

Air Contaminants — Permissible Exposure Limits

**(Title 29 Code of Federal Regulations
Part 1910.1000)**



U.S. Department of Labor
Ann McLaughlin, Secretary

Occupational Safety and Health Administration
• John A. Pendergrass, Assistant Secretary
1989

• OSHA 3112

INTRODUCTION

Soon after adoption of the Occupational Safety and Health Act in 1970, the Occupational Safety and Health Administration (OSHA) promulgated Permissible Exposure Limits (PELs) for many substances pursuant to the authority granted by Section 6(a) of the Act, which allowed the Agency to promulgate existing Federal standards or consensus standards as enforceable OSHA standards. Accordingly, the PELs identified in the Z-Tables of Title 29 Code of Federal Regulations, Part 1910.1000 (29 CFR 1910.1000) were adopted from regulations issued under the Walsh-Healey Public Contracts Act as existing Federal standards. These, in turn, were adopted from the 1968 Threshold Limit Values (TLVs) of the American Conference of Governmental Industrial Hygienists (ACGIH). Some consensus standards from the American Standards Association (now the American National Standards Institute (ANSI)) also were adopted at that time, following the Section (6a) procedures.

Industrial experience, new developments in technology, and available scientific data clearly indicate that in many instances those adopted limits are now obsolete and inadequate. Also, many new toxic materials commonly used in the workplace are not covered. These inadequacies are evidenced by the lower allowable exposure limits recommended by many technical, professional, industrial, and government organizations in the United States and elsewhere. In addition, these organizations have identified many other substances for which allowable exposure limits are needed to supplement the existing Z-Tables. Many large industrial organizations feel obligated to supplement the existing OSHA PELs with their own internal corporate guidelines.

OSHA, in the past, has focused its priorities on the development of detailed regulations for some high-priority substances. This has resulted in substance specific regulations for 24 substances. OSHA, however, has been unable to regulate the thousands of substances commonly found in the workplace, or to review the scientific information to determine whether different limits are required for the more than 400 substances regulated prior to 1988 under the provisions of the Z-Tables.

OSHA, therefore, determined it was necessary to augment the substance-by-substance approach through the use of a generic rulemaking, which would simultaneously cover many substances. The Hazard Communication Standard is an example of a regulation using such an approach. At this time, OSHA is also in the process of developing generic standards to cover respiratory protection, medical surveillance, and exposure monitoring. A major part of this generic approach to rulemaking is to modify the existing PELs and to establish PELs for substances for which no exposure limits previously existed. The existing health

literature and expert judgement indicate that such actions are required to protect against kidney and liver diseases, respiratory diseases, nerve disorders, carcinogenicity, irritation to various bodily organs, and many other deleterious health effects. Millions of employees are potentially exposed to substances of concern, and adoption of such a regulation represents a significant step in assuring the adequacy of health protection for workers.

DETAILS OF THE NEW STANDARD

OSHA therefore amended its existing Air Contaminants standard, 29 CFR 1910.1000, including Tables Z-1, Z-2 and Z-3. This amendment is limited to making more protective 212 PELs listed in these three tables, setting new PELs for 164 substances not previously regulated by OSHA, and retaining certain PELs unchanged. These changes include the revision of the PELs, the inclusion of Short Term Exposure Limits (STELs) to complement the 8-hour Time-Weighted Average (TWA) limits, the establishment of a designation for "skin" to protect against exposure by skin contact, and the addition of ceiling limits as appropriate.

The final regulation permits the use of any compliance methodology, until December 31, 1992, to achieve each revised PEL. During this period, however, the established OSHA hierarchy of controls with preference for engineering controls will be applied to achieve the level of the existing PELs. A single new Table, Z-1-A, includes all of the revised PELs and the existing OSHA PELs. Tables Z-2 and Z-3 are temporarily maintained since they contain limits that cannot be conveniently included in the format used in Table Z-1-A. The original Table Z-1 has been deleted from the regulation because all of the substances in that table have been included in the new Table Z-1-A. The design of this new Table Z-1-A makes identification of all changes to PELs possible by simply comparing the Transitional Limits at the left side of the table with the Revised Limits shown at the right side of the table. Table Z-1-A is included in this booklet following the section on regulatory text. The final regulation and this booklet also include Tables Z-2 and Z-3 because these limits could not be included in the Transitional Limits columns of Table Z-1-A due to format differences.

RISK REDUCTION AND FEASIBILITY

OSHA reviewed health, risk and feasibility evidence for all 428 substances for which changes to the PEL were considered. In each instance where a revised or new PEL was adopted, OSHA determined that the new limits substantially reduce significant risk of material health impairment among workers, and that new limits

are technologically and economically feasible. This determination is based on a complete review of the material referenced in the proposed rule issued on June 7, 1988, and a detailed review of the entire record for the rulemaking, including all comments, evidence, testimony and briefs submitted by the public during and after public hearings held from July 28 to August 16, 1988 in Washington, D.C.

For a small number of substances used in specific operations, the full record indicates that it is presently technically infeasible to achieve, through engineering controls, the PEL that is necessary based on available health information. For these specific instances, engineering controls to achieve the new PEL are required only where the Assistant Secretary demonstrates that such controls are feasible. These substances and operations are carbon monoxide and sulfur dioxide in specific foundry operations, carbon disulfide in selected rayon fiber and sausage casing manufacturing processes, and styrene in selected open molding boat manufacturing processes. Any methods of control may be used (in these identified situations) to achieve the new PELs.

PROTECTION

The revised PELs will protect workers against a wide variety of health effects that could cause material impairment of health or functional capacity. This includes protection against catastrophic effects such as cancer, cardiovascular, liver, and kidney damage; lung diseases, as well as more subtle effects resulting in central nervous system damage, narcosis, respiratory effects, and sensory irritation. For each substance, the health evidence in the record provides a substantial basis for establishing a new or revised PEL. OSHA utilized the already published and widely accepted Recommended Exposure Limits (RELs) developed by the National Institute for Occupational Safety and Health (NIOSH) and the TLVs published by the ACGIH. OSHA, however, reviewed the entire record and made an independent judgment to determine that the revised PEL was feasible and that significant risk would be reduced.

The revised standards will provide additional occupational health protection to approximately 4.5 million workers at an annual cost of approximately \$150 per employee protected. This cost is only a fraction of 1 percent of sales for all affected sectors.

OTHER STANDARDS

OSHA will continue its practice of rulemaking for individual substances when substance-specific regulations are necessary and

appropriate. OSHA also will continue its efforts to develop generic regulations to cover ancillary provisions required to supplement the PELs in 29 CFR 1910.1000.

COVERAGE

OSHA also has determined that it is appropriate to limit this rulemaking to the General Industry sector. This segment involves the largest number of workers and will result in the greatest benefit. Application to the Construction, Maritime and Agriculture segments will require examination of feasibility for these sectors and may require some modifications to this rule because of differences among these sectors. OSHA will pursue coverage for these sectors as part of second stage rulemaking and has informally notified the Advisory Committee on Construction Safety and Health of its plans.

The final Regulation covers a total of 600 substances, including the following:

- Addition of PELs for 164 new substances.
- Adoption of more protective PELs for 212 substances.
- No changes for 52 substances that were considered in this rulemaking.
- No change to existing PELs for 9 substances that are currently undergoing Section (6b) rulemaking.
- No change to existing PELs for 3 substances where some industry segments are not covered by the individual (6b) regulation (cotton dust, formaldehyde and benzene).
- No changes for PELs for 160 substances, that are unchanged, and were not evaluated during this rulemaking.

COMPLIANCE DATES

September 1, 1989, (6 months after the effective date of March 1) is the date for compliance with new or revised PELs, using any control methods. Approximately 4 years (December 31, 1992) following the regulation publication date, employers must comply with all PELs, with a preference for engineering controls. In the event that the planned OSHA regulation regarding revision to methods of compliance is not completed by December 31, 1991, the December 31, 1992 date will be delayed one year until December 31, 1993.

REGULATORY TEXT AND TABLES

The complete regulatory text preceding Table Z-1-A and the Table Z-1-A, Z-2 and Z-3 entries are as follows:

1910.1000 Air contaminants

An employee's exposure to any substance listed in Tables Z-1-A, Z-2 or Z-3 of this section shall be limited in accordance with the requirements of the following paragraphs of this section.

(a) Table Z-1-A:

(1) **Substances in Transitional Limits Columns with Limits Preceded by "C" - Ceiling Values.** An employee's exposure to any substance in Table Z-1-A under the Transitional Limits columns, the exposure limit of which is preceded by a "C", shall at no time exceed the exposure limit given for that substance in Table Z-1-A under the Transitional Limits columns.

(2) **Other Substances in Transitional Limits Columns-8-hour Time Weighted Average.** An employee's exposure to any substance in Table Z-1-A under the Transitional Limits columns, the exposure limit of which is not preceded by a "C", shall not exceed the 8-hour Time Weighted Average given for that substance in Table Z-1-A under the Transitional Limits columns in any 8-hour work shift of a 40-hour work week.

(3) **Final Rule Limits Columns.** An employee's exposure to any substance listed in Table Z-1-A shall not exceed the Time Weighted Average (TWA), Short Term Exposure Limit (STEL) and Ceiling Limit specified for that substance in Table Z-1-A under the Revised Limits columns.

(4) **Skin Designation.** To prevent or reduce skin absorption, an employee's skin exposure to substances listed in Table Z-1-A with an "X" in one or both of the Skin Designation columns, the designation "Skin" following the substance name shall be prevented or reduced to the extent necessary in the circumstances through the use of gloves, coveralls, goggles, or other appropriate personal protective equipment, engineering controls or work practices.

(5) **Definitions.** The following definitions are applicable to the Final Rule Limits columns of Table Z-1-A:

(i) **Time Weighted Average (TWA)** is the employee's average airborne exposure in any 8-hour work shift of a 40-hour work week which shall not be exceeded.

(ii) **Short term exposure limit (STEL)** is the employee's 15-minute time weighted average exposure which shall not be exceeded at any time during a work day unless another time limit

is specified in a parenthetical notation below the limit. If another time period is specified, the time weighted average exposure over that time limit shall not be exceeded at any time during the working day.

(iii) Ceiling is the employee's exposure which shall not be exceeded during any part of the work day. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time over a working day.

(6) Additional Definition. The terms "substance," "air contaminant," and "material" are equivalent in meaning for 29 CFR 1910.1000.

(b) Table Z-2:

Table Z-2 is applicable for the transitional period and to the extent set forth in paragraph (f) of this section.

(1) 8-hour time weighted averages. An employee's exposure to any material listed in Table Z-2, in any 8-hour work shift of a 40-hour work week, shall not exceed the 8-hour time weighted average limit given for that material in Table Z-2.

(2) Acceptable Ceiling Concentrations. An employee's exposure to a material listed in Table Z-2 shall not exceed at any time during an 8-hour shift the acceptable ceiling concentration limit given for the material in the table, except for a time period, and up to a concentration not exceeding the maximum duration and concentration allowed in the column under "acceptable maximum peak above the ceiling concentration for an 8-hour shift."

(3) Example. During an 8-hour work shift, an employee may be exposed to a concentration of Substance A (with a 10 ppm TWA, 25 ppm ceiling and 50 ppm peak) above 25 ppm (but never above 50 ppm) only for a maximum period of 10 minutes. Such exposure must be compensated by exposures to concentrations less than 10 p.p.m. so that the cumulative exposure for the entire 8-hour work shift does not exceed a weighted average of 10 p.p.m.

(c) Table Z-3:

Table Z-3 is applicable for the transitional period and to the extent set forth in paragraph (f) of this section. An employee's exposure to any substance listed in Table Z-3 in any 8-hour work shift of a 40-hour work week shall not exceed the 8-hour time weighted average limit given for that substance in the table.

(d) Computation formulae:

The computation formula which shall apply to employee exposure to more than one substance for which 8-Hour time weighted

averages are listed in Subpart Z of 29 CFR Part 1910 in order to determine whether an employee is exposed over the regulatory limit is as follows:

(1)(i) The cumulative exposure for an 8-hour work shift shall be computed as follows:

$$E = (C_a T_a + C_b T_b + \dots C_n T_n) \div 8$$

Where: E is the equivalent exposure for the working shift.
 C is the concentration during any period of time T where the concentration remains constant.
 T is the duration in hours of the exposure at the concentration C .

The value of E shall not exceed the 8-hour time weighted average specified in Subpart Z of 29 CFR 1910 for the material involved.

(ii) To illustrate the formula prescribed in paragraph (d)(1)(i) of this section, assume that Substance A has an 8-hour time weighted average limit of 100 ppm noted in Table Z-1-A. Assume that an employee is subject to the following exposure:

Two hours exposure at 150 p/m
Two hours exposure at 75 p/m
Four hours exposure at 50 p/m

Substituting this information in the formula, we have:

$$(2 \times 150 + 2 \times 75 + 4 \times 50) \div 8 = 81.25 \text{ p/m}$$

Since 81.25 ppm is less than 100 ppm, the 8-hour time weighted average limit, the exposure is acceptable.

(2)(i) In case of a mixture of air contaminants an employer shall compute the equivalent exposure as follows:

$$E_m = (C_1 \div L_1 + C_2 \div L_2) + \dots (C_n \div L_n)$$

Where: E_m is the equivalent exposure for the mixture.
 C is the concentration of a particular contaminant.
 L is the exposure limit for that substance specified in Subpart Z of 29 CFR Part 1910.

The value of E_m shall not exceed unity (1).

(ii) To illustrate the formula prescribed in paragraph (d)(2)(i) of this section, consider the following exposures:

Material	Actual concentration of 8-hour exposure (ppm)	8-hr. TWA PEL (ppm)
Substance B	500	1,000
Substance C	45	200
Substance D	40	200

Substituting in the formula, we have:

$$\begin{aligned}
 E_s &= 500+1,000 + 45+200 + 40+200 \\
 E_s &= 0.500 + 0.225 + 0.200 \\
 E_s &= 0.925
 \end{aligned}$$

Since E_s is less than unity (1), the exposure combination is within acceptable limits.

(e) To achieve compliance with paragraphs (a) through (d) of this section, administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and/or technical measures used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with Section 1910.134.

(f) Effective dates; start-up dates and transitional provisions:

(1) **Effective date:** The effective date for the permissible exposure limits specified in the Final Rule Limits columns of Table Z-1-A is March 1, 1989.

(2) **Start-up dates:**

(i) The permissible exposure limits specified in the Final Rule Limits columns of Table Z-1-A shall be achieved by any reasonable combination of engineering controls, work practices and personal protective equipment effective September 1, 1989, through December 30, 1992.

(ii)(a) The permissible exposure limits specified in the Final Rule Limits columns of Table Z-1-A shall be achieved by the methods of compliance specified in paragraph (e) of this section effective December 31, 1992, if by December 31, 1991 a final rule

has been published in the Federal Register amending or determining not to amend paragraph (e) of this section.

(b) If no final rule has been published in the Federal Register by December 31, 1991, amending or determining not to amend paragraph (e) of this section, then the permissible limits specified in the Final Rule Limits columns of Table Z-1-A shall be achieved by the methods of compliance specified by paragraph (e) of this section effective December 31, 1993, and paragraph (f)(2)(i) of this section shall remain in effect through December 30, 1993.

(iii) The skin designations in the Final Rule Limits columns become effective September 1, 1989. The skin designations in the Transitional Limits columns are in effect from March 1, 1989 through August 31, 1989.

(3) Transitional provisions:

(i) The permissible exposure limits specified in the Transitional Limits column of Table Z-1-A, Table Z-2 and Table Z-3 shall continue to be achieved by the methods of compliance specified in paragraph (e) of this section through December 30, 1992. If paragraph (f)(2)(ii)(b) of this section takes effect, this provision is extended through December 30, 1993.

(ii) The permissible exposure limits specified in the Transitional Limits column of Table Z-1-A, Z-2 and Z-3 shall be applicable to the extent cross referenced in 29 CFR 1915, 1917 and 1918.

(iii) If any new or amended provisions or new or revised limits for any substance or substances are either administratively stayed or judicially stayed or vacated, then the existing provisions or limits for those substances specified in the Transitional Limits columns of Table Z-1-A, Table Z-2 or Table Z-3 shall remain in effect until such stay is lifted, or indefinitely, if the limit is vacated.

(4) Enforcement of the limits are indefinitely stayed for: aluminum alkyls; ethylidene norbornene; hexafluoroacetone; mercury (alkyl compounds); oxygen difluoride; phenylphosphine; and sulfur pentafluoride; until OSHA publishes in the Federal Register a notice that a sampling and analytical technique is available.

TABLE 2-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						
		PEL ^a		mg/m ³ ^b		TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a				ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Acetaldehyde	75-07-0	200	360	-	100	180	150	270	-	-	-	
Acetic acid	64-19-7	10	25	-	10	25	-	-	-	-	-	
Acetic anhydride	108-24-7	5	20	-	-	-	-	-	5	20	-	
Acetone	67-64-1	1000	2400	-	750	1800	1000	2400	-	-	-	
Acetonitrile	75-05-8	40	70	-	40	70	60	105	-	-	-	
2-Acetylaminofluorine; see 1910.1014	53-96-3											
Acetylene dichloride; see 1,2-Dichloroethylene												
Acetylene tetrabromide	79-27-6	1	14	-	1	14	-	-	-	-	-	
Acetylsalicylic acid (Aspirin)	50-78-2	-	-	-	-	5	-	-	-	-	-	
Acrolein	107-02-8	0.1	0.25	-	0.1	0.25	0.3	0.8	-	-	-	

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation		
		PEL*		b		TWA		STEL ^c		CEILING			b	o
		ppm ^a	mg/m ³			ppm ^a	mg/m ³	ppm ^a	mg/m ³	ppm ^a	mg/m ³			
Acrylamide	79-06-1	-	0.3	X	-	0.03	-	-	-	-	-	X		
Acrylic acid	79-10-7	-	-	-	10	30	-	-	-	-	-	X		
Acrylonitrile; see 1910.1045	107-13-1													
Aldrin	309-00-2	-	0.25	X	-	0.25	-	-	-	-	-	X		
Allyl alcohol	107-18-6	2	5	X	2	5	4	10	-	-	-	X		
Allyl chloride	107-05-1	1	3	-	1	3	2	6	-	-	-	-		
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	-	5	22	10	44	-	-	-	-		
Allyl propyl disulfide	2179-59-1	2	12	-	2	12	3	18	-	-	-	-		
alpha-Alumina	1344-28-1													
Total dust		-	15	-	-	10	-	-	-	-	-	-		
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-		

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						
		PEL*		mg/m ³ ^b		TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a				ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Aluminum (as Al) Metal	7429-90-5											
Total dust		-	15	-	-	15	-	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-
Pyro powders		-	-	-	-	5	-	-	-	-	-	-
Welding fumes***		-	-	-	-	5	-	-	-	-	-	-
Soluble salts		-	-	-	-	2	-	-	-	-	-	-
Alkyls		-	-	-	-	2	-	-	-	-	-	-
4-Aminodiphenyl; see 1910.1011	92-67-1											
2-Aminoethanol; see Ethanolamine												
2-Aminopyridine	504-29-0	0.5	2	-	0.5	2	-	-	-	-	-	-
Amitrole	61-82-5	-	-	-	-	0.2	-	-	-	-	-	-
Ammonia	7664-41-7	50	35	-	-	-	35	27	-	-	-	-
Ammonium chloride fume	12125-02-9	-	-	-	-	10	-	20	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**					
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING	
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b
Ammonium sulfamate	7773-06-0	-	-	-	-	-	-	-	-	-
Total dust		-	15	-	-	10	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-
n-Amyl acetate	628-63-7	100	525	-	100	525	-	-	-	-
sec-Amyl acetate	626-38-0	125	650	-	125	650	-	-	-	-
Aniline and homologs	62-53-3	5	19	X	2	8	-	-	-	X
Anisidine (o-,p-isomers)	29191-52-4	-	0.5	-	-	0.5	-	-	-	-
Antimony and compounds (as Sb)	7440-36-0	-	0.5	-	-	0.5	-	-	-	-
ANTU (Alpha naphthylthiourea)	86-88-4	-	0.3	-	-	0.3	-	-	-	-
Arsenic, organic compounds (as As)	7440-38-2	-	0.5	-	-	0.5	-	-	-	-
Arsenic, inorganic compounds (as As); see 1910.1018	Varies with compound	-	-	-	-	-	-	-	-	-

See 1910.1018(a) for applications excluded

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**					
		PEL*		Skin Designation	TWA		STEL ^c		CEILING	
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b
Arsine	7784-42-1	0.05	0.2	-	0.05	0.2	-	-	-	-
Asbestos; see 1910.1001	Varies									
Atrazine	1912-24-9	-	-	-	-	5	-	-	-	-
Azinphos-methyl	86-50-0	-	0.2	X	-	0.2	-	-	-	X
Barium, soluble compounds (as Ba)	7440-39-3	-	0.5	-	-	0.5	-	-	-	-
Barium sulfate	7727-43-7									
Total dust		-	15	-	-	10	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-
Benomyl	17804-35-2									
Total dust		-	15	-	-	10	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-
Benzene; see 1910.1028	71-43-2	See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028 ^d								

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						
		PEL*			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Benzidine; see 1910.1010	92-87-5										
p-Benzoquinone; see Quinone											
Benzo(a)pyrene; see Coal tar pitch volatiles											
Benzoyl peroxide	94-36-0	-	5	-	-	5	-	-	-	-	-
Benzyl chloride	100-44-7	1	5	-	1	5	-	-	-	-	-
Beryllium and beryllium compounds (as Be)	7440-41-7	See Table Z-2			0.002	-	0.005 (30 min)	-	0.025	-	-
Biphenyl; see Diphenyl											
Bismuth telluride, Undoped	1304-82-1										
Total dust		-	15	-	-	15	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-
Bismuth telluride, Se-doped		-	-	-	-	5	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**					
		PEL*		Skin Designation	TWA		STEL ^C		CEILING	
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b
Borates, tetra, sodium salts										
Anhydrous	1330-43-4	-	-	-	-	10	-	-	-	-
Decahydrate	1303-96-4	-	-	-	-	10	-	-	-	-
Pentahydrate	12179-04-3	-	-	-	-	10	-	-	-	-
Boron oxide	1303-86-2									
Total dust		-	15	-	-	10	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-
Boron tribromide	10294-33-4	-	-	-	-	-	-	-	1	10
Boron trifluoride	7637-07-2	(C)1	(C)3	-	-	-	-	-	1	3
Bromacil	314-40-9	-	-	-	1	10	-	-	-	-
Bromine	7726-95-6	0.1	0.7	-	0.1	0.7	0.3	2	-	-
Bromine pentafluoride	7789-30-2	-	-	-	0.1	0.7	-	-	-	-
Bromoform	75-25-2	0.5	5	X	0.5	5	-	-	-	X
Butadiene (1,3-Butadiene)	106-99-0	1000	2200	-	In process of 6(b) rulemaking					

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation
		PEL *		TWA		STEL ^c		CEILING				
		ppm ^a	mg/m ³ ^b			ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b			
Butane	106-97-8	-	-	-	800	1900	-	-	-	-	-	
Butanethiol; see Butyl mercaptan												
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	-	200	590	300	885	-	-	-	
2-Butoxyethanol	111-76-2	50	240	X	25	120	-	-	-	-	X	
n-Butyl acetate	123-86-4	150	710	-	150	710	200	950	-	-	-	
sec-Butyl acetate	105-46-4	200	950	-	200	950	-	-	-	-	-	
tert-Butyl acetate	540-88-5	200	950	-	200	950	-	-	-	-	-	
Butyl acrylate	141-32-2	-	-	-	10	55	-	-	-	-	-	
n-Butyl alcohol	71-36-3	100	300	-	-	-	-	-	50	150	X	
sec-Butyl alcohol	78-92-2	150	450	-	100	305	-	-	-	-	-	
tert-Butyl alcohol	75-65-0	100	300	-	100	300	150	450	-	-	-	

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Design- nation	Final Rule Limits**						Skin Design- nation
		PEL*			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Butylamine	109-73-9	(C)5	(C)15	X	-	-	-	-	5	15	X
tert-Butyl chromate (as CrO ₃)	1189-85-1	-	(C)0.1	X	-	-	-	-	-	0.1	X
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270	-	25	135	-	-	-	-	-
n-Butyl lactate	138-22-7	-	-	-	5	25	-	-	-	-	-
Butyl mercaptan	109-79-5	10	35	-	0.5	1.5	-	-	-	-	-
o-sec-Butylphenol	89-72-5	-	-	-	5	30	-	-	-	-	X
p-tert-Butyltoluene	98-51-1	10	60	-	10	60	20	120	-	-	-
Cadmium fume (as Cd)	7440-43-9	See Table Z-2			In process of 6(b) rulemaking						
Cadmium dust (as Cd)	7440-43-9	See Table Z-2			In process of 6(b) rulemaking						
Calcium carbonate Total dust	1317-65-3	-	15	-	-	15	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**						
		PEL*		Skin Designation	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Calcium cyanamide	156-62-7	-	-	-	-	0.5	-	-	-	-	-
Calcium hydroxide	1305-62-0	-	-	-	-	5	-	-	-	-	-
Calcium oxide	1305-78-8	-	5	-	-	5	-	-	-	-	-
Calcium silicate	1344-95-2	-	15	-	-	15	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-
Calcium sulfate	7778-18-9	-	15	-	-	15	-	-	-	-	-
Total dust		-	5	-	-	5	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-
Camphor, synthetic	76-22-2	-	2	-	-	2	-	-	-	-	-
Caprolactam	105-60-2	-	-	-	-	1	-	3	-	-	-
Dust		-	-	-	5	20	10	40	-	-	-
Vapor		-	-	-	-	-	-	-	-	-	-
Captafol (Difolatan ^R)	2425-06-1	-	-	-	-	0.1	-	-	-	-	-
Captan	133-06-2	-	-	-	-	5	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**							
		PEL ^a		b		TWA		STEL ^c		CEILING		b	Skin Designation
		ppm ^a	mg/m ³			ppm ^a	mg/m ³	ppm ^a	mg/m ³	ppm ^a	mg/m ³		
Carbaryl (Sevin ^R)	63-25-2	-	5	-	-	5	-	-	-	-	-	-	
Carbofuran (Furadan ^R)	1563-66-2	-	-	-	-	0.1	-	-	-	-	-	-	
Carbon black	1333-86-4	-	3.5	-	-	3.5	-	-	-	-	-	-	
Carbon dioxide	124-38-9	5000	9000	-	10,000	18,000	30,000	54,000	-	-	-	-	
Carbon disulfide	75-15-0	See Table Z-2			4	12	12	36	-	-	-	X	
Carbon monoxide	630-08-0	50	55	-	35	40	-	-	200	229	-	-	
Carbon tetrabromide	558-13-4	-	-	-	0.1	1.4	0.3	4	-	-	-	-	
Carbon tetrachloride	56-23-5	See Table Z-2			2	12.6	-	-	-	-	-	-	
Carbonyl fluoride	353-50-4	-	-	-	2	5	5	15	-	-	-	-	
Catechol (Pyrocatechol)	120-80-9	-	-	-	5	20	-	-	-	-	-	X	
Cellulose	9004-34-6	-	-	-	-	-	-	-	-	-	-	-	
Total dust		-	15	-	-	15	-	-	-	-	-	-	
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-	

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**							
		PEL [*]		ppm ^a		mg/m ³ ^b	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b				ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Cesium hydroxide	21351-79-1	-	-	-	-	2	-	-	-	-	-	-	
Chlordane	57-74-9	-	0.5	X	-	0.5	-	-	-	-	-	X	
Chlorinated camphene	8001-35-2	-	0.5	X	-	0.5	-	1	-	-	-	X	
Chlorinated diphenyl oxide	55720-99-5	-	0.5	-	-	0.5	-	-	-	-	-	-	
Chlorine	7782-50-5	(C)1	(C)3	-	0.5	1.5	1	3	-	-	-	-	
Chlorine dioxide	10049-04-4	0.1	0.3	-	0.1	0.3	0.3	0.9	-	-	-	-	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	-	-	-	-	-	0.1	0.4	-	-	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	-	-	-	-	-	1	3	-	-	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	-	0.05	0.3	-	-	-	-	-	-	
Chloroacetyl chloride	79-04-9	-	-	-	0.05	0.2	-	-	-	-	-	-	
Chlorobenzene	108-90-7	75	350	-	75	350	-	-	-	-	-	-	

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**					
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING	
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b
o-Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	-	-	-	-	-	0.05	0.4
Chlorobromomethane	74-97-5	200	1050	-	200	1050	-	-	-	-
2-Chloro-1,3-butadiene; see b-Chloroprene										
Chlorodifluoromethane	75-45-6	-	-	-	1000	3500	-	-	-	-
Chlorodiphenyl (42% Chlorine) (PCB)	53469-21-9	-	1	X	-	1	-	-	-	-
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1	-	0.5	X	-	0.5	-	-	-	-
1-Chloro-2,3-epoxypropane; see Epichlorohydrin										
2-Chloroethanol; see Ethylene chlorohydrin										
Chloroethylene; see Vinyl chloride										

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL [*]			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	-	2	9.78	-	-	-	-	-
bis(Chloromethyl) ether; see 1910.1008	542-88-1										
Chloromethyl methyl ether; see 1910.1006	107-30-2										
1-Chloro-1-nitropropane	600-25-9	20	100	-	2	10	-	-	-	-	-
Chloropentafluoro-ethane	76-15-3	-	-	-	1000	6320	-	-	-	-	-
Chloropicrin	76-06-2	0.1	0.7	-	0.1	0.7	-	-	-	-	-
beta-Chloroprene	126-99-8	25	90	X	10	35	-	-	-	-	X
o-Chlorostyrene	2039-87-4	-	-	-	50	285	75	430	-	-	-
o-Chlorotoluene	95-49-8	-	-	-	50	250	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Trade Limits ^a			Skin Designation	Final Rule Limits ^{**}						Skin Designation
		PEL [*]		b		TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³			ppm ^a	mg/m ³	ppm ^a	mg/m ³	ppm ^a	mg/m ³	
2-Chloro-6-trichloro-methyl pyridine	1929-82-4	-	15	-	-	15	-	-	-	-	-	-
Total dust		-	5	-	-	5	-	-	-	-	-	-
Respirable fraction		-		-	-		-	-	-	-	-	-
Chlorpyrifos	2921-88-2	-	-	-	-	0.2	-	-	-	-	-	X
Chromic acid and chromates (as CrO ₃)	Varies with compound		See Table Z-2		-	-	-	-	0.1	-	-	-
Chromium (II) compounds (as Cr)	Varies with compound	-	0.5	-	-	0.5	-	-	-	-	-	-
Chromium (III) compounds (as Cr)	Varies with compound	-	0.5	-	-	0.5	-	-	-	-	-	-
Chromium metal (as Cr)	7440-47-3	-	1	-	-	1	-	-	-	-	-	-
Chrysene; see Coal tar pitch volatiles	218-01-9											

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation
		PEL [*]		b		TWA		SIEL ^c		CEILING		
		ppm ^a	mg/m ³			ppm ^a	mg/m ³	ppm ^a	mg/m ³	ppm ^a	mg/m ³	
Clopidol	2971-90-6											
Total dust		-	15	-	-	15	-	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-
Coal dust (less than 5% SiO ₂), Respirable quartz fraction	--		See Table Z-3			2	-	-	-	-	-	-
Coal dust (greater than or equal to 5% SiO ₂), Respirable quartz fraction	--		See Table Z-3			0.1	-	-	-	-	-	-
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	8007-45-2	-	0.2	-	-	0.2	-	-	-	-	-	-
Cobalt metal, dust, and fume (as Co)	7440-48-4	-	0.1	-	-	0.05	-	-	-	-	-	-

TABLE Z-1-A. Limits for Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation	
		PEL*		b		TWA		STEL ^c		CEILING			b
		ppm ^a	mg/m ³			ppm ^a	mg/m ³	ppm ^a	mg/m ³	ppm ^a	mg/m ³		
Cobalt carbonyl (as Co)	10210-68-1	-	-	-	-	0.1	-	-	-	-	-	-	
Cobalt hydrocarbonyl (as Co)	16842-03-8	-	-	-	-	0.1	-	-	-	-	-	-	
Coke oven emissions; see 1910.1029	--												
Copper	7440-50-8												
Fume (as Cu)		-	0.1	-	-	0.1	-	-	-	-	-	-	
Dusts and mists (as Cu)		-	1	-	-	1	-	-	-	-	-	-	
Cotton dust (raw),	--	1	-	-	1	-	-	-	-	-	-	-	
This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning, and willowing) and ginning. See also 1910.1043 for cotton dust limits applicable to other sectors.													
Crag herbicide (Sesone)	136-78-7												
Total dust		-	15	-	-	10	-	-	-	-	-	-	
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-	

TABLE 2-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation
		PEL [*]		TWA		STEL ^c		CEILING				
		ppm ^a	mg/m ³ ^b	ppm ^a		mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b		
Cresol, all isomers	1319-77-3; 95-48-7; 108-39-4; 106-44-5	5	22	X	5	22	-	-	-	-	X	
Crotonaldehyde	123-73-9; 4170-30-3	2	6	-	2	6	-	-	-	-	-	
Cruformate	299-86-5	-	-	-	-	5	-	-	-	-	-	
Cumene	98-82-8	50	245	X	50	245	-	-	-	-	X	
Cyanamide	420-04-2	-	-	-	-	2	-	-	-	-	-	
Cyanides (as CN)	151-50-8	-	5	-	-	5	-	-	-	-	-	
Cyanogen	460-19-5	-	-	-	10	20	-	-	-	-	-	
Cyanogen chloride	506-77-4	-	-	-	-	-	-	-	0.3	0.6	-	
Cyclohexane	110-82-7	300	1050	-	300	1050	-	-	-	-	-	
Cyclohexanol	108-93-0	50	200	-	50	200	-	-	-	-	X	

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**						
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Cyclohexanone	108-94-1	50	200	-	25	100	-	-	-	-	X
Cyclohexene	110-83-8	300	1015	-	300	1015	-	-	-	-	-
Cyclohexylamine	108-91-8	-	-	-	10	40	-	-	-	-	-
Cyclonite	121-82-4	-	-	-	-	1.5	-	-	-	-	X
Cyclopentadiene	542-92-7	75	200	-	75	200	-	-	-	-	-
Cyclopentane	287-92-3	-	-	-	600	1720	-	-	-	-	-
Cyhexatin	13121-70-5	-	-	-	-	5	-	-	-	-	-
2,4-D (Dichlorophenoxy-acetic acid)	94-75-7	-	10	-	-	10	-	-	-	-	-
Decaborane	17702-41-9	0.05	0.3	X	0.05	0.3	0.15	0.9	-	-	X
Demeton (Systox ^R)	8065-48-3	-	0.1	X	-	0.1	-	-	-	-	X
Dichlorodiphenyltri-chloroethane (DDT)	50-29-3	-	1	X	-	1	-	-	-	-	X

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**						
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Dichlorvos (DUPP)	62-73-7	-	1	X	-	1	-	-	-	-	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	-	50	240	-	-	-	-	-
1,2-Diaminoethane; see Ethylenediamine											
Diazinon	333-41-5	-	-	-	-	0.1	-	-	-	-	X
Diazomethane	334-88-3	0.2	0.4	-	0.2	0.4	-	-	-	-	-
Diborane	19287-45-7	0.1	0.1	-	0.1	0.1	-	-	-	-	-
1,2-Dibromo-3-chloropropane; see 1910.1044	96-12-8										
2-N-Dibutylaminoethanol	102-81-8	-	-	-	2	14	-	-	-	-	-
Dibutyl phosphate	107-66-4	1	5	-	1	5	2	10	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**					
		PEL [*]		Skin Designation	TWA		STEL ^c		CEILING	
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b
Dibutyl phthalate	84-74-2	-	5	-	-	5	-	-	-	-
Dichloroacetylene	7572-29-4	-	-	-	-	-	-	-	0.1	0.4
o-Dichlorobenzene	95-50-1	(C)50	(C)300	-	-	-	-	-	50	300
p-Dichlorobenzene	106-46-7	75	450	-	75	450	110	675	-	-
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	75-71-8	1000	4950	-	1000	4950	-	-	-	-
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5	-	0.2	-	-	0.2	-	0.4	-	-
1,1-Dichloroethane	75-34-3	100	400	-	100	400	-	-	-	-
1,2-Dichloroethylene	540-59-0	200	790	-	200	790	-	-	-	-
Dichloroethyl ether	111-44-4	(C)15	(C)90	X	5	30	10	60	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL ^a			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Dichloromethane; see Methylene chloride											
Dichloromonofluoromethane	75-43-4	1000	4200	-	10	40	-	-	-	-	-
1,1-Dichloro-1-nitroethane	594-72-9	(C) 10	(C) 60	-	2	10	-	-	-	-	-
1,2-Dichloropropane; see Propylene dichloride											
1,3-Dichloropropene	542-75-6	-	-	-	1	5	-	-	-	-	X
2,2-Dichloropropionic acid	75-99-0	-	-	-	1	6	-	-	-	-	-
Dichlorotetrafluoroethane	76-14-2	1000	7000	-	1000	7000	-	-	-	-	-
Dicrotophos	141-66-2	-	-	-	-	0.25	-	-	-	-	X
Bicyclopentadiene	77-73-6	-	-	-	5	30	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation	
		PEL*			TWA		STEL ^c		CEILING			
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b		
Dicyclopentadienyl iron Total dust Respirable fraction	102-54-5	-	15 5	-	-	10 5	-	-	-	-	-	-
Dieldrin	60-57-1	-	0.25	X	-	0.25	-	-	-	-	-	X
Diethanolamine	111-42-2	-	-	-	3	15	-	-	-	-	-	-
Diethylamine	109-89-7	25	75	-	10	30	25	75	-	-	-	-
2-Diethylaminoethanol	100-37-8	10	50	X	10	50	-	-	-	-	-	X
Diethylene triamine	111-40-0	-	-	-	1	4	-	-	-	-	-	-
Diethyl ether; see Ethyl ether												
Diethyl ketone	96-22-0	-	-	-	200	705	-	-	-	-	-	-
Diethyl phthalate	84-66-2	-	-	-	-	5	-	-	-	-	-	-
Difluorodibromomethane	75-61-6	100	860	-	100	860	-	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL*			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8	-	0.1	0.5	-	-	-	-	-
Dihydroxybenzene; see Hydroquinone											
Diisobutyl ketone	108-83-8	50	290	-	25	150	-	-	-	-	-
Diisopropylamine	108-18-9	5	20	X	5	20	-	-	-	-	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7										
Dimethoxymethane; see Methylal											
Dimethyl acetamide	127-19-5	10	35	X	10	35	-	-	-	-	X
Dimethylamine	124-40-3	10	18	-	10	18	-	-	-	-	-
Dimethylaminobenzene; see Xylidine											

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL ^a			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Dimethylaniline (N-Dimethyl-aniline)	121-69-1	5	25	X	5	25	10	50	-	-	X
Dimethylbenzene; see Xylene											
Dimethyl-1,2-dibromo- 2,2-dichlorophosphate	300-76-5	-	-	-	-	3	-	-	-	-	X
Dimethylformamide	68-12-2	10	30	X	10	30	-	-	-	-	X
2,6-Dimethyl-4-hepta- none; see Diisobutyl ketone											
1,1-Dimethylhydrazine	57-14-7	0.5	1	X	0.5	1	-	-	-	-	X
Dimethylphthalate	131-11-3	-	5	-	-	5	-	-	-	-	-
Dimethyl sulfate	17-78-1	1	5	X	0.1	0.5	-	-	-	-	X
Dinitolmide (3,5- Dinitro-o-toluidide)	148-01-6	-	-	-	-	5	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL [*]			TWA		SICL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Dinitrobenzene (all isomers)	528-29-0 99-65-0 100-25-4	-	1	X	-	1	-	-	-	-	X
Dinitro-o-cresol	534-52-1	-	0.2	X	-	0.2	-	-	-	-	X
Dinitrotoluene	121-14-2	-	1.5	X	-	1.5	-	-	-	-	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X	25	90	-	-	-	-	X
Dioxathion (DeNav)	78-34-2	-	-	-	-	0.2	-	-	-	-	X
Diphenyl (Biphenyl)	92-52-4	0.2	1	-	0.2	1	-	-	-	-	-
Diphenylamine	122-39-4	-	-	-	-	10	-	-	-	-	-
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate											
Dipropylene glycol methyl ether	34590-94-8	100	600	X	100	600	150	900	-	-	X

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**						
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Dipropyl ketone	123-19-3	-	-	-	50	235	-	-	-	-	-
Diquat	85-00-7	-	-	-	-	0.5	-	-	-	-	-
Di-sec octyl phthalate (Di-2-ethylhexyl-phthalate)	117-81-7	-	5	-	-	5	-	10	-	-	-
Disulfiram	97-77-8	-	-	-	-	2	-	-	-	-	-
Disulfoton	298-04-4	-	-	-	-	0.1	-	-	-	-	X
2,6-Di-tert-butyl-p-cresol	128-37-0	-	-	-	-	10	-	-	-	-	-
Diuron	330-54-1	-	-	-	-	10	-	-	-	-	-
Divinyl benzene	108-57-6	-	-	-	10	50	-	-	-	-	-
Emery	112-62-9	-	-	-	-	-	-	-	-	-	-
Total dust		-	15	-	-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-
Endosulfan	115-29-7	-	-	-	-	0.1	-	-	-	-	X

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						
		PEL ^a			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Endrin	72-20-8	-	0.1	X	-	0.1	-	-	-	-	X
Epichlorohydrin	106-89-8	5	19	X	2	8	-	-	-	-	X
EPN	2104-64-5	-	0.5	X	-	0.5	-	-	-	-	X
1,2-Epoxypropane; see Propylene oxide											
2,3-Epoxy-1-propanol; see Glycidol											
Ethanethiol; see Ethyl mercaptan											
Ethanolamine	141-43-5	3	6	-	3	8	6	15	-	-	-
Ethion	563-12-2	-	-	-	-	0.4	-	-	-	-	X
2-Ethoxyethanol	110-80-5	200	740	X	In process of 6(b) rulemaking						
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	100	540	X	in process of 6(b) rulemaking						

TABLE Z-1-A. Limits for Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						
		PEL ^a		mg/m ³ ^b		TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a				ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Ethyl acetate	141-78-6	400		1400	-	400	1400	-	-	-	-	-
Ethyl acrylate	140-88-5	25		100	X	5	20	25	100	-	-	X
Ethyl alcohol (Ethanol)	64-17-5	1000		1900	-	1000	1900	-	-	-	-	-
Ethylamine	75-04-7	10		18	-	10	18	-	-	-	-	-
Ethyl amyl ketone (5-Methyl-3-heptanone)	106-68-3	25		130	-	25	130	-	-	-	-	-
Ethyl benzene	100-41-4	100		435	-	100	435	125	545	-	-	-
Ethyl bromide	74-96-4	200		890	-	200	890	250	1110	-	-	-
Ethyl butyl ketone (3-Heptanone)	106-35-4	50		230	-	50	230	-	-	-	-	-
Ethyl chloride	75-00-3	1000		2600	-	1000	2600	-	-	-	-	-
Ethyl ether	60-29-7	400		1200	-	400	1200	500	1500	-	-	-
Ethyl formate	109-94-4	100		300	-	100	300	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						
		PEL [*]			TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Ethyl mercaptan	75-08-1	(C)10	(C)25	-	0.5	1	-	-	-	-	-
Ethyl silicate	78-10-4	100	850	-	10	85	-	-	-	-	-
Ethylene chlorohydrin	107-07-3	5	16	X	-	-	-	-	1	3	X
Ethylenediamine	107-15-3	10	25	-	10	25	-	-	-	-	-
Ethylene dibromide	106-93-4	See Table Z-2			In process of 6(b) rulemaking						
Ethylene dichloride	107-06-2	See Table Z-2			1	4	2	8	-	-	-
Ethylene glycol	107-21-1	-	-	-	-	-	-	-	50	125	-
Ethylene glycol dinitrate	628-96-6	(C)0.2	(C)1	X	-	-	-	0.1	-	-	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate											
Ethyleneimine; see 1910.1012	151-56-4										

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**					
		PEL *		TWA		STEL ^c		CEILING		Skin Designation	
		ppm ^a	mg/m ³ ^b			ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b		
Ethylene oxide; see 1910.1047	75-21-8	See 1910.1047(a)(2) for operations excluded									
Ethylidene chloride; see 1,1-Dichloroethane											
Ethylidene norbornene	16219-75-3	-	-	-	-	-	-	-	5	25	-
N-Ethylmorpholine	100-74-3	20	94	X	5	23	-	-	-	-	X
Fenamiphos	22224-92-6	-	-	-	-	0.1	-	-	-	-	X
Fensulfothion (Dasanit)	115-90-2	-	-	-	-	0.1	-	-	-	-	-
Fenthion	55-38-9	-	-	-	-	0.2	-	-	-	-	X
Ferbam	14484-64-1										
Total dust		-	15	-	-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-
Ferrovanadium dust	12604-58-9	-	1	-	-	1	-	3	-	-	-
Fluorides (as F)	Varies with compound	See Table Z-2			2.5	-	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Final Rule Limits**						
		PEL ^a		Skin Designation	TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Fluorine	7782-41-4	0.1	0.2	-	0.1	0.2	-	-	-	-	-
Fluorotrichloromethane (Trichlorofluoromethane)	75-69-4	1000	5600	-	-	-	-	-	1000	5600	-
Fonofos	944-22-9	-	-	-	-	0.1	-	-	-	-	X
Formaldehyde; see 1910.1048;	50-00-0	See Table Z-2 for operations or sectors excluded or for which limit(s) is(are) stayed.									
Formamide	75-12-7	-	-	-	20	30	30	45	-	-	-
Formic acid	64-18-6	5	9	-	5	9	-	-	-	-	-
Furfural	98-01-1	5	20	X	2	8	-	-	-	-	X
Furfuryl alcohol	98-00-0	50	200	-	10	40	15	60	-	-	X
Gasoline	8006-61-9	-	-	-	300	900	500	1500	-	-	-
Germanium tetrahydride	7782-65-2	-	-	-	0.2	0.6	-	-	-	-	-

TABLE Z-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						
		PEL [*]		Skin Designation		TWA		STEL ^c		CEILING		Skin Designation
		ppm ^a	mg/m ³ ^b			ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
Glutaraldehyde	111-30-8	-	-	-	-	-	-	-	-	0.2	0.8	-
Glycerin (mist)	56-81-5	-	-	-	-	-	-	-	-	-	-	-
Total dust		-	15	-	-	10	-	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-
Glycidol	556-52-5	50	150	-	25	75	-	-	-	-	-	-
Glycol monoethyl ether; see 2-Ethoxyethanol												
Grain dust (oat, wheat, barley)	—	-	-	-	-	10	-	-	-	-	-	-
Graphite, natural respirable dust	7782-42-5	See Table Z-3			-	2.5	-	-	-	-	-	-
Graphite, synthetic	--											
Total dust		-	15	-	-	10	-	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-
Guthion ^R ; see Azinphos methyl												

TABLE Z-1-A. Limits for Air Contaminants

Substance	CAS No.	Transitional Limits			Skin Designation	Final Rule Limits**						Skin Designation	
		PEL*		ppm ^a		mg/m ³ ^b	TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b				ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a		mg/m ³ ^b
Gypsum	7778-18-9												
Total dust		-	15	-	-	15	-	-	-	-	-	-	-
Respirable fraction		-	5	-	-	5	-	-	-	-	-	-	-
Hafnium	7440-58-6	-	0.5	-	-	0.5	-	-	-	-	-	-	-
Heptachlor	76-44-8	-	0.5	X	-	0.5	-	-	-	-	-	X	X
Heptane (n-Heptane)	142-82-5	500	2000	-	400	1600	500	2000	-	-	-	-	-
Hexachlorobutadiene	87-68-3	-	-	-	0.02	0.24	-	-	-	-	-	-	-
Hexachlorocyclopentadiene	77-47-4	-	-	-	0.01	0.1	-	-	-	-	-	-	-
Hexachloroethane	67-72-1	1	10	X	1	10	-	-	-	-	-	X	X
Hexachloronaphthalene	1335-87-1	-	0.2	X	-	0.2	-	-	-	-	-	X	X
Hexafluoroacetone	684-16-2	-	-	-	0.1	0.7	-	-	-	-	-	X	X
n-Hexane	110-54-3	500	1800	-	50	180	-	-	-	-	-	-	-
Hexane isomers	Varies with compound	-	-	-	500	1800	1000	3600	-	-	-	-	-

TABLE 2-1-A. Limits For Air Contaminants

Substance	CAS No.	Transitional Limits		Skin Designation	Final Rule Limits**						Skin Designation
		PEL*			TWA		STEL ^c		CEILING		
		ppm ^a	mg/m ³ ^b		ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	ppm ^a	mg/m ³ ^b	
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	-	5	20	-	-	-	-	-
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	-	50	205	75	300	-	-	-
sec-Hexyl acetate	108-84-9	50	300	-	50	300	-	-	-	-	-
Hexylene glycol	107-41-5	-	-	-	-	-	-	-	25	125	-
Hydrazine	302-01-2	1	1.3	X	0.1	0.1	-	-	-	-	X
Hydrogenated terphenyls	61780-32-7	-	-	-	0.5	5	-	-	-	-	-
Hydrogen bromide	10035-10-6	3	10	-	-	-	-	-	3	10	-
Hydrogen chloride	7647-01-0	(C)5	(C)7	-	-	-	-	-	5	7	-
Hydrogen cyanide	74-90-8	10	11	X	-	-	4.7	5	-	-	X
Hydrogen fluoride (as F)	7664-39-3	See Table 2-2		-	3	-	6	-	-	-	-

IPEL & STEL LEVELS FOR PRODUCTS IN DERIVATIVES

<u>PRODUCT</u>	<u>PPM (VOL.)</u>	
	<u>IPEL</u>	<u>STEL</u>
ETHYL CHLORIDE (EC)	200	375
ETHYLENE DICHLORIDE (EDC)	1	2
METHYLCHLOROFORM (MC)	350	450
PERCHLOROETHYLENE (PER)	25	100
TRICHLOROETHYLENE (TRI)	50	200
VINYLDENE CHLORIDE (VDC)	1	10
1,1 DICHLOROETHANE (DCE)	10	25

SYSTEM ELEMENTS:

TANK OR VESSEL TO CLEAR (CONTAMINATED WITH ORGANICS)
UTILITIES LIKE N2, STEAM, AIR (ENERGY CARRIERS)
MEANS TO DO IT (ENGINEERING CONTROLS)
PEOPLE (WITHOUT THEM, NOTHING CAN BE ACCOMPLISH AND THE
INVESTMENT IS WASTED)
TIME (WE HAVE A LIMITED TIME TO DO THE JOB)

- 2) GATHER THE ENGINEERING DESIGN DATA OF THE DERIVATIVES
PROCESS EQUIPMENT: PRESSURE & TEMPERATURE RATING AND IF
THE EQUIPMENT IS RATED FOR VACUUM. THIS DATA WILL
EVENTUALLY HELP US IN DETERMINING WHAT WE CAN OR CAN NOT
DO TO CLEAR THE EQUIPMENT OF ORGANICS SO MAINTENANCE CAN
WORK ON.
- 3) TESTING & EXPERIMENTATION: A GROUP OF PEOPLE FROM
OPERATIONS, ENGINEERING, LAB, ENVIRONMENTAL, INDUSTRIAL
HYGIENIST, ETC. WAS ASSEMBLED TO CONSIDER OPTIONS ON HOW
WE ARE GOING TO ACHIEVE THE GOALS SET BY THE RULES &
REGULATIONS. CONSIDERATION WAS GIVEN TO HOW LIKELY WILL
WE BE ABLE UTILIZE A PARTICULAR CLEARING PROCEDURE. ARE
WE GOING TO CREATE ADDITIONAL PROBLEMS? IS THE VESSEL
RATED TO UNDERGO THE PROCEDURE? THESE AND OTHER QUESTIONS
WERE CONSIDERED IN THIS PHASE. PRELIMINARY SOP'S WERE
PREPARED. THESE WILL BE UTILIZED AS BLUEPRINTS FOR
THE SPECIFIC SOP'S.
- 4) AFTER EXPERIMENTATION, SORTING OUT PROS & CONS, THE WAYS
TO CLEAR EQUIPMENT ARE: HOT N2 PURGING, STEAMING (FOLLOWED
BY DRYING), WATER WASHING, VACUUM. IN SOME CASES, WE WILL
END UP UTILIZING MORE THAN ONE PROCEDURE. FOR EXAMPLE,
HOT N2 FOLLOWED BY STEAMING.

REMARKS:

- 1) THIS IS AN EXPENSIVE PROPOSITION THAT WE NEED TO
COMPLY. CONSIDERABLE EFFORT IS BEING PUT TOGETHER TO
COMPLY WITH THE REGULATION.
- 2) EVERYBODY'S COOPERATION IS NEEDED TO MAKE THIS A
SUCCESSFUL EFFORT. THE PEOPLES ELEMENT IS PROBABLY
THE MOST IMPORTANT IN ALL THIS PROJECT.
- 3) THINGS WILL NOT GET EASIER FROM THE REGULATORY ARENA,
SO IT IS SAFE TO ASSUME THAT MORE IS TO COME.
HOWEVER, WE WILL HAVE THE DETERMINATION TO OVERCOME
THEM AS THEY SHOW UP.

TE-II SAFETY MEETING: EDC IPEL EQUIPMENT CLEARING

IPEL REGULATION: OSHA RULE 1910.1000

THE REGULATION MANDATES LOWER PERSONNEL EXPOSURE LIMITS TO EDC & OTHER CHEMICALS IN DERIVATIVES. THE REGULATION IS IN EFFECT NOW WITH A PROVISION WHICH ALLOWS WORKERS TO BE IN AREAS THAT MAY EXCEED THE NEW STANDARD IF THEY USE RESPIRATORY PROTECTIVE EQUIPMENT. THE RULE REQUIRES THAT ENGINEERING CONTROLS BE INSTALLED TO ACHIEVE COMPLIANCE WITH THE PERSONNEL EXPOSURE STANDARDS WITHOUT THE NEED OF RESPIRATORY PROTECTIVE EQUIPMENT. BY THE END OF THIS YEAR, MAY BE NEXT YEAR

EXPOSURE LIMITS @ TE-II:

	<u>TWA</u>	<u>STEL</u>
VC	1	5
EDC	1	2
DCE	10	25
MC	350	450

THIS IS WHAT WE NEED TO ACHIEVE. THE ONLY WAY WE WILL BE ABLE TO ACCOMPLISH THIS TASK IS BY THE DEDICATION OF ALL OF US IN TAKING CARE THE ENGINEERING CONTROLS THAT ARE IN THE PROCESS OF DESIGN AND PROCUREMENT ARE PROPERLY USED. COMMON-SENSE WORKING PRACTICES WILL GO A LONG WAY IN THIS EFFORTS, TOO.

HOW TO DEAL WITH THIS PROJECT: (Derivative wide project).

- A) SORTED OUT THE CLEAR MANDATED CATEGORIES OF THE OSHA RULE. THIS INCLUDE PUMPS, COMPRESSORS, PRESSURE RELIEVES IN GAS & LIQUID SERVICES, CLOSED LOOP SAMPLING, OPEN LINES, VALVES, AND PROCESS EQUIPMENT CLEARING.
- B) DIVIDED THE PROJECT IN TWO PHASES FOR IMPLEMENTATION. PHASE I DEALS WITH THE PUMPS, COMPRESSORS, PRESSURE RELIEF DEVICES IN GAS SERVICE (LOW PRESSURE TANKS), SMALL VESSEL CLEARING, AND SAMPLING. THIS PHASE IS IN THE PROCESS OF BEING IMPLEMENTED. ACT Approved.
- C) PHASE II DEALS PRIMARILY WITH PROCESS EQUIPMENT CLEARING. DISTILLATION COLUMNS, TANKS, HEAT EXCHANGERS, REACTORS, ETC. THIS PHASE IS IN THE DETAIL ENGINEERING DESIGN. For Cost Estimate. ACT for Approval will follow.

PROCESS ENGINEERING APPROACH:

- (What is all about)
- 1) MAIN GOAL IS TO DRIVE OUT THE ORGANICS OUT OF A VESSEL OR TANK. THE CONSTRAINS ARE: MEET OR EXCEED THE PERSONNEL EXPOSURE STANDARDS SET BY OSHA, AND COMPLY WITH OTHER ENVIRONMENTAL RULES AND REGULATIONS LIKE THE IMPENDING CLEAN AIR ACT. NOT AN EASY TASK, BUT IF WE WANT TO STAY IN BUSINESS, WE NEED TO COMPLY WITH THEM.