Occupational Health and Safety Bulletin

Health and Safety Issues Associated with the Refrigerant HCFC-123 (R-123)

Background

Chlorofluorocarbons (CFCs) have ideal properties for use as refrigerants. They are nonflammable, chemically stable and low in toxicity. Freon 11 (R-11), for example, was widely used for many years as a refrigerant in low-pressure centrifugal chillers for commercial building refrigeration and air-conditioning systems. Similarly, CFC-12 (R-12) was used as a refrigerant in automotive air-conditioning systems and domestic refrigerator-freezers. However, the stability of these refrigerants and their chlorine content have linked them to the depletion of the ozone layer and to an increase in the earth's temperature (the "greenhouse effect").

As part of an effort to protect people and the environment, an international agreement was reached in September 1987 to phase out fully halogenated CFCs by the year 2000 and to regularly review the use of ozone-safe alternative refrigerants, which are scheduled to be replaced no later than 2040. Under the *Montreal Protocol on Substances that Deplete the Ozone Layer*, Canada, the United States and some 55 other nations agreed to restrict the future availability of fully halogenated CFCs. The controlled substances affected by this agreement included CFCs 11, 12, 113, 114 and 115, and Halons 1211, 1301 and 2402.

Hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) are considered the replacements for CFCs in refrigeration and air-conditioning systems. HFCs do not contain chlorine, and their potential for depleting the ozone layer is significantly less than that of CFCs. The hydrogen in the molecular structure of HCFCs increases their instability, which allows the gas to break down in the lower atmosphere before reaching the stratospheric ozone layer. However, while more environmentally friendly, the CFC substitutes may pose different health and safety concerns to users, such as increased toxicity or flammability.

Alberta Government

The leading ozone-safe refrigerant substitute for CFC-11 (trichlorofluoromethane) is HCFC-123, (R-123), (1, 1, 1-trifluoro-2, 2-dichloroethane). According to the *Canadian Ozone Depleting Substances Regulations*, HCFC-123 can continue to be used in Canada until January 1, 2030.

Alberta Human Services supports using environmentally friendly products, as long as employers ensure that the health and safety of workers using the products is protected.

Health effects associated with HCFC-123

Studies conducted with HCFC-123 have indicated that while the gas is not a skin irritant or sensitizer, it is a mild to moderate eye irritant. When inhaled at concentrations greater than 5,000 ppm, HCFC-123 can cause anesthetic effects and affect the central nervous system. Inhalation of more than 20,000 ppm can cause heart damage. The acute health effects from CFC-11 are similar to those for HCFC-123, but occur at much higher concentrations of 10,000 ppm or more. Animal studies have linked exposure to HCFC-123 to the risk of liver damage and liver tumour formation.

Alberta has adopted an occupational exposure limit (OEL) of 50 ppm for HCFC-123 as listed in Table 2, Schedule 1 of the OHS Code. The legislation is available online at:

http://humanservices.alberta.ca/documents/WHS-LEG_ohsc_2009.pdf
Occupational Health and Safety Code

In summary, although the HCFC-123 refrigerant may be more environmentally friendly than CFC-11, it is more toxic and poses a greater potential health risk to people working with and around it. Both HCFC-123 and CFC-11 refrigerants are nonflammable.

Implications of using HCFC in mechanical systems

New installations

The Canadian Standards Association (CSA) Standard B52-05 (R2009), *Mechanical Refrigeration Code*, provides the minimum requirements for refrigeration systems and refrigerating-machinery rooms.

These requirements conform to the refrigerant manufacturer's recommendations and the classification of HCFCs by the American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard 34-2010, *Designation and Classification of Refrigerants*.

HCFC-123 is in the Group B1 refrigerant classification. CFC-11 refrigerant falls into a Group A1 classification. Group B1 includes substances with low flammability and high toxicity. Group A1 is for substances with low flammability and low toxicity.

Refrigeration systems and rooms that use HCFC-123 refrigerant should be designed in accordance with the Group B1 requirements. In view of the more toxic nature of HCFC-123, additional safeguards **must** be considered and incorporated into the design of new systems to protect the health and safety of workers. Appendix A lists design guidelines for additional safeguards for refrigerating-machinery rooms.

Existing installations

The replacement of CFC-11 with HCFC-123 refrigerant in existing refrigeration systems presents several concerns.

Since CFC-11 is classified as a Group A1 refrigerant, while HCFC-123 is classified as a Group B1 refrigerant, existing mechanical rooms must be upgraded to Group B1 refrigerant requirements and include additional safety systems as listed in Appendix A. As well, the use of Group B1 refrigerants in certain types of refrigeration and air-conditioning systems is restricted. For instance, systems containing Group B1 refrigerants may not be used for applications involving air conditioning for human comfort in institutional, commercial, industrial or public spaces.

Furthermore, HCFC-123 is not compatible with neoprene-type elastomer materials typically used in CFC-11 systems. And its strong solvent properties may damage existing Freon refrigerant-system sealing mechanisms. This may cause the refrigerant to leak from the system and pose a greater risk to workers. It is important to ensure that all materials used in the retrofit of refrigeration systems be compatible with the refrigerant used in the system.

The *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*, published by the Environmental Protection Service of Environment Canada, provides additional guidance for retrofitting equipment to use more environmentally friendly refrigerants.

Health and safety precautions

For handling, storage or use of HCFC-123 refrigerant, building owners, contractors and workers must follow the precautions and requirements described in the Material Safety Data Sheet (MSDS) provided by the supplier of the refrigerant. If no MSDS is available at the work site, one should be obtained from the supplier before work begins. The Workplace Hazardous Materials Information System (WHMIS) requires suppliers to provide an MSDS for the refrigerant. Employers are required to make the MSDS available to workers and to ensure that workers have the appropriate training to use the information in the MSDS to protect themselves and others.

Appendix A

Design Guidelines to Address Additional Safety Considerations for Refrigerating-Machine Rooms

In view of the increased toxic nature of some of the refrigerants or refrigerant substitutes, safety systems to prevent worker exposure to these refrigerants must be provided and incorporated into the new design or retrofitting of refrigeration systems or rooms. Such design features include:

- Installing a refrigerant leak-detection or monitoring system with remote sensors located in the refrigerating-machinery room to monitor continuously any leaks of refrigerant inside the room. This system should be capable of activating a warning system with a warning light or alarm, etc., if refrigerant exceeds a pre-set concentration or level due to a leakage to alert people inside and outside the room of the leak, so that it can be quickly located and repaired.

- Locating the exhaust pick-ups of the mechanical general-exhaust ventilation system for the refrigerating-machinery room from low-lying areas near the refrigerating equipment. Leaked refrigerant is heavier than air and is likely to accumulate in these areas.

- Installing a local-exhaust or leak-collection system, in addition to the general-exhaust system, near the refrigerating equipment. This applies to any refrigerating-machinery room using refrigerants with moderate toxicity or classified as belonging to Group B1. Such a system will remove leaking refrigerant to the outdoors or into a refrigerant recovery system while emergency repair is underway.

- Locating the exhaust discharge of any refrigerant exhaust ventilation system away from any building-air system intakes, above ground level and away from pedestrian areas. This will prevent such contaminant from re-entering the building and reduce the public's exposure to these toxic refrigerants.

- Routing any emergency refrigerant discharge from pressure-relief or purge devices to discharge outdoors, away from fresh-air intakes or pedestrian areas.

To protect staff and maintenance personnel from the harmful effects of toxic refrigerants, provide approved respiratory protective equipment in appropriate areas for maintenance and escape purposes. Develop a safe-operating procedure that includes refrigerant-leak handling and other emergency measures, and ensure that the respiratory protective equipment is being used.

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