PROGRAM DIRECTIVE

Program Directive A-243
Issued 9/21/00
Revised 12/01/04

Subject: Spray Finishing: Assessing Fire Safety and Industrial Hygiene Issues for Diisocyanates

Referenced Codes/Directives:

OAR 437-002-0107, Spray Finishing
"Preventing Asthma and Death from Diisocyanate Exposure," NIOSH Publication 96-111
"Automotive Refinishing Industry Isocyanate Profile," New Chemicals Environmental Technology Initiative, U.S.E.P.A. Contract No. 68-D4-0098, May 1, 1997
NIOSH Health Hazard Evaluation Report, HETA 95-0311-2593

Purpose: This directive provides a coordinated process for evaluating the hazards of diisocyanate in relation to standards dealing with fire safety and industrial hygiene/worker safety and respiratory protection wherever diisocyanates are encountered.

Background: Diisocyanates are a family of chemicals which can compromise the health and well-being of workers. They present an inhalation and skin hazard. Signs and symptoms of occupational exposure include irritation of the eyes, nose and throat. Sensitization of the skin and respiratory system can be debilitating, especially with the development of occupational asthma.

There are a variety of processes where chemicals containing diisocyanates are used. Examples include foam-in-place insulation, packaging, and truck-bed linings, flexible and rigid foams, fibers, coatings such as paints and varnishes, elastomers, automotive refinishing, autobody repair and building insulation materials. See Appendix A for a diisocyanate nomenclature list. The term "diisocyanates" is often used interchangeably with the term "isocyanates." In many uses the "isocyanate" monomers have been prepolymerized into small "oligomers" that still contain active "isocyanate" groups.

Scope: This instruction applies OR-OSHA wide.

Action: This section identifies pertinent fire safety and industrial hygiene issues for evaluation and mitigation of diisocyanate-related hazards.

Fire Safety Issues: Spray Finishing/Spray Application involving

Flammable or Combustible Liquids

OR-OSHA's 437-002-0107, "Spray Finishing," combine the spray finishing requirements from federal OSHA's 29 CFR 1910.107, "Spray Finishing using Flammable and Combustible Liquids," and 29 CFR 1910.94, "Ventilation."

1910.107 is a fire safety code derived from NFPA 33-1969, which is the National Fire Protection Association's "Standard for Spray Application Using Flammable and Combustible Materials," and 1910.94 incorporated concepts from NFPA 33-1969. With periodic updates made by NFPA to its "33 Standard," they have made it clear that the "33 Standard" is not designed or intended to be used in the mitigation of industrial health hazards.

The Oregon State Fire Marshal's Office adopted the Uniform Fire Code (UFC) as their fire safety rules, and Article 45, "Application of Flammable Finishes," was used in the creation of 437-002-0107. In those areas where Article 45 is more restrictive than 1910.107 or NFPA 33, those elements were adopted into 437-002-0107 since those requirements already existed for Oregon.

All spraying areas must be kept free from the accumulation of deposits of combustible residues. Cleanup and removal of residues from the spray area, and proper disposal are essential safety practices applicable to all spray finishing operations. See 437-002-0107(3)(e)(B) and (e)(C).

In the automobile undercoating industry, various classes of flammable or combustible liquids are used. 437-002-0107 was written to allow for noncombustible and Class IIIB liquids to be used outside of a spray booth, but still within a defined spray area. 1910.107 and NFPA 33 exempt automobile undercoating from the spray finishing rules, however, UFC 45 does not. Generally, the local fire authority may exempt operations using Class III Combustible Liquids (those having flashpoints of 140°F and above) from their spray finishing requirements, but this is by no means a given.

The compliance officer should check with the fire marshal having jurisdiction to ascertain if a fire safety issue is substantiated based on such factors as the combustibility of the chemical(s) or residues, electrical safety, ventilation control, sprinkler systems, access/egress, or work practices. This collaborative effort is viewed as a reasonable step to assure fire safety issues are established and being addressed, and does not predispose agencies from enforcing rules within their jurisdiction.

Whether it is this specific issue, or any other matter related to fire safety, agency interaction to identify compliance efforts reduces duplicative

enforcement actions when good faith efforts are being made on the part of an employer. If possible obtain a written statement from the fire marshal regarding their position on the matter(s) in question. Employer compliance with current fire safety regulations through verification with the local fire marshal may substantiate a minimal violation of OR-OSHA rules. If there is disagreement between OR-OSHA and a fire marshal about fire safety issues, document the reason(s) for each issue.

Once it has been determined that fire safety issues exist in relation to spray finishing, OAR 437-002-0107(3)(a) will be cited when it is deemed a spray booth or spray room is needed.

Ventilation

In evaluating spray finishing operations where flammable or combustible liquids are in use, the compliance officer must determine if dangerous accumulation of vapors can occur.

Document that flammable and combustible liquids are used in spray finishing operations inside the spray booth. If so, sampling for LEL is not required. If the air flow through the open face or cross-sectional area is less than 100 fpm, this condition can be cited as a violation of OAR 437-002-0107(3)(h)(C)(i) or (ii), in order to prevent dangerous accumulation of vapors (UFC Article 45 at 4502.5.1 and 4502.5.2).

Where flammable or combustible liquids are used for spray finishing operations outside of a spray booth, the compliance officer must evaluate their use as a spray area. Factors that will influence the establishment of a hazardous condition include:

(i) quantities of flammable or combustible liquids in excess of one day's use {OAR 437-002-0107(4)(b)(B)};

(ii) the presence of combustible residues, dusts or deposits in the spray area {OAR 437-002-0107(3)(e) and (4)(d)(A)};

(iii) spraying operations are not infrequent or of short duration {OAR 437-002-0107(2)(e) and (3)(a)(A)};

(iv) flammable or combustible vapors present above 25% of the lower explosive limit {OAR 437-002-0107(3)(h)(C)}. Sampling for the LEL is required. If sample results are greater than 25% LEL, the ventilation rate must be at least 6 air changes per hour of air flow {OAR 437-002-0107(3)(b)(E)}. Where sampling establishes that 25% LEL is not exceeded, no further actions for fire prevention/control are required.

Where diisocyanates are used in a spray finishing application, the

compliance officer should evaluate worker exposure(s) to these constituents only. If overexposures to diisocyanates are identified, this condition can be cited as a violation of OAR 437-002-0382(5). Administrative or engineering controls must be determined and implemented whenever feasible to achieve compliance with those air contaminant standards.

Refer compliance issues related to LEL to the local fire authority having jurisdiction.

Industrial Hygiene Issues: Assessing Worker Exposures to Diisocyanates

Diisocyanates, as a family of chemicals, are known to produce sensitization of the respiratory system among exposed workers, resulting in asthma-like symptoms that are often debilitating for the remainder of a person's life. Respiratory sensitization can occur either through inhalation or skin contact.

Published data suggest a substantial contribution to worker exposure and resulting injury/illness occurs via skin contact specifically related to diisocyanates. The significance of chemical toxicity via skin contact should not be overlooked in the evaluation of worker exposure with diisocyanates. Skin patches provide for detection of diisocyanate(s) as an indication of dermal exposure; however, standards that interpret what is a "safe" level of diisocyanate exposure via the skin route are not available. The best practice is to avoid skin contact with diisocyanates to the extent possible. In the absence of appropriate glove protection and worker contact with diisocyanates is documented, reference OAR 437-002-0123(2).

There are several factors to consider in evaluating worker exposure to diisocyanates. Work practices, confined spaces, ventilation and airflow characteristics, frequency and duration of exposure, surface contamination, personal protective equipment and respiratory protection should be evaluated. Where overexposure(s) to diisocyanate-based chemicals are identified through air monitoring, cite OAR 437-002-0382(5). Where overexposure to diisocyanate-based chemicals are identified in spray finishing operations, OAR 437-002-0382(5) establishes that administrative or engineering controls are required to mitigate the identified overexposure(s).

Successful management of worker exposures to diisocyanates typically include effective hazard communication information and training; use of gloves and other PPE to control skin contact; respiratory protection; effective ventilation control methods; work practices designed to reduce

or eliminate exposure and control strategies for any other site-specific conditions which can influence a worker's exposure potential.

Respiratory Protection:

OR-OSHA's respiratory protection standard, 1910.134, identifies three choices of respirators for use with chemicals that produce either a gas or vapor: (1) supplied-air respirators (SARs); (2) air-purifying respirators (APRs) with cartridges or canisters equipped with End-of-Service-Life-Indicators (ESLI); or (3) change schedules for cartridges or canisters without ESLI.

With regard to diisocyanates, OR-OSHA's longstanding policy has limited respirator selection only to SARs when overexposure is documented. The rationale includes the significant hazards associated with diisocyanates, e.g., corrosive and irritant properties; exposure potential through inhalation and skin absorption, which can lead to respiratory sensitization; increased risk of overexposure associated with oligomers, especially when the vapor and aerosol phases are present; limitations of air-purifying respirators such as improper fit and leakage around sealing surfaces or wrong choice of cartridges and prefilters; and mixtures of chemicals that produce additive or synergistic health effects. OR-OSHA strongly urges the use of supplied-air respirators as the most protective class of respiratory protection for worker safety.

At least one manufacturer has produced a NIOSH-certified organic vapor cartridge with an ESLI for toluene diisocyante (TDI). This ESLI cannot be used for any other diisocyante.

Federal OSHA issued a Letter of Interpretation dated July, 18, 2000, outlining when APRs are acceptable for use with chemicals having poor warning properties. APRs are permitted for use with diisocyanates when certain requirements are met: an exposure assessment has been completed that accurately describes and documents employee exposure, change schedules are in place and followed such that cartridges or canisters are replaced prior to chemical breakthrough, and data used to develop change schedules are adequately documented in the written respiratory protection program. Employers and workers should follow manufacturers' recommendations for respirator selection and change schedules. Since many of the variables affecting respirator selection and use are user-specific and site-dependent, the information derived through the exposure assessment bear directly on the successful development and implementation of an effective change schedule. The reader is directed to 1910.134 for other requirements addressing respirator selection, medical evaluation, fit testing, care and maintenance, training, record-keeping and program evaluation.

Based on 1910.134(d)(1)(iii), an employer must identify and evaluate the

respiratory hazard(s) present in the workplace. The evaluation must include a reasonable estimate of employee exposures to those respiratory hazard(s). The contaminant's chemical state and physical form must also be identified. For example, in spray finishing operations, diisocyanates can be present in both a vapor phase and a particulate phase. From 1996 through 2000, OR-OSHA has identified through air sampling for the biuret and isocyanurate forms of hexamethylene diisocyanate that approximately 35-39% of those samples (319 total) were above the 8-hour time-weighted average PELs. The majority of these samples came from evaluation of spray finishing operations in autobody/automotive refinishing. Diisocyanates have Ceiling Limits which must never be exceeded (an exposure limit for which worker exposures must never exceed the concentration established for each chemical).

Work practices that involve close-in work with spray finishing equipment may produce exposure above acceptable limits even though engineering controls such as ventilation achieve or exceed minimum linear flow and/or volumetric flow rate recommendations. In such a case, supplied air respiratory protective devices are the preferred protection.

When APRs are used to control worker overexposure to diisocyanates, the compliance officer will thoroughly review the employer's respiratory protection program to assure that an exposure assessment has been completed and documented, and that change schedules are established and followed. Where an exposure assessment and/or change schedule has not been completed or is inadequate, supplied-air respirators must be used as an interim control if operations continue. Reference 1910.134(d)(1)(iii) and (d)(3)(iii).

Training: OR-OSHA will assure that health and safety staff understand the hazards presented by diisocyanates to assure better uniformity in the assessment and mitigation of hazards.

Effective Date: This directive is effective immediately and will remain in effect until canceled or superceded.

APPENDIX A
DIISOCYANATE SYNONYMS

(adapted from NIOSH published information and other sources)

Note: This list is not meant to restrict the application of this directive to only what is included here.

TDI [584-84-9]

2,4-Diisocyanato-1-methylbenzene
2,4-Diisocyanatotoluene
2,4-TDI
2,4-Tolylene diisocyanate
4-Methyl-phenylene diisocyanate
Di-iso-cyanatoluene
Isocyanic acid, 4-methyl-m-phenylene ester
Isocyanic acid, methylphenylene ester
m-tolylene diisocyanate
Toluene-2,4-diisocyanate
Toluene diisocyanate

MDI [CAS 101-68-8]

1,1-Methylenebis(4-isocyanatobenzene)
4,4'-Diisocyanatodiphenylmethane
4,4'-Diphenylmethane diisocyanate
4,4'-Methylenebis(phenyl isocyanate)
4,4'-Methylenediphenyl diisocyanate
Bis(1,4-isocyanatophenyl)methane
Bis(4-isocyanatophenyl)methane
Diphenylmethane 4,4'-diisocyanate
Diphenylmethane diisocyanate
Methylenebis(4-isocyanatobenzene)
Methylenebis(4-phenylene isocyanate)
Methylene bisphenyl isocyanate
Methylene-di-p-phenylene isocyanate
Methylene di(phenylene isocyanate)

HDI [CAS 822-06-0]

1,6-Diisocyanatohexane
1,6-Hexamethylene diisocyanate
1,6-Hexanediol diisocyanate
Hexamethylene-1,6-diisocyanate
Hexamethylene diisocyanate

HMDI (4,4' dicyclohexylmethane diisocyanate)
Isocyanic acid, hexamethylene ester

HDI-BT [CAS 4035-89-6]

Hexamethylene Diisocyanate Biuret
Imidodicarbonic diamide, N,N',2-tris(6-isocyanatohexyl)-
HDI Biuret
Biuret of Hexamethylenediisocyanate
Desmodur N
polymeric hexamethylene diisocyanate
hexamethylene diisocyanate polymer
Hexane, 1,6-diisocyanato-, Homopolymer
Hexamethylene diisocyanate, homopolymer
homopolymer of HDI

HDI-IC [CAS 28182-81-2]

1,6-Hexamethylene Diisocyanate Homopolymer
polymeric hexamethylene diisocyanate
hexamethylene diisocyanate polymer
Hexamethylene diisocyanate, homopolymer
1,6-Hexamethylene diisocyanate polycyclotrimer
Desmodur N3300
1,6-Diisocyanato-Hexane Homopolymer
homopolymer of HDI

References

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NIOSH [1995] Registry of toxic effects of chemical substances. Cincinnati, OH: U.S. Department of Health and Human
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http://chemfinder.camsoft.com/

MSDSs from Bayer Corporation, Pittsburgh, PA

MSDSs from Mobay Corporation, Pittsburgh, PA