



Labour

Control Measures Guide

**Control measures to eliminate or reduce
exposure of employees to isocyanates in
spray-painting operations**

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The purpose of this control measures guide is to assist a Health and Safety Officer, as well as, any other individual who possesses the knowledge, experience, and training in the occupational health and safety field in verifying whether the health of an employee is protected from exposure to isocyanates during spray-painting operations.

This guide is intended for those officers who specialize in Part II of the *Canada Labour Code* and the pursuant regulations. It can also be used to assist employers in federally regulated work places in complying with the control measures requirements prescribed in the *Canada Occupational Health and Safety Regulations* (COHSR), as well as, in other *Health and Safety Regulations* made under Part II of the *Canada Labour Code*. These include the *Marine, Rail, On-board Trains* and *Oil and Gas Occupational Health and Safety Regulations*.

Table of Contents

	Page
Introduction	3
Health Effects	3
Threshold Limit Value	4
Control Measures	4
• Ventilation	6
• Respiratory Protection	7
• Protective Clothing	8
• Medical Surveillance	9
• Training	9
• Spills and Decontamination	10
• Storage	11
Reference Material	12
Contact	13

Introduction

Isocyanates are chemical compounds which contain one or more $-N=C=O$ functional groups. In reaction with polyalcohols, isocyanates polymerize and form macromolecular compounds, the so-called polymers.

Hexamethylene diisocyanate (HDI) is an aliphatic isocyanate which is almost exclusively used in the production of paints and surface coatings. The monomer of HDI possesses such properties that make the isocyanate effectively irreplaceable, e.g. it gives the product excellent durability, colour stability, resistance to chemicals and light, as well as resistance to extreme temperatures. In spraying isocyanate paints and primers, HDI is present in two forms, monomer and polymer. The monomer content is usually less than 1%.

Other very important isocyanates are:

- toluene diisocyanate (TDI),
- diphenylmethane diisocyanate (MDI),
- naphthalene diisocyanate (NDI), and
- isophoron diisocyanate (IPDI)

Health Effects

Potential health effects associated with exposure to free/unreacted isocyanates include skin and eye irritation and skin and respiratory sensitization.

NOTE:

Fully cured paints contain no free isocyanates and therefore, do not present any danger.

Some of the most common symptoms experienced by workers exposed to isocyanates are:

- excessive tear secretion,
- dry throat,
- dry cough,
- chest pains, and
- difficulty in breathing.

Direct skin contact may cause rashes, blistering, hardening and reddening of the skin. If the liquid splashes into the eyes, damage to the cornea can occur.

Isocyanates are considered to be one of the main causes of occupational asthma worldwide. The results of one study conducted on the compensations paid by the CSST in Quebec, between 1988 and 1997, indicate that out of 531 registered cases of occupational asthma, 27% have been related to exposure to isocyanates.

Threshold Limit Value

Part X, *Hazardous Substances* of the COHSR and of other *Health and Safety Regulations* issued pursuant to Part II of the *Canada Labour Code* reference the American Conference of Governmental Industrial Hygienists (ACGIH) publication entitled *Threshold Limit Values and Biological Exposure Indices*. The ACGIH lists a Threshold Limit Value (TLV) of 0.005 ppm as an 8-hour time-weighted average concentration for HDI monomer but there is no TLV adopted for polyisocyanates.

Control Measures

When concentrations to the HDI monomer exceed the TLV, the employer is required to reduce worker exposure to the contaminant below the prescribed limit. Since there is no TLV for HDI

polyisocyanates, it is necessary that exposure to the polymer be reduced to the minimum.

Section 19.5 of Part XIX of the COHSR states that the employer shall, in order to address identified and assessed hazards, take preventive measures that consist first of the elimination of hazards, then the reduction of hazards and finally, the provision of personal protective equipment. As part of the preventive measures, the employer is also required to develop and implement a preventive maintenance program.

In work places where isocyanate containing materials (paints, coatings etc.) are used, as per COHSR section 10.4, the employer must appoint a qualified person to carry out the necessary hazard investigation and to set out in a written report recommendations for complying with COHSR sections 10.7 to 10.24, specifically with respect to:

- medical examinations,
- storage, handling and use,
- warning of hazardous substances,
- employee education,
- substitution of substances,
- ventilation,
- control of hazards,
- warnings, and
- assembly of pipes.

Some of the key control measures recommended by the qualified person to eliminate or reduce exposure of an employee to isocyanates may include the following:

- ventilation,
- respiratory protection,
- protective clothing,

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- medical surveillance,
 - training,
 - spills and decontamination, and
 - storage.

Ventilation

Subsection 10.17(1)(a) of the *Canada Occupational Health and Safety Regulations* requires that every ventilation system to control the concentration of an airborne hazardous substance shall be so designed, constructed, installed, operated and maintained that the concentration of the airborne hazardous substance does not exceed the prescribed limits.

Airless spray paint and air spray paint design data for different types and sizes of paint booths are outlined in the publication of the American Conference of Governmental Industrial Hygienists entitled *Industrial Ventilation* and in the ANSI Standard ANSI Z9.2 *Fundamentals Governing the Design and Operation of Local Exhaust Systems*. For construction and safety, Part 6 of the *National Building Code* must also be consulted. Due to the hazardous nature of isocyanates, it is important that the ventilation is designed and operated in a manner consistent with the prescribed Standards.

Where spray paint booths are used, attention must be paid to the following:

- exhausts are vented to the outside, away from air intakes for the work area,
- the ventilation does not vent back into the work area,
- proper paint arresting filters are in place,
- air filters are placed in doors, when necessary,
- baffles and water curtains are installed, when necessary, and are in operation/use,

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- all of the equipment is approved for use in flammable or explosive atmospheres,
 - for electrostatic spray booth, automatic high-voltage disconnects for conveyor failure, fan failure or grounding are installed and are in operation,
 - sufficient make-up air is provided,
 - exhaust fan interlock with make-up air supply and compressed air to spray gun is installed, when necessary, and is in operation.

Respiratory Protection

The respiratory protection program implemented in the work place must address selection, fit testing, maintenance and inspection. All employees who are provided with and wear respirators must be trained. Reference should be made to the CSA Standard Z.94.4, *Selection, Use and Care of Respirators*.

A respirator must be of a type approved for its intended use and listed in the National Institute for Occupational Safety and Health (NIOSH) *Certified Equipment List* published by NIOSH. There are three types of respirators classified according to the mode of operation:

- atmosphere-supplying respirators,
- air-purifying respirators, and
- combination atmosphere-supplying and air-purifying respirators.

Atmosphere-supplying respirators provide a breathing air that is independent of atmospheric conditions. For air-purifying respirators, ambient air, prior to being inhaled, is passed through a filter, cartridge, or canister that removes particles and gases.

It must be noted that air-purifying respirators for organic vapours can adsorb and remove isocyanates from air. However, due to the isocyanates' poor warning properties, the respirator user will not be able to know that the sorbent is approaching saturation or is no longer

effective. Therefore, NIOSH has not approved any air-purifying respirators for protection against isocyanates.

Since there is no NIOSH approved air-purifying respirator for isocyanates, it is necessary that painters wear a NIOSH certified supplied-air respirator when:

- spraying paints and primers,
- cleaning spray guns by passing solvent through the gun under pressure (free isocyanates may be released into the work environment).

The breathing air that is provided for the purpose of a respirator must meet the standards set out in the CSA Standard Z180.1 *Compressed Breathing Air and Systems*.

NOTE:

Some manufacturers state that for some applications, a half-face or a full-face double cartridge respirator for organic vapours is sufficient to provide limited protection against isocyanates as long as the respirator is worn for no more than one hour – for example, during the dispensing of liquid polyurethane into a container, or the curing process, or touch painting. It is, however, recommended that the manufacturer or the qualified person be consulted every time an air-purifying respirator is used to ensure that the health of the employee is protected from exposure to isocyanates. It may be necessary to change cartridges even more frequently or have them completely replaced after each use regardless of the duration.

Protective Clothing

Since isocyanates can affect the skin and eyes, workers who handle isocyanate containing materials must wear:

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- appropriate solvent-resistant gloves, e.g., nitrile, polyurethane, butyl, laminated PE/EVAL and fluorized rubber,
 - close-fitting boots to protect their feet,
 - coveralls to protect their arms and legs,
 - full face shields with goggles, unless they wear full-face piece respirators to protect their eyes from irritation or splashes.

Medical Surveillance

The qualified person may recommend that medical examination be provided to all workers exposed to isocyanates in the work place. The need for medical examination will depend on how isocyanate containing products are being used and on whether appropriate control measures including respiratory protection are in place. A baseline health assessment should include the isocyanate-exposure history, as well as, pre-existing respiratory conditions and smoking history. It is also recommended that a pulmonary function test be done on a regular basis, at least 48 hours following the last exposure to isocyanates and before the worker is re-exposed. Forced vital capacity (FVC) and forced expiratory volume (FEV) should be measured and the measurements be repeated during, or at the end of the same work shift, between 4 and 10 hours after the worker resumes exposure to isocyanates. Attention should also be paid to each worker's ability to use respiratory protection.

Training

All employees who use isocyanate containing products must receive training with respect to the product use, handling and storage. Particular attention should be paid to ensuring that workers understand the nature of the hazards associated with exposure to isocyanates and the safe ways of doing things. It is also necessary that workers understand the importance of wearing protective clothing and respiratory protection equipment, as well as, the need for good personal hygiene.

Isocyanate containers must be properly labelled and the material safety data sheet (MSDS) for each product must be available. Employers must keep MSDS readily available for examination by employees. A computerized version of the MSDS is acceptable.

Spills and Decontamination

The employer's training program must include procedures to follow in an emergency.

The following items must be part of these procedures:

- wearing respiratory protection and protective clothing during cleaning and decontamination,
- treating the spillage with absorbent material, such as sand or sawdust and with an isocyanate neutralizer (liquid decontaminants containing water, ammonia and detergent are commercially available),
- collecting the residues in a container and if necessary, adding more neutralizer to ensure that the spillage has no free/unreacted isocyanates,
- discarding the residues (usually after one day),
- washing down with the isocyanate neutralizer and marking off with a rope the contaminated surface; "No smoking" signs should be posted,
- cleaning and decontaminating safety equipment.

If there is no qualified person or personnel to take immediate action to clean and decontaminate the spillage, it is necessary that the area be evacuated and the qualified emergency response team be notified. Usually, emergency response teams are on duty 24 hours a day.

Procedures for waste disposal and transport should also be established.

Storage

It is necessary that the following storage requirements be met:

- isocyanates containing materials are stored in a cool, lockable, enclosed area with adequate ventilation;
- isocyanates containing materials are stored separately from incompatible substances, e.g., storing isocyanates away from acids, alkalis or amines, and avoiding risks of mixing and cross-contamination;
- all containers and packaging are properly labelled and MSDS are available;
- access to chemical storage areas is limited to authorized people only;
- flammable, explosive or toxic substances are stored away from possible sources of electric spark, heat or flame;
- all containers are checked against leakage or seepage and lids and caps are kept tightly sealed;
- all workers who handle containers are formally trained in safe procedures for handling chemical containers;
- appropriate fire fighting and emergency equipment is available.

Reference Material

1. Part II of the *Canada Labour Code*
2. *Occupational Health and Safety Regulations* made under Part II of the *Canada Labour Code*
3. *ACGIH Threshold Limit Values (TLVs®) for Chemical Substances and Physical Agents & Biological Exposure Indices (BEIs®)*. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio
4. *ACGIH Documentation of the TLVs® and BEIs®*. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio
5. CSA Standard Z.94.4, *Selection, Use and Care of Respirators*. Canadian Standard Association, Mississauga, Ontario
6. CSA Standard Z180.1 *Compressed Breathing Air and Systems*. Canadian Standard Association, Mississauga, Ontario
7. *NIOSH Pocket Guide to Chemical Hazards*. National Institute for Occupational Safety and Health, Washington, D.C.
8. *Industrial Ventilation. A Manual of Recommended Practice*. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio
9. ANSI Standard ANSI Z9.2 *Fundamentals Governing the Design and Operation of Local Exhaust Systems*.
10. Part 6 of the *National Building Code*
11. *Guide to the Management of Hazardous Substances*. Human Resources and Skills Development Canada – Labour Program
12. Karpinski, E.: *Occupational Exposure to Isocyanates during Spray-Painting of Aircraft*. Human Resources Development Canada – Labour Program
13. *Guide for the Safe Use of Isocyanates*. Institut de recherche Robert-Sauvé en santé et en sécurité du travail – IRSST, Québec

Contact

For additional information or technical assistance regarding the health and safety hazards associated with exposure to isocyanates, or other work-related health and safety issues, contact Eva Karpinski, Industrial Hygiene Engineer, the **Technical Services Unit** of Occupational Health and Safety and Injury Compensation Division, Labour Operations:

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Notes
