be directed to the Office of Health Enforcement. The OHE will coordinate with the Directorate of Technical Support and Emergency Management (DTSEM), the Office of Occupational Medicine (OOM), and other offices for assistance as needed.

B. Regional Office.

Each Regional Administrator is required to identify a coordinator for this NEP who will work with the Office of Health Enforcement.

XIX. Program Evaluation.

This NEP will be evaluated using data collected from inspection case files and follow-up site visit reports submitted by each Area Office to the Regional Office. The data will be evaluated to determine the impact of OSHA inspections on the reduction of worker exposures to isocyanates.

XX. Federal Agencies.

This instruction describes a change that may affect Federal agencies. Federal agencies that are subject to inspection and have employees exposed to hazards covered by this emphasis program are also included in this NEP. See [FOM](#) Chapter 13, Federal Agency Field Activities.



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)**

<b>SIC</b>	<b>SIC Title</b>	<b>NAICS 2007</b>	<b>NAICS Title</b>
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)**

<b>SIC</b>	<b>SIC Title</b>	<b>NAICS 2007</b>	<b>NAICS Title</b>
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 Plate, Sheet, and Profile Shapes	326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing
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

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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 B

**ISOCYANATE SAMPLING, FIELD EXTRACTION,  
and SAMPLE SHIPMENT PROCEDURES**

The CSHO should contact the SLTC laboratory directly for questions regarding a sampling and/or analytical method.

(Ref: OSHA [Chemical Sampling Information](#))

Isocyanate CAS no. OSHA IMIS no.	Synonyms	Vapor Pressure	Occupational Exposure Limits (OEL)						OSHA Method no.	Sampling Medium	Flow Rate (L/min)	Sample Volume (L)
			OSHA PEL		NIOSH REL <sup>1</sup>		ACGIH TLV <sup>®2</sup>					
			ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>				
Methyl isocyanate 624-83-9 1773	MIC; Isocyanatomethane	348 mmHg @ 68 °F	0.02 T	0.05 T	0.02 T	0.05 T	0.02 T		Method 54 FV	XAD-7 tube 1-2PP	0.05	15
Methylene bisphenyl isocyanate 101-68-8 1073	4,4-Diphenylmethane diisocyanate; MDI; 4,4-Diisocyanadiphenyl-methane; Methylene bis(4- phenylisocyanate); Methylene Bis(Phenyl Isocyanate)	0.000005 mmHg @ 77 °F	0.02 C	0.2 C	0.005 T 0.02 C	0.050 T 0.2 C	0.005 T		Method 47 FV	GFF 1-2PP	1.0	15
Toluene-2,4- diisocyanate (TDI) 584-84-9 2470	2,4-Diisocyanato-1- methylbenzene; TDI; 2,4-TDI; 2,4-Toluene diisocyanate	0.01 mmHg @ 77 °F	0.02 C	0.14 C		4	0.005 <sup>5</sup> T 0.02 STEL		Method 42 FV	GFF 1-2PP	1.0	15 to 240
Hexamethylene diisocyanate 822-06-0 1377	HDI; HMDI; 1,6-Diisocyanatohexane	0.5 mmHg @ 77 °F			0.005 T 0.02 C <sup>6</sup>	0.035 T 0.14 C <sup>6</sup>	0.005 T		Method 42 FV	GFF 1-2PP	1.0	15
1,6-Hexamethylene diisocyanate biuret 4035-89-6 D668	1,6-Hexamethylene diisocyanate Biuret; HDI Biuret; HDIB	0.000075 mmHg @ 77 °F							PV2030 PV	GFF 1-2PP	1.0	15

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Isocyanate CAS no. OSHA IMIS no.	Synonyms	Vapor Pressure	Occupational Exposure Limits (OEL)						OSHA Method no.	Sampling Medium	Flow Rate (L/min)	Sample Volume (L)
			OSHA PEL		NIOSH REL <sup>1</sup>		ACGIH TLV <sup>® 2</sup>					
			ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>	ppm	mg/m <sup>3</sup>				
1,6-Hexamethylene diisocyanate homopolymer 28182-81-2 H130	Hexamethylene Diisocyanate Homopolymer; HDIH; Desmodur N3300; 1,6-Diisocyanato-Hexane Homopolymer; Poly(hexamethylene diisocyanate)	5.2x10 <sup>-9</sup> mmHg @ 77 °F							PV2125 PV	GFF 1-2PP	1.0	15
Isophorene diisocyanate 4098-71-9 1539	IPDI; Isocyanic acid, methylene (3,5,5-trimethyl-3,1-cyclohexylene) ester; 3-Isocyanatomethyl-3,5,5-trimethylcyclohexyl-isocyanate; Isophorone diamine diisocyanate	0.0003 mmHg @ 68 °F			0.005 T 0.02 ST	0.045 T 0.18 ST	0.005 T		PV2034 PV	GFF 1-2PP	1.0	15 To 60
Methylene-bis(4-cyclohexylisocyanate) 5124-30-1 2651	Hydrogenated MDI; Dicyclohexylmethane-4,4'-diisocyanate; HMDI; Desmodur W	5.2x10 <sup>-9</sup> mmHg @ 77 °F			0.01 C <sup>6</sup>	0.11 C <sup>6</sup>	0.005 T		PV2092 PV	GFF 1-2PP	1.0	15
1,5-Naphthalene diisocyanate 3173-72-6 N119	1,5-Naphthylene Ester Isocyanic Acid, Naphthalene Diisocyanate	0.003 mmHg @ 75 °F			0.005 T 0.02 C <sup>6</sup>	0.04 T 0.17 C <sup>6</sup>			PV2046 PV	GFF 1-2PP	1.0	60
Toluene-2,6-diisocyanate <sup>3</sup> 91-08-7 T177	2,6-diisocyanato-1-methylbenzene; 2,6-TDI	0.01 mmHg @ 77 °F					0.005 <sup>5</sup> T 0.02 STEL		Method 42 FV	GFF 1-2PP	1.0	15 to 240

CAS = Chemical Abstract System

IMIS = Integrated Management Information System

C = 15-minute ceiling; T = 8-hour time-weighted average; ST = short-term exposure limit; STEL = short-term exposure limit

FV = fully validated method, PV is partially validated method

GFF = glass fiber filter

1-2PP = 1-(2-pyridyl)piperazine

<sup>1</sup>REL = NIOSH recommended exposure limit

<sup>2</sup>American Conference of Governmental Industrial Hygienists Threshold Limit Value 2010

<sup>3</sup>Toluene-2,6-diisocyanate is usually not found in a pure state and often occurs in a mixture of 80% toluene-2,4-diisocyanate and 20% toluene-2,6-diisocyanate

<sup>4</sup>NIOSH has designated toluene-2,4-diisocyanate as an occupational carcinogen with no safe exposure level

<sup>5</sup>ACGIH TLV for toluene diisocyanate is for toluene-2,4- or 2,6-diisocyanate, or a mixture of the two: Notice of Intended Change 0.001 ppm TWA, 0.003 ppm STEL Inhalable fraction and vapor.

<sup>6</sup>NIOSH Ceiling REL is a 10-min average

## ISOCYANATE SAMPLING, FIELD EXTRACTION, and SAMPLE SHIPMENT PROCEDURES

### Introduction

Chemicals containing the isocyanate functional group (-NCO) can contain more than one isocyanate group, for example toluene diisocyanate has two isocyanate groups, but as a class of chemicals they are often collectively referred to as isocyanates.

Except for methyl isocyanate which is extremely volatile and is sampled using coated adsorbent tubes, OSHA monitors workplace exposure to isocyanates using glass fiber filters that are impregnated with 1 milligram of 1-(2-pyridyl)piperazine (1-2PP). 1-2PP reacts with isocyanates to form a stable chemical derivative. These samples are normally extracted and analyzed by chemists at OSHA's laboratory in Salt Lake City, Utah. OSHA compliance officers will now be instructed in how to perform field extraction of isocyanate samples when using filter sampling procedures. Methyl isocyanate samples do not have the same derivatization issues inherent in filter samples and they do not require field extraction.

This isocyanate sampling, field extraction, and sample shipment protocol is now standard operating procedure to be followed for this NEP. All area offices and state plan offices must follow this procedure.

### Purpose of Field Extraction

The purpose of field extraction is to enhance the recovery of highly reactive isocyanates that are collected on the air sampler but for various reasons do not come into contact with the derivatization reagent coated on the filter. Such isocyanates may become unavailable for reaction with the 1-2PP reagent because of unwanted chemical side-reactions that occur during or after sampling. One way to bring collected isocyanates and the reagent into contact is to extract the samples immediately after sampling. Field extraction is of benefit only if it is performed immediately after sampling.

### Apparatus

Personal sampling pump. A personal sampling pump that can be calibrated to within  $\pm 5\%$  at the recommended flow rate with the sampling device in line.

Coated glass fiber filters. Glass fiber filters (GFF) coated with 1.0 mg 1-(2-pyridyl) piperazine (1-2PP). Coated GFFs can be obtained from SLTC using the "SLTC Supplied Sample Media Order Form." Store the coated filters in a refrigerator until use. Avoid exposure of the coated filters to sunlight or heat. Discard the coated filters if they are not used within a month after receipt from SLTC. OSHA employees can also obtain the coated adsorbent tubes used for methyl isocyanate from SLTC.

Field extraction solution. The field extraction vials each contain 3-mL of a solution composed of 90% v/v acetonitrile and 10% v/v dimethyl sulfoxide. **CAUTION.** These are both extremely

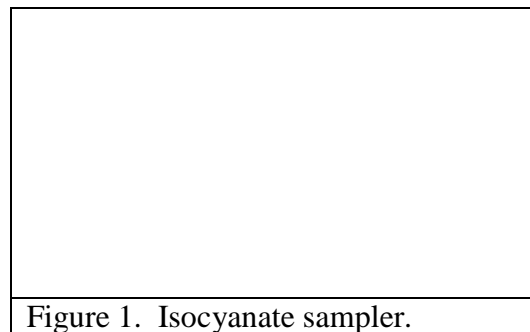
toxic and flammable solvents (see MSDS). OSHA employees can obtain glass vials containing the correct volume of field extraction solution from SLTC in the same way that the coated filters were obtained. It is important to keep the packaging material in which the vials containing the extraction solution was shipped from SLTC for use to pack and return the vials to SLTC for analysis.

Vial rack (tray) to hold extraction solvent vials, sized for 15-mm vials. Vial racks are used to secure the field extraction vials because they may help prevent spilling of the solvent.

Backup (support) pads. 37-mm cellulose.

Polystyrene cassettes. Three piece, 37-mm standard with top, bottom, and ring pieces and end plugs.

Isocyanate sampler. Except for methyl isocyanate, OSHA's methods for isocyanates specify sampling using the filter cassette sampler shown in Figure 1. Assemble the three-piece polystyrene cassette containing a coated glass fiber filter and a backup pad as shown in Figure 1. Use disposable gloves and metal forceps to handle the filters. There is no need to change gloves for each sampler to be assembled. Do not assemble more cassette samplers than expected to be used in a single sampling site visit. Do not expose the assembled isocyanate samplers to high temperatures or direct sunlight.



Disposable gloves. Disposable nitrile gloves such as Ansell "Touch N Tuff," no. 92-600, are convenient and have good touch sensation properties. **CAUTION.** The Ansell "Touch N Tuff" gloves are rated by the manufacturer as having excellent resistance to dimethyl sulfoxide, but only fair resistance to acetonitrile. Immediately change the gloves if you spill solvent on them. Equivalent gloves from another manufacturer can also be used.

Metal Forceps. Clean the forceps with isopropyl alcohol and wipe them dry before each use. Isopropyl alcohol obtained from a local pharmacy is adequate for cleaning purposes.

A six-pack cooler together with frozen ice packs (e.g., Blue-Ice type or equivalent) is a convenient and effective way to transport sampling and extraction media to and from the CSHO's office in a vehicle. This is a precaution intended to prevent degradation of the sampling media.

The Cincinnati Technical Center (CTC) has available an Isocyanates Sampling Kit (FES0001912) that has the equipment necessary to extract air samples in the field. These supplies can be ordered together as a kit, or each item can be ordered separately through CTC.

## Sampling Procedure



Sample open-face by removing the top piece and the end plug from the cassette sampler immediately before sampling.

Attach the cassette to the calibrated sampling pump with flexible tubing and position it in the workers breathing zone so that it is in an approximately vertical position with the open-face pointing down during sampling. Position the sampling pump, cassette and tubing so it does not impede work performance or worker safety.

Do not allow air being sampled to pass through any hose or tubing before entering the cassette.

Sample for the appropriate time using the flow rate shown in Table 2 of Appendix B.

### **Field Extraction Procedure**

Wear disposable gloves for the following procedure and do not spill any of the solvent because this will affect sample results. Extract each sample separately and wear new gloves for each sample. **CAUTION.** The extraction solution is extremely toxic and flammable (see MSDS). Immediately after sampling and in a clean location remove the coated filter from the cassette using clean forceps and place it in the glass vial containing the field extraction solution. If you spill any solvent on your gloves, replace them with new gloves immediately. Place the filter flat against the inside surface of the vial. Do not fold or crumple the filter. Immediately tightly seal the vial with the lined cap. Check to be certain that the cap on the vial is firmly tightened and does not leak. Vigorously shake the vial to wet the filter. Properly identify the sample and wrap each sample with a Form OSHA-21. Note any solvent spills on the Form OSHA-91A. Discard the backup pad and the polystyrene cassette in the regular trash.

Submit at least one blank sample with each set of samples. Extract and handle the blank sampler in the same manner as the other samples except draw no air through it. Do not leave the cassette top off the blank sample while air samples are being collected. Briefly remove the top cassette piece from the blank sample and then immediately replace it and extract the sample.

Record sample air volume (in liters of air) for each sample, along with any potential interference such as anhydrides, amines, alcohols, and carboxylic acids on the Form OSHA-91A.

Waste from the field extraction procedure except for the extraction solvent can be disposed of as regular trash. The CSHO's office may want to keep unused coated filters if they will be sampling again within the next month otherwise they can be disposed of as regular trash. The extraction solvent should either be returned to SLTC for disposal or disposed of locally if the office has access to a hazardous waste handler (e.g., perhaps a local laboratory could dispose of the waste).

### **Shipping Procedure**

Ship any bulk samples separate from the air samples.

Use the same packaging material in which the vials containing the extraction solution was shipped from SLTC to pack and return the sample extraction vials to SLTC for analysis.

Submit the extracted samples to SLTC for analysis as soon as possible after sampling. As a precaution, store the samples in a refrigerator for up to 1 week if delay is unavoidable. The samples do not require refrigerated shipment. Be certain to follow all applicable hazardous materials shipping restrictions and requirements. Persons shipping hazardous goods must be trained and certified by an authorized contract carrier such as UPS or FedEx that has been approved by U.S. Department of Transportation (DOT).

CSHOs should check with their area director to obtain the required DOT Hazardous Goods training.

### **Resources**

OSHA's sampling and analytical methods for isocyanates can be accessed and downloaded from OSHA's public website [www.osha.gov](http://www.osha.gov). They are located under Chemical Sampling Information.

Appendix C

Health Surveillance Form (Non-mandatory) – Isocyanate Exposure

Interviewer: \_\_\_\_\_ Date: \_\_\_\_\_

Worker Name: \_\_\_\_\_

1. What was the month and year that you were hired at this company? \_\_\_\_\_

2. What is your job title? \_\_\_\_\_

3. Please describe your job duties: \_\_\_\_\_  
\_\_\_\_\_

4. How many hours per week do you work on average? \_\_\_\_\_

5. In what area or areas of the plant do you work? \_\_\_\_\_

6. Have there been any recent changes to your immediate work environment or processes in your worksite? \_\_\_\_\_  
\_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

a. If **YES**, what has changed and when? \_\_\_\_\_  
\_\_\_\_\_

7. Do you use any of the following personal protective equipment while working or while in the work area?

a. Respirator \_\_\_\_\_ **YES** \_\_\_\_\_ **NO** **TYPE** \_\_\_\_\_

b. Gloves \_\_\_\_\_ **YES** \_\_\_\_\_ **NO** **TYPE** \_\_\_\_\_

c. Protective Clothing \_\_\_\_\_ **YES** \_\_\_\_\_ **NO** **TYPE** \_\_\_\_\_

d. Eye Protection \_\_\_\_\_ **YES** \_\_\_\_\_ **NO** **TYPE** \_\_\_\_\_

e. Other Protective Equipment (If worker answers **YES**, please list below):

*Please ask the worker the following questions in regard to past and current medical conditions:  
(For **YES** responses, note the month and date of first diagnosis).*

8. Has a doctor ever told you that you have asthma? \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

9. Has a doctor ever told you that you have any of the following work-related conditions?

a. Work-related asthma - \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

b. Allergies from exposures at work - \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

c. Bronchitis from exposures at work - \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

d. Skin rash from exposures at work - \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

e. Hypersensitivity pneumonitis - \_\_\_\_\_ **YES** \_\_\_\_\_ **NO**

If **YES**, when did the doctor tell you this? \_\_\_\_\_

(If the worker has been diagnosed with any work-related condition or has symptoms that may be associated with isocyanate exposure, consider asking the worker to sign a medical release to

**NOTICE: This is an OSHA ARCHIVE document and may no longer represent OSHA policy.**

obtain a copy of the worker's personal medical records or obtain a medical access order (MAO) for the worker's employer medical records).

**10.** Please ask the worker the following questions regarding symptoms. (If worker answers **NO**, go to the next symptom. If the answer is **YES**, ask the questions across the row):

Symptom*	YES	NO	If yes, approximately what date did you first notice symptoms?	Do your symptoms occur at work?	Do your symptoms improve when you are away from work such as while on vacation or on the weekends? <i>(Describe):</i>	Do you think your symptoms are brought on by any particular work activity, chemical exposure, or work area? <i>(Describe):</i>
Cough						
Wheezing						
Watery or itchy eyes						
Nose stuffiness or itching						
Skin rash or itching						
Shortness of breath						
Chest tightness						
Fever or chills						

\*Not related to a cold or infection

**11.** Have you missed any days from work because of respiratory symptoms? \_\_\_**YES** \_\_\_**NO**

**12.** Have you been restricted or transferred from one job assignment to another because of respiratory symptoms? \_\_\_**YES** \_\_\_**NO**

**13.** Have you informed anyone in management or supervision of symptoms related to isocyanate exposure? \_\_\_**YES** \_\_\_**NO**

Other Comments:

## Appendix D

### Sample Isocyanates Hazard Alert Letter

*Note: This letter must be adapted to the specific circumstances noted in each inspection. The letter below is an example of the type of letter that may be appropriate in some circumstances. If the employer has implemented, or is in the process of implementing efforts to address problem conditions, those efforts should be recognized and encouraged, if appropriate.*

*Italicized comments are for OSHA compliance use only and should not be included in the letter.*

Dear Employer:

An inspection of your workplace and evaluation of your OSHA recordkeeping logs at (*location*) on (*date*) disclosed the following condition(s), which are consistent with employee exposure to (*list isocyanate*), a known occupational health hazard; (*list conditions*).

*(Include a general description of the risk factors for each task/job associated with respiratory sensitization/asthma, such as lack of ventilation, lack of PPE, inappropriate PPE, etc.)*

Even though sampling did not show exposures above an OSHA permissible exposure limit, in the interest of workplace safety and health, I recommend that you voluntarily take the necessary steps to materially reduce or eliminate your employees' exposure to the conditions listed above.

While the risk of health hazards associated with exposure to isocyanates can be reduced or eliminated by implementing a single means of abatement, in most cases a variety of abatement methods will provide a more effective method of addressing these hazards. These include workplace analysis of jobs and tasks to assess hazards associated with those jobs and tasks and the steps to abate them; product substitutions; engineering, administrative and work practice controls; accurate injury and illness recordkeeping; medical surveillance; medical management of occupational illnesses and injuries; education and training of employees; and management oversight. When respiratory sensitization, asthma or other hazards associated with isocyanate exposure are addressed on an incremental basis to determine the effectiveness of a specific control strategy, it is important to evaluate the effectiveness of the results in a timely manner. If the initial control strategy fails to eliminate or substantially reduce employee exposures, additional control measures should be implemented.

We have examined available information on the hazards associated with these jobs/tasks, and your efforts to address these hazards. The evaluation suggests that the following additional methods of abatement should be implemented.

#### 1. Engineering Controls

If substitution is not possible, engineering controls are the first line of defense in employee protection. Therefore, employers should provide appropriate engineering controls and should train their employees in their use and in proper work practices to ensure that employee

occupational exposure to isocyanates are maintained below levels hazardous to employees. The following engineering controls are recommended:

- *(list possible engineering controls: local exhaust ventilation, automated process, isolating the process, etc.)*

## 2. Administrative and Work Practices Controls

The following work practices should be used to ensure that occupational exposure to an isocyanate(s) during *(list operation(s))* is (are) reduced:

- *(List possible controls such as: limiting the time employees are exposed);*
- *(Job rotation);*
- *(Monitor employee exposures on a regular basis);*
- *(Limit the number of employees who have access to areas where the operation occurs);*
- *(Provide separate lockers for work clothes and street clothes);*
- *(Do not eat, drink, apply cosmetics or use tobacco products in work area(s));*
- *(Do not leave the workplace wearing protective work clothing or equipment or take it home to launder);*
- *(Wash face, hands, and forearms before eating, drinking, smoking, or applying cosmetics);*
- *(Shower at end of work shift);*
- *(Immediately and thoroughly wash off skin with soap and flowing water if dermal contact occurs);*
- *(Wear appropriate personal protective equipment);*
- *(A medical surveillance program as described in Appendix I);*
- *(Etc.)*

## 3. Personal Protective Equipment

To be effective, personal protective equipment must be individually selected; properly fitted and periodically refitted; conscientiously and properly worn; regularly maintained; and replaced as necessary. In addition, employers must:

- Perform a workplace hazard assessment in accordance with 29 CFR 1910.132(d) (or equivalent construction or maritime standard) to determine if hazards are present, or are likely to be present which necessitate the use of personal protective equipment (PPE);
- Provide and ensure the use of the appropriate gloves (e.g., butyl, nitrile), goggles, and protective clothing when a potential for eye or dermal exposure exists (e.g., exposure to contaminated equipment, chemical containers, etc.);
- Train employees on the limitations and use of PPE required during *(list operations)*;
- Establish, implement, and maintain a written respiratory protection program in accordance with 29 CFR 1910.134(c) whenever the employer requires the use of respiratory protection;
- Provide and ensure that employees use appropriate respiratory protection;

- (Etc.).

#### 4. Training and Information

Employers must comply with the OSHA Hazard Communication standard, 29 CFR 1910.1200. In particular, employers must ensure that employees exposed to isocyanates are trained in and have access to the following information:

- The specific nature of the operations in their workplace where exposure may occur;
- Safety Data Sheets (SDSs) for chemicals containing isocyanates;
- The signs and symptoms of isocyanate exposure;
- The importance of avoiding dermal contact when working with isocyanates;
- The engineering controls the employer is using to reduce employee exposures to isocyanates;
- Specific work practices that should be used to reduce exposure to isocyanates;
- The use of appropriate protective equipment, including respirators and skin protection and the limitations of that equipment; and
- Methods that may be used to detect the presence of the isocyanates in the workplace, such as workplace monitoring.

In addition, the results of any air or wipe sampling the employer or others have conducted for levels of isocyanates should be shared with employees and/or their representative.

*(Using the above components, together with information gathered during the inspection, describe the specific conditions or weaknesses and suggest methods of abatement.)*

You may voluntarily provide this Area Office with progress reports on your efforts to address these conditions. OSHA may return to your worksite to further examine the conditions noted above.

Enclosed is a list of available resources that may be of assistance to you in preventing work-related injuries and illnesses in your workplace.

If you have any questions, please feel free to call [name] at [phone number].

Sincerely,

Area Director

Enclosure

## 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/dccsp/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](http://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 F

### Sample General Duty Clause Citation Language

Where exposures to isocyanates exist and the conditions meet the elements of a 5(a)(1) violation, a General Duty Clause citation may be issued. Below is an example of language to use for a 5(a)(1) citation.

Section 5(a)(1) of the Occupational Safety and Health Act of 1970: The employer did not furnish a place of employment that was free from recognized hazards that were causing or were likely to cause death or serious physical harm to employees in that employees were exposed to (*chemical name*), which was causing or likely to cause respiratory illness such as asthma or skin sensitization:

- a. On or about (*date*), (*list employee titles, or names*) working in the (*name area(s)*) was/were exposed to (*name chemical*). Exposures occurred via (*list routes of entry: inhalation, ingestion, dermal absorption, etc.*) at concentrations of (*list exposure levels, surface/dermal contamination levels*).

The employer could feasibly adopt measures that would be effective in reducing or eliminating employee exposure to (*name chemical*) and the associated risk of developing (*asthma or other effects of exposure/disease*). Examples of such measures may include:

- 1) Engineering controls including (*if applicable, list relevant engineering controls, such as local exhaust ventilation, substitution, etc.*).
- 2) Administrative and work practice controls, including (*if applicable, list relevant administrative and work practice controls, such as rotation, cleaning working surfaces, maintenance of engineering controls, medical monitoring, etc.*).
- 3) Personal Protective Equipment, including (*if applicable, list relevant PPE*).

## 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](http://www.osha.gov/SLTC/etools/respiratory/change_schedule.html).

The International Isocyanate Institute<sup>5</sup> 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 (<100ug/m<sup>3</sup>) 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;

<sup>5</sup> Information on the International Isocyanate Institute, Inc. may be found at [www.diisocyanates.org](http://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 include<sup>6</sup>:

- Preplacement, annual and exit general medical examinations with:
  - Special emphasis on the respiratory tract
  - A medical history including an extensive work history, history of pre-existing respiratory conditions such as asthma, and a smoking history.
  - Spirometry (more information for employers and employees can be found on the Spirometry Information sheet (<http://www.osha.gov/Publications/osha3415.html>) and Spirometry Worker Information sheet (<http://www.osha.gov/Publications/osha3418.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](http://www.deir.qld.gov.au/workplace/resources/pdfs/ddp-isocyanateguide.pdf)

<sup>6</sup>These recommendations can be found at [http://www.michigan.gov/documents/cis\\_wsh\\_cet5045\\_90179\\_7.doc](http://www.michigan.gov/documents/cis_wsh_cet5045_90179_7.doc)