November 2008

Perchloroethylene

White Paper

Executive Summary

Perchloroethylene, also known as tetrachloroethylene or perc, has been used safely in industry for over 50 years. It is an effective, nonflammable solvent that does not contribute to the formation of smog (ground-level ozone) or to the depletion of stratospheric ozone. The US Environmental Protection Agency (EPA) has approved the use of perchloroethylene as a replacement for stratospheric ozone-depleting solvents. Perchloroethylene is one of nearly 200 substances listed as hazardous air pollutants under the federal Clean Air Act. EPA has developed national emissions standards for drycleaning, degreasing, and other sources of the solvent.

Under certain conditions, overexposure to perchloroethylene may cause central nervous system (CNS) and liver effects. Animal bioassays of perchloroethylene have shown an increased incidence of liver tumors in mice and marginal or equivocal results in rats. The relevance of these results to humans, however, has been questioned because of research indicating that the mechanism of liver tumor induction in mice does not apply to humans. The available epidemiology studies show no consistent link between exposure to perchloroethylene and an increased risk of cancer in humans. A study of workers in the Nordic countries published in 2006 provides the strongest evidence to date that perchloroethylene does not cause cancer in humans.

It is nevertheless important that workplace activities and user operations be carried out in such a way as to keep exposure and environmental release as low as is reasonably practicable. Compliance with applicable regulations, using engineering controls and work practices, will enable perchloroethylene to be used in a safe and environmentally sound manner.

Introduction

Perchloroethylene is a member of a family of aliphatic halogenated hydrocarbons. It is a colorless, volatile liquid that is essentially nonflammable and has no measurable flashpoint. Total U.S. demand for the chemical in 2007 was estimated to be about 370 million pounds (168,000 metric tons), of which about 78 million pounds (35,300 metric tons) were imported. An additional 41 million pounds (18,600 metric tons) were exported.

Perchloroethylene is primarily used as a chemical intermediate in the production of several fluorinated compounds. Its other major uses are as a solvent in commercial and industrial dry cleaning, for the cleaning and degreasing of fabricated metals, and as a solvent in automotive aerosols.

Uses

For 2007, the use of perchloroethylene can be broken down into the following categories:

chemical intermediate	70 %
drycleaning/textile processing	10 %
automotive aerosols	10 %
metal cleaning/degreasing	7 %
miscellaneous	3 %

Chemical Intermediate

Perchloroethylene is used as a basic raw material in the manufacture of hydrofluorocarbon (HFC) 134a, a popular alternative to chlorofluorocarbon (CFC) refrigerants. It also is used in the synthesis of hydrochlorofluorocarbon (HCFC) 123 and 124 and HFC 125.

Drycleaning

Perchloroethylene is used by about 70 percent of commercial dry cleaners, as well as some industrial cleaning establishments. It had replaced other synthetic solvents, such as carbon tetrachloride, by the late 1940s or early 1950s. A gradual shift from petroleum derivatives to perchloroethylene began in the late 1940s. This shift in solvents increased in the 1950s and early 1960s. However, in the period before 1960, petroleum derivatives were still the dominant solvents.

In addition to its nonflammability and relatively low toxicity, the popularity of perchloroethylene in the dry cleaning industry can be attributed to the following properties:

- safe to use on all common textiles, fibers, and dyes;
- effective at removing fats, oils, and greases;
- free of residual odor;
- chemically stable under all common use conditions;

- noncorrosive to the metals and other materials used in drycleaning machinery;
- easily removed from clothes; and
- energy- and cost-efficient (can be easily distilled and reused).

The textile industry has used perchloroethylene as a spotting agent for the removal of spinning oils and lubricants. It also has been used in wool scouring and as a solvent carrier in dyes and water repellents.

Automotive Aerosols

Perchloroethylene is used in aerosol formulations for the automotive aftermarket, particularly for brake cleaning. These formulations provide auto repair shops with highly effective, nonflammable products.

Metal Cleaning/Degreasing

Many industries, including aerospace, appliance, and automotive manufacturers, use perchloroethylene for vapor degreasing metal parts during various production stages. Its high boiling point and resultant longer cleaning cycle are advantageous in removing "difficult" soils such as waxes with high melting points. The ability of the chemical to remove water during vapor degreasing is useful to jewelry manufacturers and other metal finishers.

Perchloroethylene's nonflammability and low vapor pressure make it an effective cold (room temperature) metal cleaner, when used in compliance with applicable regulatory requirements. Its low vapor pressure contributes to reduced emissions from cold cleaning operations where it is employed.

Miscellaneous

Perchloroethylene is used as an insulating fluid in some electrical transformers as a substitute for polychlorinated biphenyls (PCBs). Relatively small quantities of perchloroethylene are used in printing inks, aerosol specialty products, adhesive formulations, paper coatings, and silicones. In addition, perchloroethylene is a component of chemical maskant formulations used to protect surfaces from chemical etchants used in the aerospace and other industries.

Health Effects

General

Under certain conditions, overexposure to perchloroethylene may cause central nervous system and liver effects. Prolonged exposure to concentrations of 200 parts per million (ppm) or more has been associated with dizziness, confusion, headache, nausea, and irritation of the eyes and mucous tissue. At higher exposures (>600 ppm) these symptoms are intensified. Prolonged exposure to extremely high levels (>1,500 ppm) may lead to unconsciousness due to anesthesia and, in extreme cases, death from respiratory depression.

Changes in the liver and kidney of laboratory animals have been observed following prolonged exposure to concentrations of 200 ppm or more. In humans, reversible effects in liver function have been noted in persons exposed to high levels of perchloroethylene vapor for extended periods of time. No effects on the liver or kidney were seen in human volunteers exposed to up to 150 ppm, 7.5 hours per day, 5 days per week for 11 weeks. For occupational exposures, there are reports of mild alterations of liver or kidney function in a few studies, but other studies have found no detectable effect.

Genotoxicity

The ability of perchloroethylene and its major metabolites to cause mutations or other damage to genetic material has been tested in a very large number of studies. These include bacterial systems, cell preparations (animal and human) and whole animal (in vivo) tests. Overall, these tests are considered to show an absence of genotoxicity.

Developmental and Reproductive Toxicity

A number of studies have been conducted of the effects of perchloroethylene on mammalian fetal development. The results of these studies in a variety of species indicate that perchloroethylene is not likely to be teratogenic (i.e., unlikely to cause significant developmental defects). On the basis of the available data, EPA has concluded that there is no evidence suggesting that the fetus is uniquely susceptible to the effects of perchloroethylene.

Exposure of female Sprague-Dawley rats and Swiss-Webster mice to 300 ppm of perchloroethylene during gestation, conducted by Schwetz *et al*, led to mild fetotoxicity in the presence of maternal toxicity. However, studies by Beliles *et al* in CD rats and rabbits with exposure of mothers before and during pregnancy showed no maternal toxicity or fetotoxicity at 500 ppm. A study in rats and rabbits by Hardin *et al* also showed no teratogenic effect at dose levels of 100 and 500 ppm.

An inhalation study by Tepe *et al* of Long-Evans hooded female rats exposed to 1,000 ppm of perchloroethylene prior to and during gestation found a significant reduction in body weight and an increased incidence of variations in skeletal and soft tissue development. However, weight gain and survival of offspring followed up to 18 months of age were not influenced by exposure to perchloroethylene. Some changes in maternal body weight and liver and kidney weight were noted in these studies.

In 2003, HSIA sponsored a study of the potential for developmental effects in the offspring of CD rats exposed to up to 600 ppm of perchloroethylene as part of HSIA's voluntary testing program with the Agency for Toxic Substances and Disease Registry (ATSDR) of the US Department of Health and Human Services. The study was conducted according to current EPA guidelines. Slight maternal toxicity and only minimal effects on fetal body weight and ossification (bone formation) were observed.

HSIA also sponsored a multi-generation reproduction study in rats. The study involved the exposure of groups of rats (Wistar-derived strain) to three dose levels of perchloroethylene prior to mating, through pregnancy, followed by exposure of the offspring through a second mating cycle. Parents and offspring in each generation were evaluated against control animals.

In this HSIA-sponsored study, parental toxicity was apparent as reduced body-weight gain at the top dose level of 1,000 ppm and, to a lesser extent, at 300 ppm. The high dose also induced histopathological changes in the kidney. Offspring growth and survival were reduced at 1,000 ppm, at least partially mediated through parental toxicity, and offspring growth alone was marginally affected at 300 ppm. There were no effects on fertility at any dose level. The no-effect level for general parental and offspring toxicity was 100 ppm and for reproductive effects was 300 ppm.

Studies of fertility rates among wives of dry cleaning workers exposed to perchloroethylene found a slight increase in fertility in comparison with national averages and no increase in miscarriages. The fertility of female dry cleaning workers was also not affected, although one report suggests that time to become pregnant might be somewhat longer.

The Health and Safety Executive of the United Kingdom sponsored a study of spontaneous abortion (miscarriages) in a limited number of drycleaning workers. The study showed that, of the different types of workers, only those operating the cleaning equipment experienced a higher rate of miscarriage than the general population. The UK Department of Health concluded that the observed increase in miscarriages could not be attributed specifically to perchloroethylene. Previous studies have found physical activity, such as the lifting of clothes associated with operating drycleaning machinery, to be a risk factor for miscarriage.

Neurotoxicity

The major symptoms of acute overexposure to perchloroethylene are central nervous system effects typical of anesthesia, which generally disappear when the individual is removed from exposure. To test the potential for chronic (long-term) neurotoxic effects, HSIA sponsored testing in rats exposed to the solvent for up to 90 days. The techniques used in this study included sophisticated and sensitive neurophysiology plus extensive histopathology of the nervous system. The results showed no significant neurotoxicity after exposure to concentrations of up to 800 ppm, and established a no-observed-effect level of 200 ppm.

While this study provides the most complete assessment of neurotoxicity, studies by Altmann *et al* and Schreiber *et al* have reported minor neurobehavioral effects in humans exposed to low levels of perchloroethylene. These studies are difficult to interpret, however, since the effects are small and the methodologies used have raised questions. More recent follow-up work, moreover, has failed to confirm the results.

Carcinogenicity

Laboratory Animal Studies

Eight studies of the carcinogenic potential of perchloroethylene in laboratory animals have been conducted. Three of the studies showed a significant increase in liver tumors in mice, and two studies found an increase in leukemia among rats.

A study reported by the National Cancer Institute (NCI) in 1977 exposed (by gavage) Osborne-Mendel rats and B6C3F1 mice to up to 949 milligrams of perchloroethylene per kilogram (mg/kg) body weight and up to 1072 mg/kg body weight, respectively, each day, 5 days a week, for 78 weeks. The study showed a significant increase in liver tumors in both sexes of mice. Low survival in the rats tested, believed to result from exposure to doses higher than the maximum tolerated dose, compromised the study's ability to detect a carcinogenic effect in this species. Because of several significant limitations in its design and conduct, the results of this study should be interpreted with caution.

The Dow Chemical Company conducted an inhalation study of the carcinogenic effect of perchloroethylene on Sprague-Dawley rats. The Dow study exposed male and female rats to 0, 300, and 600 ppm of the chemical for 6 hours per day, 5 days per week, for 52 weeks (and observed them for another 52 weeks), and showed no significant differences between the exposed and control animals. Another study in Sprague Dawley rats, by Maltoni and coworkers, in which the animals were exposed to an oral dose of 500 mg/kg body weight per day for 2 years showed no increase in tumor incidence at any site.

In 1986 the National Toxicology Program (NTP) reported the results of a 2-year inhalation study that found a significant increase in liver tumors in male and female B6C3F1 mice. The study exposed the mice and Fischer 344 rats to perchloroethylene concentrations of 0, 100, and 200 ppm and 0, 200, and 400 ppm, respectively, for 6 hours per day, 5 days a week, for the length of the study. NTP also reported an increased incidence in mononuclear cell leukemia (MNCL) in male and female rats and a marginal increase in kidney tumors in male rats. NTP concluded that these data demonstrated "clear evidence" of carcinogenicity in mice and male rats and "some evidence" of carcinogenicity in female rats.

In studies conducted by the Japan Bioassay Research Center, (1993), Fischer 344 rats were exposed to dose levels of 0 to 600 ppm, and Crj:BDF1 mice were exposed to doses of 0 to 250 ppm, for two years. The results were similar to those in the NTP bioassays except that no increase in kidney tumors was observed in the rat study.

Science Advisory Board Review of the NTP Study

After reviewing the results of the NTP study, the EPA Science Advisory Board concluded in 1987 that the study does not provide a basis for associating either the MNCL or the kidney tumors observed in the rats with exposure to perchloroethylene. The Board's conclusion were based on the high and variable spontaneous background rate of MNCL in concurrent and historical controls in this particular rat strain and the low incidence of rat kidney tumors in the NTP study. In addition, the Board stated that the mechanism responsible for the marginal increase in kidney tumors appears to be unique to male rats and is probably not operative in humans. The Board also indicated that the increase in the mouse liver tumors may be due to the operation of a mechanism that is tumorigenic only in rodents, such as factors associated with peroxisome proliferation (see below).

Significance of Mouse Liver Data

Following the observation that perchloroethylene produces liver tumors in mice, but not in rats, studies were initiated to investigate the reasons for this species difference and to determine the significance of the mouse data to humans. This research indicates that perchloroethylene is not the proximal carcinogen in the mouse bioassays, but that a metabolite of perchloroethylene, trichloroacetic acid (TCA), is the likely cause of the mouse liver tumor response. Tumor induction in rodent liver cells has been associated with TCA production and the TCA-induced proliferation of enzyme-containing organelles (called peroxisomes) in the cells. In fact, peroxisome proliferation may not lead directly to tumor induction, but the associated cell proliferation and reduction in controlled cell death (apoptosis) are considered to be responsible.

Production of TCA occurs at a much higher rate in mice than in rats or humans. TCA does not induce liver tumors in rats, moreover, even when administered directly in high doses. In vitro (test tube) exposure of human liver cells to TCA does not result in peroxisome proliferation. This research appears to explain why liver tumors were seen in mice, but not rats, and suggests that such a response is unlikely in humans.

TCA is regarded as a relatively weak peroxisome proliferator, however, and questions have been raised as to whether the levels of TCA produced in mice following exposure to perchloroethylene are sufficient to explain the liver tumors. In 2003 HSIA initiated a research project to further investigate the role of peroxisomes in the production of liver tumors in B6C3F1 and 129/Sv mice strains, as well as a strain of the 129/Sv mice that lacks the receptor believed to be critical in the carcinogenic effect of peroxisome proliferators ("PPARα_knockout"). The results of this research, expected to be published in 2009, indicate that the amount of TCA formed in both strains of mice exposed to levels of perchloroethylene that resulted in liver tumors in the cancer bioassays is sufficient to cause peroxisome proliferation and subsequent cell proliferation and apoptosis. Cell proliferation and apoptosis were not observed in the knockout mice, confirming that the PPARα receptor is necessary for these cancer-causing mechanisms to occur. These responses were confirmed in both whole animal (in vivo) and in vitro studies.

Cell proliferation and apoptosis also were not observed in human liver cells at levels of TCA higher than those that could ever be achieved following perchloroethylene exposure, providing further evidence that the mouse liver cancers should not be extrapolated to humans.

Epidemiology

Several epidemiology studies have investigated cancer mortality among drycleaning workers and show no consistent link between perchloroethylene exposure and cancer. For the most part, the workers studied were exposed to a variety of cleaning agents, including petroleum solvents. Two of the studies, however, identified small subgroups of individuals exposed predominantly to perchloroethylene. One of these studies, conducted by NCI, included a subgroup of workers entering a Missouri drycleaners union after 1960 when perchloroethylene had become the predominant solvent used in the industry. The second study, conducted by the National Institute of Occupational Safety and Health (NIOSH), included a group of 625 workers employed in shops where perchloroethylene was believed to be the primary or only solvent. A more recent study by Lynge et al, sponsored by HSIA and the Danish Medical Research Council, looked at cancer mortality among more than 7,000 workers in the Nordic countries where perchloroethylene was the predominant drycleaning solvent during the period of interest.

Among all of the worker studies, those tumor types observed in experimental animals (i.e., liver, kidney) were not observed to occur with increased frequency within the worker groups studied. Among other sites, slightly elevated rates of bladder cancer were observed in some of the studies, but not in the two subgroups of workers exposed only to perchloroethylene. An increase in bladder cancer was noted in the Nordic study that was not related to the duration or extent of exposure to perchloroethylene. The bladder cancer increase seen in the various studies may be associated with exposure to other dry cleaning solvents or with lifestyle factors like smoking, a well-established risk factor for bladder cancer.

An increase in esophageal cancer was observed by the NCI and NIOSH researchers, but not in the other studies. In the NCI study, however, the incidence of esophageal cancer in the post-1960 group was not different from the incidence among all members of the union and was not found to increase with duration or level of solvent exposure. In the NIOSH study, a significant increase in esophageal cancer was observed in the entire cohort and among workers with exposure to other solvents, but not in the perchloroethylene-only group. All of the NIOSH cases were found among workers with the longest latency (20 years or more since first employment) and half were among workers who were employed for 5 years or more.

The Nordic study, however, did not find an increase in esophageal cancer among the drycleaning workers. While the Nordic researchers suggest that exposures in their study may not have been as high as those in the NIOSH study, the most plausible explanation for the absence of esophageal cancers is that the Nordic study was better able to eliminate the potential contribution of confounding factors associated with lifestyle. The potential contribution of lifestyle factors for confounding factors is great for esophageal cancer, given the strong association between the disease and the combination of smoking and alcohol consumption. In the Nordic study the cancer incidence among drycleaning workers was compared with those of laundry workers, a group with a similar job and lifestyle apart from the use of solvent, rather than to the general population as in the NIOSH study.

Carcinogenicity Classification

The International Agency for Research on Cancer (IARC) classifies perchloroethylene in Group 2A, as a substance considered "probably carcinogenic to humans." IARC, following its own restrictive classification scheme, concluded that the combination of the results of some of the epidemiology studies provided "limited" evidence of carcinogenicity in humans. In addition, NTP listed perchloroethylene as "reasonably anticipated" to be a carcinogen based on a finding of "sufficient" evidence of carcinogenicity in experimental animals. The American Conference of Governmental Industrial Hygienists (ACGIH), however, classifies perchloroethylene in its Category A3 ("Confirmed Animal Carcinogen with Unknown Relevance to Humans"):

> *The agent is carcinogenic in experimental animals at a relatively high dose, by route(s) of administration, at site(s), of histologic type(s), or by mechanism(s) that may not be relevant to worker exposure. Available epidemiological studies do not confirm an increased risk of cancer in exposed humans. Available evidence does not suggest that the agent is likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure.*

EPA's Science Advisory Board concluded that the weight of the evidence for perchloroethylene does not support its classification as a probable human carcinogen under EPA's 1986 Guidelines for Carcinogen Risk Assessment. The Board concluded that "[t]he available scientific information does not suggest to us the same regulatory responses that would be appropriate for a chemical whose bioassay responses were clearly relevant to human cancer." Perchloroethylene currently is considered by EPA to be on a "continuum" between a probable and possible carcinogen and is being reassessed under the Agency's 2005 cancer guidelines. A draft of this reassessment was made available in the summer of 2008 and will be reviewed by an expert panel of the National Academy of Sciences. A final assessment is expected in 2010.

Regulation

Environmental Exposure

A national emission standard for the use of perchloroethylene in drycleaning was adopted in September 1993, and subsequently revised in July 2006, under Section 112 of the federal Clean Air Act, as amended, relating to the regulation of emissions of hazardous air pollutants (HAPs). Under Section 112, EPA is required to develop national emission standards based on maximum achievable control technology, or MACT, for major sources (>10 tons of emissions per year) of perchloroethylene and 188 other substances. Emissions of sources emitting less than 10 tons/year also may be regulated, but can be subject to a lesser degree of control (generally available control technology, or GACT). Section 112 also requires EPA to review the need for additional control of regulated sources within 8 years of the implementation of a MACT standard.

A MACT standard for organic solvent cleaning (degreasing) with perchloroethylene and the other chlorinated solvents became effective for existing sources in December 1997. As a result, degreasing sources are required to install one of several control options to reduce emissions. This standard was amended in May 2007 to require that, in addition to the MACT control requirements, facilities emit no more than 4,800 kilograms (10,500 pounds) of perchloroethylene annually from their degreasing operations.

Additional national standards have subsequently been adopted to address perchloroethylene use in other applications. Under the Clean Air Act, major sources of perchloroethylene and other HAPs are required to obtain an operating permit from the state regulatory agency. Permitting of small (area) sources of perchloroethylene has been deferred in many states.

Perchloroethylene does not contribute to the depletion of the stratospheric ozone layer. EPA has determined, consequently, that perchloroethylene is an acceptable alternative in many applications for ozone depleting solvents whose production has been phased out under the federal Clean Air Act. Because perchloroethylene does not contribute appreciably to smog formation, EPA exempted the solvent from the federal definition of a reactive volatile organic compound (VOC). As a result, the Agency does not provide credit for reductions of perchloroethylene emissions in state control strategies for achieving the national ambient air quality standard for ground-level ozone. Perchloroethylene has been exempted by most states that have VOC regulations, in accordance with federal guidelines. A few states have prohibited use of the solvent in certain consumer and commercial products, however, based on its designation as a HAP.

EPA has established national primary drinking water regulations setting a maximum contaminant level, or MCL, of 5 micrograms per liter for perchloroethylene (equal to 5 parts per billion, or ppb), and a maximum contaminant level goal (MCLG) of zero. EPA has indicated that "[t]he establishment of an MCLG at zero does not imply that actual harm necessarily occurs to humans at a level somewhat above zero, but rather that zero is an aspirational goal, which includes a margin of safety, within the context of the Safe Drinking Water Act." Various states also may have drinking water regulations that apply to perchloroethylene.

For several industry categories EPA has established effluent limitation guidelines, which may contain limits for perchloroethylene. EPA also has published criteria for perchloroethylene for use by states in developing water quality standards. Perchloroethylene waste is considered hazardous under the federal Resource Conservation and Recovery Act (RCRA) and many state laws. Such waste must be stored, transported, and disposed of in accordance with applicable RCRA and state requirements.

The reportable quantity (RQ) for releases of perchloroethylene under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) is 100 pounds. Releases in excess of this amount must be reported to the National Response Center, the local emergency planning commission, and the state emergency response commission. Some states have lower thresholds that trigger notification.

Perchloroethylene is one of several hundred chemicals subject to material safety data sheet (MSDS), inventory, and release reporting under the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986).

Occupational Exposure

The current permissible exposure limits (PELs) for perchloroethylene are 100 ppm as an 8-hour time weighted average (TWA), 200 ppm as a ceiling limit, and 300 ppm as a peak limit. In 1989, the Occupational Safety and Health Administration (OSHA) lowered the PEL for perchloroethylene from 100 ppm to 25 ppm for an 8-hour TWA, as part of an overall PEL update. This action was overturned by a federal court in 1993, however, and the PELs for perchloroethylene reverted to the former limits. OSHA has urged employers not to roll back measures they may have taken to comply with the lower limits that were overturned, and several states that adopted the lower 1989 limit have not adopted the higher limit.

ACGIH currently recommends threshold limit values (TLVs) of 25 ppm for an 8-hour TWA and 100 ppm for a 15-minute short-term exposure limit, or STEL.

Beyond Compliance

HSIA does not recommend the use of perchloroethylene in any application, including cold cleaning, unless all applicable workplace, disposal, and other environmental regulatory requirements are met. In addition to complying with these various regulatory requirements, HSIA encourages operators of drycleaning, degreasing, and other equipment to adopt practices and standards for the use, management, and disposal of perchloroethylene and perchloroethylene-containing wastes that go beyond the strict legal requirements. Operators who do implement additional measures recognize that environmental protection is their responsibility. They also understand that they are potentially liable for environmental contamination that can be traced to their solvent wastes, whether at their own plant or elsewhere, regardless of the fact that they may have complied with the letter of the law. These operators recognize that additional measures that go "Beyond Compliance" make good business sense because they minimize the risks of liability that arise when perchloroethylene is released to the environment.

One of the most widely adopted "Beyond Compliance" measures is ending sewer discharge of water that has come in contact with perchloroethylene (i.e., contact or separator water). Other common pollution prevention steps include installation of dikes and containment structures around solvent-containing equipment and containers. Pans or other impermeable containers should be placed beneath equipment, as under certain conditions perchloroethylene can penetrate concrete. Sealing floor drains and using solvent-resistant floor coatings in areas where spills are most likely to occur can provide additional protection.

In addition, companies who qualify as conditionally exempt small quantity generators under EPA regulations may wish to forego the exemption and ensure that their perchloroethylene wastes are picked up by an authorized solvent recycler or a permitted hazardous waste disposal service. In a few states, drycleaners using perchloroethylene are required to conduct some or all of these actions.

Regulatory and Other Information for Perchloroethylene

CAS Number	75-09-2
Flash Point	none
Flammable limits	none
OSHA PELs	
8-hour TWA	100 ppm
Ceiling	200 ppm
Peak	300 ppm
ACGIH TLVs	
8-hour TWA	25 ppm
15-minute STEL	100 ppm
Cancer Classification	
ACGIH	A3 (“confirmed animal carcinogen”)
IARC	2A (‘probably carcinogenic to humans”)
NTP	“reasonably anticipated to be a human carcinogen”
RCRA Hazardous Waste No.	U 210
US Department of Transportation designations	
Hazard Classification	6.1 (packing group III)
ID No.	UN 1897

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