FINAL
BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) BACKGROUND DOCUMENT ADDENDUM FOR

F002 (1,1,2-TRICHLOROETHANE)

AND

F005 (BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE)

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NOTE: This Background Document is an amendment to the November 1986 Final Best Demonstrated Available Technology (BDAT) Background Document for F001-F005 Spent Solvents (EPA/530-SW-86-056, 3 volumes)

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1. INTRODUCTION AND SUMMARY

This background document presents the data and rationale for the development of treatment standards for 1,1,2-trichloroethane (F002), benzene (F005), 2-ethoxyethanol (F005), and 2-nitropropane (F005). This document is issued as an addendum to the November 1986 background document for F001-F005 spent solvents (USEPA 1986).

F002 and F005 are listed as hazardous wastes from nonspecific sources as identified in 40 CFR 261.31:

F002 - The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluorethane, orthodichlorobenzene, trichlorofluoromethane, and **1,1,2-trichloroethane**; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

F005 - The following spent nonhalogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, **benzene, 2-ethoxyethanol, and 2-nitropropane**; all spent solvent mixtures/blends containing, before use, a total of 10 percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.

The Environmental Protection Agency (EPA) promulgated treatment standards for F002 and F005 as part of the final "Solvents and Dioxins Rule" (51 FR 40572, November 7, 1986). However, treatment standards for 1,1,2-trichloroethane (F002) and for benzene (F005), 2-ethoxyethanol (F005), and 2-nitropropane (F005) were not included in the final "Solvents and Dioxins Rule" because these solvents were added too late for the Agency to gather data to characterize and evaluate them. The

final rule adding 1,1,2-trichloroethane to F002 and adding benzene, 2-ethoxyethanol, and 2-nitropropane to F005 was promulgated on February 25, 1986 (51 FR 6737).

Although the Hazardous and Solid Waste Amendments (HSWA) directed the Agency to restrict the disposal of these new constituents 6 months after they were listed, EPA was unable to propose or promulgate treatment standards because there were no SW-846 analytical methods that could satisfactorily analyze 2-ethoxyethanol and 2-nitropropane in complex waste matrices. Therefore, the Agency has been unable to propose treatment standards for these constituents until today's proposal.

Further, since the final "Solvents and Dioxins Rule" was promulgated, the Agency has obtained additional data and performed further evaluations of these wastes and thus has enough information to establish numerical treatment standards for 1,1,2-trichloroethane (F002) and benzene (F005) and require methods of treatment for 2-ethoxyethanol (F005) and 2-nitropropane (F005).

The final treatment standards for 1,1,2-trichloroethane (F002) and benzene (F005) wastewaters and nonwastewaters are presented in Tables 1-1 and 1-2 at the end of this section. These standards are based on the total concentration of the constituents in the waste for both wastewaters and nonwastewaters.

The Agency is modifying the proposed treatment standards in the November 22, 1989, 54 FR 48461 for 2-ethoxyethanol and 2-nitropropane. These revisions are in response to comments. EPA determined that there is not sufficient information to develop a concentration-based standard for wastewaters and nonwastewaters containing 2-ethoxyethanol and 2-nitropropane (see Sections 6.3 and 6.4). EPA is instead promulgating methods of treatment for these two F005 constituents.

For the purpose of determining the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids* and less than 1 percent (weight basis) total organic carbon (TOC).

At this time, EPA is withdrawing the alternative method of treatment, steam stripping followed by carbon adsorption, for F005 wastewaters containing 2-nitropropane. This revision to the proposed regulatory approach follows EPA's determination that the adoption of steam stripping followed by carbon adsorption as BDAT should require minimum operating conditions to ensure that 2-nitropropane wastewaters do not go untreated through this treatment technology. EPA based its determination on the azeotrophic behavior of 2-nitropropane in F006 wastewaters and the fact that steam stripping of azeotropes would require a combination of more than one distillation unit. EPA lacks sufficient information to incorporate such requirements in the BDAT standard. However, EPA has determined that wet air oxidation followed by carbon adsorption as well as chemical oxidation followed by carbon adsorption represent BDAT for 2-nitropropane based on the treatment of wastewaters containing nitrobenzene. The Agency is promulgating these last two treatment technologies as an alternative treatment standard for F005 wastewaters and nonwastewaters containing 2-nitropropane. Wastewater effluents from the carbon adsorption unit can be land disposed. Nonwastewater residues from these two alternative treatment technologies must meet the nonwastewater treatment standards for F005 nonwastewaters containing 2-nitropropane, as a pre-requisite for land disposal.

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* The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids is measured by method 209C (Total Suspended Solids Dried at 103-105°C) in Standard Methods for the Examination of Water and Wastewater, 16th edition.

Note that at the time treatment standards were originally promulgated for F001-F005 (51 FR 40572), useful data were not available on total constituent concentrations in nonwastewater residuals; hence, TCLP was, at that time, considered to be the best available measure of performance for solvents in nonwastewaters. Since that time EPA has consistently promulgated total concentration standards for organic constituents in nonwastewater residuals and will do so for the four solvents for which standards are being promulgated here.

In developing the promulgated treatment standards for 1,1,2-trichloroethane and benzene solvent wastes, EPA is using the same methodology that it is using for U and P waste codes in this Third Third rulemaking. This somewhat modifies the methodology used in the First Third and Second Third rulemakings (USEPA 1989a). In the current rulemaking for U and P regulatory standards, the Agency considered all of the treated waste performance data where the constituent was treated to the detection limit in all cases. Then the Agency determined which of the detection limits were the most representative of the specific U and P wastes. To account for the anticipated variability in waste characteristics of untreated U and P wastes, the Agency typically selected the highest detection limits for the constituent that corresponded to the chemical represented by the U or P code. Thus, the Agency believes the resultant treatment standards should be achievable on a routine basis for the majority of U and P wastes. Because of the diversity of solvent wastes, the Agency believes this same methodology should apply to two of the four solvents for which standards are being promulgated here: 1,1,2-trichloroethene (F002) and benzene (F005). The 2-ethoxyethanol and 2-nitropropane treatment standards are being promulgated as methods of treatment.

The technologies used as the basis for BDAT are presented in Section 3, and the treatment data used to develop specific performance levels are presented in Section 4. In Section 5, BDAT is selected for

each solvent. Section 6 contains the calculation of treatment standards for each solvent.

Compliance with these treatment standards is a prerequisite for placement of these wastes in facilities designated as land disposal treatment units according to 40 CFR Part 268. The BDAT treatment standards for 1,1,2-trichloroethene and benzene wastewaters and nonwastewaters are presented in Tables 1-1 and 1-2. Tables 1-3 and 1-4 present the BDAT treatment standards for 2-ethoxyethanol and 2-nitropropane.

Table 1-1 BDAT Treatment Standards for 1,1,2-Trichloroethane (F002) and Benzene (F005) Wastewaters

Constituent	Maximum (composite sample) Total concentration (mg/l)
1,1,2-Trichloroethane	0.03
Benzene	0.07

Table 1-2 BDAT Treatment Standards for 1,1,2-Trichloroethane (F002) and Benzene (F005) Nonwastewaters

Constituent	Maximum (single grab) Total concentration (mg/kg)
1,1,2-Trichloroethane	7.6
Benzene	3.7

Table 1-3 BDAT Treatment Standards for 2-Ethoxyethanol and 2-Nitropropane Nonwastewaters

INCINERATION[a] AS A METHOD OF TREATMENT

[a]Incineration must be conducted in accordance with the technical requirements of 40 CFR Part 264 or Part 265, Subpart O.

Table 1-4 BDAT Treatment Standards for 2-Ethoxyethanol and 2-Nitropropane Wastewaters

Constituent	Treatment Standard
2-Ethoxyethanol	Incineration[a] or Biological Treatment
2-Nitropropane	Incineration;[a] or Wet Air Oxidation followed by Carbon Adsorption; or Chemical Oxidation followed by Carbon Adsorption

[a]Incineration must be conducted in accordance with the technical requirements of 40 CFR Part 264 or Part 265, Subpart O.

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

2.1 Industries Affected

A background document was produced to support the proposed listing (50 FR 20908, July 30, 1985) of 1,1,2-trichloroethane, benzene, 2-ethoxyethanol, and 2-nitropropanol as constituents of F002 and F005. This background document was revised slightly for the final rule (51 FR 6537) listing the four solvents as part of F002 and F005. The background documents for both the proposed rule and the final rule are contained in their respective public dockets. The listing background document for the final rule is also contained in the public docket for this rulemaking. Information in the listing background documents indicates that the principal uses of these four solvents as solvents are as follows:

1,1,2-Trichloroethane	Manufacture and use of paints and coatings; organic synthesis and miscellaneous processing.
Benzene	Organic synthesis and miscellaneous processing.
2-Ethoxyethanol	Manufacture and use of paints, coatings, and inks; organic synthesis and miscellaneous processing.
2-Nitropropane	Manufacture and use of paints, coatings, and inks; organic synthesis and miscellaneous processing.

Since promulgation of the final rule listing the four solvents as part of F002 and F005, the Agency has contacted potential generators of the four solvents. The contacted facilities confirmed the types of industries affected, as cited in the final listing background document (Cain Chemical 1988, Eastman Kodak 1988, Safety-Kleen 1988, Sinclair and Valentine 1988, Versar 1988). However, at least two printing ink

manufacturers expressed the opinion that 2-ethoxyethanol and 2-nitropropane are used very sparingly, if at all, in printing inks.

2.2 Waste Characterization

Since promulgation of the final rule listing the four solvents, the Agency has received additional characterization data for three of the four solvents from a facility that incinerates them (Eastman Kodak 1988). These data are presented in Table 2-1.

As with most F001-F005 spent solvent wastes, the four solvents are expected to be found mixed with other wastes. Table 2-2 lists industries for which characterization data were available to the Agency for the development of BDAT standards for F001-F005 spent solvents (USEPA 1986).

Table 2-1 Characterization Data for Benzene, 2-Ethoxyethanol, and 1,1,2-Trichloroethane[a]

Solvent	Approx. Conc.	Generating Process	Quantity Generated	Physical Characteristic	Other Constituents
Benzene	95%	Chemical manufacturing	270 gal/day	Liquid	Water 5%
Benzene	80%	Chemical manufacturing	30 gal/day	Liquid	Miscellaneous organics 20%
Benzene	10%	Laboratory use	2400 gal/yr	Liquid	Miscellaneous solvents 20% Carbon tetrachloride 10% Carbon disulfide 10% Water 10%, DMSO 10% Chloroform 15% Acetonitrile 15%
2-Ethoxyethanol	10%	Dispersion coating	300 lb	Liquid with some sediment	Methyl ethyl ketone 25% Iron oxide 25% Amyl acetate 20% Lindol 10% Cellulose nitrate 10%
2-Ethoxyethanol	10%	Parts painting	55 gal	Sludge	Xylene 10% Paint solids 64% Tin 4% Butyl cellosolve 12% Hexyl cellosolve 10%
2-Ethoxyethanol	Trace	Dispersion	100 lb/yr	Solid	Filters and dispersion 99.9%
1,1,2-Trichloroethane	5%	Testing	165 gal/yr	Liquid	Dichloromethane 95%
1,1,2-Trichloroethane	15%	Cleaning	800 gal/yr	Liquid	Dichloromethane 50% Toluene 20% Ethanol 15%

Table 2-1 (continued)

Solvent	Approx. Conc.	Generating Process	Quantity Generated	Physical Characteristic	Other Constituents
1,1,2-Trichloroethane	Trace	Solvent coating	68700 lb/yr	Solid	Waste filters, rags, poly containers, and other solid refuse 98% Miscellaneous organics 2%
1,1,2-Trichloroethane	Trace	Solvent coating	3300 lb/yr	Solid	Waste filters, polyethylene bags, rags, etc. 99% Miscellaneous solvents 1%
1,1,2-Trichloroethane[a]	50%	Solvent coating	3000 gal/yr	Liquid	Methyl acetate 1% Dichloromethane 49%
1,1,2-Trichloroethane	10%	Research	1000 gal/yr	Liquid with some sludge	Dichloromethane 62% 2-Butanone 9% Miscellaneous organics 3.3% Acetone 1% Methanol 5% Tetrahydrofuran 1% Ethanol 1% Ethyl acetate 1% Methyl acetate 1% Toluene 1.7% Acetonitrile 4%
1,1,2-Trichloroethane	98%	Chemical manufacturing	800 gal/yr	Liquid	Residual Organics 2%

[a]Unlike other waste streams, which were incinerated after being mixed with other wastes, this waste was incinerated separately.

Source: Eastman Kodak 1988

Table 2-2 Summary of Industries for Which Spent Solvent Waste Characterization Data Are Available

Industry	Description of spent solvent waste
Furniture manufacturing	Spent thinner and solvent
Plastics and resins manufacturing	Still bottoms and caustic Epoxy resin waste Phenolic and polyester/alkyd resin waste
Fiber manufacturing	Solvent recovery bottoms, laboratory solvents, and chrome plating solution
Pharmaceutical manufacturing	Solvent recovery bottoms
Paint manufacturing	Paint tank wash Spent thinner
Dyes and pigments manufacturing	Dyes and pigments waste
Organic chemicals manufacturing	Still bottoms and caustic Isocyanates manufacturing wastes Alkenes manufacturing waste Aldehyde furan manufacturing wastes
Agricultural chemicals manufacturing	Pesticide manufacturing waste
Printing industry	Spent recovery bottoms Spent ink wash
Can coating industry	Spent can coating residue
Membrane production industry	Spent solvents and organics

3. APPLICABLE AND DEMONSTRATED TREATMENT TECHNOLOGIES

The background document for F001-F005 spent solvents (USEPA 1986) identified applicable and demonstrated technologies for treating F002/F005 wastes containing the four new solvents. The Agency has identified a new emerging technology that may be applicable to the treatment of at least two of the four solvents. This technology, catalytic hydrodehalogenation (IITRI 1989), has been tested at bench scale on 1,1,2-trichloroethane and benzene. Hydrodehalogenation is a gaseous phase chemical reaction involving a chlorinated solvent and hydrogen gas in the presence of a noble metal catalyst, such as platinum. Products of the reaction are hydrogen chloride and the dehalogenated solvent. To the best of the Agency's knowledge, however, no commercial-scale plants use this technology. Therefore, the technology cannot be considered demonstrated.

Technologies considered to be applicable and demonstrated for spent solvents are described fully in the background document for F001-F005 spent solvents (USEPA 1986). Based on the 1986 information, EPA conversations with generators and treaters of these newly listed wastes and the multi-source leachates (see Section 4), EPA has identified several applicable waste management practices for the newly listed solvents, EPA has determined that incineration and wet air oxidation followed by carbon adsorption are applicable and demonstrated for 1,1,2-trichloroethane, benzene, 2-ethoxyethanol, and 2-nitropropane in F002 and F005 spent solvents for nonwastewaters; and distillation (including air or steam stripping), biological treatment, and carbon adsorption are applicable and demonstrated for wastewaters. Some of these treatment technologies allow for the recovery of the spent solvents. For example, an F005 waste containing 2-ethoxyethanol could be treated by distillation to recover 2-ethoxyethanol. However, these recovery technologies may leave behind residuals that may require further treatment prior to disposal.

4. PERFORMANCE DATA

This section presents the data available on the performance of demonstrated technologies in treating the listed wastes. These data are used later in this document for determining which technologies represent the best demonstrated available technology (BDAT) and for developing treatment standards.

EPA lacks performance data for the treatment of F002 and F005 wastes containing 1,1,2-trichloroethane, benzene, 2-ethoxyethanol, and 2-nitropropane. Instead, EPA has performance data from the treatment of other wastes that contain these or similar constituents. EPA believes that those constituents identified as similar constituents are at least as difficult to treat as those for which EPA currently lacks performance data. In addition, the Agency believes, based on its contacts with facilities managing these wastes, that none of the constituents in F002 and F005 are likely to interfere with, or reduce the treatment of, 1,1,2-trichloroethane, benzene, 2-ethoxyethanol, and 2-nitropropane. The characterization data presented in Table 2-1 for incineration of solvent wastes support this belief.

Treatment data from several sources were examined by the Agency to develop the proposed treatment standards (USEPA 1987, 1988a, 1988b, 1989b; Accurex 1986; University of Cincinnati 1989a, 1989b). A summary of the performance data used to establish standards for the solvents is presented in Table 4-1. The individual data sets are presented in Tables 4-2 through 4-8. Each of the data sets shown in Tables 4-2 through 4-8 is presented in its unedited version. However, the data were eventually edited, as noted on each table, when standards were calculated based on the data. Data editing was performed consistent with the EPA methodology for BDAT rulemaking (USEPA 1989a).

Table 4-1 Data Set Summary

Table No.	Title	Source
4-2	Biological treatment of benzene	USEPA 1987b.
4-3	Incineration data for benzene-containing nonwastewaters	Acurex 1986, USEPA 1989b, and USEPA 1988a.
4-4	Biological treatment of 1,1,2-trichloroethane	USEPA 1987b.
4-5	Steam stripping of wastewaters containing 1,1,2-trichloroethane	USEPA 1987b.
4-6	Incineration data for 1,1,1-trichloroethane nonwastewaters	Acurex 1986, USEPA 1989b, and USEPA 1988b.
4-7	Steam stripping of wastewaters containing 2-nitropropane	University of Cincinnati 1989a.
4-8	Biological treatment of wastewaters containing 2-ethoxyethanol	University of Cincinnati 1989b.
4-9	Wastewater treatment performance data for n-butyl alcohol	USEPA 1989c

Table 4-2 BAT Performance Data for the Biological Treatment of Benzene

Plant no.	Sampling date	Concentration of benzene in influent (ppb)	Concentration of benzene in effluent (ppb)	Recovery-corrected concentration of benzene in effluent (ppb)[a]	Notes
12F	5/12/81	1543	<10	19.6	
	5/19/81	737	<10	19.6	
	5/26/81	1024	<10	19.6	
	6/2/81	444	<10	19.6	
	6/9/81	738	<10	19.6	
	6/15/81	877	<10	19.6	
	6/16/81	607	<10	19.6	
296V	2/20/79	<19,900	<10	13.9	
306V	2/27/79	278,300	<10	18.5	
	2/28/79	280,000	38	70.4	
	3/1/79	380,000	11	20.4	
384T	11/27/83	40,039	<10	10	
	11/28/83	34,692	<10	10	
	11/29/83	33,642	<10	10	
	11/30/83	90,757	<10	10	
	12/1/83	36,508	<10	10	
	12/4/83	58,191	<10	10	
	12/5/83	62,675	<10	10	
	12/6/83	25,554	<10	10	
	12/7/83	30,637	<10	10	
	12/8/83	31,970	<10	10	
	12/11/83	24,891	<10	10	
	12/12/83	21,165	<10	10	
	12/13/83	24,600	<10	10	
	12/14/83	30,285	<10	10	
	12/15/83	18,744	<10	10	
444V	11/14/78	957	<10	10	
	11/15/78	1,500	<10	10	
	11/16/78	879	<10	10	
695V	12/4/78	<10	<10	12.6	T
	12/5/89	<10	<10	12.6	T
	12/6/78	<10	<10	12.6	T
851V	3/6/79	36,640	<10	10	
	3/7/79	36,150	<10	10	
	3/8/79	41,290	<10	10	

Table 4-2 (continued)

Plant no.	Sampling date	Concentration of benzene in influent (ppb)	Concentration of benzene in effluent (ppb)	Recovery-corrected concentration of benzene in effluent (ppb)[a]	Notes
948F	6/18/80	250	<10	19.6	
	6/19/80	188	<10	19.6	
	6/20/80	74	<10	19.6	
	6/23/80	640	<10	19.6	
	6/24/80	130	<10	19.6	
	6/25/80	670	<10	19.6	
	6/26/80	110	<10	19.6	
	6/27/89	450	<10	19.6	
	7/7/80	1,400	<10	78.4	
	7/8/80	271	27	52.9	
	7/9/80	220	<10	19.6	
	7/10/89	1,200	<10	19.6	
	7/11/80	330	74	145.0	
948F	7/14/80	66	280	549	
	7/15/80	19	<10	19.6	
	7/16/80	<10	<10	19.6	T
	7/17/80	<10	<10	19.6	T
	7/18/80	<10	13	25.5	T
	7/21/80	<10	<10	19.6	T
	7/22/80	205	<10	19.6	
	7/23/80	150	<10	19.6	
	7/24/80	<10	<10	19.6	T
	7/25/89	<10	<10	19.6	T
	7/28/80	390	<10	19.6	
	7/29/80	65	112	219.6	
	7/30/89	230	<10	19.6	
	7/31/89	110	<10	19.6	
	8/1/80	<10	<10	19.6	T
	8/4/80	74	<10	19.6	
	8/5/80	804	<10	19.6	
	8/6/80	<10	<10	19.6	T
	8/7/80	<10	<10	19.6	T
	8/8/80	<10	<10	19.6	T

Table 4-2 (continued)

Plant no.	Sampling date	Concentration of benzene in influent (ppb)	Concentration of benzene in effluent (ppb)	Recovery-corrected concentration of benzene in effluent (ppb)[a]	Notes
1293T	2/19/84	569	<10	10	
	2/20/84	445	<10	10	
	2/21/84	360	<10	10	
	2/22/84	<10	<10	10	T
	2/23/84	417	<10	10	
	2/26/84	209	<10	10	
	2/27/84	510	<10	10	
	2/28/84	668	<10	10	
	2/29/84	821	<10	10	
	3/1/84	705	<10	10	
	3/4/84	712	<10	10	
	3/5/84	1,127	<10	10	
	3/6/84	1,185	<10	10	
	3/7/84	983	<10	10	
	3/8/84	1,105	<10	10	
1609V	9/11/78	160	<10	10	
	9/2/78	157	<10	10	
	9/13/78	365	<10	10	
1650P	2/17/83	1,150	<10		Y
	2/23/83	<10	<10		T
	3/2/83	<10	<10		T
	3/14/83	640	<10		Y
1650V	5/22/79	5,423	<10	11.0	
2430V	1/9/79	948	<10	10.3	
	1/10/79	990	<10	10.3	
	1/11/79	480	<10	10.3	
2481F	10/11/80	11	<10	19.6	
	10/12/80	246	<10	19.6	
	10/13/80	168	<10	19.6	
	10/14/80	138	11	21.6	
	10/15/80	168	<10	19.6	
	10/16/80	162	<10	19.6	
	10/17/80	210	<10	19.6	
	10/18/80	85	<10	19.6	
	10/19/80	181	<10	19.6	
	10/20/80	27	<10	19.6	

Table 4-2 (continued)

Plant no.	Sampling date	Concentration of benzene in influent (ppb)	Concentration of benzene in effluent (ppb)	Recovery-corrected concentration of benzene in effluent (ppb)[a]	Notes
2481F (cont.)	10/21/80	<10	<10	19.6	
	10/24/80	59	15	29.4	
	10/25/80	57	<10	19.6	
	10/26/80	36	<10	19.6	
	10/27/80	168	<10	19.6	
	10/28/89	247	<10	19.1	
	10/29/80	52	<10	19.6	
	10/30/80	60	<10	19.6	
	10/31/89	59	<10	19.6	
	11/1/80	61	<10	19.6	
	11/2/80	106	<10	19.6	
	11/3/80	69	<10	19.6	
	11/4/80	43	<10	19.6	
	11/5/80	27	<10	19.6	
	11/6/80	32	<10	19.6	
	11/7/89	38	<10	19.6	
	11/8/80	34	<10	19.6	
	11/9/80	40	<10	19.6	
	11/10/80	60	<10	19.6	
	11/11/60	<10	<10	19.6	T
2631F	6/2/80	2,000	<10	19.6	
	6/3/89	2,190	<10	19.6	
	6/4/80	1,913	<10	19.6	
	6/5/80	2,565	<10	78.4	
	6/9/80	6,985	11	21.6	
	6/10/80	5,213	<10	19.6	
	6/11/80	3,079	<10	19.6	
	6/12/80	2,398	<10	19.6	
	6/16/89	9,524	<10	19.6	
	6/17/80	5,925	<10	19.6	
	6/18/80	2,825	<10	19.6	
	6/19/80	5,575	<10	19.6	
	6/23/80	4,880	<10	19.6	
	6/24/80	3,557	<10	19.6	
	6/25/80	4,497	<10	19.6	
	6/26/80	5,363	<10	19.6	

Table 4-2 (continued)

Plant no.	Sampling date	Concentration of benzene in influent (ppb)	Concentration of benzene in effluent (ppb)	Recovery-corrected concentration of benzene in effluent (ppb)[a]	Notes
2631F (cont.)	6/30/89	10,800	<10	19.6	
	7/1/80	7,683	<10	19.6	
	7/2/80	9,200	<10	19.6	
	7/3/80	4,030	<10	78.4	
	7/7/80	11,000	17	33.3	
	7/8/80	7,893	<10	19.6	
	7/9/80	11,800	<10	19.6	
	7/10/80	7,508	<10	19.6	
	1/16/79	3,783	23	23	
	1/17/79	3,300	20	20	
	1/18/79	3,200	<10	10	
4051V	4/23/79	190	<10	19.6	
	4/24/79	62	<10	19.6	

Notes:

T Data not used. Influent benzene concentration was less than detection limit; thus, treatment may not have been substantial.

Y Data not used; improper QA/QC or no QA/QC used.

[a] Recovery-corrected concentration of benzene in effluent was calculated by dividing the concentration of benzene in the effluent by a recovery factor. Recovery factors were obtained from laboratory matrix spike or surrogate spike data. They are percent recoveries divided by 100. Plants with a T suffix are not adjusted for recovery because of the analytical method used. Plants with a V suffix have the following recovery factors: 296V, 0.72; 306V, 0.54; 444V, 1.0; 695V, 0.79; 851V, 1.0; 1609V, 1.0; 1650V, 0.91; 2430V, 0.97; and 4051V, 0.51. Recovery data were not available for plants with an F suffix, so the lowest recovery factor from the V plants (0.51) was used. Recovery factors greater than 1.0 were set to 1.0.

Source: USEPA 1987b.

Table 4-3 Incineration Data for Benzene-Containing Nonwastewaters

Plant no.	Nonwastewater concentration	Scrubber effluent	Kiln ash	TCLP (kiln ash)	Ash recovery-corrected conc.	Notes
Site 1	93 mg/kg	<5 mg/l	<1 mg/kg	2 µg/l	1.33 mg/kg	R
Site 2	<0.1 g/kg	<50 µg/l	<0.1 g/kg	3 µg/l		T
Site 3	ND	ND	ND	ND		
Site 4	ND	ND	ND	ND		
Site 5	ND	ND	ND	ND		
Site 6	<0.1 g/kg	<50 µg/l	<0.1 g/kg	10 µg/l		T
Site 7	<0.1 g/kg	<50 µg/l	<0.1 g/kg	3 µg/l		T
Site 8	<0.1 g/kg	<50 µg/l	<0.1 g/kg	3 µg/l		T
Site 9	ND	ND	ND	ND		
Site 10	6700 mg/l	<0.5 mg/l	ND	ND	0.57 mg/l[a]	R, ND
#1	57 mg/kg	<0.01 mg/l	<0.01 mg/kg	ND	0.01 mg/kg	R
#2	61 mg/kg	<0.01 mg/l	<0.01 mg/kg	ND	0.01 mg/kg	R
#3	48 mg/kg	ND	ND	ND		
#4	59 mg/kg	<0.01 mg/l	<0.01 mg/l	ND	0.01 mg/kg	R
#5	55 mg/kg	<0.01 mg/l	<0.01 mg/l	ND	0.01 mg/kg	R
#6	ND	ND	ND	ND		
Sample 1	17 mg/kg	ND	<0.025	ND	0.03	
Sample 2	19 mg/kg	ND	<0.025	ND	0.03	
Sample 3	5.6 mg/kg	ND	<0.025	ND	0.03	
Sample 4	212 mg/kg	ND	<0.025	ND	0.03	
Sample 5	170 mg/kg	ND	<0.025	ND	0.03	

Notes:

ND - No data, not analyzed, or data not used.
R - Recovery-corrected concentration is based on recovery of surrogates 1,2-dichloroethane, toluene, and p-bromofluorobenzene (75% recovery for Site 1; 141% recovery-rounded to 100%-for #1, #2, #4, and #5).
T - Data not used; influent concentration below detection limits.

[a]Scrubber wastewater recovery-corrected concentration.

Source for Sites 1-9: Acurex 1986.
Source for #1-#6: USEPA 1989b.
Source for Samples 1-5: USEPA 1988a.

Table 4-4 Performance Data for the Biological Treatment of 1,1,2-Trichloroethane

Plant no.	Sampling date	Concentration of 1,1,2-trichloroethane in influent (ppb)	Concentration of 1,1,2-trichloroethane in effluent (ppb)	Recovery-corrected concentration of 1,1,2-trichloroethane in effluent (ppb)	Notes
415T	11/29/83	<10	<10		T
	11/30/83	<10	<10		T
	12/1/83	<10	<10		T
	12/2/83	<10	<10		T
	12/3/83	<10	<10		T
	12/4/83	<10	<10		T
	12/5/83	<10	<10		T
	12/6/83	<10	<10		T
	12/7/83	<10	<10		T
	12/8/83	<10	<10		T
	12/11/83	<10	<10		T
	12/12/83	<10	<10		T
	12/13/83	<10	<10		T
	12/14/83	<10	<10		T
	12/15/83	<10	<10		T
2631F	6/2/80	23	<10	10.2	
	6/3/80	<10	<10		T
	6/4/80	<10	<10		T
	6/5/80	<10	<10		T
	6/9/80	<10	<10		T
	6/10/80	<10	<10		T
	6/11/80	<10	<10		T
	6/12/80	<10	<10		T
	6/16/80	<10	<10		T
	6/17/80	<10	<10		T
	6/18/80	<10	<10		T
	6/19/80	<10	<10		T
	6/23/80	24	<10	10.2	
	6/24/80	28	<10	10.2	
	6/25/80	11	<10	10.2	
	6/26/80	11	<10	10.2	
	6/30/80	<10	<10		T
	7/1/80	<10	<10		T
	7/2/80	12	<10	10.2	
	7/3/80	12	<10	10.2	
	7/7/80	<10	<10		T

Table 4-4 (continued)

Plant no.	Sampling date	Concentration of 1,1,2-trichloroethane in influent (ppb)	Concentration of 1,1,2-trichloroethane in effluent (ppb)	Recovery-corrected concentration of 1,1,2-trichloroethane in effluent (ppb)	Notes
2631F (cont)	7/8/80	<10	<10		T
	7/9/80	12	<10	10.2	
	7/10/80	<10	<10		T
2631V	1/16/79	523	33	33.7	
	1/17/79	680	<10	10.2	
	1/18/79	690	11	11.2	

Notes:

T - Data not used. Influent concentration was less than detection limit; thus, treatment may not be substantial.

Recovery Recovery factor for Plant No. 2631V = 98%.
Recovery factor for Plant No. 2631F was not available; therefore, 98% was used.

Source: USEPA 1987b.

Table 4-5 Performance Data for Steam Stripping of Wastewaters Containing 1,1,2-Trichloroethane

Plant no.	Sampling date	Concentration of 1,1,2-trichloroethane in untreated use (ppb)	Concentration of 1,1,2-trichloroethane in effluent (ppb)	Recovery-corrected concentration of 1,1,2-trichloroethane in effluent (ppb)	Notes
415T	11/29/83	8,900	<10	10	
	11/30/83	3,900	<10	10	
	12/1/83	<10	<10	10	T
	12/2/83	<10	<10	10	T
	12/3/83	<10	<10	10	T
	12/4/83	870	<10	10	
	12/5/83	<10	<10	10	T
	12/6/83	12,900	<10	10	
	12/7/83	13,500	<10	10	
	12/8/83	11,200	<10	10	
	12/11/83	220	<10	10	
	12/12/83	<10	10	10	T
	12/13/83	<10	<10	10	T
	12/14/83	<10	<10	40	T
	12/15/83	2,000	<10	10	
913P	8/12/85	<10	<10		Q,T
	8/13/85	<10	<10		Q,T
	8/14/85	<10	<10		Q,T
	8/19/85	24,400	11		Q
	8/20/85	<10	<10		Q,T
	8/29/85	<10	<10		Q,T
	8/30/85	<10	<10		Q,T
	9/16/85	<10	<10		Q,T
	9/17/85	<10	<10		Q,T
	9/18/85	18,800	<10		Q
	9/19/85	<10	<10		Q,T
	9/20/85	<10	<10		Q,T
	9/25/85	<10	<10		Q,T
	10/9/89	<10	25		Q,T

Notes:

T - Data not used. Influent 1,1,2-trichloroethane concentration was less than detection limit; thus, treatment may not have been substantial.

Q Data not used. Source of data was public submittal, and Agency was unable to verify whether QA/QC procedures for sampling and laboratory analyses were fully satisfactory or whether treatment system was well operated on days of sampling.

Recovery Data from plants with the T suffix do not require recovery correction because analytical method 1625 was used.

Source: USEPA 1987b.

Table 4-6 Incineration Data for 1,1,1-Trichloroethane Nonwastewaters

Plant no.	Nonwastewater untreated concentration	Treated kiln ash (mg/kg)	Ash recovery-corrected concentration (mg/kg)	Notes
Site 1	8,800 mg/l	<1	1.33	
Site 2	ND	ND		ND
Site 3	29,000 mg/l	<.5	0.7	
Site 4	ND	3.7		T
Site 5	ND	ND		ND
Site 6	ND	ND		ND
Site 7	1,900 mg/l	<100	183.3	Y
Site 8	10,000 mg/l	<1 ug/kg	0.002	
Site 9	17,500 mg/l[a]	<500 ug/kg	0.7	
Site 10	6,700 mg/l	<1	1.33[b]	ND
#1	0.045 mg/kg	<0.01	0.01	
#2	0.026 mg/kg	<0.01	0.01	
#3	0.029 mg/kg	ND		ND
#4	0.02 mg/kg	<0.01	0.01	
#5	0.032 mg/kg	<0.01	0.01	
#6	ND	ND		ND
Sample 1	81,000 mg/kg	<2	2.13	
Sample 2	33,000 mg/kg	<2	2.13	
Sample 3	34,000 mg/kg	<2	2.13	
Sample 4	44,000 mg/kg	<2	2.13	
Sample 5	45,000 mg/kg	<2	2.13	
Sample 5	44,000 mg/kg	<2	2.13	

Notes:

T - Data not used. Influent concentrations were less than detection limit; therefore, treatment may not be substantial.

Y - Detection limit so high as to make data meaningless. Data not used.

ND - Data not used, no data, or data not analyzed.

Recovery 75% for Sites 1-10, 100% for #1-#6; 94% for Sample Sets 1-6.

[a]Flow-based composite of two feed streams.

[b]Concentration of constituent in APCE effluent.

Source for Sites 1-10: Acurex 1986.

Source for #1-#6: USEPA 1989b.

Source for Samples 1-6: USEPA 1988b.

Table 4-7 Performance Data for the Steam Stripping of Wastewaters Containing 2-Nitropropane

Plant no.	Sampling date	Concentration of 2-nitropropane in influent (ppm)	Concentration of 2-nitropropane in effluent (ppm)	Recovery-corrected concentration of 2-nitropropane in effluent (ppm)
University of Cincinnati	9/1/88	3,480 1,314	0.114	0.126
	9/1/88	2,560 303	0.141	0.156
	9/1/88	977 405	0.456	0.504
	9/1/88	1,120 743	0.398	0.440
	9/1/88	701 737	0.319	0.353
	9/1/88	646 775	0.348	0.385

Notes: Sample holding times were exceeded for effluent samples.

Duplicate samples were taken of the influent. Corresponding effluent duplicates were not taken.

Information on the analytical method used to generate these data is presented in Appendix A.

Recovery - Data were recovery-corrected by applying the formula R = X/.745, where R is the recovery-corrected value, X is the as-reported value, and 0.904 is the percent recovery divided by 100.

Source: University of Cincinnati 1989a.

Table 4-8 Performance Data for the Biological Treatment of Wastewaters Containing 2-Ethoxyethanol

Plant no.	Sampling date	Concentration of 2-ethoxyethanol in influent (ppm)	Concentration of 2-ethoxyethanol in effluent (ppm)	Recovery-corrected concentration of 2-ethoxyethanol in effluent (ppm)	Notes
University of Cincinnati	4/6/89	412	<10	17.0	
		2020	<10	17.0	
	4/11/89	414	<10	17.0	
		1760	<10	17.0	
	4/14/89	386	<10	17.0	
		1250	<10	17.0	
	4/18/89	466	<10	17.0	
		2105	<10	17.0	
	4/21/89	441	<10	17.0	
		2270	<10	17.0	
	4/25/89	500	<10	17.0	
		2600	<10	17.0	
	4/27/89	954	<10	17.0	
		2640	<10	17.0	
	5/2/89	894	39	66.2	
		2588	<10	17.0	
	5/4/89	837	24	40.7	
		2532	<10	17.0	
	5/9/89	442	22.5	51.3	
		3070	<10	17.0	
	5/12/89	ND	23.5		T
		ND	<10		T
	5/17/89	793	125	212.2	X
		2675	<10	17.0	
	5/18/89	2070	<10	17.0	
	5/19/89	2720	<10	17.0	

Table 4-8 (continued)

Plant no.	Sampling date	Concentration of 2-ethoxyethanol in influent (ppm)	Concentration of 2-ethoxyethanol in effluent (ppm)	Recovery-corrected concentration of 2-ethoxyethanol in effluent (ppm)	Notes
	5/20/89	850	296	502.0	X
		2690	<10	17.0	
	5/23/89	797	226	384	X
		3340	<10	17.0	
	6/27/89	455	<10	17.0	X
		2650	623	1060	X
	7/4/89	480	30.3	51.4	X
		3110	589	1000	X
	7/11/89	480	18.1	30.7	X
		2690	782	1330	X
	7/18/89	455	18.5	31.4	X
		2460	27.8	47.2	X
	7/25/89	500	63.6	108	X
		2630	576	978	X
	8/1/89	532	117	199	X
	8/2/89	505	88.4	150	X
	8/3/89	505	89.2	151	X
	8/4/89	438	ND		

Notes: Two parallel experiments were run, one in which the influent value was always approximately 500 mg/l and one in which the influent value was always approximately 2,500 mg/l.
Information on the analytical method used to generate these data is presented in Appendix A.

T Data not used since no 2-ethoxyethanol was detected in influent.

ND - Not detected.

X Data not used because system was in upset condition (temperature allowed to get too high).

Source: University of Cincinnati 1989b.

Table 4-9 Wastewater Treatment Performance Data for n-Butyl Alcohol

Technology	Technology Size	Facility	Range Influent Concentration (ppb)	Average Effluent Concentration (ppb)	Removal (%)	Reference
AS	Full	1168E	10000-100000	40.000	99.79	WERL

Source: USEPA 1989c.

5. DETERMINATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

The Agency has reviewed several data sets relating to the performance of treatment technologies for wastewaters and nonwastewaters containing benzene, 1,1,2-trichloroethane, 2-nitropropane, and 2-ethoxyethanol in F002/F005 solvents.

5.1 Nonwastewaters

For nonwastewaters, EPA has treatment data from a well-designed and well-operated incinerator treating wastes containing benzene. Thus, BDAT for benzene-containing nonwastewaters is incineration. For the remaining wastes, BDAT treatment of nonwastewaters is determined based on transfer by comparing the parameters that affect treatment of the specific wastes with parameters of other similar wastes for which demonstrated treatments are known. Further, the contacted facilities have reported that they routinely treat these wastes by incineration prior to land disposal. As a result, the Agency believes that the constituents in the subject wastes can be treated to the same performance levels as those observed in other wastes for which the Agency has treatment data. The Agency believes that none of the constituents in F002 and F005 are likely to interfere with, or reduce, treatability of the four solvents. This belief is based on characterization data received from facilities currently incinerating these wastes. Therefore, BDAT for 1,1,2-trichloroethane, 2-nitropropane, and 2-ethoxyethanol is incineration by transfer from 1,1,1-trichloroethane, nitrobenzene, and methyl ethyl ketone, respectively, for specific reasons discussed in Section 6.

5.2 Wastewaters

Performance data sets are available for the treatment of wastewaters containing benzene, 2-nitropropane, 1,1,2-trichloroethane, and

2-ethoxyethanol. For benzene, data sets for three technologies are available: (1) steam stripping, (2) liquid-liquid extraction followed by steam stripping followed by activated carbon adsorption, and (3) biological treatment. Biological treatment performance data are presented in Table 4-2; performance data for steam stripping and liquid-liquid extraction followed by steam stripping and activated carbon adsorption are presented in Appendix A. Each of these technologies is demonstrated and available. A review of the data sets for each technology indicates that biological treatment achieves the greatest reduction of the constituent in the effluent. For some of the facilities for which biological treatment data are available, the treatment technology includes such additional treatment steps as steam stripping, ion exchange, solvent extraction, carbon adsorption, and gravity separation. In those cases where additional treatment steps are present, however, biological treatment is the principal removal step. Thus, biological treatment is considered BDAT for benzene-containing wastewaters.

Both biological and steam stripping treatment data (see Tables 4-4 and 4-5, respectively) are available for 1,1,2-trichloroethane. The Agency has reviewed these data sets and has concluded that both technologies significantly reduce the constituent in the treated effluent and that these treatment levels are comparable. The data sets were compared using the statistical "analysis of variance" (ANOVA) technique described in the methodology document (USEPA 1989a). In this analysis the calculated "F value" is less than the "critical value." Statistically, this indicates that the mean effluent concentration values of the two treatment systems are not significantly different (i.e., they are homogeneous); thus, both technologies are considered to be "best demonstrated." Therefore, BDAT for 1,1,2-trichloroethane-containing wastewaters is either biological treatment or steam stripping.

For 2-nitropropane, the only treatment performance data available for wastewater treatment are for steam stripping; however, these data are flawed (see Section 6.3.1). For a similar compound, nitrobenzene, there are data for steam stripping followed by carbon adsorption. Nitrobenzene is believed to be harder to treat by these technologies than 2-nitropropane. Although the treated nitrobenzene data appear to indicate that this constituent is amenable to steam stripping, the data show flaws in the design of the steam stripper and the detection of isotropic behavior of the wastes (see Section 6.3.1). Therefore, BDAT for 2-nitropropane-containing wastewaters is incineration, or wet air oxidation or chemical oxidation followed by carbon adsorption.

For 2-ethoxyethanol, the only treatment performance data available to the Agency are for biological treatment of wastewaters. However, EPA is not using these data because of system upsets and missed holding times (see Section 6.4.1). Therefore, BDAT for 2-ethoxyethanol-containing wastewaters is biological treatment (e.g., activated sludge) based on transfer of treatment technology from n-butyl alcohol.

6. CALCULATION OF TREATMENT STANDARDS

The specific data used in the development of the treatment standards and the approach used by the Agency to develop these standards are discussed below for each of the four solvents.

6.1 Benzene

Data from well-designed and well-operated demonstrated treatment facilities were available to establish the treatment standards for benzene-containing wastewaters and nonwastewaters.

6.1.1 Wastewaters

For wastewaters, the Agency is basing the standard on performance data received from 16 facilities employing biological treatment. These data are presented in Table 4-2. Data from plants with the V suffix were recovery corrected by applying actual benzene spike recovery values as reported in the Summary of Analytical Data to Support BAT Guidelines. Data from plants with the T suffix do not require recovery correction because analytical method 1625 was used. (This method automatically incorporates a recovery-correction factor.) Data from plants with the F suffix were recovery corrected by applying the formula $R = X/0.51$, where R is the recovery-corrected value, X is the as-reported value, and the constant 0.51 is the lowest recovery value reported by the V-suffix facilities.

The mean recovery-corrected concentration of the 133 data points used in the analysis is 25.0 μg/l. The statistically determined variability factor value of 2.88 multiplied by the mean recovery-corrected concentration results in a treatment standard for benzene wastewaters of 72.0 μg/l (rounded to 0.07 mg/l).

6.1.2 Nonwastewaters

For nonwastewaters, the Agency has reviewed three data sets on the performance of incineration systems to treat benzene-containing wastes (see Table 4-3). The data sets are the Acurex data set (Acurex 1986), the K011/K013/K014 data set (USEPA 1989b), and the K087 data set (USEPA 1988a). Only one of the ten data points in the Acurex data set (site 1) was used in determining the standard. (The reported detection limit is 1 mg/kg.) For eight of the remaining Acurex data points either there was no analysis for benzene in the feed or the untreated waste benzene concentrations were below detection limits, suggesting that treatment may not have been substantial. A ninth Acurex data point showed benzene in the untreated and treated wastes, but the treated waste sample had benzene concentration data only for the scrubber water and not for the kiln ash (nonwastewater). Four data points from the BDAT K011/K013/K014 background document were used. (The reported detection limit is 0.01 mg/kg.) Although two other data points were available in this data set, they lacked data on benzene levels in the treated residuals and thus were not used in establishing the standard.

The Agency notes the difference in the benzene detection limits of the three data sets. The Agency also notes that a benzene concentration below the BDAT K011/K013/K014 background document detection limit of 0.01 mg/kg would also be below the benzene detection limit of 0.025 mg/kg presented in the K087 background document and the detection limit of 1.0 mg/kg used by Acurex. Therefore, for the purpose of establishing the standard for benzene, a detection limit of 1.0 mg/kg is assumed for all benzene incineration ash data. In this way, EPA has reasonable assurance that all analytical laboratories can measure compliance. Further, choosing the highest detection limit is consistent with the Third Third methodology for U and P wastes, as discussed in Section 1 of this document.

The reported benzene recovery factor presented in the K087 background document data is 98 percent. For the other two data sets, mixtures of 1,2-dichloroethane, toluene, and p-bromofluorobenzene were spiked into ash samples prior to analysis for volatile organics. The lowest percent recovery for the Acurex data was 75 percent; for the BDAT K011/K013/K014 background document data, the lowest recovery value was 141 percent. The 75 percent recovery rate is used to set the standard.

To determine the standard, the average of all recovery-corrected performance data is multiplied by a variability factor. The Agency has determined that the variability factor of 2.8 should be used when all performance data are below detection limits, as explained in the methodology document (USEPA 1989a). Therefore, the standard for benzene nonwastewaters is 1.0 mg/kg x (1/0.75) x 2.8 = 3.72 mg/kg benzene.

6.2 1,1,2-Trichloroethane

6.2.1 Wastewaters

Data sets for both biological treatment and steam stripping treatment of 1,1,2-trichloroethane-containing wastewaters were used by the Agency to establish the treatment standard. As described in Section 5.2, the ANOVA analyses showed no statistical difference in the treatment performance of the two technologies.

Biological treatment data are presented in Table 4-4; steam stripping treatment data are presented in Table 4-5. Biological treatment performance data consisted of data sets from two facilities. Constituent levels in the influent waste stream from Plant No. 415 were all below the detection limit of the constituent; therefore, these data were not used in establishing the standard because evidence of substantial treatment cannot be demonstrated. Eleven data points from Plant No. 2631 were used

to establish the standard. The reported recovery-correction factor is 98 percent. Data from this plant also included data points with influent concentrations below detection limits; these data points were not included in the analysis. The mean recovery-corrected effluent concentration of the 11 data points used in the analysis is 12.4 μg/l. The statistically determined variability factor of 2.13 multiplied by the mean recovery-corrected concentration results in a treatment standard for biologically treated 1,1,2-trichloroethane-containing wastewaters of 26.4 μg/l (rounded to 0.03 mg/l).

Steam stripping treatment data are presented in Table 4-5. While steam stripping is considered by the Agency to be a fully demonstrated and available treatment technology, only one of the two data sets is considered to be from a well-designed and well-operated system (i.e., Plant No. 415T). The second data set, from Plant No. 913, was a public data submittal, and the Agency is unable to verify whether quality assurance/quality control procedures for sampling and laboratory analysis were completely satisfactory or whether the treatment system was well operated on the days of sampling. For comparison purposes, however, these data do indicate treatment results similar to those achieved by Plant No. 415T.

Data from plants with the T suffix do not require recovery correction because analytical method 1625 was used.

All data on the treated effluent were below the method detection limit of 10.0 μg/l. The Agency notes that 1,1,2-trichloroethane concentrations in many of the untreated waste samples were also below detection limits. Since all treated waste data were also below the limit, the mean concentration of 1,1,2-trichloroethane used in developing the standard is 10.0 μg/l. In the instance in which all performance data for a constituent are nondetects, the Agency uses a variability

factor of 2.8 to determine the standard, as explained in the methodology document (USEPA 1989a). Thus, the calculated standard for 1,1,2-trichloroethane in wastewaters using the steam stripping treatment data is 10.0 μg/l x 2.8 = 28.0 μg/l (rounded to 0.03 mg/l), which, by comparison, is the same value calculated by using the biological treatment data. Thus, the BDAT standard for 1,1,2-trichloroethane-containing wastewaters is 0.03 mg/l.

6.2.2 Nonwastewaters

The Agency has no performance data for the treatment of 1,1,2-trichloroethane-containing nonwastewaters. Therefore, the Agency is setting the standard for 1,1,2-trichloroethane by transferring data from the treatment of a similar constituent, 1,1,1-trichloroethane, which the Agency believes should behave similarly to 1,1,2-trichloroethane when incinerated because of their similarities in structure and physical/chemical properties.

The Agency has reviewed three data sets on the performance of incineration systems to treat 1,1,1-trichloroethane-containing wastes (see Table 4-6). The data sets are the Acurex data set (Acurex 1986), the K011/K013/K014 data set (USEPA 1989b), and data from the Final Best Demonstrated Available Technology Background Document for K016, K018, K019, K020, and K030 Wastes (USEPA 1988b). Five of the ten data points in the Acurex data were used in determining the standard. Of the remaining five data points, four had constituent levels in the feed reported below the detection limit (thus presenting the possibility that treatment may not have been substantial) or the constituent had not been analyzed for, and one data point had 1,1,1-trichloroethane-treated values only for the air pollution control equipment effluent and not for the ash or bottoms residue. Four of six data points were used from the BDAT K011/K013/K014 background document. The remaining two data points

did not have the constituent analysis results reported for the treated residuals. Six data points were used from the BDAT K016/K018/K019/K020/K030 background document (USEPA 1988b).

The Agency notes the difference in the 1,1,1-trichloroethane detection limits of the three data sets. Detection values for the Sites 1 through 10 data (Acurex 1986) ranged from 1 μg/kg for Site 8 to 100 mg/kg for Site 7. A detection limit of 1 μg/kg for 1,1,1-trichloroethane analysis is considered to be suspect by the Agency. Similar detection limits for volatiles in the wastewater matrix are achievable, but they are not likely to be achieved in the analysis of solids. Similarly, a detection limit of 100 mg/kg is so high as to make the data useless; therefore, data from this site are not being considered in the analysis. The reported detection limits for 1,1,1-trichloroethane in the two background documents cited above are 0.01 mg/kg and 2.0 mg/kg. The Agency uses a logic similar to that presented for determining the detection limit for the benzene nonwastewater standard; that is, the highest reported value in the data sets considered in the analysis is used to establish the standard. Therefore, for 1,1,1-trichloroethane, a detection of 2.0 mg/kg is assumed for all constituent incineration ash data. As previously stated, this assumption allows the Agency reasonable assurance that all analytical laboratories can measure for compliance. Therefore, since all data used in the analysis were presented as being below detection limits, 2.0 mg/kg is considered to be the uncorrected basis for the standard.

The reported constituent recovery factors for the Acurex, BDAT K011/K013/K014, and BDAT K016/K018/K019/K020/K030 data sets are 75, 100, and 94 percent, respectively. Each data point used in the analysis has been corrected by the recovery factor specific to that data set. The 75 percent recovery rate is used to calculate the recovery-corrected concentration, or 2.0 mg/kg x 1/.75 = 2.7 mg/kg. The recovery-corrected

concentration is multiplied by a variability factor in order to determine the standard. The Agency notes that the variability factor is 2.8 when performance data are below detection limits, as explained in the methodology document (USEPA 1989a). Therefore, the standard for 1,1,2-trichloroethane, which is transferred from 1,1,1-trichloroethane, is 2.7 mg/kg x 2.8 = 7.6 mg/kg.

6.3 2-Nitropropane

6.3.1 Wastewaters

Data from well-designed and well-operated commercial-scale treatment facilities are not available to the Agency for 2-nitropropane-containing wastewaters.

Two data sets were received by the Agency. The first data set was a pilot-scale study of 2-nitropropane treated by steam stripping at the University of Cincinnati (University of Cincinnati 1988). However, this data contained analyses of samples whose holding times were exceeded. Thus, the development of a treatment standard for 2-nitropropane-containing wastewaters cannot be based on these data.

A second set of data was reviewed that presented performance data for treatment of wastewaters containing nitrobenzene by liquid-liquid extraction, followed by steam stripping and carbon adsorption. Nitrobenzene should be more difficult to treat using steam stripping and carbon adsorption than 2-nitropropane, based on a comparison of the physical properties of both compounds. Table 6-1 presents a comparison of the physical properties of 2-nitropropane and nitrobenzene. The data indicate similar solubilities of the two compounds in water. Further, the lower boiling point and higher vapor pressure of 2-nitropropane indicate that it should be less difficult to treat than nitrobenzene

Table 6-1 Physical Properties of 2-Nitropropane and Nitrobenzene

Property	2-Nitropropane	Nitrobenzene
Molecular weight	89.09	123.0
Boiling point (°C)	129.25	210.9
Density at 20°C (g/cm^3)	0.99	1.19
Solubility at 20°C (percent)	1.7	1.9
Vapor pressure at 28.2°C (mmHg)	22	<1.0

using steam stripping. Carbon adsorption is expected to treat residual 2-nitropropane from the steam stripper to the nondetect level as it did for nitrobenzene because less nitropropane should be contained in the steam stripper treated effluent. Performance data for treatment of wastewaters containing nitrobenzene by steam stripping followed by carbon adsorption is presented in Table 6-2. Although the treated nitrobenzene data appear to indicate that this constituent is amenable to stream stripping, the data show flaws in the design of the steam stripper and detection of azeotropic behavior of the wastes.

At this time, EPA is withdrawing the alternative method of treatment, steam stripping followed by carbon adsorption, for F005 wastewaters containing 2-nitropropane. This revision to the proposed regulatory approach follows EPA's determination that the adoption of steam stripping followed by carbon adsorption technology as BDAT should require minimum operating conditions to ensure that 2-nitropropane wastewaters to not go untreated through this treatment technology. EPA based its determination on the azeotropic behavior of 2-nitropropane in F005 wastewaters and the fact that steam stripping of azeotropes could require a combination of more than one distillation unit. EPA lacks sufficient information to incorporate such requirements in the BDAT standard. EPA, however, has determined that wet air oxidation followed by carbon adsorption as well as chemical oxidation followed by carbon adsorption, represent BDAT for 2-nitropropane based on the treatment of wastewater containing nitrobenzene. EPA is promulgating these last two treatment technologies as an alternative treatment standard for F005 wastewaters and nonwastewaters containing 2-nitropropane. Wastewater effluents from the carbon adsorption unit can be land disposed. Nonwastewater residues from these two alternative treatment technologeis must meet the nonwastewater treatment standards for F005 nonwastewaters containing 2-nitropropane, as a pre-requisite for land disposal.

Several commenters have expressed concern over the proposal of different treatment technologies for the same waste constituent. The Agency realizes the burden of treating constituents for which different wastewater criteria for the same listed waste have been promulgated. However, these problems are academic since the Agency is promulgating incineration or wet air oxidation followed by carbon adsorption, or chemical oxidation followed by carbon adsorption as a method of treatment for wastewater forms of 2-nitropropane.

EPA believes that the promulgated treatment standard option of oxidation, chemical or wet-air, followed by activated carbon is superior to steam stripping because steam stripping is considered a technology that treats the waste, whereas oxidation technologies destroy the waste. Oxidation followed by carbon adsorption is also superior because oxidation is more rugged than biotreatment: an oxidation system is less easily disabled by a refractory influent stream and more easily restored to working order than a biological treatment unit. As discussed in the proposed rule, wet-air oxidation is most appropriate for those wastewaters near the wastewater cutoff level (i.e., 1 percent TOC), while chemical oxidation effectively treats those wastes with lower percentages of TOC. EPA's decision to require activated carbon following the oxidation step ensures a backup system to compensate for the uncertainty about final effluent concentrations of these U and P wastes inherent in any process treating unquantifiable wastes. Most importantly, however, since spent activated carbon from treating these wastewaters becomes a nonwastewater form of these wastes (54 FR 48384) and thus must be incinerated according to the promulgated nonwastewater standard, requiring activated carbon treatment ensures that both wastewater and nonwastewater forms of these wastes go to incineration, a method demonstrated to successfully treat a wide variety of organic wastes.

Table 6-2 Performance Data for Treatment of Wastewaters Containing Nitrobenzene by Steam Stripping Followed by Carbon Adsorption

Untreated waste (mg/l) K103	K104	Treated waste (mg/l)
<1500	2700	<0.03
<1500	2200	<0.03
<3000	2300	<0.15
<3000	2900	<0.03
<3000	3900	<0.03

Source: USEPA 1988c. Data obtained from Onsite Engineering Report for E.I. Du Pont de Nemours, Inc., Beaumont, Texas.

6.3.2 Nonwastewaters

The Agency has no performance data for the treatment of 2-nitropropane-containing nonwastewaters. In addition, the Agency has determined that concentration-based treatment standards cannot be promulgated for nonwastewater forms of this constituent because not enough data are available to support the proposed standard. As a result, the Agency is promulgating treatment standards for this constituent expressed as methods of treatment. The method of treatment for nonwastewater forms of 2-nitropropane is incineration.

6.4 2-Ethoxyethanol

6.4.1 Wastewaters

Data from well-designed and well-operated commercial-scale treatment facilities are not available to the Agency for 2-ethoxyethanol-contaminated wastewaters. A data set consisting of 41 data points is available from pilot-scale studies conducted at the University of Cincinnati (University of Cincinnati 1989b), where synthetic wastewaters containing 2-ethoxyethanol were treated by biological treatment and removal efficiencies greater than 99 percent were achieved (see Table 4-8). The analytical method used to analyze 2-ethoxyethanol is described in Appendix B. The studies included results from two systems--one using a concentration of 500 mg/l of the constituent in the feed and the other using 2,500 mg/l. The Agency notes that according to information reported by the source, the pilot data indicate several plant upsets. One upset resulted from high ambient temperatures in the test area from the end of June through early July; the other resulted from sludge recycle problems in the 500-mg/l system in May.

The analytical data for biological treatment also included analysis of samples whose holding times were exceeded prior to analysis; therefore, EPA is not using these data. Further, EPA is attempting to develop a more precise analytical test for 2-ethoxyethanol. A copy of the procedure is attached as Appendix B. However, in view of the experimental status of this method, EPA at this time is not setting any concentration-based treatment standards but is instead promulgating a method of treatment.

EPA does, however, have data for biological treatment (e.g., activated sludge) of n-butyl alcohol. n-Butyl alcohol is a very similar compound based on a comparison of the physical and structural properties of 2-ethoxyethanol and n-butyl alcohol. This comparison indicates similar structures, molecular weights, and boiling points (see Table 6-3). The data for n-butyl alcohol indicate that an influent concentration of up to 100 ppm can be treated to a concentration of 0.04 ppm. These performance data are presented in Table 6-4. The Agency believes 2-ethoxyethanol can also be treated to these levels based on similarities in physical ad structural properties to n-butyl alcohol. Therefore, the Agency is promulgating biological treatment (e.g., activated sludge) as a method of treatment for 2-ethoxyethanol based on transfer from n-butyl alcohol.

6.4.2 Nonwastewaters

The Agency does not have performance data for the treatment of 2-ethoxyethanol nonwastewaters. In addition, the Agency has determined that concentration-based treatment standards cannot be promulgated for nonwastewater forms of this constituent because not enough data are available to support the proposed standard. As a result, the Agency is promulgating treatment standards for this constituent expressed as methods of treatment.

Table 6-3 Physical and Structural Properties of 2-Ethoxyethanol and n-Butyl Alcohol

Property	2-Ethoxyethanol	n-Butyl Alcohol
Empirical formula	$C_4H_{10}O_2$	$C_4H_{10}O$
Molecular weight	90.12	74.12
Boiling point (°C)	135	118
Molecular formula	$HOCH_2CH_2OC_2H_5$	$CH_3CH_2CH_2CH_2OH$

Table 6-4 Wastewater Treatment Performance Data for n-Butyl Alcohol

Technology	Technology Size	Facility	Range Influent Concentration (ppb)	Average Effluent Concentration (ppb)	Removal (%)	Reference
AS	Full	1168E	10000-100000	40.000	99.79	WERL

Source: USEPA 1989c.

However, EPA does have data for incineration of nonwastewater forms of methyl isobutyl ketone (MIBK). Because of its similarity in structure, boiling point, vapor pressure, and heat of combustion, 2-ethoxyethanol should behave similarly to MIBK when incinerated. Based on an examination of data from numerous facilities that incinerate MIBK-containing nonwastewaters, the Agency expects that MIBK will be completely destroyed in incineration systems that are well designed and well operated. Therefore, the Agency is promulgating incineration as the method of treatment for nonwastewaters containing 2-ethoxyethanol.

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APPENDIX A

PERFORMANCE DATA FOR TREATMENT OF BENZENE-CONTAINING WASTEWATERS

Table A-1 Performance Data for Steam Stripping of Benzene-Containing Wastewaters

Plant	Date	Influent concentration (ppb)	Recovery-corrected effluent concentration (ppb)
415P	1/31/85	ND	80 [a]
	2/1/85	ND	55 [a]
	2/11/85	22,300	<10 [a]
	2/11/85	48,100	<10 [a]
	12/4/85	412,000	329 [a]
	12/5/85	279,000	138 [a]
	12/6/85	274,000	134 [a]
1494T	1/22/84	1,242,040	171
	1/25/84	1,076,150	57
	2/5/84	289,500	<10
	2/6/84	372,910	95
	2/7/84	1,068,840	76
	2/8/84	1,551,220	38
	2/9/84	1,591,810	32
	2/10/84	166,040	53
	2/12/84	ND	<10
	2/13/84	137,303	<10
	2/14/84	198,146	<10
	2/15/84	269,360	<10
	2/16/84	1,506,800	<10
2680T	3/25/84	94,893	<10
	3/26/84	147,212	<10
	3/27/84	34,693	<10
	3/28/84	61,172	<10
	3/29/84	61,110	<10
	4/1/84	83,329	<10
	4/2/84	54,921	<10
	4/3/84	129,069	<10
	4/4/84	127,658	<10
	4/5/84	127,530	<10

[a]Data not used; improper QA/QC or no QA/QC used.

Source: USEPA 1987b.

Table A-2 Performance Data for Liquid-Liquid Extraction Followed by Steam Stripping Followed by Activated Carbon Adsorption of Benzene-Containing Wastewaters

Parameter	Influent concentration (ppb) K103	K104	Recovery-collected effluent concentration (ppb)
Benzene	81,000	240,000	55
	73,000	320,000	7
	65,000	70,000	22 [a]
	55,000	11,000	25
	32,000	4,500	12

[a]Data not used; system not well operated.

Source: EPA-collected data presented in USEPA 1988c.

APPENDIX B

ANALYTICAL METHODS

FOR

2-NITROPROPANE AND 2-ETHOXYETHANOL

Analytical Method for 2-Nitropropane

Samples were prepared for measurement of 2-nitropropane and other BDAT parameters in accordance with SW-846 Method 8030. Options included SW-846 Method 5030 (purge and trap) and instrument calibration by an external standard.

Analytical Method for 2-Ethoxyethanol (2E)

The Federal Register (40 CFR Chapter 1, Part 261, App. III) recommends SW-846 Methods 8030 and 8240 for the detection of 2E. Initial analytical efforts established that the usual cleanup methods, purge and trap or heated purge and trap (SW-846 Method 5030), resulted in very poor recoveries because of the low purging efficiency of 2E. Direct injection was identified as the only choice. However, direct injection of aqueous samples significantly deteriorates the performance of GC/MSs, rendering Method 8240 impractical for routine analysis of samples. Validation was attempted for Method 8030 with direct injection. Reliable data could not be obtained for 2E, but methylene chloride and toluene recoveries from the same samples were excellent, leading the analyst at EER Technologies Corporation and the project staff to believe that the GC column and not the technique was at fault. An adaptation of this method utilizing a different GC column was tested.

This adapted method utilized a packed gas chromatograph column containing 3 percent SP1500 on 80/120 mesh Carbopack B and the run conditions found in Table B-1. The chosen column was tested at the specified conditions on spiked sample matrices. The project staff developed a scheme of injections to formalize the process of determining the validity of the results. EER Technologies Corporation analyzed the samples and reported the data in Table B-2 as well as the information summarized below:

In analyzing standards to develop a calibration curve, the resulting curve yielded a fairly linear response ($r^2 = 0.9760$, $y = 2.056x - 19.64$). The surrogate responses gave mean peak height responses of 21.5 for methylene chloride and 104 for toluene, with standard deviations of 2.55 and 1.72, respectively. Injections to obtain the MDL and MQL were carried out as outlined in SW-846, and the appropriate calculations were made. Based on this testing, the MDL and MQL were calculated to be 1.15 and 1.91, respectively, but EER felt that a more realistic value for the MQL would be 5.0 mg/l since injections at the 2.0-mg/l level did not exhibit a measurable peak.

Table B-1 Gas Chromatograph Conditions for 2E Analysis

Parameter	Value
GC column	6' x 1/8" stainless steel
Column packing	80/120 mesh Carbopack B w/3% SP1500
Injection temperature	250°C
Column temperature	220°C
Detector temperature	300°C
Detector type	FID at 128 x 10^{-10} AFS
Carrier gas	Nitrogen at 20 ml/min
Injection volume	2 μl
Temperature program	4 min at 50°C then to 220°C at 32°C/min and hold

Table B-2 Validation Data for 2E Analytical Method

Sample Matrix		Matrix Spike (% Rec.)	Matrix Spike Dup. (% Rec.)	% Relative Range
Unpreserved feed	Run 1	96.0	100.0	4.08
	Run 2	105.0	106.0	0.95
	Avg	101.0	103.0	2.46
	%RR	8.96	5.82	---
Unpreserved effluent	Run 1	87.4	98.5	11.9
	Run 2	92.9	92.9	0.00
	Avg	90.2	95.7	5.97
	& RR	6.10	5.85	---
Preserved feed	Run 1	93.2	102.0	9.02
	Avg	93.2	102.0	9.02
Preserved effluent	Run 1	88.2	102.0	14.5
	Run 2	99.3	92.8	6.77
	Avg	93.8	97.4	3.82
	% RR	11.8	9.40	---

NOTE: The Method Detection Limit (MDL) was determined to be 1.15 mg/l and the Method Quantitation Limit (MQL) was determined to be 1.91 mg/l. These limits were determined via methods outlined in SW-846. The spiking concentration used was 5 times the MQL, which was 10.0 mg/l. Seven blanks were also run, and the average background "noise" was 5.14 mg/l with a standard deviation of 0.06 mg/l.

As testing with the column continued, it showed decreased sensitivity. It is not unusual for a GC system to vary by this amount, especially using direct injection and an FID detector. Also, the variation may have been the result of short shelf-life of the stock standard. Recalibration was done with freshly prepared stock standard, and the results were acceptable. Since the sensitivity of the column resulted in poor results as testing continued, a new column was installed, but the original sensitivity was never reproduced. The MQL was then increased to 10 mg/l.

Source: University of Cincinnati 1989b.