



A Guide to Preventing Asthma and Death When Applying Spray-on Truck-bed Liners

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Summary

Spray-on truck-bed liners contain diisocyanates – chemical compounds that can cause serious health problems and even death from overexposure during the spraying process. There are many steps you can take to protect yourself and your employees. Your current practices may not be enough to prevent overexposure.

In Washington State, there has been a recent increase in workers' compensation claims for work-related asthma related to spray-on truck-bed liners. Worker monitoring by the department has shown an unusual level of diisocyanate exposures above permissible limits. In 2003, a worker in Michigan died from an asthma attack after applying a spray-on liner.

This guide is an update of a WISHA (Washington Industrial Safety and Health Act) Hazard Alert¹ distributed by the Department of Labor and Industries in March 2003.

Why is there a problem?

Applying spray-on truck-bed liners can expose workers to high levels of diisocyanates. Diisocyanates are a group of very reactive compounds used to make urethane, polyurethane and polyurea coatings. Spray-on truck-bed liners, automotive paints and rigid foams are examples of materials that can contain diisocyanates.

Protective liners are applied to truck beds using a spray-application process. All spray-on truck-bed liners involve mixing two-part urethane components and spraying the polymerizing urethane onto a cleaned and scuffed truck bed. The greatest risk of overexposure occurs when the mixture is applied in a poorly ventilated area. It is important to realize that the object being sprayed can also create a confined area that greatly increases the airborne concentration of diisocyanate.

The greatest risk is from breathing in the fine droplets (aerosols) generated by the spray gun. If the spray operation is not well controlled, especially with properly functioning exhaust ventilation, then shop helpers, office workers, sales staff, managers and others can also be exposed to lower but potentially harmful levels of diisocyanates.

In the 2003 Michigan case, a worker in his mid-forties died from an acute asthmatic attack after applying a diisocyanate-based spray-on bed liner to the interior of a van.^{2,3} He was found outside of the building, on his knees gasping for breath. Attempts at CPR were unsuccessful, and he was pronounced dead 46 minutes later. The Medical

Examiner's findings were summarized as "asthmatic reaction due to inhalation of chemicals." After he died, co-workers mentioned that the victim had difficulty breathing after previous spray-liner applications.

This death occurred *even though the individual was wearing the appropriate type of respirator for the task* – a positive pressure respirator with supplied fresh air. However, in this case, the worker had modified the respirator and he was using a hose that was too long for the pump to which it was attached. He hadn't been fit-tested for the respirator nor had he had a medical evaluation for the job. In addition, it is unknown whether the respirator leaked or whether the worker took off the respirator in the spray area after spraying or both.

This incident highlights the need to ensure that enclosures are properly ventilated, respirators and other personal protective equipment (PPE) are maintained and used according to the manufacturer's instructions, and that workers receive appropriate training.

Having a medical-monitoring program in place – under the supervision of a qualified physician – may have also helped to prevent this tragedy.

Approximately 200 businesses in Washington State are involved in spray-on truck-bed liner application. Although no fatalities have been recorded in Washington State, several cases of asthma have been found in truck bed liner application workers.

What are the health effects from exposure?

The following health effects may occur **immediately or shortly** after exposure to diisocyanates:

- Allergic sensitization, which is a permanent condition where breathing or skin problems can return with increasing severity following further exposure to the sensitizing agent, even at very low exposure levels.
- Wheezing, shortness of breath or coughing.
- Irritation of the eyes and lungs.
- Stuffiness of the nose.
- Sore throat.
- Tightness in the chest.

These symptoms may be delayed up to eight hours after the person has been exposed. Workers who develop breathing problems should see a doctor *immediately*.

The following **long-term** health effects may occur at some time after exposure and can last for months or years:

- Permanent breathing or chest problems, including asthma, even when no longer exposed.

- Increased sensitivity. Severe asthma attacks could result if a person is exposed again – even at concentrations well below the established exposure limits. Once sensitized to diisocyanates, a worker should not be exposed to any concentration and should not be allowed to work where he or she may be exposed further.
- Repeated or prolonged exposure of the skin to diisocyanates may cause a skin rash and cause an allergic skin reaction.

An unusual property of diisocyanates is their ability to sensitize the respiratory system (i.e., lungs) even if the initial exposures are only to the skin (there may be no reaction on the skin). This means that a worker who gets diisocyanates on their skin may later have a very severe allergic reaction (like asthma) when they breathe in these compounds.

What if a worker develops symptoms?

Workers who develop any of the symptoms listed above should see a doctor immediately and not return to the shop until a physician has cleared them. Continued exposure could lead to permanent lung damage and even death from a severe asthmatic reaction.

How do I protect my workers and myself?

There are several steps you must take to ensure that you and your workers do not breathe in or come in direct contact (via the skin or eyes) with diisocyanates.

If you use diisocyanates or products containing diisocyanates, you must **determine the potential for worker exposure**. In most spray-on bed liner operations, diisocyanates will become airborne during the application process. Depending on the bed liner product and efforts at control, diisocyanates may be present above the permissible exposure limit (PEL). Your sense of smell will not warn you that you are being overexposed to these compounds. Measuring the amount of diisocyanates in the air is the only reliable way to determine the exposure level. If you need assistance in taking the measurements, you can call an L&I safety and health consultant (see the last page for contact information).

You must **control employee exposures** to diisocyanates. There are three ways to control exposure to diisocyanates: engineering controls, work practices, and personal protective equipment.

- 1. Engineering controls.** Whenever possible, engineering controls should be the first line of defense to control exposure:
 - Ventilation systems and spray areas must be designed to contain, capture, dilute, and direct the spray aerosol to a safe location – to reduce exposure to the sprayer and others.
 - Although they are not specifically designed for spray-on truck-bed liner applications, drive-in vehicle spray booths are commercially available and may work well when properly installed and maintained.

- A contractor or engineer knowledgeable about industrial ventilation principles should be consulted. References such as the American Conference of Governmental Industrial Hygienists (ACGIH) *Industrial Ventilation* manual should be used when designing a custom-made truck-bed-liner enclosure.
- Ask your supplier or product manufacturer about spray equipment or processes that can reduce overspray.
- Filters for ventilation equipment should be changed frequently because they can clog rapidly and reduce the effectiveness of exhaust ventilation.
- Ventilation equipment should be checked daily for adequate performance and inspected at least every three months for preventative maintenance.

Common mistakes include:

- Insufficient volume of air – the enclosure should have similar levels of flow as a paint spray booth; and
- Poorly located or no make-up air for the enclosure – arrange for make-up air along with the location of the exhaust to direct the aerosol away from the sprayer.

2. Work practices. Make sure that all workers near the area understand that they may be exposed to diisocyanates under the following circumstances:

- In the enclosure during spraying.
- Outside the enclosure due to leakage.
- Entering the enclosure before the overspray has cleared.
- Near exhaust air from the ventilation system.
- Removing respirators inside the enclosure.

Ensure that the following good practices are followed:

- Worker position during spraying is very important. While spraying, workers should minimize the amount of time they stand between the truck bed and the exhaust-air outlet – otherwise the ventilation system may draw the aerosols towards the worker, increasing exposure. Whenever possible, the worker should stand outside of the truck bed while spraying.
- All workers must wear appropriate personal protective equipment.
- If diisocyanate compounds come into contact with skin, workers should immediately wash off any material. Sprayers should always wear full body protection and gloves.
- Do not allow workers to eat, drink or smoke where diisocyanates are handled, processed or stored.
- Workers should wash their hands before eating, drinking, smoking, or using the bathroom.

- Do not allow workers to take contaminated clothing home. Provide workers with clean clothing or disposable garments.
- Ambient-air pumps that supply breathing air for supplied-air respirators must be serviced according to the manufacturer's recommendations. The placement of the pump must not introduce exhaust gases at the intake.
- All spills and leaks of diisocyanates should be given prompt attention by trained personnel. Contaminated materials must be handled and disposed of appropriately.

3. Personal protective equipment.

- **Respirators:** Even when ventilation controls are used, a full-face positive-pressure supplied-air respirator should be worn while applying spray-on diisocyanate bed liners - including the applicator and anyone located inside the spray enclosure during spraying.

The respirator should not be removed until the spraying has stopped and the airborne spray mist has cleared. When using a supplied-air respirator, ensure that there is adequate airflow to the facepiece – by meeting the manufacturer's pressure ranges specified for the respirator and hose length. A minimum of 4 cubic feet per minute (cfm) is required for a tight-fitting facepiece and 6 cfm for a loose-fitting hood.

An air-purifying respirator may be used if the breathing zone diisocyanate concentrations do not exceed the assigned protection factor for the respirator style. A full-face respirator is preferred because it provides eye and skin protection. The respirator must be equipped with combination organic vapor cartridges/P100 filters. Respirators equipped with organic vapor cartridges/P100 filters should be used by helpers who can be exposed to bed-wipe solvents and paint dusts. A change schedule must be established for the organic vapor cartridges. Change schedules are based on the particular air contaminant, the exposure level, the work pace of the employee, and environmental conditions such as temperature and humidity. The P100 filters must be changed whenever they become plugged with particulate and/or when breathing resistance increases.

A written respiratory protection plan is required whenever respirators are used. Any respirator use must, at a minimum, meet the requirements of the WISHA respiratory protection rules found in Chapter 296-842 WAC. Any worker who is assigned a task that requires the use of a respirator must be physically able to perform the work while using the respirator. Therefore, an employer must establish a medical evaluation program to determine if employees can tolerate the stresses associated with respirator use. *Please note that this medical evaluation for respirator use is different from the medical monitoring for diisocyanate exposure described below.*

- **Clothing, goggles, gloves, etc.:** When there is a chance for skin or eye contact with diisocyanates, workers should be provided with and required to use appropriate personal protective clothing and equipment. Depending on the task, protective wear includes coveralls, head cover, footwear, chemical-resistant gloves and eye protection, including goggles or full-face shield. Protective clothing should be made of a material resistant to diisocyanates. For example, nitrile gloves should provide sufficient protection. Most solvents have rapid break-through times for latex gloves, which are not recommended.

Control methods must be re-evaluated if anyone working around the operation develops breathing or skin problems.

What else can I do to be sure workers are protected?

Although there is no legal requirement, a **medical-monitoring program** should be established for the early detection and prevention of health problems. Physical examinations by an occupational physician should be given to workers who will be regularly exposed to diisocyanates at the beginning of their employment, with follow-up visits on an annual basis. If workers develop symptoms of diisocyanate overexposure, a pulmonary (lung) specialist can judge whether he or she has become sensitized. Once sensitized, a worker should no longer work in an area where further diisocyanate exposure is possible. *Please note that this voluntary medical-monitoring program for diisocyanate exposure is different from the medical evaluation for respirator use described above, which is required under the law.*

Employee **education and training** is vital to a good occupational safety and health program. WISHA workplace safety rules require that workers be informed about:

- Operations or work areas where diisocyanates are used.
- The physical and health hazards of the diisocyanates, including the likely symptoms from exposure. The Material Safety Data Sheet (MSDS) has a section that covers this vital information.
- How employees can protect themselves from these hazards, including an understanding of the steps you have taken (i.e., engineering controls, work practices, emergency procedures, and personal protective equipment.).
- Details of your company's Hazard Communication Program, including explanations of the labeling system, health-hazard data on the MSDS, and how workers can get and use this information.

Pay attention to **other industry hazards**, such as hazardous materials used in the bed lining process. Exposures to the solvents used to wipe down the scuffed surface (such as acetone and methanol) can exceed permissible exposure limits. Safer solvent substitutes such as denatured alcohol (ethanol), lacquer thinner, or wax and grease removers should be considered. In order to eliminate static discharge and potential fire, the drum containing a flammable solvent and the container being filled require a bonding wire to ground.

Plunger cans (Justrite®, Eagle®) are the best way to handle flammable liquids because solvent use can be kept to a minimum and rag saturation can be controlled. Always use the minimum amount of solvent to do the job.

Methanol is not approved for use with organic vapor cartridge respirators because of very short break-through times. Acetone can migrate through organic vapor cartridges, and they should be changed out daily. Information about respirator cartridge change schedules is available from an L&I safety and health consultant or the OSHA website.

What if I need help?

L&I offers free safety and health consultations. At your request, a safety and health consultant will come to your business and analyze your employee safety and accident prevention programs. The consultant can take air samples to measure exposure to diisocyanates and solvents. The consultant can also provide engineering-control guidelines and written program assistance.

For a free on-site consultation or help assessing workplace exposure, call your regional L&I office and ask for a WISHA consultation supervisor.

Region 1: 425-290-1431

(Island, San Juan, Skagit, Snohomish, and Whatcom counties)

Region 2: 206-515-2800

(King County)

Region 3: 253-596-3917

(Clallam, Jefferson, Kitsap, and Pierce counties)

Region 4: 360-902-5472

(Clark, Cowlitz, Grays Harbor, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston, and Wahkiakum counties)

Region 5: 509-886-6570

(Adams--west side, Benton, Chelan, Columbia, Douglas, Franklin, Grant, Kittitas, Okanogan, Walla Walla and Yakima counties)

Region 6: 509-324-2600

(Adams--east side, Asotin, Ferry, Garfield, Lincoln, Pend Oreille, Spokane, Stevens and Whitman counties)

Employees have the right to make confidential complaints about unsafe working conditions by calling a regional L&I office and asking for a WISHA Compliance Supervisor.

Reference and Resources

WISHA Hazard Alert

¹ “Spray-on urethane truck bed linings and isocyanate exposures”, March 2003, www.LNI.wa.gov/wisha/hazalerts/March2003HazardAlert_Final_.pdf

Michigan State University Reports

² Project Sensor News: “Fatal work-related asthma”, Volume 14, No.4, Fall 2003, <http://web2.chm.msu.edu/oem/news/Sv14n4.pdf>

³ Michigan Fatality and Control Evaluation (MIFACE) Investigation #03MI018, December 2003, www.chm.msu.edu/oem/miface/03mi018.pdf

WISHA Rules

Safety and Health Core Rules, Chapter 296-800 WAC, www.LNI.wa.gov/wisha/rules/corerules/default.htm

Employer Chemical Hazard Communication, Chapter 296-800-170 WAC, www.LNI.wa.gov/wisha/rules/corerules/HTML/296-800-170.htm

Respiratory Protection:

www.LNI.wa.gov/Safety/KeepSafe/Programs/Respiratory/default.asp

Air Contaminants, Chapter 296-62 WAC, Part H,

www.LNI.wa.gov/WISHA/Rules/generaloccupationalhealth/HTML/62H_1.htm

Other rules may apply.

Occupational Safety and Health Administration (OSHA)

OSHA general website: www.osha.gov/

Isocyanate-specific information: www.osha.gov/SLTC/isocyanates/index.html

Respirator Change Schedules:

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

National Institute for Occupational Safety and Health (NIOSH)

NIOSH (National Safety & Health Topic: “Isocyanates”

www.cdc.gov/niosh/topics/isocyanates

NIOSH “Criteria for a Recommended Standard: Occupational Exposure to Diisocyanates,” September 1978, DHHS (NIOSH) Publication No. 78-215, www.cdc.gov/niosh/78-215.html

NIOSH Hazard Alert: “Preventing Asthma and Death from Diisocyanate Exposures”, 1996, DHHS (NIOSH) Publication No. 96-111 www.cdc.gov/niosh/asthma.html

Alliance for the Polyurethanes Industry (API)

The Environmental Health and Safety section of API's bookstore includes the following technical documents that provide information about MDI and other diisocyanates:

www.polyurethane.org/bookstore/bookstore.asp#15:

- Working with MDI and Polymeric MDI: What You Should Know.
- Hyperreactivity and Other Health Effects of Diisocyanates: Guidelines for Medical Personnel.
- Suggested Protective Clothing for Potential Exposure During Handling of MDI.