

Isocyanates: Working Safely

Isocyanates are chemicals used in many products, including polyurethane foams and automotive paint. Exposure to isocyanates at work can cause asthma. Occupational asthma has overtaken asbestosis as the leading cause of new work-related lung disease. Employers can make product selections and encourage work practices that minimize isocyanate exposure. Cal/OSHA regulations mandate that workers be protected.

Do you work with isocyanates?

You probably do if you...

- ▶ Paint at an auto body shop
- ▶ Apply spray polyurethane foam (SPF) for insulation or on roofs
- ▶ Apply spray-on truck bed linings or industrial coatings
- ▶ Apply orthopedic casts
- ▶ Make packaging using expanding foam
- ▶ Make polyurethane cushioning
- ▶ Weld polyurethane materials
- ▶ Make polyurethane molds, or
- ▶ Paint airplanes.

Isocyanates can make you sick.

Do you have any of these symptoms?

- ▶ Wheezing
- ▶ Chest tightness
- ▶ Cough
- ▶ Shortness of breath
- ▶ Skin rash or irritation



Worker applying spray-on polyurethane truck bed liner Source: Wikimedia / Creative Commons

FACT SHEET
HESIS

This Isocyanate Factsheet is an Information Alert from HESIS.

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Isocyanates can cause health problems

How are workers exposed?

Isocyanates are toxic until they react with other chemicals to form the hardened or cured polyurethane product. Fully-cured polyurethanes are non-toxic, unless they are heated. Polyurethane materials give off isocyanates and other toxic substances when they are burned or abraded.

Isocyanates can enter the lungs when workers breathe in vapors, mists, or smoke. Workers can also be exposed when liquids, resins, or droplets contact the skin.

Workers who don't handle isocyanates directly, but work near others who are using isocyanates, can still be exposed.

What health problems can isocyanates cause?

Isocyanates can cause skin sensitization, asthma, skin or mucous membrane irritation, and, rarely, a lung reaction called hypersensitivity pneumonitis.

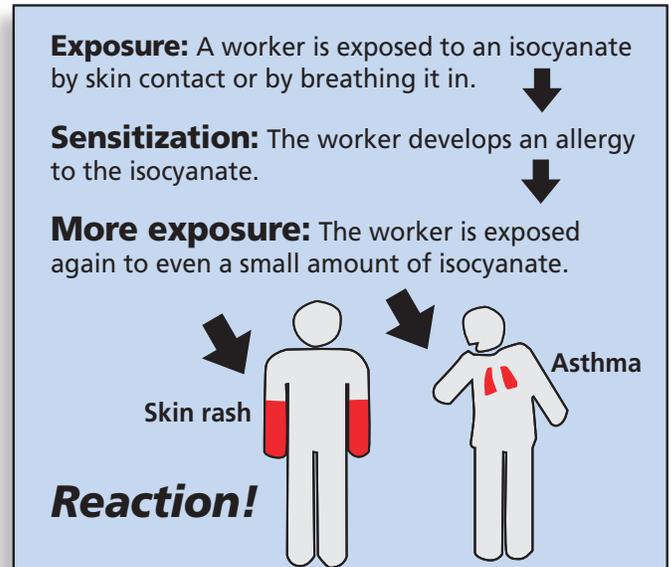
Sensitization (Allergy)

Some workers who are exposed to isocyanates can become sensitized (which means they develop an allergy). When a worker has an isocyanate allergy, small exposures can cause skin or lung reactions.

Asthma is the most common form of isocyanate allergy. Symptoms of asthma are:

- wheezing
- tightness in the chest
- cough
- shortness of breath

Asthma symptoms can occur while you are at work, or you might notice them later, after a day's work. If you think you might have work-related asthma, tell your doctor that



you work with isocyanates. Your doctor will send you for breathing tests.

Continued exposure to isocyanates can make the asthma worse. After a worker is sensitized, any exposure, even to low levels, can produce an asthma attack which may be life threatening. Workers sometimes have to change jobs if they cannot be protected from isocyanates.

Sensitization by skin contact can cause allergies that affect the skin or the lungs. A skin specialist can do a patch test to determine if a worker's rash is caused by isocyanates.

➤ Irritation

Isocyanates can be irritating to the eyes, nose, throat, skin, and lungs. Sensitization can occur from levels in air that are lower than those that produce irritation.

➤ Cancer

Although isocyanates have not been found to cause cancer in workers, one isocyanate, TDI (toluene diisocyanate), was found to cause cancer in some laboratory animals. A cancer warning therefore accompanies any TDI-containing product.

➤ Reproductive Health

Isocyanates are not likely to cause problems with human fertility, pregnancy, or fetal development.

Employers need an Isocyanate Safety Plan

1. Substitution

Read the Safety Data Sheet to learn about the chemicals in the products you use on-the-job. When practical, choose materials that do not contain isocyanates.

2. Engineering Controls

Design work areas to limit contact with isocyanates.

- ▶ **Isolation:** When possible, isolate workers from isocyanates by using automated equipment operated from a control booth or room with a separate air supply.
- ▶ **Ventilation:** Use ventilation systems to reduce the levels of isocyanates in the air.

3. Cleanup

- ▶ Clean up isocyanates that get on work surfaces.
- ▶ Wash skin immediately with soap and water if contact occurs.
- ▶ Provide an **eyewash and shower** for emergencies.

4. Administrative Controls

- ▶ **Exclusion:** Where isocyanates are being used, restrict access to protected workers only.
- ▶ **Medical monitoring:** Exposed workers should be monitored for symptoms of sensitization.
 - Medical exams are recommended on initial employment and once a year as long as workers continue to be exposed.
 - Medical monitoring should include a general medical exam, breathing tests, and questions about past work and health.
 - Physicians who treat isocyanate-exposed workers must be given information about any exposures that the worker has had.
- ▶ **Medical removal:** Exposure to isocyanates after sensitization occurs is hazardous. Once sensitized, workers must be protected from further exposure. Personal protective equipment may not be sufficient, and reassignment may be necessary.

5. Personal protective equipment (PPE)

Use **barriers** to protect the skin and eyes.

- ▶ Cover all exposed skin. Disposable suits protect better than street clothes.
- ▶ Use gloves made from neoprene, nitrile, or butyl rubber.
- ▶ Wear eye protection such as chemical safety goggles or a full-face respirator when handling a liquid or spraying isocyanates.

Respiratory protection is needed in inadequately ventilated workplaces and when isocyanate-containing material is heated or sprayed.

- ▶ **Respirator choice** is based on the measured or expected levels of isocyanate in the worker's breathing zone, other hazards present, and individual characteristics of the worker. Supplied-air respirators are most protective. When air-purifying respirators are used to protect against isocyanates, use organic vapor cartridges. When particles, droplets, or sprays are also present, use combination N-95 filter / organic vapor cartridges.
- ▶ **A medical clearance** ensures each worker can safely wear a respirator.
- ▶ **A fit test** ensures each worker has a respirator that seals to their face. A quantitative fit test is best and is required for full-face and supplied-air respirators, but a qualitative fit test is acceptable for half-mask respirators.
- ▶ **The respirator cartridge replacement schedule** is based on information such as air monitoring data and the capacity of the cartridge. Professional guidance from an industrial hygienist or respirator manufacturer is helpful in determining a schedule.
- ▶ **Training on respirator use.** For more information on respirators, see www.cdph.ca.gov/programs/ohb/Pages/Resp.aspx

6. Train Workers to:

- ▶ Recognize the hazards
- ▶ Know the health effects and early symptoms
- ▶ Use ventilation systems
- ▶ Use protective clothing and respirators
- ▶ Wash up before taking breaks or going home.

Implementing an Isocyanate Safety Plan in an

Autobody Shop

Automotive refinishing products that use isocyanates are generally formulated with polyisocyanates derived from hexamethylene diisocyanate (HDI) and isophorone diisocyanate (IPDI). Many activators and hardeners used in auto body shops contain isocyanates. Even water-based products can contain isocyanates! Check labels and Safety Data Sheets to identify the products you work with that contain isocyanates. Spraying can release high levels of isocyanates into the air. Mixing 2-component paints and cleaning spray guns can also expose workers to isocyanates.

1. Substitution

- ▶ Isocyanates cannot be completely avoided in automotive refinishing. Clearcoats always contain isocyanates.
- ▶ When possible, choose isocyanate-free one-component (1K) products.
- ▶ There are isocyanate-free primers available that work on a wide variety of materials.

2. Engineering Controls

- ▶ Spraying can release high levels of isocyanates into the air. Use well-maintained spray booths to capture overspray and vapors.
- ▶ Work areas used for mixing isocyanates should be well ventilated.
- ▶ Exhaust systems protect body shop workers and the environment.
- ▶ Use high volume low pressure (HVLV) nozzles—as required by many Air Districts—to help reduce worker exposures.

3. Administrative Controls

See page 3 for administrative controls.

4. Training

See page 3 for training points.

5. Personal protective equipment (PPE)

- ▶ **Spray suits:** Anti-static spray suits with head coverings are recommended for spraying.
- ▶ **Gloves:** Painters should wear nitrile gloves when handling and spraying isocyanates. When handling a solvent such as methyl ethyl ketone, use more resistant butyl rubber gloves.
- ▶ **Respirators:**
 - Mixing:** For paint mixing that does not generate a mist, air-purifying respirators with organic vapor cartridges may be adequate. Cartridges must be replaced on a schedule based on air monitoring data for the tasks being performed.

Spraying: For paint spraying, a full-face positive pressure supplied-air respirator or supplied-air hood with assigned protection factor of 1,000 is recommended. When isocyanate levels in air are less than 25 times the exposure limits, a powered air purifying respirator (PAPR) with paint spray cartridge combining an organic vapor cartridge and pre-filter may be an acceptable alternative. PAPRs need to be “intrinsically safe” (explosion-proof) and a cartridge change schedule will be needed.

See page 3 for more information on respirator programs.



Worker applying spray paint to automobile

Source: Auto Prévention (autoprevention.qc.ca)

Implementing an Isocyanate Safety Plan for

Spray Polyurethane Foam (SPF)

Poor controls and work practices during polyurethane foam spraying can lead to health effects from exposure to MDI (methylene diphenyl diisocyanate) and its pre-polymers. Roofers and insulation workers can be exposed to MDI by breathing it in, through skin contact, and by touching things that go into their mouths, like cigarettes or food.

1. Substitution

- ▶ Preformed (rather than spray) foam insulation can be used for selected applications.
- ▶ For protective coatings over spray foam, choose materials such as acrylic, silicone, or butyl rubber, instead of 2-component products formulated with isocyanates (polyureas or polyurethanes).

2. Engineering Controls

- ▶ For indoor applications, isolate operations from occupied areas and use active area ventilation.

3. Administrative Controls

- ▶ Require workers to wash hands before breaks and before going home. Maintain skin protection during cleanup operations, and dispose of gloves and coveralls properly.
- ▶ **Roofing:** Provide portable hand-washing stations at worksites.
- ▶ **Outdoor spraying:** Stop spraying during windy conditions to protect bystanders.
- ▶ **Indoor spraying:** During active spraying and until curing is completed, limit access to SPF workers only.



Worker applying SPF roofing material

Source: Thomas Gravenstreter

4. Training

See page 3 for training points.

5. Personal protective equipment (PPE)

▶ Roofing:

- Wear chemically-resistant coveralls (such as Tychem®) with long sleeves, long pants, head covering, boots, and gloves during spraying, even in hot weather. Roofers' exposure to MDI often exceeds allowable limits, so respirators will be needed. For spraying outdoors, wear a full-face air-purifying respirator with organic vapor cartridges and particle filters.
- Cartridges must be replaced on a schedule based on air levels and the capacity of the cartridge. If air levels are not available, change the cartridges at least every 8 hours.
- Full-face respirators are more protective than half-masks and offer eye protection.
- If fall hazards are not present, supplied-air respirators can provide a higher degree of respiratory protection.

▶ Indoor insulation:

- Levels of MDI will be highest when foam is sprayed in enclosed spaces. A supplied-air respirator is recommended for indoor SPF application. See page 3 for information on respirator programs.



Worker applying SPF interior insulation

Source: Wikimedia / Creative Commons

RESOURCES

REGULATIONS THAT HELP PROTECT WORKERS

➤ **Exposure Limits.** Exposure limits are the maximum levels of isocyanate permitted in air in a worker's breathing zone. Employers must determine if employees are exposed to isocyanates and must maintain exposures below these limits. Cal/OSHA enforces the following exposure limits:

- Permissible exposure limits (PELs) are the maximum average exposure over 8 hours. TDI, MDI, HDI, and IPDI have PELs of 5 parts per billion (ppb).
- Short-term exposure limits (STELs) are the maximum average exposure over 15 minutes. TDI and IPDI have of STELs of 20 ppb.
- Ceiling limits are levels that are never to be exceeded at any time. TDI has a ceiling limit of 20 ppb, and NDI has a ceiling limit of 10 ppb.

Note: A sensitized worker may have symptoms even when exposed to levels that are below these legal limits.

See California Code of Regulations (CCR), Title 8, Section 5155

www.dir.ca.gov/title8/5155.html.

➤ **Hazard Communication.** This standard (CCR Title 8, Section 5194) requires your employer to tell you if you are working with hazardous substances, train you to work with them safely, and make Safety Data Sheets available. www.dir.ca.gov/title8/5194-May-6-2013.html.

➤ **Respiratory Protection.** This standard (CCR Title 8, Section 5144) requires employers to provide respirators when necessary to protect the health of employees. See www.dir.ca.gov/title8/5144.html.

List of Isocyanates: Methylene diphenyl diisocyanate (MDI), Polymeric MDI, Toluene diisocyanate (TDI), Isocyanurate of TDI, TDI-trimethylolpropane adduct, Polymeric TDI, Hexamethylene diisocyanate (HDI), HDI isocyanurate, HDI biurate, Polymeric HDI, Isophorone diisocyanate (IPDI), IPDI isocyanurate, Polymeric IPDI, Naphthalene diisocyanate (NDI), Methylene bis-cyclohexylisocyanate (HMDI).

WHERE TO GET HELP

- **HESIS.** Answers questions about chemicals and other workplace hazards for California workers, employers, and health professionals. Call **(510) 620-5817** or **(866) 282-5516** toll free in California. To request a copy of any of our free publications, leave a message at **(510) 620-5717** or **(866) 627-1586** toll free in California, or visit www.cdph.ca.gov/programs/ohb.
- **California Division of Occupational Safety and Health (Cal/OSHA).** Investigates workers' complaints about workplace health and safety issues. Identities of workers making complaints are kept confidential. To find the nearest Cal/OSHA Enforcement District Office, visit www.dir.ca.gov/dosh/DistrictOffices.htm.
- **Cal/OSHA Consultation Service.** Helps employers who want free assistance to improve health and safety conditions and comply with Cal/OSHA regulations. Employers can call **1-800-963-9424**.

ADDITIONAL RESOURCES

- **The American Chemistry Council** has free online health and safety training. www.spraypolyurethane.org
- **The NIOSH MultiVapor™** computer tool may assist an industrial hygienist or other qualified person to set cartridge change-out schedules. www.cdc.gov/niosh/npptl/multivapor/multivapor.html
- **NIOSH Isocyanate topic page.** <http://www.cdc.gov/niosh/topics/isocyanates/>
- **OSHA Isocyanate topic page.** <https://www.osha.gov/SLTC/isocyanates/index.html>

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