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Project Summary

Prevention Reference Manual: Chemical Specific, Volume 6: Control of Accidental Releases of Carbon Tetrachloride (SCAQMD)

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The South Coast Air Quality Management District (SCAQMD) of California has been considering a strategy for reducing the risk of a major accidental air release of toxic chemicals. The strategy, which will serve as a guide to industry and communities, includes monitoring activities associated with the storage, handling, and use of certain chemicals. This manual summarizes information that will aid in identifying and controlling carbon-tetrachloride-associated release hazards specific to the SCAQMD.

Carbon tetrachloride has an immediately dangerous to life and health (IDLH) concentration of 300 ppm, making it a moderate acute toxic hazard.

To reduce the risk associated with an accidental release of carbon tetrachloride, the potential causes of releases from processes using carbon tetrachloride in the SCAQMD must be identified. Such measures include recommendations on: plant design practices; prevention, protection, and mitigation technologies; and operation and maintenance practices. Conceptual costs of possible prevention, protection, and mitigation measures are estimated.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The South Coast Air Quality Management District (SCAQMD) conducted a study in 1985 to determine the presence, quantities, and uses of hazardous chemicals in the SCAQMD, which comprises Los Angeles, Orange, San Bernandino, and Riverside Counties. This study culminated in a 1985 report, "South Coast Air Basin Accidental Toxic Air Emissions Study," which outlined an overall strategy for reducing the potential for a major toxic chemical release.

The strategy involves monitoring industry activities associated with the storage, handling, and use of certain chemicals to minimize the potential for accidental releases and the consequences of any releases that might occur.

This volume of the manual discusses process operations and practices relating to the prevention of accidental releases of carbon tetrachloride as it is used in the SCAQMD.

Carbon tetrachloride is manufactured commercially by chlorinating carbon disulfide or hydrocarbons at pyrolytic temperatures. Its primary current applications include chlorofluorocarbon production, grain fumigation, and use as a reaction medium. In the SCAQMD, carbon tetrachloride is used primarily as a reactant in chlorofluorocarbon manufacture and as a solvent in the chlorination of paraffins.

Potential Causes of Releases

Carbon tetrachloride can be used safely in appropriate processing and storage equipment; however, there are many possible sources of a hazardous release. Large-scale releases could result from leaks or ruptures of large storage vessels or from the failure of process machinery such as pumps. Failures leading to accidental releases may be caused by process, equipment, or operational problems.

Possible process causes of a carbon tetrachloride release include: (1) backflow of chlorofluorocarbon process reactants to a carbon tetrachloride feed tank; (2) inadequate water removal from carbon tetrachloride and hydrocarbon feedstock feed in the chlorofluorocarbon process, leading to possible corrosion; (3) excessive feeds in any part of the system, leading to overfilling or overpressuring of equipment; (4) loss of condenser cooling to distillation units; and (5) overheating in reactors or distillation units.

A carbon tetrachloride release can also be caused by: the failure of vessels at normal operating conditions brought on by excessive stress, corrosion, or external loadings; mechanical fatigue and shock in any equipment; or thermal fatigue and shock in reaction vessels, heat exchangers, and distillation columns. Brittle fracture of equipment can occur, as well as creep failure in high temperature equipment subjected to extreme operational upsets.

Operational causes of accidental releases result from incorrect procedures and human error, including overfilled vessels, improper process system operation, errors in loading and unloading, inadequate maintenance (especially of water removal units and pressure relief systems), and lack of inspection and nondestructive testing of vessels and piping to detect corrosion weakening.

Hazard Prevention and Control

Prevention of accidental releases of carbon tetrachloride relies on the proper design, construction, and operation of facilities where the chemical is stored and used and on the protective systems that guard against accidental release.

The most important process design considerations are preventing moisture from entering the process and preventing the overheating of systems containing carbon tetrachloride. Wide temperature fluctuations can significantly decrease the life span of construction materials. Monitoring of the moisture content will prevent the decomposition of carbon tetrachloride and the formation of highly corrosive hydrogen chloride.

Equipment used in carbon tetrachloride service must be constructed of materials chosen to minimize the possible decomposition of carbon tetrachloride. When dry, carbon tetrachloride can be stored in contact with many metal surfaces, but it does react, sometimes explosively, with aluminum and its alloys. Nickel and nickel-copper alloys are used at critical points of processing plants to minimize and control thermal decomposition of carbon tetrachloride.

Pressure vessels (including storage tanks, tank trucks, and rail cars) are usually protected by pressure relief valves and/or rupture disks. Relief piping must be sized for adequate flow. To avoid direct discharge to the environment, an overflow tank might be provided for overpressurized liquid. Carbon tetrachloride pipework design must also reflect the pressure, temperature, and corrosion concerns associated with the chemical. As with other hazardous chemicals, the number of pipe joints and connections should be minimized. Valve placement should ensure isolation of leaking pipes and equipment.

Siting and layout facilities and equipment should be designed to reduce personnel exposure to a possible carbon tetrachloride release. There should be a good distance between large inventories and sensitive receptors and ready ingress and egress in the event of an emergency. Vehicular traffic near carbon tetrachloride process or storage areas should be kept to a minimum, and carbon tetrachloride piping should not be located adjacent to other piping that is under pressure or that carries flammable materials. Storage facilities should be segregated from the main process if possible. Carbon tetrachloride equipment, piping, and vessels should be protected from heat sources, and storage should be located away from control rooms, offices, utilities, and laboratory areas.

Storage vessel shutoff valves should be easily accessible. Containment for liquid storage tanks can be provided by diking. When possible, the carbon tetrachloride should be transferred using fixed rigid piping. Vapor balance systems consisting of a pipeline between the vapor spaces of an unloading vessel and a carbon tetrachloride storage tank can be used to create a closed system that minimizes releases of carbon tetrachloride vapor.

Three protection technologies for containing and/or neutralizing releases of carbon tetrachloride are enclosures, vapor recovery systems, and incinerators. Enclosures, which can provide secondary containment of a released chemical, should be equipped with continuous monitoring equipment and alarms. An enclosure for carbon tetrachloride could be a building or bunker constructed of concrete blocks or sheets. It should be gastight and have a ventilation system to draw air in when the building is vented to a vapor recovery or incinerator system.

Vapor recovery systems recover toxic materials from process streams. Carbon tetrachloride discharges are commonly sent to a refrigerated vapor recovery unit or to a carbon absorption unit.

Incineration, another method of destroying toxic vapor from process streams, can be used to control releases from vents and pressure relief discharges from process equipment or from secondary containment enclosures.

Mitigation techniques are those that reduce the consequences of an accidental release of a hazardous chemical. Such measures include physical barriers, water sprays and fogs, and foams where appropriate. These techniques can divert, limit, or disperse the chemical that has been spilled or released into the atmosphere to reduce the concentration and the area affected by the chemical. Secondary containment systems (e.g., impounding basins, dikes, and flotation devices and foams) reduce the evaporation rate of a spilled chemical.

Since accidental releases of toxic materials result not only from design deficiencies but also from operational deficiencies, safe operation of plants using carbon tetrachloride requires competent and experienced managers and staff. Proper maintenance and modification programs should be incorporated into plant design and operation to prevent possible hazardous releases of the chemical.

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The complete report, entitled "Prevention Reference Manual: Chemical Specific, Volume 6: Control of Accidental Releases of Carbon Tetrachloride (SCAQMD)," (Order No. PB 87-234 514/AS; Cost: $13.95, subject to change) will be available only from:

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