

LISTING BACKGROUND DOCUMENT

Wastes from Usage of Halogenated Hydrocarbon
Solvents in Degreasing Operations

The following spent halogenated solvents used in degreasing: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride and the chlorinated fluorocarbons; and sludges from the recovery of these solvents in degreasing operations.(T)*,**,***

I. SUMMARY OF BASIS FOR LISTING

Solvent degreasing operations remove grease, wax, dirt, oil, and other undesirable substances from various materials. All degreasing facilities which use the halogenated hydrocarbon solvents listed above generate spent solvent solutions which are either discarded or processed to recover the solvent from the spent solution. Spent solvents include those which are no longer useful without further processing, either because they have outlasted their shelf life or because they have been contaminated, or so changed chemically or physically that they are no longer useful as solvents. The recovery operations invariably generate solvent sludges.

* In December, 1978, the Agency proposed a generic listing for this class of wastes.

** These solvents are often marketed under various trade marks; the listing obviously includes all trade mark solvents which have the generic chemical name listed above. Another point of consideration is that different names may be used to refer to the same solvent:

tetrachloroethylene = perchloroethylene
1,1,1-trichloroethane = methyl chloroform
carbon tetrachloride = tetrachloromethane
methylene chloride = dichloromethane
trichloroethylene = 1,1,2-trichloroethylene

*** In response to industry comments, it should be noted that the Agency is no longer listing these wastes on the basis of ignitability or EP toxicity. However, these solvents may be contaminated with metals (i.e., lead and chromium) in the degreasing operations; therefore, the generator will be responsible for determining whether the waste would also meet the EP toxicity characteristic.

The Administrator has determined that spent halogenated solvents from degreasing and the sludges that result from associated solvent reclamation operations are solid wastes which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of, or otherwise managed; therefore, these wastes should be subject to appropriate management requirements under Subtitle C of RCRA.

For all of the listed waste solvents, this conclusion is based on the following considerations:

1. The chlorinated hydrocarbons are toxic and, in some cases, genetically harmful, while chlorofluorocarbons may deplete the ozone layer following environmental release.
2. Approximately 99,000 metric tons of waste halogenated solvents from degreasing operations are generated each year(1). There are approximately 460,000 facilities dispersed throughout the country that use halogenated solvents and generate these wastes(1). It is estimated that about 30,000 metric tons per year of halogenated hydrocarbons from these facilities are either disposed of annually in landfills or by open-ground dumping, either as crude spent solvents or as sludges. The remainder of these wastes are usually incinerated. The large quantity of wastes generated and the large number of disposal sites utilized increases the possibility of waste mismanagement and environmental release of harmful constituents.
3. Since a large majority of the spent solvents and sludges are in liquid form, the potential for these wastes to migrate from land disposal facilities is high. Further, the solubility of these solvents is generally high, increasing their migratory potential.
4. The spent solvent solution from degreasing operations may contain up to 90 percent of the original solvent. Depending on the recovery technique, sludges that result from reclamation processes can contain up to 50 percent of the original solvent. Such high concentrations

of hazardous constituents increases the chance of waste constituents escaping in harmful concentrations.

5. Spent solvents can create an air pollution problem via the volatilization of the solvents from the wastes.

For the five chlorinated solvents (not including chlorofluorocarbons) found in the waste streams, this conclusion is based on the following considerations:

6. Incomplete combustion of the spent chlorinated hydrocarbon solvents during incineration can cause emissions of the solvent and generate toxic degradation products (e.g. phosgene).
7. These spent halogenated solvents can leach from the waste to adversely affect human health and the environment through the resulting contamination of groundwater.
8. Current waste management practices have resulted in environmental damage. These incidents serve to illustrate that the mismanagement of these wastes does occur and can result in substantial environmental and health hazards.
9. A number of these solvents are carcinogenic or mutagenic, or are suspected carcinogens or mutagens, and are lethally toxic to humans and animals.

For the chlorofluorocarbons, the Agency is basing the listing on the following consideration:

10. Chlorofluorocarbons, after release at the surface of the earth, mix with the atmosphere and rise into the stratosphere where they are decomposed by ultra violet radiation to release chlorine atoms. These atoms catalytically deplete the ozone, leading to adverse effects, including skin cancer and climate changes.

II. OVERALL DESCRIPTION OF INDUSTRY USAGE

Degreasing operations are not industry specific. Degreasing operations are prevalent in twelve major SIC (Standard Industrial Classification) categories, numerous subcategories, and automotive maintenance shops. The pertinent industries where halogenated hydrocarbons are used primarily are presented in Table 1. A summary of the number and types of plants that conduct degreasing operations is presented in Table 2.

Table 1
Industries Using Halogenated Hydrocarbons
in Degreasing Operations

<u>Source</u>	<u>SIC Code</u>
Metal Furniture	25
Primary Metals	33
Fabricated Products	34
Non-electric Machinery	35
Electric Equipment	36
Transportation Equipment	37
Instruments and Clocks	38
Miscellaneous Industry	39
Automotive Repair Shops	75
Automotive Dealers	55
Automotive Maintenance Shops	--
Textile Plants (Fabric Scouring)	22
Gasoline Stations	55

Table 2 - Solvent Degreasing Source Types*(1)

<u>Source</u>	<u>SIC</u>	<u>Number of Plants</u>	<u>Estimated Number of Vapor Degreasing Operations</u>	<u>Estimated Number of Cold Cleaning Operations</u>
<u>Material Degreasing</u>				
Metal Furniture	25	9,233	492	22,869
Primary Metals	33	6,792	1,547	17,558
Fabricated Products	34	29,525	5,140	76,329
Non-electric Machinery	35	40,792	5,302	105,456
Electric Equipment	36	12,270	6,302	31,720
Transportation Equipment	37	8,802	1,917	22,756
Instruments and Clocks	38	5,983	2,559	15,467
Miscellaneous	39	15,187	886	39,262
<u>Automotive</u>				
Auto Repair Shops	75	127,203		141,977
Automotive Dealers	55	121,369		135,463
Gasoline Stations	55	226,445		277,440
Maintenance Shops		320,701		252,735
<u>Textiles</u>				
Textile Plants (Fabric Scouring)	22	<u>7,201</u>	<u> </u>	<u> </u>
Total		931,513	24,145	1,230,006

*Includes facilities which do not use halogenated solvents

III. OVERALL PROCESS DESCRIPTION, WASTE GENERATION LEVELS AND GEOGRAPHIC DISTRIBUTION OF DEGREASING FACILITIES

1. Solvents Used in Degreasing Process

As indicated in Table 3, out of the more than 1,230,000 non-halogenated and halogenated degreasing operations (see Table 2), approximately 460,000 use halogenated solvents(1). Table 3 breaks down the number of plants which use halogenated solvents to show the estimated number of these plants using a particular halogenated solvent by their type of degreasing operation. As the table indicates, the largest number of these plants use cold cleaning and open top vapor degreasing operations (see next section for more detailed discussion of specific degreasing operations). In both of these operations, the largest number use trichloroethylene and trichlorethane. Of the industries with conveyORIZED vapor degreasing operations, the largest number use trichloroethylene; fabric scouring operations use principally tetrachloroethylene (perchloroethylene). Overall, trichloroethylene is the solvent used most prevalently.

2. Process Description

Degreasing operations may be classified into four basic categories: cold cleaning, vapor degreasing (open top), vapor degreasing (conveyORIZED), and fabric scouring.

In cold cleaning operations, the solvent is maintained well below its boiling point. The item to be cleaned is either immersed in the agitated solvent

Table 3 - Estimated Number of Plants using Halogenated
Solvents by Type of Degreasing (1974) (1)

Solvent	Vapor (open top)	Cold Cleaning	Vapor Conveyorized	Fabric Scouring
Carbon tetrachloride		10,568		
Fluorocarbons*	2,130	66,932	319	
Methylene Chloride	298	21,136	45	
Tetrachloroethylene	3,121	45,795	467	2,522
Trichloroethylene	11,440	149,715	1,713	693
Trichloroethane	<u>4,011</u>	<u>137,386</u>	<u>601</u>	<u> </u>
Total	21,000	431,532	3,145	3,215

Note: Blanks indicate no use of specified solvent in that type of degreasing operation.

*This refers to all fluorocarbons, some of which are chlorinated.

or suspended above the solvent where it is systematically sprayed in a manner similar to that of an automatic dish washer. Simple cold cleaning operations may even consist of a container of solvent in which items are manually immersed, as is the case in small auto repair shops and in service stations.

Simple vapor degreasing (open top) is achieved by suspending the item to be cleaned above the boiling solvent in a vat. Condensation continues until the temperature of the object approaches that of the solvent vapors. Often the suspended item is sprayed with liquid solvent to facilitate further degreasing. In order to control vapor emissions, a layer of cold air is often maintained above the open top degreaser.

The conveyORIZED vapor degreaser operates in much the same manner, except that the objects to be cleaned are continuously conveyed through the vapor zone. Auxiliary solvent sprays are also used to improve the cleaning efficiency of the operations.

Fabric scouring operations are slightly more complex. Generally, the fabric is conveyed through the degreasing machine, where it is sprayed with solvents. The solvents are then removed with an aqueous solution of alcohol.

3. Waste Generation Levels and Projected Levels

The annual growth rate for the use of the listed halogenated solvents in degreasing applications is expected to

be 4 percent(1). Growth is expected to be uniform among the various solvents, except for trichloroethylene, which has been banned in several states for use in occupational settings because it is a carcinogen. (1,2,21). In California, the use of trichloroethylene has been restricted by legislation, but tetrachloroethylene and 1,1,1-trichloroethane are exempt(1) from the restrictions and are still used in degreasing operations. Rhode Island has completely banned the use of trichloroethylene(2).

4. Geographic Distribution of Degreasing Operations

The location of the vapor degreasing operations has been determined by identifying the industries with which the operations are associated. There are about 24,145 vapor degreasing operations in the United States, which consume about 52 percent of the total halogenated solvents used(1). More than 63 percent of these operations are found in nine states (California, Illinois, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania and Texas). Figure 1 and the associated Table 4 present the geographic distribution of these plants.

There are about 431,532 operations that perform cold cleaning using about 35 percent of the total halogenated solvent consumption, while approximately 3,125 fabric scouring operations consume about 13 percent of the total halogenated solvent(1). Assuming an equal distribution of halogenated solvent use among cold cleaning and fabric scouring operations, over 59 percent

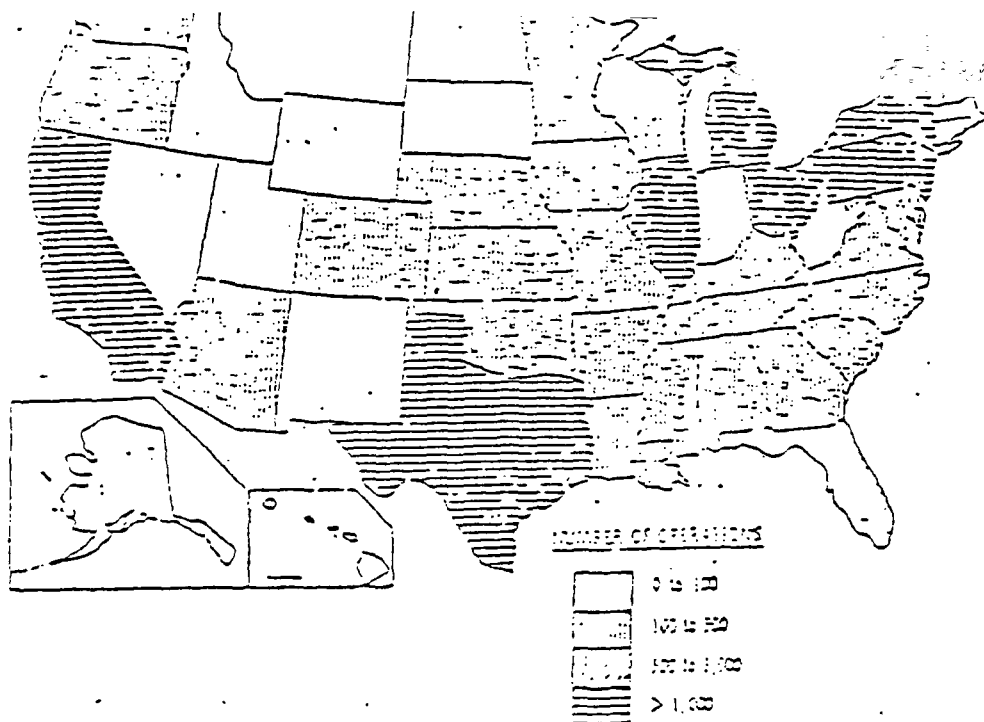


Figure 1 - GEOGRAPHIC DISTRIBUTION OF VAPOR DEGREASING OPERATIONS (1)

Table 4 - GEOGRAPHIC DISTRIBUTION OF VAPOR (OPEN TOP AND CONVEYORIZED) DEGREASING OPERATIONS (1).

State	Number of plants	State	Number of plants
Alabama	247	Montana	26
Alaska	0	Nebraska	100
Arizona	169	Nevada	30
Arkansas	147	New Hampshire	36
California	3,313	New Jersey	1,300
Colorado	218	New Mexico	64
Connecticut	648	New York	2,514
Delaware	28	North Carolina	407
District of Columbia	11	North Dakota	20
Florida	730	Ohio	1,576
Georgia	316	Oklahoma	185
Hawaii	29	Oregon	246
Idaho	39	Pennsylvania	1,356
Illinois	1,737	Rhode Island	121
Indiana	688	South Carolina	140
Iowa	235	South Dakota	26
Kansas	217	Tennessee	386
Kentucky	193	Texas	1,119
Louisiana	174	Utah	60
Maine	65	Vermont	19
Maryland	217	Virginia	218
Massachusetts	912	Washington	315
Michigan	1,509	West Virginia	88
Minnesota	426	Wisconsin	204
Mississippi	116	Wyoming	7
Missouri	485	Total	24,146

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of the total halogenated solvent used for degreasing occurs in ten states (California, Illinois, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Texas and North Carolina).

IV. WASTE STREAM SOURCES AND DESCRIPTION

The usefulness of a solvent decreases with time as contaminants adulterate and become concentrated in the solvent. When the boiling point of the solution (i.e., solvent and contaminants) increases to about 30°C above that of the pure solvent, the solvent is considered spent. Halogenated solvent use pattern by type of degreasing operation is presented in Table 5. Approximately 527,520 metric tons of halogenated solvents are used each year for degreasing operations(1).

Spent solvent solutions include those solvents which are no longer useful without further processing, either because they have outlasted their shelf life or because they have been contaminated, or so changed chemically or physically that they are no longer useful as solvents. These spent solvents are either disposed of, reclaimed and recycled by the waste generator, or processed by a contract solvent reclaiming operator.* Reclamation is achieved via settling and/or batch distillation. The listed sludge results from this reclamation process.

The composition of the spent solvent is dependent on the application of the degreasing operation. The spent solvent

*At this time, applicable requirements of Parts 262 through 265 and 122 will apply insofar as the accumulation, storage and transportation of hazardous wastes that are used, reused, recycled or reclaimed. The Agency believes this regulatory coverage is appropriate for the subject wastes. These wastes are hazardous insofar as they are being accumulated, stored or transported. These wastes may not pose a substantial hazard during their recycling and, even though its listed as hazardous, this aspect of their management is not presently being regulated.

Table 5

USE PATEERN OF HALOGENATED SOLVENTS IN DEGREASING AND
FABRIC SCOURING OPERATIONS IN 1974

Chemical	Total U.S. Consumption (10 ³ kkg)	U.S. Consumption for Degreasing (10 ³ kkg)		U.S. Consumption for Fabric Scouring (10 ³ kkg)	Total U.S. Consumption for Degreasing and Scouring (10 ³ kkg)
		Cold	Vapor		
Halogenated hydrocarbons:					
Carbon tetrachloride	534.8	0.72	5		5.72
Fluorocarbons*	428.6	6	11.1		17.1
Methylene Chloride	235.4	46.2	10		56.2
Perchloroethylene	330.2	11.4	43	54.6	109
Trichloroethylene	173.7	43.8	112.7	15	171.5
Trichloroethane	236.3	78	90		<u>168</u>
TOTAL	1939.0	186.12	271.8	69.6	527.52

*This refers to all fluorocarbons, a percentage of which are chlorinated.

solution contains up to 90 percent of the original solvent(4). Depending on the recovery technique, sludges which result from reclamation processes contain from 1 to 50 percent of the original hydrocarbon solvent(5). However, because of the economic considerations of the reclaiming process, the solvent content of the sludge is seldom reduced below 10 percent. Heavy metal fines and other organics are also present in these wastes, in addition to the original solvent(3).

V. QUANTITIES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

Disposal practices include overt open ground dumping, containerized landfilling, and incineration (3). Approximately 99,000 metric tons of waste halogenated solvents from degreasing operations are generated annually(1). It is estimated that about 30,000 metric tons of these are either landfilled or open dumped. The remaining quantity of waste halogenated solvents from degreasing operations are incinerated. The rationale and derivation of this estimated quantity is presented in Appendix I.

VI. HAZARDOUS PROPERTIES OF THE WASTES

As indicated earlier, the spent halogenated solvents and sludges from the reclamation of these solvents contain very significant concentrations of the solvent itself -- the spent solvent solution contains up to 90 percent of the original solvent and the sludge contains a minimum of 10 percent of the original solvent. The landfilling or open ground dumping of these wastes in an unsecure land disposal facility may

result in the migration of the toxic halogenated solvents into the surrounding environment, thus becoming a potential contaminant of groundwater. For example, since a large majority of these wastes are in liquid form -- including all of the spent solvents -- these wastes' physical form makes them amenable to migration from a land disposal facility. Additionally, the solubility in water of these halogenated solvents is appreciable (13): 1,1,1-trichloroethane - 950 mg/l, tetrachloroethylene 150 mg/l, methylene chloride - 20,000 mg/l, carbon tetrachloride 800 mg/l, and trichloroethylene - 1,000 mg/l(14a). These relatively high solubilities demonstrate a strong potential for migration of these substances from inadequate land disposal facilities in substantial concentrations. Thus, improperly constructed or managed landfills (for example, landfills located in areas with permeable soils, or landfills with inadequate leachate control practices) could easily fail to impede leachate formation and migration. Haphazard dumping of the wastes is even more likely to result in migration of waste constituents.

Once released from the matrix of the waste, the halogenated solvents could migrate through the soil to ground and surface waters utilized as drinking water. In the National Organics Monitoring Survey, the Agency detected a number of these solvents in drinking water samples tested over the past several years, thus demonstrating the propensity of these solvents to migrate from the

waste disposal environment and to persist in drinking water following migration* (14a, 14b, 14c, 14e). In addition, a number of actual documented damage incidents show the potential for a very common halogenated solvent, trichloroethylene, to leach from disposal sites into groundwater. (See Damage Incidents Resulting from the Mismanagement of Halogenated Hydrocarbons, p. 16.)

These actual damage incidents confirm literature data points indicating the environmental persistence of these compounds. Thus, 1,1,1-trichloroethane, methylene chloride, and carbon tetrachloride are all likely to persist in the environment long enough to reach environmental receptors (1,1,1-trichloroethane is subject to hydrolysis, but has a half-life in groundwater of 6 months)(37).

Another problem which could result from improper landfilling of these wastes is the potential for the contaminants to volatilize into the surrounding atmosphere. All of the listed chlorinated solvents are volatile and thus could present an air pollution problem if they are improperly managed (for example, disposed of in the open, or without adequate cover), since they are uniformly toxic via inhalation.

A special problem is posed by chlorofluorocarbon solvents. These solvents are also highly volatile, but instead of posing a direct toxicity hazard, they may be released at the surface of the earth, mix with the atmosphere and rise slowly into the stratosphere,

*The specific solvents detected in these samples were methylene chloride, carbon tetrachloride, trichloroethylene, and tetrachloroethylene and trichlorofluoromethane.

Damage Incidents Resulting From The Mismanagement of
Trichloroethylene

1. In one incident in Michigan, an automotive parts manufacturing plant routinely dumped spent degreasing solutions on the open ground at a rate of about 1000 gallons per year from 1968 to 1972. Trichloroethylene was one of the degreasing solvents present in the spent solutions. Beginning in 1973, trichloroethylene was detected at levels up to 20 mg/l in nearby residential wells. The dump site was the only apparent source of possible contamination (10).
2. In a second incident, also in Michigan, an underground storage tank leaked trichloroethylene which was detected in local groundwater up to four miles away from the land (11).
3. In April of 1974, a private water well in Bay City, Michigan became contaminated by trichloroethylene. The only nearby source of this chemical was the Thomas Company (which replaced the well with a new one). The company claimed that, although it had discharged trichloroethylene into the ground in the past, it had not done so since 1968. Nevertheless, in May of 1975, two more wells were reported to be contaminated with trichloroethylene at concentrations of 20 mg/l and 3 mg/l, respectively (12).

In March, 1978, EPA banned the use of chlorofluorocarbons in aerosol propellants. The primary concern in the enactment of this ban was the ozone depletion effects resulting from chlorofluorocarbons entering the stratosphere and reaction with ozone. In the troposphere, chlorofluorocarbons are decomposed by the intense ultra violet radiation to release chlorine atoms. The chlorine atoms catalytically remove ozone, thereby reducing the total amount of ozone in the stratosphere, leading to an increase in skin cancer, climatic changes and other adverse effects.(33,34) The Agency is therefore concerned about chlorofluorocarbon use and disposal. Therefore, the Agency has proposed the regulation of non-aerosol uses of chlorofluorocarbons.(8)

The Agency also expects to propose regulations controlling the airborne emissions of these solvents and other volatile organics so as to reduce the air pollution problems presented when these solvents are used or disposed. These proposed regulations will apply certain standards to a number of the Volatile Organic Compounds (VOC) which have been demonstrated to be precursors of or lead to the formation of ozone and other photochemical oxidants in the atmosphere. Ozone air pollution endangers the public health and welfare and is thus reflected in the Administrator's promulgation of a National Ambient Air Quality Standard for Ozone (February 8, 1979, 44 FR 8202). Additionally, 1,1,1-trichloroethane and

methylene chloride, which are not ozone precursors, are being regulated under the proposed rule since under EPA's proposed airborne carcinogen policy, a compound which shows evidence of human carcinogenicity is a candidate for regulation under Section 111 as a pollutant "reasonably anticipated to endanger public health and welfare". Finally, trichlorofluoromethane, as indicated in the earlier discussion of chlorofluorocarbons in general, has been implicated in the depletion of the stratospheric ozone layer, a region of the upper atmosphere which shields the earth from harmful wavelengths of ultra violet radiation, that would increase skin cancer risks in humans. (33,34)

Additionally, if these wastes are incinerated, as a large percentage are, and the wastes are not subject to proper incineration conditions (i.e., temperature and residence times), pollution of the environment may result from the airborne disposal of uncombusted halogenated organics, partially combusted organics and newly formed organic compounds. Phosgene is an example of a partially combusted chlorinated organic which is produced by the decomposition or combustion of chlorinated organics by heat (15,16,17). Phosgene has been used as a chemical warfare agent and is recognized as extremely toxic.

The large quantities of the spent solvent and sludges resulting from the recovery of these solvents, a combined total of 99,000 metric tons per year, are another area of concern.

As previously indicated, these wastes are generated in substantial quantities and contain very high concentrations of the original solvent (the spent solvent solution contains up to 90 percent and the sludges contain up to 50 percent of the original solvent). The large quantities of these contaminants pose the danger of polluting large areas of ground or surface waters. Contamination could also occur for long periods of time, since large amounts of pollutants are available for environmental loading. All of these considerations increase the possibility of exposure to the harmful constituents in the wastes.

VII. HEALTH AND ECOLOGICAL EFFECTS ASSOCIATED WITH THE
CONSTITUENTS IN THE WASTES

The toxicity of tetrachloroethylene, methylene chloride, 1,1,1-trichloroethane, trichloroethylene, carbon tetrachloride and chlorofluorocarbons has been well documented. Capsule descriptions of the adverse health and environmental effects are summarized below; more detail on the adverse effects of these solvents can be found in Appendix A.

Tetrachloroethylene has been included on EPA's list of chemicals which have demonstrated substantial evidence of carcinogenicity.(21) Repeated exposure of rats and mice to tetrachloroethylene in air or in the diet has resulted in fatty degeneration of the liver, increased kidney weight and toxic nephropathy.(18,19,20). Additionally, tetrachloroethylene is slightly toxic to freshwater fish.(14b,22,23)

Methylene chloride has been shown to be mutagenic to a bacterial strain, *S. typhimurium*.⁽²⁴⁾ In addition, acute exposure to methylene chloride in humans is a central nervous system depressant resulting in narcosis in high concentrations and is metabolized to carbon monoxide and causes an increase in carboxyhemoglobin⁽²⁵⁾.

Although 1,1,1-trichloroethane (MC) has been shown in an NCI bioassay to induce a variety of neoplasms⁽²⁶⁾, these data were not conclusive. A high incidence of deaths in test animals has led to retesting of this compound by a manufacturer and the NCI⁽²⁶⁾. In vitro studies have indicated that MC is slightly mutagenic in the Ames test, and can cause mammalian cell transformation. Human toxic effects seen after exposure to 1,1,1-trichloroethane include changes in several central nervous system functions, including reaction time, perceptual speed, manual dexterity and equilibrium⁽²⁷⁾. In addition, animal studies have produced toxic effects in the central nervous system, cardiovascular system, pulmonary system, and induced liver and kidney damage⁽²⁷⁾.

Trichloroethylene has been included on EPA's list of chemicals which have demonstrated substantial evidence of carcinogenicity.⁽²¹⁾ Trichloroethylene has also been shown, both through acute and chronic exposure, to produce disturbances of the central nervous system and other neurological effects^(28,29,30).

Carbon tetrachloride has been included on EPA's list of chemicals which have demonstrated substantial evidence of

carcinogenicity.(21) In addition, toxicological data for non-human mammals are extensive and show carbon tetrachloride to cause liver and kidney damage, biochemical changes in liver function and neurological damage(32).

The hazards associated with exposure to the above halogenated solvents have been recognized by other regulatory programs. Tetrachloroethylene, methylene chloride, 1,1,1-trichloroethane, trichloroethylene, and carbon tetrachloride and the two fluorocarbons, trichlorofluoromethane and dichlorodifluoromethane, are listed as toxic pollutants in accordance with §307(a) of the Clean Water Act of 1977.* Under §6 of the Occupational Safety and Health act of 1970, final standards for occupational exposure have been established and promulgated in 29 CFR 1910.1000 for carbon tetrachloride, methylene chloride and 1,1,1-trichloroethane. On March 17, 1979, fully halogenated fluorocarbons were banned by the Consumer Products Safety Commission as propellants in the United States, except for essential uses because of their threat to the ozone. In addition, final or proposed regulations in the States of California, Louisiana, Maryland, Massachusetts, Minnesota, Missouri, New Mexico, Oklahoma and Vermont define compounds containing one or more of the solvents tetrachloroethylene, methylene chloride, 1,1,1-trichloroethane, trichloroethylene, carbon tetrachloride and trichlorofluoromethane as hazardous wastes or components thereof.³⁵

*The Agency has recently proposed to remove trichlorofluoromethane and dichlorodifluoromethane from the list of toxic pollutants under §307(a) of the Clean Water Act (45 FR 46103, July 9, 1980).

ATTACHMENT I

DERIVATION OF THE ESTIMATED QUANTITIES OF THE WASTE

I. ANNUAL QUANTITIES OF WASTES

Total amount of spent solvents (Halogenated and non-halogenated)(1) = 425,560 kkg

Total amount of spent solvents from vapor degreasing(1)
= 54,560 kkg

Vapor degreasing units only use halogenated solvents so all of the 54,560 kkg from this source are halogenated solvents. Cold cleaners and fabric scourers use both halogenated and non-halogenated solvents. Assume that the spent solvent solutions contain solvents in the same proportion as their use. About 12 percent of solvent use in applications other than vapor degreasing is halogenated(1).

∴ (425,560 kkg - 54,560 kkg) (0.12)(1)
= 44,250 kkg of halogenated solvents contained in wastes from sources other than vapor degreasing

54,560 kkg + 44,250 kkg = 99,000 kkg of halogenated
solvents yr

II. DISPOSITION OF WASTE

The disposition of about 30 percent of these wastes can be derived from information which is documented in the literature. The disposition of the remaining 70 percent is based upon extrapolations and economic consideration of waste management alternatives.

A. DISPOSITION OF 30 PERCENT OF THE WASTE

- ° Vapor degreasers only use halogenated solvents(1)
- ° Virtually all metal finishing shops (SIC 35, 36, 37, and 39), and by implication vapor degreasing operations, either reclaim their spent solvents or sell them to solvent refiners.(1,3)
- ° Between 50-99 percent of the solution is recovered(4,5)
- ° Approximately 37 percent of the plants which recover these solvents on-site dispose of their waste sludges in landfills(3).

(amount of waste) (1-percent recovery)(percent of plants with on-site recovery) x (percent of plants that landfill) = Amount of waste landfilled.

1. Assume 50 percent of the solution is recovered

$$(54,560 \text{ kkg}) (0.50)(0.37)(0.70) = 7,065 \text{ kkg}$$

2. Assume 99 percent of the solution is recovered

$$(54,560 \text{ kkg}) (0.01) (0.37)(0.70) = 140 \text{ kkg}$$

140 kkg to 7,065 kkg of halogenated solvents disposed of in landfills.

About 20 percent of the solvent reclaimers which process the remaining 63 percent of the solvents from this source also landfill their waste. The remaining 80 percent of the solvent reclaimers reportedly incinerate their sludges(4,5). Therefore an additional 109 to 5,456 kkg of halogenated solvents are landfilled by solvent reclaimers.

B. DISPOSITION OF THE REMAINING 70 PERCENT OF THE WASTE

The wastes generated by the plants in the SIC categories delineated above represent about 60 percent of all vapor degreasing operations and about 30 percent of all wastes generated by all degreasers. Reportedly, a facility which generates at least 350 gallons of spent halogenated solvents annually has economic incentive to implement a recovery strategy(4,9). Virtually all vapor degreasers meet this criteria.

The disposition of spent solutions from cold cleaning and fabric scouring operations is not as well defined. In order to account for these wastes, some economic factors have been considered. In general, it is expected that a plant or industry which has a high incidence of use of a relatively expensive solvent will probably have some kind of recovery strategy, assuming the scale of operations permits an acceptable payback period. In cold cleaning and fabric scouring operations, the following factors are pertinent:

- ° Cold cleaning and fabric scourers use halogenated solvents in conjunction with inexpensive non-halogenated solvents. It has been estimated that these operations must have six to twelve times the solvent throughput of plants which only use halogenated solvents in order to economically justify a recovery strategy.
- ° Cold cleaning and fabric scouring operations represent about 94.7 percent of all facilities that use halogenated solvents but only use about 43 percent of the total supply of these solvents

that are used for degreasing. The implication is that, on the average, the solvent throughput rate is much lower in this segment of the degreasing industry than that of the vapor degreasing segment.

Although some cold cleaning and fabric scouring operations probably operate on a scale that would make a recovery strategy economically attractive, it is not possible to estimate the extent of recovery operations in this segment of the industry. The economics seem to indicate that the incidence of recovery from these operations is probably very low.

C. THE GROSS ESTIMATE

In estimating the disposition of all the wastes, the best and worst cases pertaining to the portion of the waste which cannot be documented in the literature are considered. The ideal case is where all of the wastes from cold cleaning and fabric scouring operations are processed by contract reclaimer using maximum efficiency recovery techniques (i.e., 99 percent recovery). The worst case would be where all of this waste is simply disposed of. The following is the basis for the estimate.

From Section A

249 kkg to 12,521 kkg of halogenated solvents are landfilled.

Best Case for Cold Cleaning and Fabric Scouring

(amount of waste)(percent recovered)(percent landfilled) = amount landfilled

(44,520 kkg)(0.01)(0.2) = 90 kkg of waste landfilled

Worst case for cold cleaning and fabric scouring is when all 44,520 kkg of waste is landfilled

The estimated best and worst cases for the disposition of halogenated solvents from all types of degreasing operations are 339-57,041 metric tons per year. It is unlikely that either the best or worst case is representative of reality. In this case, about half of the waste is generated by vapor degreasers where it is likely that the incidence of recovery is high. The remaining half is generated in environments where

the incidence of recovery is probably very low. A reasonable inference and prudent estimate based on available data would be about 30,000 metric tons per year of halogenated solvents disposed of on land.

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WASTES FROM USAGE OF ORGANIC SOLVENTSI. LISTING

The listed wastes are those major streams which result from usage of organic solvents. The listed solvents include both halogenated and non-halogenated organic compounds. The specific wastes listed are:

F002 The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, o-dichlorobenzene, trichlorofluoromethane, and the still bottoms from the recovery of these solvents (T);

F003 The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, n-butyl alcohol, cyclohexanone, methanol, methyl isobutyl ketone; and the still bottoms from the recovery of these solvents (I);

F004 The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents (T); and

F005 The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine; and the still bottoms from the recovery of these solvents (I,T).

Listing codes for the most widely used halogenated organic solvents are presented in Table I-1, and codes for widely-used non-halogenated organic solvents are in Table I-2.

II. SUMMARY OF BASIS FOR LISTING

Wastes resulting from usage of organic solvents typically contain significant concentrations of the solvent. Examples of wastes from usage of organic solvents include still-bottoms

from solvent recovery and spent solvents from dry cleaning operations and maintenance and repair shops.

The Administrator has determined that waste from usage of the 24 organic solvents listed in Tables I-1 and I-2 may be a solid waste, and as a solid waste, may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations*:

1. Of the list of 24 solvent types presented in Tables I-1 and I-2, each solvent exhibits one or more properties (i.e., ignitability and/or toxicity) which pose a potential hazard. These solvents represent approximately 95 percent or more of organic solvent usage in the United States (see Table II-1).
2. The use of organic solvents is widespread throughout the United States, and the quantities involved are large; according to Table II-1 the total annual usage of the listed materials as solvents is over 2.8×10^6 kkg.
3. Of the twenty-four solvents listed in Tables I-1 and I-2, nine are listed for meeting only the ignitability characteristic. These nine spent solvents all have a flash point below 60°C (140°F) and are thus considered hazardous.

*The Agency is presently aware that these solvents may contain concentrations of additional toxic constituents listed in Appendix VIII of the regulations. For purposes of this listing, however, the Agency is only listing those wastes for the presence of the halogenated and non-halogenated solvents. The Agency expects to study these listings further to determine whether the waste solvent and still bottom listings should be amended.

TABLE I-1

LISTING CODES FOR HALOGENATED ORGANIC SOLVENTS*
(in order of usage as solvent)

Solvents	Listing Codes	Flash Point (°F)
Perchloroethylene	T	-
Methylene chloride	T	-
Trichloroethylene	T	-
1,1,1,-Trichloroethane	T	-
Chlorobenzene	T	-
1,1,2-Trichloro-1,2,2- Trifluoroethane	T	-
o-Dichlorobenzene	T	-
Trichlorofluoromethane	T	-

*All data in this table are based on information contained in Reference (1). Dashes in place of data mean either the values were not available or (in the case of flash points) not applicable.

TABLE I-2

LISTING CODES FOR NON-HALOGENATED ORGANIC SOLVENTS*
(in order of usage as solvent)

Solvents	Listing Codes	Flash Point (°F)
Xylenes	I**	84(2)
Methanol	I,**	54
Toluene	I,T**	39
Methyl ethyl ketone	I,T**	22(3)
Acetone	I**	3
Methyl isobutyl ketone	I,**	61
Carbon disulfide	I,T**	-25
Ethyl acetate	I**	45(2)
Ethyl benzene	I**	59
Ethyl ether	I**	-49(2)
n-Butyl alcohol	I**	115
Isobutanol	I,T**	82
Cresols and cresylic acid	T	-
Cyclohexanone	I**	111(3)
Nitrobenzene	T	-
Pyridine	I,T**	68

* All data in this table are based on information contained in Reference (1) except as noted. Dashes in place of data mean either that the values were not available or (in the case of flash points) not applicable.

**Because the listed waste typically would contain a large percentage of these solvents, the listed wastes would fail the ignitability characteristic for liquids--a flash point less than 60°C (140°F).

The fifteen solvents listed as either toxic or toxic and ignitable pose a further hazard to human health and the environment. If improperly managed, these solvents could migrate from the disposal site into ground and surface waters, persist in the environment for extended periods of time, and cause substantial hazard to environmental receptors.

The two fluorocarbons, 1,1,2-trichloro-1,2,2-trifluoroethane and trichlorofluoromethanes present a different type of hazard. Due to their high volatility, these two organics can rise into the stratosphere and deplete the ozone, leading to adverse health and environmental effects.

4. Damage incidents resulting from the mismanagement of waste solvents have been reported. These damage incidents are of three types:
 - (a) Fire/explosion damage resulting from ignition of the solvents;
 - (b) Contamination of wells in the vicinity of inadequate waste storage or disposal (with resulting illness in at least one instance); and
 - (c) Direct entry of solvent into a waterway, resulting in fish kills.
5. These damage incidents show that mismanagement occurs and that substantial hazard to human health and the environment may result there from.

III. SOURCES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

A. Overall Description of Industry Usage*

The primary solvent-using industries and the quantity of solvents they use annually are as follows:⁽¹⁾

*Large amounts of chemicals listed in Table II-1 are used in such non-solvent applications as chemical feedstock so that the total production of specific solvent chemicals for all applications is often many times larger than the amount used specifically as a solvent.

Table II-1

RANKING AND AMOUNTS OF THE LISTED SOLVENTS(1)

Chemical Name	Amount Used As Solvent (kkg/yr)
Xylenes	489,900
Methanol	317,500
Toluene	317,500
Perchloroethylene	255,800
Methylene chloride	213,200
Methyl ethyl ketone	202,300
Trichloroethylene	188,200
1,1,1-Trichloroethane	181,400
Acetone	86,200
Methyl isobutyl ketone	78,000
Chlorobenzene	77,100
Carbon disulfide	77,100
Ethyl acetate	69,900
Ethyl benzene	54,430
Ethyl ether	54,430
n-Butyl alcohol	45,360
1,1,2-Trichloro-1,2,2-tri-fluoroethane	24,040
Isobutanol	18,600
o-Dichlorobenzene	11,800
Cresols & cresylic acid(a)	11,800
Cyclohexanone	9,072
Nitrobenzene	9,072
Trichlorofluoromethane	9,072
Pyridine	907

(a) Consumption amounts for cresol and cresylic acid were combined.

Paint & Allied Products and Industrial Operations	1,153,500 kkg/yr
Surface Cleaning	610,600 kkg/yr
Pesticide Production	266,700 kkg/yr
Laundry and Dry Cleaning Operations	214,550 kkg/yr
Pharmaceuticals Manufacture	34,740 kkg/yr
Solvent Recovery Operations (Contract and in-house)	499,000 kkg/yr (feedstock)

Table III-1 summarizes the use pattern of the 10 most widely used solvents in the industrial categories listed above. These data illustrate the distinct difference between halogenated and non-halogenated solvents in industrial usage; the chlorinated and other halogenated solvents in Table III-1 are used almost exclusively in the surface cleaning, laundry and dry cleaning categories, whereas the non-halogenated solvents are used primarily in the production categories (paint, pesticides and pharmaceuticals). The ten specific solvents included in this table are believed to account for about 80 percent of all organic solvent usage.(1)

The composition of the spent solvent* is dependent on its application, but the spent solvent contains up to 90 percent of the original solvent**. Depending on the recovery techniques,

*Spent solvents include those solvents which are no longer useful without further processing either because they have outlasted their shelf life or because they have been contaminated, or so changed chemically or physically that they are no longer useful as solvent.

**United States Environmental Protection Agency. 1976. Assessment of Industrial Hazardous Waste Practices Electroplating and Metal Finishing Industries - Job Shops PB-264-349.

Table III-1

USE DISTRIBUTION OF THE 10 MOST WIDELY USED ORGANIC SOLVENTS (1)

(All data in units of 10^3 kg/yr)

	Xylene	Methanol	Toluene	Perchloroethylene	Methylene chloride	Methyl ethyl ketone	Trichloroethylene	1,1,1-Trichloroethane	Acetone	Methyl isobutyl ketone	Total*
Paint & Allied Products	243	300	292	-	-	165	-	-	91	61	1153
Surface Cleaning	-	-	-	46	214	-	161	163	N/A	-	610
Pesticides	243	-	-	-	-	-	-	14	-	8	267
Pharmaceuticals	N/A	1	23	-	N/A	N/A	-	N/A	N/A	8	34
Laundry & Dry Clean.	-	-	-	203	-	-	7	-	-	-	215
TOTAL	490	301	317	236	214	165	168	182	91	77	
Listed Use Level in Reference (1)	490	317	317	236	214	202	168	181	96	78	

*This total is for the 10 primary solvents only and does not include other solvents used in the respective categories.

"N/A" indicates that the solvent at issue is probably used, but the amount that is used is not known.

sludges which result from reclamation processes contain from 1 to 50% of the original solvent.* However, because of the economic considerations of the reclaiming process, the solvent content of the sludge is seldom reduced below 10 percent.**

B. Solvent Usage in Paint & Allied Products and Industrial Operations

The category of Paint & Allied Products and Industrial Operations is taken here to include the following solvent-use industrial operations:

- ° Paint & Allied Products Manufacture
- ° Roll Coatings
- ° Paper Coatings
- ° Dye Manufacture
- ° Ink Manufacture
- ° Adhesive Manufacture
- ° Printing Operations

The Paint and Allied Products and Industrial operations category accounts for about half of all organic solvent utilization by industry. The Paint and Allied Products portion of this category is the largest solvent-use subcategory, with Printing Operations being the second largest use subcategory.

For the Paint & Allied Products Industry, there are about 1200 paint manufacturing companies that operate more

*United States Environmental Protection Agency. 1979. Organic Solvent Cleaners-Background Information for Proposed Standards. EPA-45/12-78-045a.

**United States Environmental Protection Agency. 1978. Source Assessment: Reclaiming of Waste Solvents. State of the Art. PB-289-934.

than 1500 plants. Solvents are important ingredients in formulations for solvent-thinned paints, lacquers, and factory-applied coatings.

Solvent containing wastes arise from the use of solvents to clean equipment, and still bottoms from the recovery of the solvents used in production*. It is estimated⁽⁴⁾ that approximately one-third of the solvents used for equipment cleaning are reclaimed, and that 7×10^6 gallons of solvent are disposed of yearly from this source.

The total quantity of solvent-containing wastes from the paint industry is estimated to contain 14,300 kkg/yr of solvents.⁽⁴⁾ These are primarily non-halogenated solvents such as xylenes, methanol, acetone, toluene, MEK, etc.

The remaining industrial processes included in this overall category (manufacture of inks, adhesives, dyes, and various types of coatings) utilize organic solvents (primarily non-halogenated) in much the same manner as the paint industry; that is, as an important component of formulations and for equipment cleaning.⁽¹⁾ Printing operations also use solvents for cleaning operations and as dye or pigment carriers. The types of waste generated from these industries should be generally similar to those from the paint industry and include:

Equipment cleaning wastes;

Still bottoms from solvent recovery.

*Additional waste streams from these industrial categories (such as off-specification product and spills of finished product) are expected to be covered by future listings.

Spent solvents used for equipment cleaning, if not reclaimed, are drummed and landfilled(4). Most paint companies contract for waste disposal services. Solvent recovery still bottoms are incinerated, landfilled, or injected into deep wells.(5)

C. Surface Cleaning

The Surface Cleaning category consists of two important subcategories:

- ° Industrial Degreasing
- ° Repair work
 - Industrial Maintenance and Repair
 - Commercial Service and Repair
 - Consumer-performed Maintenance and Repair

About half of the solvents used in Surface Cleaning Operations, as shown in Table III-1, are used in Industrial Degreasing, (see the Listing Background Document for Solvent Degreasing Operations) with the other half being used in various types of repair work.(1) According to Reference (6), the total number of degreasing operations in the United States for 1976 was over 1,300,000, of which nearly half were associated with manufacturing operations of various types. The major solvents used are trichloroethylene, 1,1,1-trichloroethane, and chlorofluorocarbons. Most of the solvents used in surface cleaning were halogenated, due to their nonflammable character; this property is especially important in high-temperature degreasing operations.

Neither surface cleaning nor either of its two subcategories can be classified as industry specific, per se; rather, these operations are conducted in a number of types of industries (i.e., primary metals, auto repair shops, textile plants).

With respect to the geographic distribution, industrial degreasing is the most concentrated source of solvent wastes from the surface cleaning category since degreasing is associated with manufacturing operations that involve metal finishing (including etching, plating, priming and painting) and electronic components manufacture. The repair work subcategory is much more diffuse in distribution, with both commercial service and repair and consumer-performed maintenance and repair being generally distributed in the same pattern as the population itself.(5)

The major types of wastes from solvent usage in the industrial degreasing subcategory are used (spent) solvent and solvent recovery still bottoms. Wastes from the repair work subcategory would include both halogenated and non-halogenated solvents, and would take the form of relatively small amounts of used solvent (typically up to a few gallons), plus contaminated rags and other materials.

D. Production of Pesticides, Pharmaceuticals and Other Organic Chemicals

Solvent applications in the production of pesticides, pharmaceuticals and other organic chemicals include usage as

a reaction (synthesis) medium, and usage in equipment cleaning.⁽¹⁾ The solvents used are primarily non-halogenated and are typically selected for compatibility with the production process. Toluene is the most widely used solvent in pharmaceuticals manufacture, methanol is used as the reaction solvent in Nylon 66 production, and acetone is used as the solvent in the production of cellulose acetate.⁽¹⁾

Wastes from solvent usage in these industries take the form of off-specification product material, equipment cleaning wastes, and solvent recovery still bottoms. The destination of all solid wastes is not known, but a large percentage is reclaimed either in-house or by contract recovery operations.⁽⁵⁾

Solvent-containing wastes in these industries are not as geographically distributed as in the other categories discussed herein, but would be expected to follow the general geographical pattern of the organic chemical industry.

E. Laundry and Dry Cleaning

There are about 25,000 retail dry cleaning plants in the United States, 18,000 of which use between 167,000 kkg/yr⁽⁷⁾ and 208,000 kkg/yr⁽¹⁾ of perchloroethylene. Of the other 7000 plants, 6000 use about 72,700 kkg/yr of Stoddard's solvent*, (which is a petroleum distillate), and 1000 use trichlorofluoroethane at a rate of about 900 kkg/yr.⁽⁷⁾ The

*Stoddard solvent is not specifically included in the waste listings, however, since this solvent has a flash point of 105°F (i.e., meets the ignitability characteristic), it would also be regulated under the Subtitle C regulatory control system.

solvents are used to remove dirt, grease and other materials. It is believed that 8 percent⁽⁷⁾ of the amount of perchloroethylene used in dry cleaning is disposed of along with still-bottom and cooker residues, so that the amount of perchloroethylene discarded is between 13.4 and 16.6 thousand kkg/yr.

The distribution of dry cleaning plants is uniform with respect to population and is especially associated with population in large urban areas.⁽⁷⁾

Still bottoms from retail dry cleaning consist of about 60 percent solvent and 40 percent oily residue.⁽⁷⁾ "Coker"* residues are 25 percent solvent and 75 percent spent filter (mostly diatomaceous earth).⁽⁷⁾

F. Solvent Recovery Operations

Still bottoms from solvent recovery operations are the remaining waste streams included in this listing. Each of the solvent use industry categories discussed above generates feedstocks for solvent recovery operations. Recovery may be accomplished either in-house or by contract to a recovery firm.

With regard to contract solvent recovery operations, there are between 30 and 100 contract solvent recovery operations in the U.S.⁽⁴⁾ The surface cleaning category, and particularly industrial degreasing operations is one of the largest sources of spent solvents sent to contract reclaimers.

*A "cooker" is a type of still in which solvent-contaminated diatomaceous filter powder is heated to drive off the solvent fraction of the total liquid residue contained in the filter powder.

Other important sources of spent solvents are the paint, ink, and coatings manufacturers and manufacturing processes where very pure solvents are used in organic synthesis (e.g., the organic chemical and pharmaceuticals industries).⁽⁸⁾ Some contract reclaiming of solvents is also carried out on solvents from commercial and industrial dry cleaning operations. The geographic distribution, by state, of contract solvent recovery operations is presented in Table III-2.

The volume of feedstock sent to the contract solvent recovery industry is approximately 287,000 kkg/yr; of this volume, about 27 percent are halogenated.⁽⁴⁾

Although there are approximately 100 contract solvent recovery companies, the total number of solvent recovery operations is much larger due to on-site recovery. Of the total number of plants involved in "cleaning operations", 97.89 percent perform on-premises solvent recovery.⁽⁸⁾

Excluding the dry cleaning plants, which are distributed geographically in the same pattern as population, the geographic distribution of all solvent recovery operations is as shown in Table III-3.

Solvent recovery still bottoms (sludges) from contract reclaiming operations amount to about 73,900 kkg/yr, of which between 5 and 50 percent is solvent, or an average solvent content of about 25 percent.⁽⁴⁾ About 27 percent of the solvents in still-bottom sludges are halogenated.⁽⁴⁾ Thus, the total still bottom waste from contract reclaiming consists of the following components:

Table III-2

GEOGRAPHIC DISTRIBUTION OF CONTRACT SOLVENT
RECOVERY OPERATIONS(4)

New Jersey	9
California	9
Ohio	8
Illinois	8
Michigan	7
New York	5
Indiana	4
Massachusetts	3
Rhode Island	2
Maryland	2
South Carolina	2
Georgia	2
Kentucky	2
Tennessee	2
Missouri	2
Texas	2
Connecticut	1
North Carolina	1
Florida	1
Kansas	1
Arizona	$\frac{1}{74}$

Table III-3

STATE DISTRIBUTION OF SOLVENT RECLAIMING OPERATIONS (3)

State	Number of Plants	Percent of Total
Alabama	72	1.6
Arizona	37	0.94
Arkansas	39	0.99
California	424	10.
Colorado	44	0.16
Connecticut	60	1.5
Delaware	12	0.35
Florida	141	3.5
Georgia	98	2.4
Idaho	14	0.4
Illinois	224	5.5
Indiana	112	2.8
Iowa	59	1.4
Kansas	49	1.2
Kentucky	70	1.7
Louisiana	63	2.0
Maine	19	0.5
Maryland	63	2.0
Massachusetts	65	2.0
Michigan	176	4.3
Minnesota	76	1.8
Mississippi	45	1.1
Missouri	98	2.3
Montana	15	0.41
Nebraska	30	0.77
Nevada	10	0.29
New Hampshire	13	0.33
New Jersey	153	3.7
New Mexico	21	0.57
New York	372	8.9
North Carolina	105	2.5
North Dakota	13	0.37
Ohio	213	5.1
Oklahoma	56	1.3
Oregon	40	1.1
Pennsylvania	245	5.9
Rhode Island	31	0.57
South Carolina	55	1.3
Tennessee	33	2.0

Table III-3 (cont'd)

State	Number of Plants	Percent of Total
Texas	242	5.8
Utah	21	0.56
Vermont	8	0.24
Virginia	97	2.3
Washington	72	1.7
West Virginia	41	0.99
Wisconsin	90	2.2
Wyoming	6	0.14
Total	4,158	100

18,250 kkg/yr solvent, including 13,320 kkg/yr non-halogenated and 4,930 kkg/yr halogenated;
54,750 kkg/yr non-solvent contaminant, including oils, waxes, metals and chlorinated and nonchlorinated organics.

The estimate of 25 percent average solvent content, as presented above, can probably be applied to solvent recovery still bottoms for all of the industries discussed herein, since the technology used to reclaim solvents is roughly similar throughout U.S. industry.⁽⁸⁾

Waste Management Practices*

The most widely used management practices for spent solvents is either recovery/reclamation (either on-site or by contract recovery operations), land disposal (which may include anything from open ground dumping to landfilling), or incineration. For still bottoms, about 35⁽⁸⁾ to 36⁽⁴⁾ percent of these bottoms from contract solvent reclaimers

*The Agency has concluded that it does have jurisdiction under Subtitle C of RCRA to regulate waste materials that are used, reused, recycled or reclaimed. Furthermore, it has reasoned that such materials do not become less hazardous to human health or the environment because they are intended to be used, reused, recycled or reclaimed in lieu of being discarded. Therefore, at this time, applicable requirements of Parts 262 through 265 and 122 will apply to the accumulation, storage and transportation of hazardous wastes that are used, reused, recycled or reclaimed. The Agency believes this regulatory coverage is appropriate to the subject wastes. These spent solvents and still bottoms from the recovery of these solvents are hazardous in so far as they are being accumulated or stored in drums or tanks prior to recycling. Therefore, these wastes will be considered as hazardous whether recycled or disposed. However, at the present time, the management of these wastes during recycling operations will not be regulated.

are incinerated. Still bottom sludges from both contract reclaimers and from solvent recovery operations performed by solvent-using industries, if not incinerated, are either landfilled or injected into deep wells.(8,5) Land disposal of still bottom sludges from contract reclaimers is mostly in landfills that are covered daily.(4) A small amount of sludge is used as asphalt extender (about 0.1 percent).(4)

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IV. HAZARDS POSED BY THE WASTES

A. Hazardous Properties of the Solvents

The major halogenated solvents exhibit organic toxic properties which make them potentially hazardous to human health and the environment. In particular, the two halogenated solvents, perchloroethylene and trichloroethylene are on CAG's List of Carcinogens and 1,1,1-trichloroethane is a suspect carcinogen. All of the listed halogenated organic solvents, except 1,1,2-trichloro-1,2,2-trifluoroethane, are priority pollutants under Section 307(a) of the CWA.

A number of the non-halogenated organic solvents also exhibit toxicity properties. For example, nitrobenzene has been identified as a suspect carcinogen. These compounds are toxic via one or more of the exposure routes inhalation, ingestion and/or through the skin. Short term human exposure to these compounds can have numerous adverse effects. (For more information on the adverse health effects of these halogenated and non-halogenated solvents, see Health and Environmental Effects, pp. 38-45. In addition, almost all of the non-halogenated solvents also present an ignitability hazard.

In light of the health hazards associated with the waste

solvents--particularly those which are genetically active-- and the high concentrations of hazardous solvents contained in the waste, the Agency believes a decision not to list these waste solvents as hazardous would be warranted only if the Administrator were convinced that waste solvents could not migrate and persist, reaching human or environmental receptors (if improperly managed). Such assurance does not appear possible. Not only do all of the waste solvents in varying degrees, have significant potential for migration, mobility, and persistence, but many have been implicated in actual damage incidents as well. The Administrator thus believes the hazardous waste listing to be warranted.

In addition, almost all non-halogenated solvents also present an ignitability hazard. According to Table I-2, the fourteen most-used non-halogenated organic solvents exhibit flash points of 115°F or below, and are thus well below the limit set for defining an ignitable waste under RCRA §261.21 (flash point below 140°F); therefore, these spent solvents and the still bottoms from the recovery of these solvents are defined as hazardous.

Based on the information in Section III, most of the wastes from usage of organic solvents are landfilled or incinerated. Smaller amounts of these solvent wastes are either placed on open land (or dumps), into storm sewers, and into deep wells. Mismanagement and improper disposal of these

wastes by any of these methods could result in a substantial health and environmental hazard.

Actual damage incidents (see pp. 32-35) involving certain of these listed wastes confirm the dangers of ignitability, and of leaching of waste constituents from landfills to groundwater. Improper waste incineration could also lead to substantial hazard. Thus, inadequate incineration conditions (temperature and residence time) can result in emission of solvents or toxic degradation products. Where a chlorinated solvent is involved, emissions could be more dangerous than the waste itself. For example, phosgene is a partially combusted chlorinated organic (halogenated solvent) which is produced by the decomposition or combustion of chlorinated organics by heat. (1a,1b,1c) Phosgene has been used as a chemical warfare agent and is recognized as extremely toxic.

3. Migratory Potential and Persistence of Halogenated And Non-Halogenated Solvents

The following section discusses the migratory potential, mobility, and persistence of the individual waste solvents. In general, all of these solvents appear capable of sufficient migration, mobility and persistence to create a substantial hazard should waste mismanagement occur.

Environmental fate data showing the potential for release of the individual halogenated and non-halogenated solvents is

described below and summarized in Table IV-1 and Table IV-2.

Perchloroethylene

Perchloroethylene, if not properly disposed of, may migrate from the waste into the environment via both air and groundwater exposure pathways.

Having been detected in several sites away from the disposal area (i.e., found in varying amounts in school basement air, in basement sumps, and on solid surface samples at the Love Canal site), perchloroethylene has indeed been demonstrated to be quite mobile and persistent.⁹

Methylene Chloride

Methylene chloride, if not properly managed, may migrate from the waste into the environment. It is very water-soluble (20,000 mg/l), thus could leach into groundwater and persist there due to its stability.¹⁰ It is also very volatile (350 mm Hg at 20°C) and could present an air pollution problem because of its high evaporation rate (1.8 times the rate of ether) and its stability in air and light.¹⁰

Trichloroethylene

Trichloroethylene, if not properly managed, may migrate from the disposal site into the environment via air and groundwater pathways. First, it is volatile (77 mm Hg at 20°C, 141.04 mm Hg at 40°C⁸), so it may be released from the waste into the air; it has been detected in school and basement air at the Love Canal site.⁹

TABLE IV-1

Halogenated Solvents*

Compound	Vapor Pressure (mm Hg)	Solubility in Water (mg/l)	Octanol/Water Partition Coefficient
Perchloroethylene	19 at 25°C ⁵	150 at 25°C ⁵	339 ²
Methylene chloride	350 at 20°C	20,000 at 25°C ⁵	20
Trichloroethylene	77 at 25°C ⁵	1,000 at 20°C ⁵	195 ²
1,1,1-Trichloroethane	100 at 20°C	950 at 25°C	158
Chlorobenzene	10 at 22°C	488 at 25°C	690
1,1,2-Trichloro- 1,2,2-Trifluoroethane	270 at 20°C	10 at 25°C	100
1,2-Dichlorobenzene	1.56 at 25°C ⁵	145 at 25°C	2400 ²
Trichlorofluoromethane	687 at 20°C ¹¹	1,100 at 25°C ¹¹	339 ²

* Table compiled from data given in "Physical Chemical Properties of Hazardous Waste Constituents" (U.S. EPA, 1980) unless otherwise specified by superscript.

Table IV-2

Non-Halogenated Solvents*

Compound	Vapor Pressure (mm Hg)	Solubility in Water	Octanol/Water Partition Coefficient
Methanol	100 at 21.2°C	Miscible	5
Toluene	28.4 at 25°C	470 at 25°C	117
Methyl ethyl ketone	100 at 25°C	100,000 at 25°C	1
Methyl isobutyl ketone	16 at 20°C	19,000 at 25°C	1
Carbon disulfide	260 at 20°C	2,200 at 25°C	100
Isobutanol	10 at 25°C	95,000 at 18°C	8
Cresols and cresylic acid ortho (1,2)	0.24 at 25°C ¹¹	31,000 at 40°C ¹¹	110 ²
meta (1,3)	0.04 at 20°C ¹¹	23,500 at 20°C ¹¹	102 ²
para (1,4)	0.11 at 25°C ¹¹	24,000 at 40°C ¹¹	98 ²
nitrobenzene	1 at 44.4°C	1,900 at 25°C	62
Pyridine	20 at 25°C	Miscible	5

*Table compiled from data given in "Physical Chemical Properties of Hazardous Waste Constituents" (U.S. EPA, 1980) unless otherwise specified by superscript.

It is also relatively water-soluble (1,000 mg/l), so that it may leach into groundwaters if not adequately contained. Trichloroethylene has been detected in a number of wells and residue ponds near groundwater contaminated by a chemical company dump, as well as in basement sumps at the Love Canal site, confirming its mobility and persistence in groundwater.⁹

1,1,1-Trichloroethane

1,1,1-Trichloroethane is a highly mobile compound, and if not properly managed, could migrate from wastes into the environment. It is highly volatile (100 mm Hg at 20°C; approximately 210 mm Hg at 40°C), so that it may be released from waste sites into the air. Once in the air, it will only decompose at elevated temperatures. Because of this, and the fact that 1,1,1-trichloroethane is reactive to sunlight at high altitudes, while stable at low altitudes, it may create air-pollution problems if disposed of inadequately.¹⁰ It has been detected in school and basement air at the Love Canal site.⁹

1,1,1-trichloroethane is also relatively water-soluble (950 mg/l) and mobile, particularly where soils are low in inorganic content.¹⁰ It is also relatively persistent in groundwater where it reacts slowly, releasing hydrochloric acid.¹⁰

Chlorobenzene

Chlorobenzene may migrate from the disposal site into the environment if inadequately disposed of. Its water solubility is fairly high (488 mg/l) to enable its leaching into groundwater where it would persist, since it is not amenable to hydrolysis.¹⁰

Chlorobenzene is also volatile so it could be released from wastes into the air.¹⁰ It has been detected in school and basement air, basement sumps, and solid surface samples at the Love Canal site.⁹ Because it does not biodegrade well, chlorobenzene is very persistent in the environment.¹⁰
1,1,2-Trichloro-1,2,2-trifluoroethane/Trichlorofluoromethane

These two solvents, if improperly managed, can migrate from the disposal site into the environment. They are extremely volatile (1,1,2-trichloro-1,2,2-trifluoroethane-270 mm Hg at 20°C, to over 500 mm Hg at 40°C;¹⁰ trichlorofluoromethane-687 mm Hg at 20°C⁷) and very persistent in the environment due to resistance to biodegradation, photodecomposition, and chemical degradation.⁷ Because of their high volatility and persistence, after release at the surface of the earth, these solvents rise to the stratosphere where they may release chlorine atoms and deplete the ozone. This can lead to various adverse health and environmental effects resulting from an increase in the amount of ultraviolet radiation reaching the earth, as well as possible changes in the earth's climate induced by the "greenhouse effect".^{3,4}

o - Dichlorobenzene

o - Dichlorobenzene, if disposed of improperly, may migrate from the disposal site into the environment by both air and water pathways. Having been detected at several sites away from the disposal area (found in school and basement air, in basement sumps, and in solid surface samples at

the Love Canal site), o-dichlorobenzene has been demonstrated to be mobile and persistent.⁹

o-Dichlorobenzenes has a very high octanol/water partition coefficient of 2,400, indicating a high bioaccumulation potential. Thus, migration, even in small concentrations, could lead to a chronic toxicity hazard (Appendix A).

Toluene

Toluene, if improperly managed, may migrate from the the disposal site into the environment. It is relatively volatile (vapor pressure 28 mm Hg at 20°C) and so can migrate via and air pathway. It can re-enter the hydrosphere in rain.¹² Toluene is also capable of migration via a groundwater pathway since it is relatively soluble (470 mg/l), and persistent in abiotic environments (such as most aquifers).

Toluene has been detected in school and basement air, basement sumps, and solid surface samples at the Love Canal site, demonstrating its mobility and persistence in both air and groundwater.⁹

Methyl Ethyl Ketone

Methyl ethyl ketone, if disposed of inadequately may migrate from the disposal site into the environment. It is extremely soluble in water (100,000 mg/l), and therefore could leach into groundwater. It is also very volatile (185.4 mm Hg at 40°C⁸), and could present an air pollution problem if improperly contained. Because of its high solubility

it could be re-entrained from air into the hydrosphere via rain.

Methyl ethyl ketone has been detected at several sites near groundwater contaminated by an old chemical company dump, as well as in school and basement air at the Love Canal site, demonstrating both its mobility and persistence.⁹

Carbon Disulfide

Carbon disulfide, if improperly managed, may migrate from the disposal site into the environment. It is extremely volatile (260 mm Hg at 20°C) and although subject to photolysis, could present an air pollution problem if inadequately contained. It is also quite soluble in water (2200 mg/l), and is not known to attenuate in soils; therefore it could leach into the groundwater, where, being unamenable to hydrolysis, it is likely to persist for an extended time period.¹⁰

Isobutanol

Isobutanol, if improperly managed, may migrate from the disposal site into the environment. It is extremely water-soluble (95,000 mg/l); thus, if inadequately contained, it may contaminate surface water and adversely affect its self-purification ability.¹⁰ In addition, isobutanol could leach into groundwater if disposal is inadequate.

Cresols (and cresylic acid)

Cresols, if improperly managed, may migrate from the disposal site into the environment. Cresols are highly soluble (23,500 to 31,000 mg/l) and are not known to attenuate

significantly in soils; thus, they could leach into groundwater if disposal is inadequate. Once in water, cresols rapidly form chlorinated compounds, which are more environmentally objectionable.¹⁰ Cresols are not known to hydrolyze and so would be likely to persist in groundwater.¹¹

Nitrobenzene

Nitrobenzene, if disposed of inadequately, may migrate from the disposal site into the environment. It is water-soluble (1900 mg/l) and would be mobile where soil organic content is low,¹⁰ and thus could leach into groundwater if disposal is not adequate. It is likely to be highly persistent in groundwater since it is not amenable to hydrolysis and does not biodegrade well.¹⁰

Pyridine

Pyridine, if disposed of inadequately, may migrate from the disposal site. Because pyridine is miscible with water, it has high migratory potential. It would be mobile as well, unless soil has high clay content.¹⁰ Pyridine also would be likely to persist in the abiotic environment of most groundwaters.

C. Mismanagement of Wastes Destined for Land Disposal

Documented damage incidents resulting from the mismanagement of these wastes from usage of organic solvents are presented below:

Damage Resulting from Ignitability of Wastes

- (1) A load of used pesticide containers delivered to a disposal site in Fresno County, California, also contained several drums of an acetone-methanol solvent mixture. When the load was compacted by a bulldozer, the waste ignited, engulfing the bulldozer in flames and dispersed pesticide wastes.(13)
- (2) A large number of drums containing organic solvent wastes were deposited in a landfill at Contra Costa, California. In the immediate area were leaking containers of concentrated mineral acids and several bags of beryllium wastes in dust form. The operators failed to cover the wastes at the end of the day. The combination of wastes ignited during the night, starting a large chemical fire which possibly dispersed toxic beryllium oxide.(13)
- (3) Two serious fires at the Merl-Milam Landfill, St. Clare County, Illinois (August, 1973 and April, 1974) were attributed to the presence of solvent wastes from plastics manufacture.(13)

Contamination of Groundwaters

- (1) In two separate instances in Michigan, trichloroethylene was dumped on the ground and later found to have migrated into groundwater. In one case, trichloroethylene dumped at a rate of 1000 gallons per year over a four-year period was detected in residential wells as much as 1100 feet from the site of dumping. Concentrations ranged as high as 28 ppm.(13)

In the other case, the Air Force at a base near Oscoda, Michigan, had problems with contaminated groundwater because of a leaking tank which use to hold trichloroethylene. The problem was compounded when a waste hauler apparently mismanaged the trichloroethylene that was hauled from the leaking tank, and groundwater contamination up to four miles away was considered one of the results.(11)

- (2) A sump overflow in 1971 at the Superior Tube Company allowed trichloroethylene wastes to leak into a cooling pond. Seepage from this pond was found to contaminate a private well 75 yards distant and a company well at the site.(13)
- (3) Open dumping of wastes, including solvent wastes, from a chemical packing plant by U.S. Avtex Company resulted in entry of organic solvents into the water table and contamination of several nearby water wells in 1973. One family reported illness resulting from use of the contaminated well water.(13)
- (4) [Mono]chlorobenzenes, at concentrations of 5 mg/l and 30 mg/l has been detected in the water from 2 of 21 observation wells, installed at depths up to 50 feet at varying distances from an industrial manufacturing complex devoted to the development and manufacture of engineering plastics.(14)

The damage incidents presented above illustrate the following potential hazards associated with wastes from usage of organic solvents:

- (1) Ignitability hazard during mismanagement;
- (2) Potential toxicity hazard to humans via groundwater exposure pathways.

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D. Health and Environmental Effects*

Perchloroethylene (Tetrachloroethylene)

Perchloroethylene (PCE) was reported carcinogenic to mice.⁽¹⁶⁾ It has also been identified by the Agency as a chemical which has demonstrated substantial evidence of being carcinogenic. PCE is chronically toxic to rats and mice, causing kidney and liver damage;^(10,16,21) and to humans, causing impaired liver function.⁽²⁾ Subjective central nervous system complaints were noted in workers occupationally exposed to PCE.⁽¹⁴⁾ PCE exposure is reported to cause alcohol intolerance to humans.

PCE is a priority pollutant under Section 307(a) of the Clean Water Act.

Methylene Chloride (Dichloromethane)

EPA has found "suggestive" evidence of the carcinogenicity of methylene chloride, therefore, methylene chloride is considered a "suspect carcinogen" (Appendix A); methylene chloride was also reported as being mutagenic to a bacterial strain, S. typhimurium.⁽²⁴⁾ It was reported to be fetotoxic or embryo-toxic to rats and mice.⁽²³⁾ Female workers had gynecological problems after prolonged exposure to methylene chloride.⁽³⁶⁾ Methylene chloride also causes central nervous system depression and elevation of carboxyhemoglobin levels.⁽¹⁸⁾ Severe contamination of food or water can cause irreversible renal and hepatic injury.⁽³⁰⁾ Acute toxicity values range from 147,000 to 310,000 ug/l for aquatic

*Ethyl benzene, which is only being listed for its ignitability hazard, is also considered a priority pollutant under Section 307(a) of the Clean Water Act.

organisms (Appendix A)

Trichloroethylene

Trichloroethylene (TCE) has been reported to be carcinogenic to mice.(15) It has also been identified by the Agency as a chemical which has demonstrated substantial evidence of being carcinogenic.(38) Industrial exposure to TCE caused some cases of central nervous system disturbances (headaches, insomnia, tremors) as well as peripheral nervous system impairment (neuritis, temporary loss of tactile sense, finger paralysis).(1,13) Rare cases of hepatic damage have been reported following repeated abuse of TCE.(6)

TCE was found to be toxic in varying degrees to several freshwater organisms.(28) There was also a 50% decrease noted in ^{14}C uptake by a saltwater algae at a concentration of 8,000 mg/l.(20)(Appendix A)

1,1,1-Trichloroethane (Methyl Chloroform)

Data regarding the carcinogenicity of 1,1,1-trichloroethane is inconclusive.(17) It is mutagenic in the Ames test, and in a mammalian cell transformation system (See Appendix A). Chronic exposure, albeit is greater than ambient levels, can cause central nervous system disorders in humans. Animal studies showed toxic effects on the central nervous system, cardiovascular system, pulmonary system, and induced liver and kidney damage.(34) 1,1,1-Trichloroethane is a priority pollutant under Section 307(a) of the Clean Water Act.

Chlorobenzene (Monochlorobenzene, MCB)

Chlorobenzene has been found to produce histopathological changes in the lungs, liver, and kidneys following its inhalation by rats, rabbits and guinea pigs.⁽⁷⁾ Oral administration of monochlorobenzene to rats was reported to cause growth retardation in males.⁽¹¹⁾ MCB also appears to increase the activity of some microsomal enzyme systems, which enhances the metabolism of many drugs, pesticides, and other xenobiotics.⁽²⁹⁾(Appendix A)

MCB was reported to be toxic to varying degrees to several fresh- and salt-water organisms, including algae,⁽²⁸⁾ has a high biomagnification factor (Appendix B), is resistant to biodegradation and hydrolysis and is, therefore, persistent.

MCB is a priority pollutant under Section 307(a) of the Clean Water Act, is a subject of TSCA section 4 Test Rule, and has been selected for bioassay by NCI. These regulatory actions point to concern regarding its toxicity.

1,1,2 Trichloro-1,2,2 trifluoroethane

The Agency's primary concern in listing this solvent is the air pollution hazard resulting from its release at the surface of the earth. This can have many adverse health and environmental effects including increased incidence of skin cancer, reduced productivity in several important agricultural crops, and increased mortality in the larvae forms of several important seafood species resulting from the depletion of the ozone.^(39,40) Because of these effects, EPA is currently considering regulation of CFC production and use.

1,2-Dichlorobenzene (ortho isomer)

Ortho 1,2-dichlorobenzene exhibits moderate toxicity via inhalation and oral routes. The major toxicological effect is injury to the liver and kidneys; it is also a central nervous system depressant after short periods of exposure (19,22) (Appendix A).

1,2-dichlorobenzene is designated a priority pollutant under section 307(a) of the Clean Water Act.

Trichlorofluoromethane

The Agency's primary concern in listing this solvent is the air pollution hazard resulting from its release at the surface of the earth. This can have many adverse health and environmental effects including skin cancer resulting from the depletion of the ozone (Vide Sufora). (39,40) However, additional adverse health effects have been found and are presented below.

Exposure of rabbits to trichlorofluoromethane was reported to cause cardiac arrhythmias. (26) It induced cardiac arrhythmias, sensitized the heart to epinephrine-induced arrhythmias, and caused tachycardia (increased heart rate) myocardial depression, and hypertension in the monkey, dog, rat and mouse. (26)

Trichlorofluoromethane is a priority pollutant under Section 307(a) of the Clean Water Act.*

*The Agency has recently proposed to remove trichlorofluoromethane from the list of toxic pollutants under §307(a) of the Clean Water Act (45 FR 46103, July 9, 1980).

Toluene

Toluene is a toxic chemical absorbed into the body by inhalation, ingestion, and through the skin. Data on its mutagenicity and carcinogenicity are inconclusive, but it has been reported to cause chromosomal change; teratogenic problems were also recently reported.⁽⁴⁷⁾ The acute toxic effect is central nervous system depression, ⁽⁴⁵⁾ and irritation of eye and throat. These effects occur at low concentrations [200 ppm].⁽⁴⁶⁾ Chronic occupational exposure to toluene has led to the development of neuro-muscular disorders. Occupational exposure to female workers to toluene reported to cause several reproductive problems, both to the woman and the offspring.⁽²⁵⁾ Chronic toluene exposure can cause dermatitis, affect the immune system, and cause permanent damage to the central nervous system.⁽⁴⁸⁾

Since toluene is metabolized in the body by a protective enzyme system which is also involved in the elimination of other toxins, it appears that over-loading the metabolic pathways with toluene may greatly reduce the clearance of other more toxic chemicals. Additionally, the high affinity of toluene for fatty tissue can assist in the absorption of other toxic chemicals into the body. Thus, synergistic effects of toluene on the toxicities of other contaminants may render the waste stream more hazardous (Appendix A).

Toluene is a priority pollutant under Section 307(a) of the Clean Water Act.

Methyl Ethyl Ketone

Methyl ethyl ketone is a highly volatile ignitable liquid of moderate toxicity via ingestion which can affect the peripheral nervous system and is an experimental teratogen (Appendix A). It is also a strong irritant of the mucous membranes of the eyes and nose. A lethal dose in animals (LC₅₀ - 700 ppm) has caused marked congestion of the internal organs and slight congestion of the brain. Lungs also showed emphysema (Appendix A).

Carbon Disulfide

Short term human exposure to low atmospheric concentrations of carbon disulfide may result in central nervous system depression, headaches, breathing difficulty and gastrointestinal disturbances. Exposure to short term but high atmospheric concentrations can lead to narcosis and death. The symptoms of humans subjected to repeated exposure to high concentrations or prolonged exposure to low concentrations include insomnia, fatigue, loss of memory, headache, melancholia, vertigo and loss of appetite. Visual impairment, loss of reflexes, and lung irritation has been reported.(19,22) Rats and mice exposed 8 hours per day for 20 weeks to an average concentration of 37 ppm carbon disulfide showed evidence of toxic effects.(19)(Appendix A)

Isobutanol

Rats receiving isobutyl alcohol, either orally or subcutaneously, one to two times a week for 495 to 643 days showed liver carcinomas and sarcomas, spleen sarcomas and myeloid leukemia.(43)

Ingestion of one molar solution of isobutyl alcohol in water by rats for 4 months did not produce any inflammatory reaction of the liver. However, rats ingesting a two molar solution for two months developed Mallory's alcoholic hyaline bodies in the liver and were observed to have decreases in fat, glycogen, and RNA in the liver.(43)

Acute exposure to isobutyl alcohol causes narcotic effects, and irritation to the eyes and throat in humans exposed to 100 ppm for repeated 8 hour periods. Formation of facuoles in the superficial layers of the cornea and loss of appetite and weight were reported among workers subjected to an undetermined but apparently high concentration, of isobutyl alcohol.(44)

(Appendix A)

Pyridine

Pyridine exhibits moderate toxicity when absorbed into the human body through oral, dermal, and inhalation routes.(22) Liver and kidney damage has been produced in animals and man after oral administration.(3) In small doses, conjunctivitis, dizziness, vomiting, diarrhea and jaundice may appear; tremors and ataxia, irritation of the respiratory tract with asthmatic breathing, paralysis of eye muscles, vocal cords and bladder also have been reported.(22)

Adverse taste in fish (carp, rudd) has been reported at 5 ppm. Pyridine causes inhibition of cell multiplication in algae and bacteria at 23 and 340 ppm respectively.(35)(Appendix A)

Nitrobenzene

Nitrobenzene is a suspected carcinogen.⁽⁴⁾ When administered to pregnant rats, it caused abnormalities in some of the fetuses examined.⁽⁸⁾ Changes were observed in the chorionic and placental tissues of pregnant workers exposed to nitrobenzene,⁽⁴⁾ and menstrual disturbances after chronic exposure have been reported. Chronic exposure to nitrobenzene has been found to cause a variety of blood-variety disorders.

Nitrobenzene is toxic in varying degrees to several salt- and fresh-water organisms.⁽³¹⁾ (Appendix A), and nitrobenzene is a priority pollutant under Section 307(a) of the Clean Water Act.

Cresols (Cresylic Acid)

Cresol is highly toxic if orally administered, and moderately toxic if inhaled. Absorption may result in damage to kidney and liver as well as the central nervous system.⁽²²⁾ Exposure to cresol can cause severe skin burns and dermatitis.^(19,22) (Appendix A)

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Response to Comments (Proposed Listings (December 18, 1978))

- ° One commenter objected to the listing "Waste non-halogenated solvent (such as methanol, acetone, isopropyl alcohol, polyvinyl alcohol, stoddard solvent and methyl ethyl ketone) and solvent sludges from cleaning, compounding milling and other processes."* The commenter argued that without indicating the concentration or quantity of the solvent in the waste, the Agency would be listing wastes as hazardous even if the solvent were present in small concentrations and quantities.

In the listing promulgated today for waste solvents, the Agency is only listing those spent solvents or still bottoms from the recovery of these solvents which would contain substantial quantities and concentrations of the solvent. For example, spent solvents can contain up to 90% of the original solvent while the still bottoms may contain up to 50% of the spent solvent.

- ° A number of commenters objected to the listing of polyvinyl alcohol (PVA) as a solvent. These commenters argued that PVA is not a solvent but is a solid and can only be used as a solute. Therefore, they recommended that PVA be removed from the list.

*This specific listing will not be included in the final regulation; however, it will be covered under the generic listing "The Spent non-halogenated solvents...."

The Agency agrees with the commenters and therefore, has removed PVA from the listing.

- ° A number of commenters objected to the listing of waste halogenated/non-halogenated solvents. They felt that the listing was too vague and ambiguous.

In the listings promulgated today, the Agency has specifically listed only those solvents for which data or information are available which indicates a present or potential hazard could be posed to human health and the environment if improperly managed. Therefore, the listing description promulgated today should respond to the commenters' objection.

Response to Comments - Spent Halogenated and Non-Halogenated Solvents and the Still Bottoms/Sludges From the Recovery of These Solvents

A number of comments were received with respect to wastes F001 to F005 (Spent halogenated and non-halogenated solvents and the still bottoms/sludges from the recovery of these solvents).

1. One commenter requested that the Agency clarify or define what it means by the term "spent". For example, the commenter questioned whether "spent" refers to the state of the chemical which was pure initially but now appears in the waste stream after being used, or whether it refers to the altered or decomposed state of a chemical which has outlasted its shelf life.

The Agency agrees with the commenter and has thus included the following definition for "spent solvents" in the listing background documents:

"Spent solvents include those solvents which are no longer useful as solvents without further processing (i.e., solvent reclamation), either because the solvents have outlasted their shelf life, or because the solvents

have been contaminated or chemically or physically changed.

It should be clear from this discussion that the wastes encompassed by this listing do not include waste streams where the solvent is a contaminant, such that the waste stream is not a spent solvent, as defined above. Thus, wastes which contain as constituents solvents which are used in the industrial process are not included within the scope of this listing. Nor are these waste streams hazardous by virtue of the mixing rule (§261.3(a)(2)(ii)), since a spent solvent is not being mixed with another solid waste.

The Agency, however, does not believe it appropriate to define the term "spent solvent" by using a quantity/volume cut-off (i.e., spent solvents include those solvents which contain x percent or more of solvent). As we have indicated in other support documents (see e.g., Background Document on EP toxicity), the Agency does not presently believe sufficient information exists to establish minimum waste concentration levels for toxic constituents, except for those regulated by the Interim Primary Drinking Water Standards. We intend to make case-by-case determinations via the delisting mechanism to remove those wastes containing minimal concentrations of "spent solvent".

2. Another commenter argued that the scope of the listing of both spent solvents and still bottoms/sludges from the recovery of solvents, is overinclusive because it does not recognize that certain solvent recovery operations produce non-hazardous still bottoms.* For example, the commenter stated that it is possible to produce a nonleaching, non-ignitable fused waste solid containing as low as 5 percent solvent. Therefore, the commenter recommends that solvent recovery still bottoms be defined as follows:

"Solvent recovery still bottoms: residue from the distillation/evaporation process of recovered solvent which has more than 10% of the original solvent (excluding water) remaining"

The Agency disagrees with the commenter. In the first place, the commenter has not correlated the recommended concentration of solvent with a showing that exposure to these levels of contaminant will not cause substantial hazard. Nor is there documentation for the claim that still bottoms containing 5% of the listed solvent would be incapable of posing substantial harm if mismanaged. Furthermore, the Agency believes that

*It should be noted that this comment was directed to waste F004 (the following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents). However, EPA's response is also applicable to wastes F001, F002 and F005.

still bottoms containing 5% of the listed solvent may indeed pose a substantial hazard to human health and the environment if improperly managed.* This premise is based on the following factors:

- (1) The recommended cut-off level (50,000 ppm) is at least an order of magnitude above that needed to cause acute effects, and in most case orders of magnitude higher (see Appendix A to the listing background document). Thus, still bottoms with 5% concentration of a listed solvent would only have to leach a small percentage of the contained solvent to cause substantial hazard.
- (2) Cresols, cresylic acid and nitrobenzene are all toxic chemicals: nitrobenzene is a suspect carcinogen and has been found to cause a variety of blood disorders from chronic exposure. Cresols and cresylic acid are highly toxic if administered orally and moderately toxic if inhaled. In addition, cresol and cresylic acid may result in damage to the kidney and liver as well as to the central nervous system.
- (3) Because of the toxicity of these solvents, the concentration of solvent in the still bottoms (five percent) is considered significant by the Agency.

*At a 5 percent level of solvent, the waste streams may no longer be ignitable as defined in §261.21.

- (4) All of these solvents have high or appreciable water solubilities (nitrobenzene: water solubility 1900 mg/l (Appendix B); cresols and cresylic acid: water solubilities 23,500 and 31,000 mg/l (Appendix B) and therefore, could leach into groundwater under improper disposal conditions.
- (5) All of these solvents are likely to persist in groundwater; cresols, cresylic acid and nitrobenzene are not known to hydrolyze while nitrobenzene also does not biodegrade well.*/

The Agency therefore, believes that still bottoms from the recovery of cresols and cresylic acid, and nitrobenzene may pose a substantial hazard to human health and the environment even when five percent of solvent is in the waste. If an individual generator believes his still bottoms are non-hazardous, the generator should petition the Agency to de-list his waste (see §§260.20 and 260.22).

3. One commenter criticized EPA's generic designation of all spent chlorinated fluorocarbons as hazardous. Therefore, the commenter believes that the broad category (chlorinated fluorocarbons) should be replaced by specific compounds for which documented evidence of hazard is available. The commenter also argued more specifically

*These data are all taken from Appendix B to the listing background document.

that trichlorofluoromethane and dichlorodifluoromethane are not hazardous constituents*/ and that EPA's reason for regulating these materials--that they can rise into the stratosphere and deplete the ozone leading to adverse health and environmental effects--has not yet been proven. The commenter pointed out that the most sophisticated statistical analyses of actual ozone measurements taken at various places around the world have consistently failed to detect the depletion calculated to have occurred to date, despite the fact that the most recent analyses should detect this depletion even if it were only half the calculated amount. The commenter also argued that there have been growing indications that the current ozone depletion theory as it applies to chlorofluorocarbon depletion does not accurately describe the present-day atmosphere, or fails to consider aspects of atmospheric chemistry which are both significant and important. Cited in support is the study Chlorofluorocarbons and Their Effects on Stratospheric Ozone (2nd Rpt.) Pollution Paper No. 15, Department of Environment, Central Directorate on Environmental Pollution, October 1979.

*/The commenter cited several reasons for this statement:
- (1) the Health and Environmental Effects Profile (Appendix A) indicates that both trichlorofluoromethane and dichlorofluoromethane are non-toxic, (2) EPA's proposed action to remove these two compounds from the Clean Water Act toxic pollutant list indicates EPA's admission as to the innocuous nature of these two compounds in the aquatic environment, and (3) EPA's limited discussion of the various factors under §261.11(a)(3) of RCRA indicates that wastes containing these two compounds pose no hazard during storage, transportation, treatment or disposal.

Therefore, the commenter requested that all chlorinated fluorocarbons be deleted from the F001 and F002 generic waste list.

The Agency disagrees with the commenter on both points. With respect to their concern regarding the generic designation of all spent chlorinated fluorocarbons as hazardous, the Agency believes that all chlorinated fluorocarbons share the same physiological and photochemical attributes of concern, namely depletion of the ozone. Therefore, the Agency feels justified in listing the broad category of chlorinated fluorocarbons as hazardous, rather than its individual members.

As to the hazardous nature of the listed chlorofluoromethanes, the Agency agrees that they pose a low potential for adverse acute effects at ambient air concentrations, although there is some indication that long term exposure to very low levels (<400 ppt) will have chronic effects (Health Assessment Document, EPA, October, 1980). In the present instance, however, the Agency's overriding concern relates to the fact that chlorinated fluorocarbons may indirectly cause skin cancer due to the depletion of stratospheric ozone. Such depletion leads to increased intensity of damaging ultraviolet light at the earth's surface. This, in turn, leads to increased skin cancers, reduced productivity of several important agricultural crops and increased

mortality in the larval forms of several important seafood species. The fact that these compounds are proposed to be deleted from the list of toxic pollutants under Section 307(a) of the Clean Water Act does not affect our conclusion, since Section 307 does not address adverse effects arising from air exposure pathways.

The Agency has analyzed the British Ministry of the Environment report and has concluded that there are few differences in regards to the science of CFC transport into the stratosphere and the reactions involving ozone destruction between this report and a recent National Academy of Sciences report which provides the basis for. EPA's regulatory action banning the manufacturing, processing and distribution of chlorinated fluorocarbons for those non-essential aerosol propellant uses which are subject to TSCA authority (43 FR 11301, March 17, 1978). While the British Ministry of the Environmental report concluded that ample cause for regulating CFCs does not presently exist, the Agency strongly believes that there is sufficient evidence to regulate and limit chlorinated fluorocarbon emissions. In the judgment of EPA, chlorinated fluorocarbons can be a significant component of a solvent waste stream, can migrate into the environment (stratosphere) if improperly managed, are persistent (remaining intact long enough to migrate to the stratosphere), and may pose a substantial hazard

to human health and the environment. They thus should be regulated as hazardous wastes.*/ We also note that the Food and Drug Administration (FDA) has promulgated regulations which prohibit the use of chlorinated fluoro-carbons as propellants in containers for products subject to the Federal Food, Drug, and Cosmetic Act.

4. One commenter argued that the "T" (toxic) designation assigned to several of the waste solvents listed under F005, is ill-conceived in light of the information presented in the regulations and in the background documents; specifically, methanol, toluene, methyl ethyl ketone, methyl isobutyl ketone, pyridene and carbon disulfide. More specifically the commenter noted:

Methanol - this compound is not found to be carcinogenic, mutagenic or teratogenic

Toluene - this compound is shown not to be carcinogenic, mutagenic nor teratogenic

Methyl Ethyl Ketone - this compound is shown to have no chronic toxicity

Methyl Isobutyl Ketone - this compound is shown to have no chronic toxicity

*/It should be noted that the Office of Toxic Substances/ U.S. Environmental Protection Agency is currently considering further regulation of chlorinated fluorocarbon production and use.

Pyridine - this compound is not carcinogenic or mutagenic and the determination of teratogenicity is questionable

Carbon disulfide - this compound is shown to have no chronic toxicity

Therefore, the commenter recommends that these compounds no longer be designated as toxic wastes.

The Agency continues to believe that all of these spent solvents, with the exception of methanol and methyl isobutyl ketone should continue to be listed as toxic. In reviewing the data available in the record, the Agency believes that there is sufficient evidence to continue to list these solvents as "toxic" wastes (except for methanol and methyl isobutyl ketone). As explained in the health and environmental effects section of the listing background document, "Waste from usage of organic solvents" as well as the respective Appendix A health profiles for these compounds, it has been reported that chronic low level exposure to toluene has caused chromosome damage in humans and has led to the development of neuro-muscular disorders. Toluene has also been reported to cause reproductive problems to female workers during occupational exposure.

Methyl ethyl ketone (MEK), although only moderately toxic via ingestion, can affect the peripheral nervous system and is an experimental teratogen. In addition, lethal doses in animals caused marked congestion of the internal organs and slight congestion of the brain.

Chronic exposure to pyridine has produced liver and kidney damage in both animals and humans. In addition, small doses of pyridine have produced tremors and ataxia, irritation of the respiratory tract with asthmatic breathing and paralysis of the eye muscles, vocal cords and bladder.

Chronic exposure to carbon disulfide can affect the cardiovascular and central nervous system, causing personality changes. In addition, exposure to short term, but high atmospheric concentrations can lead to narcosis and death. Carbon disulfide is also suspected of being teratogenic. Therefore, these solvents will continue to be listed as toxic.

The Agency, however, agrees with the commenter that both spent methanol and methyl isobutyl ketone were improperly listed as toxic wastes. Methanol's oral toxicity is rated as low^{*} and in fact is permitted in foods for human consumption as an additive. Methyl isobutyl ketone's principal toxic effects appears to be irritation of the eyes and mucous membranes, and gastrointestinal upset. Under these circumstances, we do not believe a toxicity listing for these solvents is appropriate, thus, the Agency will no longer list spent methanol and methyl isobutyl ketone as toxic wastes. However, both methanol and methyl isobutyl ketone are ignitable (flash points

^{*}/ Sax, N. Irving. Dangerous Properties of Industrial Materials. 5th ed. Van Nostrand Reinhold Co. New York. 1979

of 54°F and 61°F, respectively). Thus spent methanol and methyl isobutyl ketone will continue to be listed as ignitable hazardous wastes.

5. One commenter criticized the Agency's determination that chlorobenzene, o-dichlorobenzene, methanol, toluene, methyl ethyl ketone, methyl isobutyl ketone, isobutanol and ethyl benzene are persistent and do not degrade well. The commenter argued that this inclusion is contrary to the published literature, including this Agency's own studies, which shows that biodegradation is the preferred method of treatment for these compounds in aqueous solutions. The commenter therefore, believes that the degradation data within the listing background document should be reviewed and properly assessed in listing.

We note initially that the commenter's claims are largely unsubstantiated. We note further that biodegradation plays a limited role in the environmental persistence of the waste constituents because groundwater, the exposure pathway of paramount concern, is abiotic. As pointed out in the listing background document (pp. 57-61), a number of these solvents have migrated via air and groundwater pathways, and persisted for long periods of time, and caused substantial hazard in the course of actual waste management practice. Thus,

chlorobenzene, o-dichlorobenzene, toluene and methyl ethyl ketone have all been detected in basement air, sump pumps and/or in solid surface samples in the Love Canal area.*/ All of these solvents (chlorobenzene, o-dichlorobenzene, toluene and methyl ethyl ketone) are thus demonstrably persistent enough to have migrated from a disposal site and contaminate adjacent areas to create a substantial hazard.

In addition, the following properties/characteristics of these compounds indicate further the persistence of these solvents:**/

chlorobenzene - this solvent is not amenable to hydrolysis nor does it biodegrade very well and therefore is expected to persist in the environment.

toluene - this solvent is persistent in abiotic environments (such as most aquifers) and therefore is expected to persist in groundwater. Toluene also is relatively soluble (water solubility 470 mg/l at 25°C), and thus would be expected to migrate into groundwater.

methyl ethyl ketone - this solvent, in addition to being reported at Love Canal, has been detected at several sites near groundwater

*/ Since methanol and methyl isobutyl ketone are no longer being considered toxic, a discussion on their persistence is no longer appropriate.

**/ These data are all taken from the listing background document, "Waste from usage of organic solvents".

contaminated by an old chemical company dump, again showing migratory potential and persistence.*/
sistence.*/

With respect to isobutanol, the Agency has not made any claim as to the persistence of this compound; however, due to its toxicity and extremely high water solubility (water solubility 95,000 mg/l at 18°C), the Agency believes that this solvent may pose a substantial hazard to human health and the environment if improperly managed.

Finally, ethyl benzene is being listed because of its ignitability hazard, not toxicity. As is indicated in the regulations (§261.21, 45 FR 33121-33122, May 19, 1980), a liquid waste is considered ignitable, and therefore hazardous, if it has a flash point less than 140°F. Consequently, the persistence of ethyl benzene is not at all relevant.

Therefore, absent any information provided by the commenter on the persistence and degradability of these solvents, the Agency finds no reason to change its original conclusions.

*/Listing Background Document, "Wastes from usage of organic solvents", Section IV. B. (Migratory potential and persistence of halogenated and non-halogenated solvents) pg. 31.

6. One commenter criticized the Agency's conclusion, as stated in the listing background document, that "the solubility of these solvents is uniformly high " (LBD pg. 3) and "the solubility in water of these halogenated solvents is quite high" (LBD pg. 14) when in fact, as the commenter points out, their solubilities vary from 10 to 20,000 mg/l (LBD pg. 55). The commenter went on to argue that the Agency's determination that "these high solubilities demonstrate a strong propensity to migrate from inadequate land disposal facilities in substantial concentrations" (LBD pg. 15) and "all of these waste solvents have significant potential for migration, mobility and persistence..." (LBD pg. 52) is overstated when in fact, as the commenter indicates, migration, mobility and persistence differ significantly with respect to both routes of transport and rates of degradation. Therefore, the commenter believes that the Agency needs to reassess these listings.

The Agency agrees with the commenter that the water solubilities of the chlorinated hydrocarbons do vary considerably. However, in re-evaluating the data, the Agency believes that the solubilities of all of these solvents except 1,1,2-trichloro-1,2,2-trifluoroethane are generally high and do indeed indicate a potential for migration from inadequate land disposal facilities.*/

*/Although the water solubility for trichlorofluoromethane is high, the principal concern with this solvent is its potential to rise to the stratosphere where it may release chlorine atoms and deplete the ozone.

The Agency recognizes that solubility is not the sole parameter which determines the potential of a substance to migrate into the environment, i.e., mobility and persistence also play a role. However, it is a key parameter in evaluating how likely these substances are to migrate from land disposal facilities. Indeed, this potential to migrate has been demonstrated for all of these solvents, except methylene chloride, in actual damage cases, i.e., tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene and o-dichlorobenzene have all been detected to migrate at Love Canal or other disposal facilities. Methylene chloride, although not detected at any disposal facilities, is highly soluble with a water solubility of 20,000 mg/l at 25°C, and thus has the potential to migrate from disposal sites and create a problem. However, the Agency has modified the listing background documents as to the solubilities of these solvents to better reflect the Agency's conclusions.

With respect to the solvent 1,1,2-trichloro-1,2,2-trifluoroethane, the Agency has indicated clearly that the potential to migrate and contaminate groundwater is not of concern. The primary hazard posed by the mismanagement of this solvent, as with all chlorinated fluorocarbons, is the potential to rise to the stratosphere and indirectly cause skin cancer due to the

depletion of stratospheric ozone*/ (see Response to Comments No. 3 of this document for a more detailed discussion).

The Agency also agrees that its conclusions regarding migration, mobility and persistence are overstated. Therefore, the listing background documents have been changed to reflect the Agency's determination that, while the various chlorinated solvents do differ in their migratory potential, mobility and persistence, they all may pose a substantial present or potential hazard to human health and the environment, if improperly managed, when considering the routes and rates of transport and degrees and rates of degradation.

7. One commenter believed that the Agency's decision to include trichloroethylene on the list of chemicals which have demonstrated substantial evidence of carcinogenicity was inaccurate. The commenter indicated that according to Elizabeth Weisberger of the National Institute of Health, whose organization did the original studies which classified trichloroethylene as a "merely suspicious carcinogen", indicated that "trichloroethylene seems not to be a carcinogen." The commenter also argued that more extensive and recent research indicates that

*/1,1,2-trichloro-1,2,2-trifluoroethane is considered to be extremely volatile (vapor pressure - 270 mm of Hg at 20°C), and thus is likely to rise into the atmosphere.

trichloroethylene may not be carcinogenic after all.

The Agency disagrees with the commenter. Trichloroethylene has been designated carcinogenic by EPA's Cancer Assessment Group (CAG) after reviewing the available data in the literature. In fact, before a chemical compound is deemed carcinogenic by CAG, it is subject to exhaustive literature study and evaluation. In light of CAG's determination, EPA will continue to include trichloroethylene as a chemical which has demonstrated substantial evidence of carcinogenicity.

8. One commenter questioned the Agency's characterization of 1,1,1-trichloroethane as a suspect carcinogen. The commenter argued that 1,1,1-trichloroethane has not been found to be a carcinogen. They quote the NCI Bioassay of 1,1,1-Trichloroethane for Possible Carcinogenicity (January 1977), which states:

"A variety of neoplasms were represented in both 1,1,1-trichloroethane treated and matched-control rats or mice. However, each type of neoplasm has been encountered previously as a lesion in untreated rats or mice. The neoplasms observed are not believed attributable to 1,1,1-trichloroethane exposure, since no relationship was established between the dosage groups, the species, sex, type of neoplasm or the site of occurrence. Even if such a relationship were inferred, it would be inappropriate to make an assessment of carcinogenicity on the basis of this test, because the abbreviated life spans of the rats and the mice."

The commenter also argued that EPA's own Office of Drinking Water, in their appendices to Planning Workshops to

Development Recommendations for a Groundwater Protection Strategy, state that methyl chloroform (1,1,1-trichloroethane) is not considered to be a carcinogen (June 1980). Therefore, the commenter believes that there is no support for the carcinogenicity of 1,1,1-trichloroethane and argues that it be deleted from all lists of hazardous wastes.

The Agency disagrees with the commenter's claim. Although the NCI Bioassay Study on the carcinogenicity of 1,1,1-trichloroethane referred to in the listing background document (pg. 464) and an unpublished study are inconclusive, positive responses in two in vitro systems (a rat embryo cell transformation assay (Price et. al. 1978, Transforming Activities of Trichloroethane and Proposed Industrial Alternatives. In vitro. 14:290.) and a bacterial mutation assay (Simmon et. al. 1977. Mutagenic activity of chemicals identified in drinking water, In: Progress in Genetic Toxicology, ed. I.D. Scott, B. A. Bridges and F. H. Sobels, pp. 249-258; McCann, J. and B. Ames, 1976. Detection of carcinogens as mutagens in the Salmonella microsome test: Assay of 300 chemicals. Proc. Nat. Acad. Sci. 78:950.)) currently used to detect chemical carcinogens, indicate that 1,1,1-trichloroethane has the potential for carcinogenicity in animals (App. A). Additionally, a two year carcinogenesis animal bioassay

is being repeated at the National Cancer Institute.

Therefore, the Agency believes that there is ample evidence to consider 1,1,1-trichloroethane as a suspect carcinogen^{*/}, and thus will continue to include 1,1,1-trichloroethane as a constituent of concern.

9. One commenter also argued that the statements in the background document that "methylene chloride is reported as being mutagenic to a bacterial strain, S. typhimurium", and "methylene chloride... is highly mutagenic" are inaccurate. The commenter pointed out that a variety of more detailed tests performed subsequently and not cited in the listing background document prove otherwise. For example, a definitive cell transformation test for methylene chloride was found negative. Additionally, many other tests have been run for carcinogenicity of methylene chloride with negative results.

The Agency agrees. The current assessment on the carcinogenicity of methylene chloride is only based on animal experiments which are so far incomplete. However, methylene chloride is the subject of an NCI sponsored bioassay. In addition, EPA has found "suggestive" evidence of the carcinogenicity of methylene chloride

^{*/}It should be noted that the Agency recently determined to retain the listing of 1,1,1-trichloroethane as a toxic pollutant under §307(a) of the Clean Water Act. The reasons for that action are incorporated by reference herein.

(App. A). The Agency cannot ignore this information. Therefore, the listing background document will be revised to indicate that methylene chloride is only a "suspect" carcinogen.

10. One commenter questioned the Agency's characterization of tetrachloroethylene, methylene chloride, trichloroethylene and 1,1,1-trichloroethane as aquatically toxic. The commenter indicated that statements relative to methylene chloride like "acute toxicity values range from 147,000 to 310,000 mg/l (correct units are ug/l) for aquatic organisms" are meaningless until put into relative significance. When compared with most common nonhalogenated solvents, the commenter argues, the halogenated solvents were less toxic to the tested fish species. In addition, the commenter pointed out that EPA, in fact, concurs with this viewpoint by stating, "aquatic organisms tend to be fairly resistant to dichloromethane (methylene chloride), with acute values ranging from 193,000 to 331,000 ug/l (EPA BD 38 at 389). Therefore, the commenter believes that EPA has not properly assessed the relatively low aquatic toxicities of these halogenated solvents.

In re-evaluating the aquatic toxicity of tetrachloroethylene, methylene chloride, trichloroethylene and 1,1,1-trichloroethane, the Agency agrees with the commenter that all four of these halogenated solvents are not of regulatory concern under the hazardous waste program to

warrant characterization as "aquatically toxic." In the Registry of Toxic Effects (1975 Edition), a widely used reference book which is published by the National Institute for Occupational Safety and Health (NIOSH), a rating of the aquatic toxicity or non-toxicity of chemical substances is provided. In this rating, substances with an LC₅₀ value of between 10,000 ug/l to 100,000 ug/l is considered slightly toxic while substances with an LC₅₀ value above 100,000 ug/l is practically non-toxic. Based upon this rating, methylene chloride is practically non-toxic while the other halogenated solvents are slightly toxic. Therefore, the Agency will modify the listing background document to reflect this change. However, it should be noted that toxic wastes are not so designated solely on the basis of their aquatic toxicity. As discussed earlier, all of these halogenated solvents exhibit other toxic effects i.e., carcinogenicity, chronic toxicity, etc. which are sufficient to warrant designation of these solvents as toxic.

11. One commenter also argued that the Agency has misinterpreted and overstated the bioaccumulation potential for both the halogenated and non-halogenated solvents, arguing that most of these solvents have a low bioaccumulation potential. In particular, the commenter believes that the Agency has shown a lack of perspective by

concluding that, "...methanol could bioaccumulate causing numerous adverse health effects from prolonged and/or repeated exposure" (EPA BD-11 at 59), despite its reported very low K_{ow} of 5 and readily biodegradable. Therefore, the commenter believes that the bioaccumulation data should be reviewed and properly assessed in listing.

As discussed in the preamble to Part 261 of the hazardous waste regulations (45 FR 33106-33107), the Agency in listing wastes for which a characteristic has not been developed has adopted a flexible, multiple factor approach to be better able to accommodate itself to the complex determinations of hazard. These multiple factors include the type of toxic threat posed, the concentrations of the toxic constituents in the waste, the migratory potential, persistence and degradation of the toxic constituents, the degree to which the toxic constituents bioaccumulate in ecosystems, the plausible types of improper management to which the waste could be subjected, the quantities of waste generated, and other factors not explicitly designated by the Act. Thus, if a substance exhibits one or more of these properties, the Agency may list the waste as hazardous. The bioaccumulation potential of a substance is not considered by the Agency as a necessary factor before a waste can be listed. Therefore, just because a chemical substance is not bioaccumulative

is no reason not to list a waste.

With respect to the commenter's claim for methanol, the Agency is no longer listing this solvent for toxicity, but for ignitability. Bioaccumulative propensity of this compound thus is no longer relevant.

12. One commenter cited some inconsistencies/errors in the listing background documents and suggested that the Agency make the appropriate revisions.

The Agency agrees. There were some typographical and transcription errors, e.g., in the methylene chloride background document, as well as some judgmental errors. Therefore, within the limits of its resources, the Agency has made every effort to correct such errors.

13. One commenter criticized the Agency's conclusion as stated in the listing background document that, "the chlorinated waste hydrocarbons are toxic" (EPA BD-11 at 3) when in fact, as the commenter points out, that the oral-rat LC₅₀ values vary by several orders of magnitude. Therefore, the commenter believes that the listing of these halogenated solvents are not fully warranted in all cases.

The Agency strongly disagrees with the commenters unsubstantiated claim. As discussed in the preamble to the May 19, 1980 hazardous waste regulations (45 FR 33107), the Agency listed a number of toxic wastes

as those "which have been shown inreputable scientific studies to have toxic, carcinogenic, mutagenic or teratogenic effects on humans or other life forms." Toxicity is defined to include systemic effects of chronic low level exposure, acutely toxic^{*}/, aquatic toxicity, phytotoxicity or the potential (as with chlorinated fluorocarbons) for indirectly causing harm to human health or other life forms. Therefore, a substance with a high LC₅₀ value is not necessarily non-toxic.

In reviewing the data available in the record^{**}/, the Agency is convinced that these substances are properly designated as toxic, and that improper management and disposal of these waste solvents may pose a substantial present or potential hazard to human health and the environment. Since the commenter failed to provide additional toxicity data except as discussed in other parts to this section, the Agency finds no reason to change its original conclusion to list these solvents as toxic wastes.

^{*}/Acutely toxic does not include those wastes which are defined in §261.11(a)(2) as acutely hazardous.

^{**}/Appendix A (Health and Environmental Effects Profiles) outlines the health and environmental effects exhibited by each of these compounds.

ADDENDUM TO SOLVENTS BACKGROUND DOCUMENT

I. Responses To Public Comments On Proposed Solvent Mixture Rule

A. Renumbering of the F001 through F005 Spent Solvent Listings

Several comments have been received regarding the proposal to renumber the list of solvents by deleting F002, F003, F004, and F005 and modifying F001 to include all the solvents formerly listed in F001 through F005. Some commenters requested that the Agency, if renumbering the listings, should distinguish between halogenated and non-halogenated solvents. The reasons for the distinction were that non-halogenated solvents usually are burned as fuel, incinerated, or reclaimed on-site, while halogenated solvents primarily are reclaimed on-site and then reused by the generator. In addition, the environmental impacts posed by halogenated and non-halogenated solvents are somewhat different (for example, biodegradation). These commenters suggested that we assign two new waste codes to distinguish halogenated from non-halogenated solvents. Alternatively, one commenter suggested that the Agency renumber the solvents listings into three codes: halogenated, non-halogenated, and ignitable non-halogenated solvents. This commenter believed that using the three codes will facilitate source separation by generators and, therefore, lead to environmentally sound treatment, disposal, and recycling of solvent wastes.

Other commenters requested that the F001 through F005 waste codes remain as originally listed, but with the addition of solvent mixtures at 10% or greater to each code. These commenters believed that the five categories should be retained

because the solvent groups require different treatment, recycling and handling processes and procedures, and one single classification number would make the differentiation between the solvents difficult.

The following are other specific concerns mentioned by the various commenters on the issue of renumbering:

- One commenter stated that renumbering would increase the cost of compliance for recyclers, transporters, etc., due to the cost of re-labeling containers, retraining hazardous waste workers, and revising hazardous waste management plans.
- Three commenters stated that the renumbering would cause confusion in future paperwork (i.e., annual reporting data manifests, transportation and storage logs), when evaluated and compared with past documents. In particular, one commenter stated that there may be possible inconsistencies with the new single waste code and the DOT manifest requirements and the manner in which solvents are segregated for recycling (i.e., halogenated, non-halogenated, and ignitable solvents are managed differently).
- One commenter stated that renumbering would require facilities to perform massive waste characterization analyses when undergoing delisting and closure procedures. The commenter noted an example where this might occur.

In some instances, generators are being required to perform analyses for every constituent in a waste code reported at their facility. Under the single combined waste code, F001, the facility would have to test for all 27 solvents, whereas before they may have only tested for five.

- Three commenters were concerned that the distinction of the solvent's hazards would be lost if all the solvents were combined into a single waste code, rendering the reporting, handling, etc., of the ignitables and toxic solvents undifferentiated. For example, in handling these chemicals, the workers would not know if a particular waste was toxic (i.e., carbon disulfide is harmful to human skin) or ignitable (i.e., acetone).
- One commenter requested that the F004 solvents be separated from the single F001 waste code because of their corrosivity to human skin. These solvents require careful handling and worker training.
- A few commenters stated that the single combined F001 code would cause confusion due to past use of the F001 number. The new F001 code, which would list all 27 spent solvents, might be confused with the present F001 code, which lists only six solvents. Computer data systems of hazardous waste manifests is an instance where confusion between the two definitions of the F001 code may appear.

- One commenter stated that many TSDs are "permitted" only for chlorinated solvents (F001 and F002). If all 27 solvents were grouped into a single waste code, these facilities would be forced either to become properly equipped to store and to handle ignitable solvents or to upgrade their waste analysis plans and laboratory capabilities to determine whether incoming wastes may be accepted at their facility.
- One commenter requested that if ignitable solvents are to remain in the hazardous waste listing as spent solvent wastes, they should be categorized under a separate hazardous waste number. "Toxic" solvents then could be easily distinguished from ignitable solvents.

Agency Response:

In considering the renumbering of the solvent listings, the Agency has concluded that renumbering may, in fact, increase compliance costs and cause confusion (i.e., re-labeling of containers, confusion for transporters and others handling the wastes, different management and handling practices for halogenated solvents, and confusion in record keeping because of past F001-F005 designation). Therefore, we are retaining the existing hazardous waste numbers.

B. Process Wastes Containing Solvents

Two commenters requested that the Agency delete the term "spent solvents" from the proposed rule. These commenters felt

that by limiting the mixture rule to the F001 through F005 spent solvent wastes, the Agency would be excluding a large universe of wastes, such as process wastes containing significant quantities of solvents. The commenters asserted that the exclusion of process wastes leads to enforcement difficulties. They pointed out that there is little difference in toxicity between solvent wastes which are spent or discarded after use, and process wastes containing solvents.

- The commenters stated that from an enforcement standpoint, it may not be possible to determine if a mixed solvent waste originally was generated as a spent solvent or as a process waste. A generator claiming that their spent solvent mixture is a manufacturing process waste could avoid regulation. One of the commenters asserted that industry has used this reasoning in past land disposal practices.
- On the other hand, several commenters requested that the proposed rule not apply to waste products in which solvents were used as carriers for active ingredients. The commenters stated that these waste quantities per container are usually small and are equivalent to household wastes. Therefore, the commenters requested that these wastes not be included in the rule.

Agency Response:

The intent of the proposed solvent mixture rule is to close a regulatory loophole in the §261.31 spent solvent listings, in

which spent solvent mixtures currently are unregulated as hazardous wastes. The Agency agrees with the first commenters that many process wastes, including those containing solvents and solvent mixtures, are erroneously unregulated. However, there are also some process wastes which should be excluded from the regulations because of the low concentration of hazardous chemicals or their low toxicity.

The Agency has not developed health-based standards or regulatory thresholds for all of the listed solvents. The level set by today's rule is an interim measure, and may be modified or superceded when work on the Toxicity Characteristic is completed.

C. Applicability of the Ten Percent Threshold Level for Solvent Mixtures

Several comments have been received concerning the 10% threshold level for solvent mixtures. Comments are as follows:

- One commenter suggested that the threshold level should be lowered to 1% to place tighter controls on these wastes. This commenter stated that the lower threshold level would be more protective in prohibiting these solvent mixtures from sanitary landfills, because they now would be considered hazardous wastes. At 1%, the solvent mixtures would be less likely to mobilize other wastes from land disposal facilities. The 1% level is based on the 1979 EPA Draft Ambient Water Criteria. The

commenter further stated that the original background document for listing solvents and the Drinking Water Criteria promulgated in November 1980, provide data for establishing health-based thresholds for solvent mixtures.

- One commenter similarly stated that the level should be 5000 ppm since this is more protective of human health and the environment. The 5000 ppm level coincides with the State of Connecticut's proposed waste oil regulations for hazardous constituents added to waste oil. The 5000 ppm level is said to be protective of human health and the environment for burning waste oil containing solvents.
- Three commenters expressed concern that the 10% threshold level will not adequately protect human health and the environment. One stated that the Agency should not exclude mixtures which are at concentrations below 10%, because their toxicities are still orders of magnitude higher than the levels considered safe for human health and the environment. Another commenter mentioned that the 10% level is adequate for an interim measure, but not for a final one. The commenter requested that the new hazardous waste characteristic be based on toxicity and that it set levels which will preempt the 10% level if necessary to protect human health and the environment.

The third commenter was concerned that many of the wastes impacting the environment contain solvents at concentrations much lower than the 10% level.

- One commenter stated that many persons in the regulated community, the EPA, and the States interpret the F001-F005 solvent listings to include solvent mixtures at all concentrations. The commenter was concerned that by specifying a threshold level for solvent mixtures, the effect will be a relaxation of the regulations.
- One commenter stated that the 10% threshold level may bring into regulation wastes containing de minimis concentrations of solvents. The commenter recommended that the 10% level apply to only the concentration of an individual solvent in a solvent mixture, rather than the total concentration of all the solvents in the mixture.

Agency Response:

In establishing the threshold for solvents, the Agency was unable to define the concentrations at which solvent mixtures are considered hazardous waste. At this time, the Agency has not developed health-based thresholds for all of the 27 listed solvents. Nor does the listing background document identify levels at which solvent mixtures would be considered hazardous waste. The Agency, therefore, expanded the universe of wastes considered "spent solvents" to include those solvent mixtures commonly used

as industrial solvents. The ten percent threshold level will bring the majority of these wastes into the hazardous waste management system. This threshold level is not intended to define the concentration at which these mixtures are considered hazardous, rather, it defines the concentration at which these wastes are considered spent solvents. The level applies to the total concentration of listed solvents (before use) in the mixture, and not simply the concentration of a single solvent in the mixture. The Agency is concerned with the total solvent effect of the mixture. Whereas a single solvent at low concentrations may not be hazardous, the Agency is concerned with possible hazardous additive effects the solvent might exhibit when in combination with other solvents in a mixture. The Agency is expanding the EP Toxicity Characteristic to establish maximum permissible concentrations for solvents. These thresholds will override the 10% level for solvent mixtures, in part, and bring many wastes containing solvents (including process wastes) into the hazardous waste management system.

The Agency believes that the proposed rule will not result in a relaxation of regulation because solvent mixtures used in commerce generally contain greater than ten percent solvent. The rule will cover many of these mixtures. Data show that solvent mixtures often contain greater than fifty percent solvent. Specifically, the Agency believes that solvent formulators cannot successfully reformulate below the ten percent level and retain the desired characteristics of solvent mixtures.

The EPA believes if the regulation is extended down below the 10% level, dilute mixtures or office type cleaning products will be brought into the system. This is not the intent of the Agency.

D. Clarification of Scope and the Definition of the Rule

Several commenters requested clarification of the scope of the rule and definitions of certain phrases used in the rule.

- One commenter stated that the new F001 spent solvent listing is confusing and should be reworded. As currently written, the rule may be interpreted such that the 10% threshold applies to both the individual spent solvents and the spent solvent mixtures. The commenter recommends that a comma be inserted after the first use of the term "spent solvents."

Agency Response:

The Agency agrees with the commenter and will redraft the rule to clarify the scope of the listing.

- Another commenter requested that the 10% threshold also should apply to still bottoms from the recovery of solvents and solvent mixtures. The commenter stated that still bottoms containing less than 10% solvent should not be considered hazardous if the individual solvents and solvent mixtures are not hazardous below 10%.

Agency Response:

The commenter has misinterpreted the proposed rule. As discussed in the preamble to the final rule, the regulation will

list as hazardous wastes certain spent solvent mixtures which contained, before use, ten percent or more of the solvents listed for toxicity. The ten percent threshold does not define the concentration at which these wastes are hazardous. (Agency data show that solvents maybe hazardous at concentrations below ten percent). Rather, it specifies a concentration low enough to bring the majority of commonly used toxic solvents into the hazardous waste management system. The preamble states that these mixtures typically and frequently contain 50 percent or greater total listed solvents. In many cases, solvent mixtures contain 100 percent total solvent. Since Agency data show that still bottoms from the recovery of these solvents may contain up to 15 percent solvents, we are including these wastes under the listing.

- One commenter requested clarification of the terms "non-solvent constituents" and "any other combination that includes a listed solvent."

Agency Response:

In defining solvent mixtures, the Agency intended the listing to cover mixtures that are considered solvents but contain non-solvent constituents such as pigments (which impart desired product color), preservatives (to enhance shelf life), or any other additives. Thus, the Agency included the terms "non-solvent constituents" and "any other combination that includes a listed solvents."

- One commenter requested that the phrase "used in degreasing" not be deleted from the F001 listing. The commenter felt that the deletion was unnecessary and unsubstantiated.

In addition, the commenter felt that the deletion would add confusion to waste characterization. The commenter contended that a paint waste containing a solvent mixture at or above 10% would be wrongly classified as a listed F001 waste.

Agency Response:

In the proposed rule, the Agency deleted the phrase "used in degreasing" as part of the renumbering issue. Thus, the qualifying phrase of each waste code had to be deleted in order for the single F001 code to apply to all the listed solvents. Since the Agency has retained the existing solvent listings, the phrase "used in degreasing" will remain in the F001 solvent listing.

E. Effective Date

Several comments were received regarding the "effective immediately" provision of the rule. One commenter stated that the provision was appropriate, however the majority stated that industry needs time to comply with the new rule. The reasons cited for allowing lead time were:

- Some companies will need time to determine whether their waste will be a newly-regulated hazardous waste under the solvent mixture rule.
- Companies who were generating solvent mixtures, but were not previously regulating them as hazardous will need time to come into compliance. For example, these companies may need to design and build hazardous waste storage and

processing equipment. In addition, company personnel need to be trained in hazardous waste management.

- The proposed effective date would severely stress smaller companies.
- EPA's justification that few generators will be newly regulated does not justify an immediate date. These generators should be given the necessary time to implement proper waste management as a result of this rule.
- The Agency has not presented a convincing argument for the immediate effective date.
- One commenter suggested that a 60 day period after promulgation would be sufficient time for the generators to come into compliance. Two commenters suggested that the usual six month advance notice be applied to the solvent mixture rule.

Agency Response:

On January 11, 1985, the Agency proposed to regulate hazardous waste and used oil burned for energy recovery in boilers and industrial furnaces (see 50 FR at 1684). These rules, signed November 8, 1985, prohibit burning in non-industrial boilers of hazardous waste, including used oils adulterated by mixing with spent chlorinated solvents. The Agency believes a substantial loophole will be created if mixtures containing chlorinated solvents remain unregulated when these new rules become effective. Generators may continue to commingle these solvents with waste oils destined for energy recovery. Based on the toxicity of

chlorinated compounds, the Agency is concerned with possible adverse health effects posed by the burning of these wastes. In view of these concerns, we believe it imperative to bring these wastes into the hazardous waste management system before the annual demands for heating oil peak.

F. Volume vs. Weight

- * One comment was received concerning EPA's decision to use volume rather than weight as the determining parameter for solvent amounts. The commenter was concerned that Material Safety Data Sheet information is expressed in terms of weight percentage and that laboratory analysis results are often reported in terms of weight per volume or weight per weight. They recommended changing the parameter from "volume" to "weight".

Agency Response:

The majority of the commenters did not dispute the use of volume rather than weight in the proposed rule. The spent solvent wastes are primarily liquids or watery sludges (slurries). Thus, the Agency felt that it would be easier to determine the spent solvent concentration by volume. In addition, the Agency has contacted chemical companies to determine how the constituents of mixtures are reported on the Material Safety Data Sheet (by volume or weight). The answers received indicated that both systems are used. However, since most commercial solvent products are

expressed in terms of volume, the Agency is expressing solvent mixtures in terms of volume.

G. Regulation of Ignitable Solvents - F003

In the proposed rule, the Agency requested comments concerning the ignitability listing for solvents. The majority of the comments were in favor of eliminating the list of ignitable solvents (F003) for the following reasons:

- the listing is duplicative and unnecessary
- ignitables are considered "hazardous waste" under the "characteristic of ignitability"
- the F001-F005 numbers should be reserved for solvents that are toxic
- One commenter favored maintaining the ignitability listing. This commenter felt that small facilities would be less likely to have access to flash-point testing. These facilities needed the ignitability listing maintained for waste classification reasons.

Agency Response:

The Agency has decided to retain the ignitable solvents in the list of hazardous wastes. Although the commenters are correct that these spent solvents would be caught by the ignitability characteristic, these solvents are likely to contain other toxic contaminants. In fact, spent solvents become spent when they have been contaminated with other materials (i.e., toxic heavy metals, toxic organic compounds) and must be disposed, reprocessed, or reclaimed. If we were to remove these solvents

from the list of hazardous wastes, we believe such action would conflict with the spirit of one of the new requirements under the Hazardous and Solid Waste Amendments of 1984. In particular, under Section 222 of HSWA, the Administrator is required, in evaluating delisting petitions to consider factors (including additional constituents) other than those for which the waste was originally listed--if there is a reasonable basis to believe that the waste may still be hazardous. (See 50 FR 28742, July 15, 1985.) Although this provision discusses site-specific delisting petitions, we believe that it is consistent with this provision to make the same finding for generic delisting as well, since such action ordinarily has far more potential impacts on the environment than a site specific listing. Thus, since the spent solvents are likely to contain other toxicants at levels of regulatory concern, and since we have not evaluated those wastes for these other toxicants, we believe it is inappropriate to remove these solvents from the hazardous waste list. Rather, persons who wish to delist those wastes will need to submit a delisting petition, pursuant to 40 CFR §§ 260.20 and §§ 260.22, to exclude the waste from the hazardous waste category.

One commenter also asked whether the ten percent used to define solvent mixtures includes solvents listed for ignitability only (F003).

Agency Response:

Since we have not evaluated these (F003) solvents for their

toxicity, then ten percent threshold does not apply. The final rule reflects this.

H. Affect of Solvents on Liners

- * One comment concerned the statement in the preamble which said "since solvents are known to degrade synthetic and clay landfill liners, these toxic constituents, once mobilized may readily migrate to ground water." The commenter requested that the Agency mention other studies which indicate that dilute solvents and solvent mixtures do not degrade clay liners.

Agency Response:

The adverse effects of concentrated solvents on synthetic and natural liners generally is accepted (Haxo et al. 1985; Lord et al. 1985; Van Schaik, 1974; Schram, 1981; Anderson and Jones, 1983.). The adverse effect of dilute solvents and their mixtures is less widely accepted. The effect of solvents on synthetic liners was shown in a study where toluene at 5000 ppm was mixed in water and exposed to a high density polyethylene liner. The toluene mixture permeated through the liner at 2 gm/m²/day. (Surprenant et al., 1984.) The Agency acknowledges that several studies indicate little or no effect on natural liners. But, these studies were conducted over a short-term period (i.e., Daniel and Liljestrang, 1984). The Agency is concerned that in the long-term (years) exposure to dilute solvent mixtures may degrade natural liners. Some studies indicate mechanisms by which dilute solvents could form into concentrated solvents so that adverse effects occur (Artiola et al., 1985;

Anderson and Brown, 1983). The Agency acknowledges that there is not sufficient information available to predict the effect on soil liners from long-term exposure to dilute solutions and that additional research is needed.

I. Human Health Effects

- One commenter stated that the rule indicates that all spent solvents pose carcinogenic, mutagenic, teratogenic, and neurotoxic health risks. The commenter asserts that at least two of the solvents, trichloroethylene and tetrachloroethylene, have been re-evaluated such that they are not probable human carcinogens. The commenter felt that the revisions should be incorporated into the development of health-based thresholds.

Agency Response:

The rule does not specify that all of the 27 listed solvents pose these health risks. The preamble clearly states that "many (solvents) are known carcinogens, teratogens, mutagens, or neurotoxins. Others are associated with acute and chronic adverse health effects." Data from a recent NTP bioassay, however, indicate that tetrachlorethylene is carcinogenic (National Toxicology Program, August 1985). Trichloroethylene is also a known human carcinogen.

J. PCB-containing Wastes

One commenter requested that EPA exempt from regulation electrical equipment fluids which contain PCBs and any of the the listed solvents.

Agency response:

The commenter has misint^{er}preted the proposed rule and the spent solvent listings. PCB transformer fluids (i.e., dielectric fluids containing PCBs and tetrachlorobenzene) are not covered under the current hazardous waste regulations. Tetrachlorobenzene is not a listed hazardous waste. (Monochlorobenzene is covered under the listing.) Furthermore, dilectric fluids are not considered "spent solvents" and, as such, are not regulated under RCRA. At this time, PCBs are regulated under the Toxic Substances Control Act.