NIOSH Testimony to DOL

TESTIMONY OF THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH ON THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION'S PROPOSED RULE ON AIR CONTAMINANTS

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I am Richard A. Lemen, Director of the Division of Standards Development and Technology Transfer (DSDTT) of the National Institute for Occupational Safety and Health (NIOSH). With me today are senior staff from NIOSH research divisions, each of whom has expertise in various aspects of this rulemaking. Our purpose for appearing at this hearing is to support the Occupational Safety and Health Administration's (OSHA's) efforts to promulgate a new standard. NIOSH may make comments or recommendations in addition to those contained in this testimony, based upon other information presented during this hearing.

I want to take this opportunity to commend OSHA for embarking upon this rulemaking effort. This comprehensive updating of the Z-Tables will directly influence the health of all American workers. NIOSH strongly supports OSHA in its desire to make the air contaminant standards consistent with the most current information. We agree that there is an urgent need to update the current air contaminant standards because they represent exposure limits based on data available prior to 1968. Current information on health effects indicates that more protective limits are required for many substances. Even though NIOSH will question some of the specific Permissible Exposure Limits (PELs) that have been proposed, NIOSH does not question the wisdom of this rulemaking. Although NIOSH will suggest that some proposed PELs are not optimal, NIOSH nevertheless advocates adoption of more protective PELs. Even if some PELs are less protective than NIOSH might prefer, the overall impact of this Z-Table update represents a significant advance for worker safety and health. On the other hand, it should be clearly understood by all that this rulemaking is an exceptional event made necessary by the passage of 20 years without significant reevaluation of the standards contained in the Z-Tables. This should in no way impede vigorous action in the future to promulgate comprehensive standards as specified under Section 6(b) of the Occupational Safety and Health Act. Instead this should serve as an impetus to proceed more swiftly and efficiently with comprehensive standards.

NIOSH has transmitted to the Department of Labor 129 Criteria Documents and 50 Current Intelligence Bulletins (CIBs) (of these, one Criteria Document and one CIB were transmitted after this rulemaking was initiated). NIOSH Criteria Documents and CIBs are unparalleled in terms of the amount of information considered, the detail to which that information is examined, the extent to which evaluations are subjected to external peer review prior to publication, and the care with which those evaluations are explained in the published recommendation. It is important that the record is clear on what a NIOSH Criteria Document represents in this regard.

Criteria Documents are based on comprehensive reviews of the world's scientific literature. They routinely cite over 100 references and many cite several hundred. NIOSH does not rely upon information that

cannot be made public. Critical evaluations of cited references with detailed discussions of their implications are included in Criteria Documents to provide the reader with an appreciation of their strengths, their weaknesses, and a clear description of how NIOSH interprets these publications. By this method, the reader has enough information to reach independent conclusions regarding these cited reports. Each draft Criteria Document is reviewed by experts representing affected industries, organized labor, and trade or professional organizations, and by scientists, physicians, and other health professionals with related experience in academia, government, or industry. The number of these external peer reviewers normally is greater than 10 and often exceeds twice that number. In addition to the invaluable contribution their comments make to the completed Criteria Document, OSHA receives, along with the completed Criteria Document, the full text of each reviewer's written comments accompanied by itemized annotations indicating how the draft was modified in response, or providing the rationale if the comment or recommendation was not adopted. Each Criteria Document contains an extensive summary in which the basis for the Recommended Exposure Limit (REL) is carefully developed with clear and explicit citation of the data relied upon at all steps of the logical development. No other source of exposure limits approximates the comprehensiveness of these documents.

NIOSH recommends that the chemical universe defined for the present rulemaking include all chemicals covered by NIOSH RELs. We recognize the practical necessity for OSHA to limit the universe of chemicals subject to this rulemaking, but as noted by OSHA in its preamble, there are relatively "few instances" of substances with a NIOSH REL but no threshold limit value (TLV®). Including these substances would not significantly affect the "boundary on the number of substances to be evaluated," a concern expressed by OSHA in the notice for proposed rulemaking. NIOSH Table N5 (Appendix A) lists these 42 chemicals excluded up to now from the Z-Table update. If these are not added to the current update, they should be targeted for priority rulemaking to begin immediately upon completion of the present effort.

For a large number of the chemicals covered by this rulemaking (277 to be exact), NIOSH concurs with the PEL being proposed by OSHA. These chemicals are listed in NIOSH Table N1 (Appendix A). For them, the available documentation appears to support the proposed exposure limits as adequate to protect workers from recognized health hazards.

NIOSH questions the proposed PELs for the 31 chemicals listed in Table N2. They are:

1) Acrylic acid (HS 1009)
2) n-Butyl glycidyl ether (BGE) (HS 1052)
3) Camphor, synthetic (HS 1063)
4) Caprolactam vapor (HS 1065)

5) Coal dust (<5% quartz) (HS 1096)
6) Coal dust (>5% quartz) (HS 1097)
7) Disulfoton - skin (HS 1152)
8) Ethyl bromide (HS 1163)
9) Ethyl ether (HS 1164)
10) Ethylene glycol vapor (HS 1169)
11) Fenthion - skin (HS 1175)
12) Fluorine (HS 1179)
13) Formamide (NIC - skin) (HS 1182)
14) Furfural - skin (HS 1183)
15) Heptane (n-Heptane) (HS 1194)
16) Hexane isomers (HS 1201)
17) 2-Hexanone (Methyl n-butyl ketone) (HS 1202)
18) Isopropoxyethanol (HS 1223)
19) Isopropyl acetate (HS 1224)
20) Isopropylamine (HS 1228)
21) Manganese tetroxide (HS 1238)
22) Mesityl oxide (HS 1243)
23) Octane (HS 1296)
24) Ozone (HS 1301)
25) Pentane (HS 1306)
26) 2-Pentanone (methyl propyl ketone) (HS 1307)
27) Silica--Amorphous (diatomaceous earth) (HS 1352)
28) m-Toluidine - skin (HS 1401)
29) Triethylamine (HS 1408)
30) Vinyl acetate (HS 1424)
31) Zirconium compounds, as Zr (HS 1439)

Examples of reasons for NIOSH's concern for the chemicals from NIOSH Table N2 are given for the following 2 substances.

1. Ethylene Glycol (EG)

OSHA currently does not have a PEL and proposes a 50 ppm ceiling as the new PEL as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). In the NIOSH review of EG, we have found that positive rat and mouse teratogenicity for oral administration of EG has been reported by Lamb et al. [1985], Price et al. [1985], and Hardin et al. [1987]. The summary statement by C. Price is germane to OSHA's consideration of PELs:

> "The lack of apparently serious maternal effects at the lowest dose which produced malformation in both species, as well as the severity and frequency of fetal defects at higher doses, suggest that EG may carry a selective risk to the embryo and should be considered a potential development hazard in situations where major EG exposure is likely to occur."

The interpretation of the human (volunteers) inhalation exposure study by Wills et al. [1974], as indicating a 50 ppm ceiling (125 mg/m^3) TLV, is questioned. Review of the reported study indicates the most common complaint was irritation of the upper respiratory tract during the 30-day, 20-22 hours per day exposures at mean daily concentrations ranging from 3 to 67 mg/m^3 (1.4-27 ppm) and the irritative phenomena became common when the concentration was raised to about 140 mg/m^3 (56 ppm). Despite the significantly erratic exposure concentrations during the 30 days of "continuous" exposure, the reported irritation would indicate that a 50 ppm limit does not offer sufficient protection from respiratory irritation. The potential teratogenicity and the known respiratory irritation at the proposed level suggests that OSHA should reconsider their proposed PEL.

In addition, the OSHA Summary of Toxicology should be corrected to read for the Wills et al. study [page 21035 of the Federal Register notice, 2nd column, 19 lines from the top]: "In a human inhalation study, Wills and colleagues [1974] reported that volunteers exposed to the aerosol from 20 to 22 hours per day for 4 weeks, at mean daily concentrations between 3 and 67 mg/m^3 (1.4-27 ppm) complained of throat irritation, and on occasion mild headache and lower back pain."

2. Ethyl Ether

OSHA proposes to add a short-term exposure limit (STEL) to their current PEL of 400 ppm for Ethyl Ether. The current PEL is the same as the ACGIH TLV and the STEL of 500 ppm is also recommended by ACGIH. ACGIH set a TLV of 400 ppm time-weighted average (TWA) and a 500 ppm STEL based upon workers developing a tolerance to irritation at that level [ACGIH 1986]. Nelson et al. [1943] tested human subjects for a period of 3 to 5 minutes for sensory responses to ethyl ether and reported, "Complaints of nasal irritation began at 200 ppm. Three hundred was objectionable as a working atmosphere." It was further suggested that 100 ppm was the highest concentration which the majority of subjects estimated satisfactory for 8-hour exposure and 200 ppm was a level which produced nasal irritation in a majority of subjects. Nelson stated that the study reported is "not sufficient" to act as a basis for new limits. However, it would appear that a 400 ppm TWA may protect workers from systemic effects, but would not prevent irritation to some individuals.

The concerns for the remaining 29 substances on NIOSH Table N2 have been submitted to the docket with NIOSH's written testimony.

Some of the chemicals in the universe defined by the 1986 ACGIH TLV list have been excluded from this rulemaking by OSHA for a variety of reasons. NIOSH concurs with OSHA's determination on 127 substances

listed in NIOSH Table N3A (Appendix A) as not needing further revisions based on available data, but believes that those listed in NIOSH Table N3B (Appendix A) should be included in this rulemaking. NIOSH has identified 9 chemicals in NIOSH Table N3B which are of concern. They are:

1) Acetylene tetrabromide (HS None)
2) Chlorobenzene (HS None)
3) Chromium (II) compounds, as Cr (insoluble) (HS None)
4) Chromium (III) compounds, as Cr (insoluble) (HS None)
5) Cresol, all isomers - skin (HS None)
6) Manganese dust & compounds (HS None)
7) Molybdenum, as Mo (soluble compounds) (HS None)
8) Nitromethane (HS None)
9) Parathion - skin (HS None)

Cresol will serve as an example of NIOSH's concern. The OSHA PEL and the ACGIH TLV [ACGIH 1986] for cresol both have identical exposure limits of 5 ppm (22 mg/m^3), TWA, with a skin notation; therefore, this chemical is not being considered for revision. However, NIOSH has established an REL of 2.3 ppm (10 mg/m^3), TWA, which should be considered in the revision of the OSHA standards. In 1952, ACGIH established a 5 ppm TWA based on an analogy with phenol [ACGIH 1986]. The toxicity of cresol compared to phenol was considered in two studies [Fairhall 1957; Hamilton et al. 1949]. It was believed the 5 ppm level would protect against irritation, and kidney and liver damage.

NIOSH [1978] established an REL of 2.3 ppm (TWA). NIOSH reported that although the data indicates similarities in toxicity between cresol and phenol when they are given by several routes of exposure, other evidence suggests that cresol is more toxic by inhalation [Uzhdavini et al. 1972]. The findings of Deichmann et al. [1963] agreed with Uzhdavini concerning the adverse effects of cresol below 20 mg/m^3. The NIOSH REL is more protective than the current OSHA PEL or TLV.

NIOSH's concerns for the other 8 substances are attached to our written comments and are in the OSHA docket.

In NIOSH Table N4 (Appendix A), NIOSH has identified 48 substances which OSHA is proposing to regulate as nuisance dusts. OSHA is proposing PELs for 47 substances (Table C10-1) that are currently regulated by OSHA's PEL for nuisance dust (15 mg/m^3 for total dust and 5 mg/m^3 for respirable dust). The proposed PELs are 5 mg/m^3 for fibrous glass dust and 10 mg/m^3 for the remaining 46 substances. The 10-mg/m^3 PELs are based on the TLVs established for these substances by ACGIH. Exposure to these substances is considered to cause adverse "nuisance" effects, including interference with vision, irritation of the upper respiratory tract and skin, and deposits of these substances in the eyes, ears, and nasal passages. Reactions of lung tissue to these substances are considered to be reversible when exposure ceases.

NIOSH has conducted a limited evaluation of the literature on the 48 substances in Table N4, and has concluded that the documentation cited by OSHA is inadequate to support the proposed PEL of 10 mg/m^3 for many of the substances. Recent toxicologic and exposure data indicate that exposure to some of these substances may cause cancer or other serious adverse health effects. Adherence to the proposed PEL of 10 mg/m^3 (total dust) would not prevent the toxicologic effects associated with many of these substances. NIOSH is therefore concerned that it is misleading to apply the term "nuisance dust" to such substances.

NIOSH is also concerned that total dust exposure may be an inappropriate criterion for assessing the relationship between exposure and effect. The 48 substances considered here are present in many occupational environments within a respirable size range, and the respiratory system is therefore the most likely route of exposure. However, differences in particle morphology and size affect pulmonary defense mechanisms differently. Furthermore, solubility and pH must be determined to assess the effects of some substances on the mucous membranes. All of the characteristics of a substance need to be assessed when determining its potential toxicity. For substances that typically become airborne in the workplace as respirable particulates, a PEL based on the respirable fraction of the substance would be warranted. Substances that exhibit a toxic effect upon contact with mucous membranes may more appropriately require exposure limits for both total and respirable particulates.

NIOSH is further concerned that exposure to several of the substances listed in Table C10-1 may involve concomitant exposure to free silica, which may cause silicosis or lung cancer. OSHA has proposed that the PEL for these substances be applied only when the quartz content is less than 1 percent. This criterion may understate the risk of airborne exposure to quartz, since the percentage of quartz is typically determined by analysis of the raw material or of the settled dust and not by analysis of airborne samples. Airborne samples should be collected and analyzed for free silica whenever workers are exposed to quartz or to any of the substances associated with free silica. Exposure to free silica should be limited to concentrations below the NIOSH REL of 50 ug/m^3.

NIOSH is particularly concerned that toxicologic evidence demonstrates a relationship between exposure to certain substances listed in Table C10-1 and chronic respiratory disease, including cancer. Clear evidence of chronic respiratory disease has been observed in workers exposed to various types of mineral fibers [Walton 1987]. Enterline et al. [1987] reported a statistically significant risk of lung cancer in workers exposed to glass and mineral-wool fibers. This risk of cancer was also observed in animals [Stanton et al. 1980] when fibers with various physical and chemical characteristics were implanted in the pleurae of rats. The ability of these fibers to induce cancer was

discovered to be related to the length and diameter of the fibers and not to their chemical compositions. Rats dosed with fibrous glass, aluminum oxide, and silicon carbide exhibited a carcinogenic response similar to that of rats dosed with asbestos.

The NIOSH evaluation of data on titanium dioxide indicates a risk of cancer from exposure. The incidence of tumors observed in animals exposed to titanium dioxide meets the OSHA criterion for potential occupational carcinogens (29 CFR 1990.103). Other data evaluated by NIOSH indicate that benomyl exposure may cause adverse reproductive effects and that magnesium oxide exposure may cause chronic respiratory disease. NIOSH has included pertinent literature on these substances as part of its submission, and OSHA should consider it in this rulemaking.

Having selected the TLV list as the universe to be considered, OSHA frequently limits its consideration of health effects to those that the ACGIH considered when establishing the TLV. The full range of available toxicologic, epidemiologic, and exposure information should be considered for all chemicals in the universe selected. The need to do so is most evident for chemicals that NIOSH and others consider to be carcinogenic. For a large number of these chemicals, OSHA proposes to establish a PEL without identifying the chemical as a potential occupational carcinogen. In some cases, OSHA acknowledges without comment the conclusion by NIOSH or others that these chemicals are potential occupational carcinogens, but still does not so designate those chemicals. In some cases the limits proposed for adoption were based on carcinogenicity; in other cases they were based on other acute or chronic health effects. Even if OSHA chooses not to accept NIOSH recommendations that occupational exposure to carcinogens should be restricted to the lowest feasible level, OSHA should designate these chemicals as potential occupational carcinogens because these chemicals meet the criteria for carcinogenicity as established by OSHA [29 CFR 1990.103]. Chemicals that should be designated as potential occupational carcinogens are listed in NIOSH Tables N6A and N6B (Appendix A) and have been submitted to the OSHA docket with our written testimony. On Table N6A, NIOSH has identified 39 substances which have proposed PELs that NIOSH can agree with, but for which a carcinogen designation should be added to the PEL. The chemicals are:

1) Acrylamide - skin (HS 1008)
2) Aldrin - skin (HS None)
3) Amitrole (HS 1020)
4) Aniline & homologues - skin (HS 1025)
5) Anisidine (o-, p-isomers) - skin (HS None)
6) Captafol - skin (HS 1066)
7) Captan (HS 1067)
8) Carbon tetrachloride - skin (HS 1073)
9) Chlordane - skin (HS None)
10) Chloroform (HS 1086)

11) Dichloroacetylene (HS 1123)
12) Dichloroethyl ether - skin (HS 1127)
13) Dichloropropene - skin (HS 1129)
14) Dieldrin - skin (HS None)
15) Diglycidyl ether (DGE) (HS 1139)
16) Dimethyl sulfate - skin (HS 1142)
17) Dinitrotoluene - skin (HS None)
18) Dioxane - skin (HS 1145)
19) Di-sec-octyl phthalate (HS 1116)
20) Ethylene dichloride (HS 1168)
21) Heptachlor - skin (HS None)
22) Hexachlorobutadiene - skin (HS 1195)
23) Hexachloroethane - skin (HS 1197)
24) Hexamethyl phosphoramide (HS None)
25) Methyl iodide - skin (HS 1259)
26) Nickel carbonyl (as Ni) (HS 1284)
27) Propylene imine - skin (HS None)
28) Silica - crystalline (cristobalite) (HS 1354)
29) Silica - crystalline (tridymite) (HS 1356)
30) 1,1,2,2-Tetrachloroethane - skin (HS 1385)
31) Toluene-2,4-diisocyanate (TDI) (HS 1398)
32) o-Toluidine - skin (HS 1399)
33) 1,1,2-Trichloroethane (HS None)
34) Trichloroethylene (HS 1406)
35) 1,2,3-Trichloropropane - skin (HS 1407)
36) Uranium (insoluble compounds, as U) (HS 1418)
37) Uranium (soluble compounds, as U) (HS 1419)
38) Vinyl cyclohexene dioxide (HS 1426)
39) Wood dust (hard wood) (HS 1430A)

There are 53 chemicals on NIOSH Table N6B that not only should be designated as carcinogens, but for which there remains a substantial level of risk at the proposed PEL. The substances are:

1) Acetaldehyde (HS 1001)
2) Arsine (HS None)
3) Asphalt (petroleum) fumes (HS 1028)
4) Benzo(a)pyrene (HS None)
5) Beryllium & compounds, as Be (HS 1033)
6) tert-Butyl chromate, as CrO3 - skin (HS None)
7) Carbon black (HS None)
8) Chlorinated camphene - skin (HS 1078)
9) Chlorodiphenyl (42% chlorine) - skin (HS None)
10) Chlorodiphenyl (54% chlorine) - skin (HS None)
11) Chromic acid and chromates (HS 1092)
12) Chromite ore processing (chromates), as Cr (HS None)
13) Chromium (VI) compounds, Cr (water soluble) (HS None)
14) Chromium (VI) compounds, Cr (certain water insoluble) (HS None)
15) Chromyl chloride (HS 1094)
16) Chrysene (HS None)

17) Coal tar pitch volatiles, as benzene solubles (HS None)
18) DDT (Dichlorodiphenyl-trichloroethane) (HS 1113)
19) p-Dichlorobenzene (HS 1125)
20) Dimethyl carbamoyl chloride (HS None)
21) 1,1-Dimethylhydrazine - skin (HS None)
22) Epichlorohydrin - skin (HS 1158)
23) Ethyl acrylate - skin (HS 1161)
24) Ethyl chloride (HS None)
25) Gasoline (HS 1185)
26) Hydrazine - skin (HS 1205)
27) Lead chromate (as Cr) (HS None)
28) Methyl bromide - skin (HS 1253)
29) Methyl chloride (HS 1254)
30) Methyl hydrazine - skin (HS None)
31) 4,4'Methylene bis(2-chloroaniline) - skin (HS 1273)
32) Nickel (soluble [or inorganic] compounds as Ni) (HS 1283)
33) Nickel sulfide roasting, fume & dust (as Ni) (HS None)
34) p-Nitrochlorobenzene (HS 1288)
35) 2-Nitropropane (HS 1291)
36) Perchloroethylene (HS 1308)
37) N-Phenyl-beta-naphthylamine (HS None)
38) Phenyl glycidyl ether (PGE) (HS 1315)
39) Phenylhydrazine - skin (HS 1317)
40) Propane sultone (HS None)
41) Propylene dichloride (HS 1341)
42) Propylene oxide (HS 1344)
43) Rosin core solder pyrolysis products, as formaldehyde (HS 1350)
44) Silica--Crystalline (quartz) (HS 1355)
45) Silica--Crystalline (tripoli) (HS 1357)
46) Silica--Crystalline (fused) (HS 1358)
47) o-Tolidine - skin (HS None)
48) p-Toluidine - skin (HS 1400)
49) Vinyl bromide (HS 1425)
50) Vinylidene chloride (HS 1428)
51) Welding fumes (HS 1430)
52) Wood Dust (soft wood) (HS 1430b)
53) Zinc chromate, as Cr (HS 1436)

Some chemicals on NIOSH Tables N6A and N6B have been excluded from this rulemaking by OSHA as is evident from their lack of a HS number. However, NIOSH concludes that OSHA should include these chemicals in this rulemaking.

On NIOSH Table N7, NIOSH has identified 15 substances for which OSHA intends to adopt a TWA instead of the recommended NIOSH Ceiling Value. NIOSH recommends that OSHA adopt the NIOSH Ceiling Values to provide the most appropriate degree of health protection. These substances are:

1) Butyl mercaptan (HS 1054)
2) Benzyl chloride (HS None)
3) Cyanides (as CN) - skin (potassium cyanide) (HS None)
4) Cyanides (as CN) - skin (sodium cyanide) (HS None)
5) Hydrogen sulfide (HS 1209)
6) Hydroquinone (HS None)
7) Isopropyl glycidyl ether (IGE) (HS 1227)
8) Methyl chloroform (HS 1255)
9) Methyl mercaptan (HS 1263)
10) Petroleum distillates (naphtha; rubber solvent) (HS 1312)
11) Phenol - skin (HS None)
12) Phenyl mercaptan (HS 1316)
13) Phosgene (HS None)
14) Vanadium (as V205) - respirable dust fume (HS 1421)
15) Vanadium (as V205) - fume (HS 1422)

Turning now to the specific questions posed in the NPRM:

1. **Are substances included which should be excluded from this rulemaking?**

   No. On the contrary, substances were excluded which should have been included. Immediately upon completion of this rulemaking, OSHA should take action to establish PELs for all substances that are excluded from this rulemaking despite the existence of a formal NIOSH recommendation to OSHA. As a first step, OSHA should initiate consolidated rulemaking similar to the present Z-Table update to adopt all NIOSH RELs pending chemical-specific Section 6(b) rulemaking to establish comprehensive standards.

2. **Is additional health and feasibility documentation available relative to the proposed PELs beyond that described in the preamble?**

   Yes. OSHA has frequently limited itself to the documentation used by the ACGIH in support of TLVs. Whenever available, NIOSH Criteria Documents, Current Intelligence Bulletins, and Alerts should be considered by OSHA in its final rulemaking. For many of the chemicals, substantial databases are available from other governments (e.g., Germany, the United Kingdom, Sweden), as well as from organizations such as the International Labor Organization, the American Industrial Hygiene Association, the Nordic Expert Group for Documentation of Occupational Exposure Limits, and the National Library of Medicine. A large number of National Cancer Institute (NCI), National Toxicology Program (NTP), and International Research on Cancer (IARC) monographs on chronic bioassay reports are available that provide extensive information on acute and chronic systemic toxicity in addition to data on potential carcinogenicity.

As part of this response, NIOSH is providing a chemical-by-chemical discussion with citations of the most pertinent supporting data that could be identified within the time limitations. For chemicals included in the PEL update, copies have been submitted to the docket of all pertinent NIOSH Health Hazard Evaluations (HHEs), as well as all citations for toxicity contained in the NIOSH Registry of Toxic Effects of Chemical Substances (RTECS). These data are collected as mandated by Section 20(a)(6) of the Occupational Safety and Health Act of 1970 (PL 91-596). These data are publicly available and will assist OSHA in fulfilling its obligation under the Occupational Safety and Health Act to consider "the latest available scientific data in the field." NIOSH has not attempted to provide OSHA with the other elements the Act requires OSHA to consider, namely, "...the feasibility of the standards, and experience gained under this and other health and safety laws." The HHE reports will provide some idea of the exposures found during requested NIOSH evaluations in industry. NIOSH is continuing to develop information and will provide to OSHA other relevant data on exposure concentrations found in industry in our post-hearing comments. These data should assist OSHA in determining feasibility.

In addition to these publicly available sources of information, OSHA should ask major employers throughout the country to provide listings of all of their own internal exposure limits along with their documentation of those limits. In many industries these may be more restrictive than existing OSHA PELs, and this should be an excellent source of information on feasibility of various limits.

Because many of the proposed PELs are derived from TLVs, OSHA should obtain from the ACGIH all unpublished data that contributed to the establishment of those TLVs. OSHA should follow up on these unpublished data to make the record as complete as possible.

Dimethyl Formamide (DMF), a compound from NIOSH Table N3A, is of particular interest to both NIOSH and OSHA because of recent published information concerning testicular cancer and liver disease. NIOSH will provide to OSHA a summary of these data presently in preparation.

3. **Are substances included in this rulemaking used in industries other than those described in the preamble?**

and

4. **Are substances included in this rulemaking used for purposes other than those described in the preamble?**

NIOSH has previously supplied to OSHA, at their request, a printout of the complete NIOSHTIC data base file on approximately 260 chemicals to aid in the identification of additional industries using the chemicals in this rulemaking. NIOSH is continuing to search its data base files (National Occupational Hazard Survey [NOHS]) for additional information which will be provided during this rulemaking process.

5. **Do alternative unpublished exposure guidelines exist, such as those used in private workplaces, which may be suitable for general usage?**

NIOSH is aware of the existence of internal exposure guidelines in a number of private workplaces. NIOSH surveyors, in assessing ethylene oxide exposure, often found internal workplace controls in the 1 to 2 ppm range when the OSHA PEL was 10 ppm. Some of the proposals for change by ACGIH incorporate workplace exposure limits being used in industry at the time of the change. Nickel carbonyl is an example. This documentation relates that a nickel refinery in Sudbury, Canada, begins treating their workers for nickel carbonyl poisoning when their blood level of nickel reaches 150 micrograms/liter. It is further noted that the factory sounds an alarm when air concentrations read 10 ppb and an evacuation alarm sounds at 80 ppb. In this case the TLV is 5 times the level thought to be safe.

There are existing guidelines on exposure to radioactive materials published by the International Commission on Radiation Protection (ICRP) and by the National Commission on Radiation Protection, which are applicable to radioactive substances, specifically, soluble and insoluble uranium in this rulemaking.

Before considering unpublished data, OSHA should update the published information on which it is relying for this proposed rule. A cursory review indicates that 72% of the references cited by OSHA were published prior to 1980 and 35% prior to 1969. The latter is the publication date for the current Z-1 table. NIOSH has submitted a complete set of references for each of the substances under consideration from its RTECS data base.

6. **Is there information regarding laboratory analytical procedures which may be used in lieu of those suggested by OSHA (see Appendix A) to determine exposure to air contaminants?**

NIOSH has transmitted to OSHA all of its applicable analytical procedures. NIOSH would caution OSHA that, in the "Sampling and Analytical Methods" table, several existing NIOSH analytical methods have been extended to compounds for which the suggested method has not been verified. Some of these compounds have

markedly different chemical properties than the compound(s) for which the method was developed. These methods will require validation before use:

Method	Validated for	Extension proposed by OSHA	HS #
NIOSH 1003	halogenated H/C	1,3-dichloropropene	1129
NIOSH S43	methyl methacrylate	2-hydroxylpropyl acrylate	1211
NIOSH 1400	isopropanol	propargyl alcohol	1335
NIOSH 1400	isopropanol	isooctyl alcohol	1220
NIOSH 1603	acetic acid	trichloroacetic acid	1404
NIOSH 1003	halogenated H/C	dichloroacetylene	1123
NIOSH 1020	1,1,2-trichloro-1,2,2-trifluoroethane	chlorodifluoromethane	1085
NIOSH 1020	1,1,2-trichloro-1,2,2-trifluoroethane	chloropentafluoroethane	1087
NIOSH 1003	halogenated hydrocarbons	o-chlorostyrene	1089
NIOSH 1003	halogenated hydrocarbons	o-chlorotoluene	1090
NIOSH 1500	hydrocarbons	cyclopentane	1111
NIOSH 1500	hydrocarbons	hexane isomers	1201
NIOSH 5021	terphenyls	hydrogenated terphenyls	1210
NIOSH 2002	aromatic amines	N-isopropylaniline	1229
NIOSH S264	ethyl silicate	methyl silicate	1266
NIOSH 1500	hydrocarbons	nonane	1293
NIOSH 2002	aromatic amines	p-toluidine	1400
NIOSH 2002	aromatic amines	m-toluidine	1401

The following are corrections to the NIOSH Analytical Methods for PEL Update Table (pp. 21308-21312 of the Federal Register).

No.	Analyte	Correct NIOSH Validated Method
4	acetone	NIOSH 1300
17	ammonia	Add NIOSH S347
20	ammonium sulfamate	NIOSH S348
63	carbon Dioxide	NIOSH S249
190	hexachlorocyclopentadiene	NIOSH 2518
304	petroleum distillates (naphtha)	NIOSH 1550
392	1,2,3-trichloropropane	NIOSH 1003

7. **Are the proposed exposure limits for each substance appropriate?**

NIOSH has addressed comments on each exposure limit it believes to be inappropriate, and has submitted these comments with supporting data to the docket as specified by OSHA in part VIII of the proposed rule.

8. Is additional information available for those substances for which ACGIH proposed a higher TLV which might affect OSHA's decision that such a change was not justified?

This rulemaking is not an appropriate proceeding for raising any permissible exposure limit. The decision to raise an occupational exposure limit should only be made through a full 6(b) rulemaking procedure with adequate time for all concerned parties to respond.

NIOSH has examined all of the available additional scientific information on substances for which the ACGIH TLV is higher and has commented where appropriate. The only substance included on Table C16-1 (Federal Register, p. 21211) that OSHA proposes to raise is Fluorine (HS 1179), and NIOSH has submitted detailed comments on this chemical which demonstrate that OSHA was not justified in raising the proposed PEL.

Additionally, OSHA inadvertently stated (on p. 21029 of the Federal Register) that the current OSHA PEL for Synthetic Camphor (HS 1063) is 2 ppm rather than 2 mg/m^3 (0.3 ppm). Because of this error, OSHA proposed to adopt the ACGIH TLV and STEL, i.e. 2 and 3 ppm, respectively, which is approximately 7 times higher than the current PEL.

9. **Should the implementation dates for some substances be delayed because of sampling/analytical limitations or short-term feasibility impact considerations?**

Delaying the implementation date would not be technology forcing with regard to reducing occupational exposures. However, it is extremely important to note that for many substances listed in the update, there are no sampling and analytical methods available or the method given has not been validated by either NIOSH or OSHA. Also, many of the proposed methods are in-house OSHA methods which are not available to NIOSH or the general public for evaluation. Finally, there are methods whose Limit of Quantitation cannot support the proposed PEL or STEL. These problems are critical and must be corrected for proper enforcement of the regulation.

Therefore, it is important that NIOSH and OSHA work together on a method development scheme that will allow the appropriate validated methods to be developed in a prioritized fashion within the implementation of the regulation. Also, it is imperative that OSHA set a high priority for promulgating followup regulations that deal with these sampling and analytical issues.

10. **Is there additional information relative to the OSHA plans to adopt some recommended 10-hour TWA REL's as an 8-hour PEL?**

A NIOSH REL "... determined as a time-weighted average (TWA) exposure for up to a 10-hour work day, 40-hour work week" first appeared in the 1973 Inorganic Arsenic Criteria Document. That document was developed during the energy crisis of the early 1970's, when many employers began using 10-hour work days as an energy conservation measure. Consideration was given to recommending a mathematical adjustment of TWA RELs based on a constant limitation of the Concentration x Time for 8-hour and longer work days. For example, an 8-hour TWA of 100 ppm (100 ppm x 8 hr = 800 ppm hr) would convert to 80 ppm for a 10-hour day (800 ppm hr/10 hr = 80 ppm hr). The conclusion at the time was that, so long as the work schedule did not exceed 10 hours per day or 40 hours per week, there was not sufficient precision in the selection of exposure limits to justify the precision implied by that mathematical adjustment. Therefore, the same TWA REL was intended to be applied to 8-hour and 10-hour work days in a 40-hour work week. The action proposed by OSHA in this rulemaking relative to these RELs is consistent with that original intent. A mathematical conversion in the opposite direction, i.e., converting a 10-hour TWA of 100 ppm (1000 ppm hr) to an 8-hour TWA of 125 ppm (1000 ppm hr), would be contrary to the original intent and would be opposed by NIOSH.

11. **Does the most current scientific information generally support acceptance of the hypothesis that all C-5-8-Alkanes are not equally toxic because a metabolite of n-Hexane exhibits unique neurotoxic properties?**

It is generally accepted that the metabolite that is responsible for the neurotoxic effects of n-hexane is 2,5-hexanedione (2,5-HD), a gamma diketone. This compound is also a metabolite of methyl-n-butyl ketone (MnBK), but is not known to be a metabolite of other alkanes in the C-5 to C-8 group. 2,5-HD produces axonal degeneration (so-called "central peripheral distal axonopathy") characterized by a breakdown of neurofilaments and their accumulation distal to Ranvier nodes in the neuron. The observable symptomatology is, in sequence, limb weakness, severe paralysis, and muscle degeneration. The observation of similar neuropathies after exposures to MnBK or n-hexane and the discovery of their common metabolite, 2,5-HD, suggested the specific hypothesis that it is the gamma spacing of the diketone in the molecule that is the necessary and sufficient characteristic for producing this type of neuropathy. It would be correct to state that 2,5-HD is the principal neurotoxic metabolite of n-hexane and MnBk. It should also be recognized that any gamma diketone or any compound that may be metabolized to a gamma diketone (e.g., 5-nonanone metabolized to

2,5-nonanedione) may be neurotoxic. It would be incorrect to conclude that the neurotoxic properties ascribed to n-hexane are unique to this compound. Other alkanes or related chemicals that are ultimately metabolized to a gamma diketone may have similar toxicity.

12. **OSHA has proposed to use exposure limits from two well-established sets of guidelines as a source of values to update the PELs. Is information available about alternative sources which OSHA might consider for this purpose?**

In its preamble to this proposed rulemaking, OSHA referred to 9 alternative sources:

International Labor Organization
World Health Organization
European Economic Community
United Kingdom Occupational Exposure Limits
West German Maximum Allowable Concentrations
Swedish Allowable Workplace Air Concentrations
Japanese Permissible Exposure Limits
American National Standards Institute
American Industrial Hygiene Association

Another possibility is the Nordic Expert Group for Documentation of Occupational Exposure Limits.

NIOSH believes all of these should be considered as equal or superior to the ACGIH TLV list in terms of the the criteria listed by OSHA.

No single source should be expected to stand alone as a comprehensive list of candidates for regulation. OSHA should construct its own comprehensive list by drawing information from all available sources.

No single list is current in its entirety. Although the ACGIH TLV list is republished annually, it is a mistake to assume that every TLV is reconsidered annually. The annual republishing is only a mechanism whereby those TLVs that have been revised can be disseminated. The ACGIH does not claim to reevaluate every TLV on a regular schedule.

Economic and technical feasibility may be considered by the ACGIH in developing TLVs, but those considerations, if any, are not defined in the documentation of TLVs. Feasibility information for PELs derived from agencies listed above would be comparable, in most cases, to that provided by the ACGIH in support of TLVs.

OSHA should consider the availability and quality of documentation on a substance-by-substance basis and use all available documentation, rather than select an exclusive list of substances simply because that list consistently has some documentation.

The fact that the alternative sources listed above do not originate in the U.S. should not disqualify them from consideration of applicability. They should be judged against what is required to protect workers from the known toxicity of each substance regulated. Only after determining the level of control necessary to ensure a safe and healthy workplace should other factors be considered. Because they are limits that other officials have judged necessary to protect worker safety and health, NIOSH believes that OSHA should at least consider limits from all of the sources listed above.

13. **OSHA has outlined its criteria for identifying special situations. Are alternative criteria available which might be used in lieu of these, or in addition to them?**

OSHA has identified five circumstances that it considers special situations:

Situations one and two involve a comparison of the ACGIH TLVs to four alternate data bases--the United Kingdom 1987 Occupational Exposure Limits, the West German 1985 Maximum Allowable Concentrations, the Japanese 1983 Permissible Exposure Limits, and the Swedish 1984 Allowable Workplace Air Concentrations. OSHA Tables 1-F-C and 1-F-D, that are based on these comparisons, are not accurate. NIOSH has reviewed the pertinent data on selected substances on Tables 1-F-C and 1-F-D and has submitted comments on the appropriateness of the limits proposed.

Situation three involves the substances where the current TLV exceeds the existing PEL. NIOSH has addressed this issue in the response to question 8.

Situation four involves the circumstances where the available analytical methods are not adequate to measure the substance at the air concentration proposed. NIOSH has addressed this situation in the answer to question 9.

In the fifth situation where recent information suggests that neither the TLV nor the REL is appropriate, NIOSH finds it difficult to identify the exact substances to which OSHA is referring. NIOSH has commented on those substances which, based on the best available scientific information, meet OSHA's occupational carcinogen definition. On other substances where recent information indicates that neither the TLV nor the REL is

low enough to be adequately protective, OSHA should adopt the lower of the available limits and immediately schedule the substance for expedited rulemaking.

14. **OSHA has outlined three alternative procedures for dealing with substances requiring special attention. Are additional approaches available which might be used in lieu of these, or in addition to them?**

NIOSH would support OSHA in its decision to adopt either the level proposed or such other level as the evidence presented to the record indicates as proper for these substances, and identify them as possibly requiring followup rulemaking. NIOSH has endeavored to provide OSHA with the required data for selecting a proper limit for selected substances on Tables I-F-C and I-F-D. NIOSH concurs with OSHA that it is in the best interest of the worker to promptly provide such increased health protection as is indicated by the evidence in the record.

15. **OSHA has performed feasibility analysis for the following substances, based on limited available information: Acetonitrile, Carbon disulfide, Carbon monoxide, Carbon tetrachloride, Chloroform, Ethylene dichloride, Ethylene glycol dinitrate, Fibrous glass dust, Hydrogen cyanide, Isophorone diisocyanate, Nitrogen dioxide, Nitroglycerin, Trichloroethylene.**

Is further information available which might be used to supplement the present findings regarding the feasibility of achieving these levels in the workplaces?

From NIOSH research data, we are including a detailed engineering feasibility study (Appendix B) for those listed in the question, as well as for the following chemicals: Acetone, Chlorine, Styrene, and Sulfur dioxide.

16. **OSHA has made a preliminary assessment of the proposed rulemakings' impact on large and small establishments. The Act requires OSHA to determine whether a regulation will have a significant impact on a substantial number of small entities, pursuant to the Regulatory Flexibility Act of 1980, 5 U.S.C. 601 et seq. Is there additional information regarding implementation of this rule for small businesses and entities which OSHA should consider?**

NIOSH has no comment.

17. **OSHA has proposed PEL's for some substances where the basis of this proposal also includes a carcinogenicity designation (e.g., TLV with an A1 or A2 designation; REL with a Ca designation). Should OSHA include a similar carcinogen designation in the Z-4 Table in this rulemaking?**

Yes. For both the TLVs and the RELs, the carcinogen designation is an inseparable part of the recommendation. OSHA should include carcinogen designations for all chemicals that meet the OSHA definition of "potential occupational carcinogen" (29 CFR 1990.103).

18. **OSHA has preliminarily decided that for substances where the ACGIH TLV is a TWA and the NIOSH REL is a Ceiling Value which is the same or one half of the TWA, OSHA will propose that the TWA be adopted as the PEL. Should this approach be modified in the final rulemaking? What approach should be used when the converse of this situation (TLV, Ceiling REL, TWA) exists?**

NIOSH would suggest that this question fails to recognize the essential differences between a time weighted average (TWA) and a Ceiling Value. A TWA is appropriate as a limit when the toxic effect of the substance is directly related to the total dose received in a daily exposure. Ceiling values are intended to minimize toxic effects related to the peak exposure.

Ceiling values are necessary when there are immediate acute responses to an air contaminant independent of the total daily dose or when chronic effects are dose-rate response related. In conjunction with a TWA, ceiling values are also used to minimize the total daily dose when there is intermittent occupational exposure, e.g., ethylene oxide.

The simple numerical relationship that OSHA has proposed is not a scientifically sound basis for selecting between a TWA and a ceiling value. An analysis of the data supporting the proposed limit must be conducted on a case-by-case basis to discern which limit is appropriate.

NIOSH has submitted specific comments on a substance-by-substance basis in this category to assist OSHA in selecting the appropriate limit. These substances are listed in the NIOSH Table N7 of the NIOSH comments.

19. **OSHA preliminarily plans to adopt a phased start-up schedule. This would include an initial start-up requirement permitting the use of alternate control methods for revised PEL's, followed at a later date by the required use of control methods fully consistent with the methods of compliance priorities in effect at that time. OSHA will shortly be requesting comments on the hierarchy of controls. An alternate approach is to set a compliance date for engineering controls based on final determinations of that rulemaking. OSHA solicits comments on those approaches and suggestions regarding appropriate times for the two proposed start-up dates.**

NIOSH believes that work practices and engineering controls such as substitution, isolation, and ventilation should be used to control occupational exposures to the fullest extent feasible. NIOSH believes that personal protective equipment should be worn only when engineering controls are not feasible, such as during maintenance procedures.

NIOSH recommends that OSHA allow industry 6 months to come into compliance by any combination of control methods, and 2 years for compliance by the NIOSH recommended hierarchy of control methods [NIOSH 1983]. OSHA currently is recommending that industry be allowed 4 years to come into compliance by OSHA's hierarchy of control methods. Furthermore, NIOSH recommends that OSHA require staged implementation over the 2-year period of conversion to the hierarchy. This latter requirement would be technology forcing and it would minimize the occurrence of last minute requests to OSHA for variances to meet the conversion requirement.

20. **OSHA requests comment on whether the establishment of margins of safety below lowest observed or no effect levels is consistent with the concept of "significant risk," and on whether the specific margins of safety required for specific chemicals are appropriate.**

Margins of safety and safety factors are attempts to adjust for uncertainty in available data and knowledge. The use of a margin of safety or a safety factor approach to identify exposure limits does not estimate the human risk associated with those proposed exposure limits. Therefore, such an approach cannot be considered to provide protection against or to reduce "significant risk" (either in a general conceptual sense or in the sense of any specific judicial precedent). Nonetheless, NIOSH recognizes that a thorough case-by-case evaluation for all major industrial agents may not be possible for a variety of reasons, and the use of a margin of safety or a safety factor approach to identify exposure limits for those chemicals provide a pragmatic method to develop standards. The exception to this statement is that NIOSH does not believe such an approach should be used to identify an exposure limit for an adverse health effect that results from non-threshold processes (e.g., cancer).

In developing its recommendations to OSHA, NIOSH conducts thorough evaluations of all research data, estimated human risks associated with specific exposures, the sensitivity of measurement and analytic methods, alternative technologies, technological feasibility of various exposure levels, background or ambient exposure levels, methods of worker protection, and many other factors pertinent to specific exposure agents or environments. NIOSH knows of no other method to develop reliable exposure limit standards that is consistent with NIOSH's

responsibility from the OSHAct to assure as far as possible, every working man and woman in the Nation, safe and healthful working conditions. Since the use of a margin of safety or a safety factor approach does not address essential issues required to develop a reliable exposure limit, including evaluation of "significant risk," NIOSH recommends that any standards developed by the use of a margin of safety or a safety factor approach be considered interim standards. NIOSH recommends that standards based on a margin of safety or a safety factor approach, as well as standards derived from a case-by-case evaluation, be periodically reviewed to determine what new information is available.

NIOSH is not recommending specific margins of safety or safety factors on any chemical.

21. **OSHA has identified sensory irritation, which causes rhinitis, cough, sputum production, chest pain, wheezing and dyspnea as material impairment of health. OSHA invites comments on this understanding.**

The recognition of sensory irritation as potentially being "material impairment of health" is consistent with the current scientific consensus related to health effects of environmental agents.

Mucous membrane irritants can cause increased blink frequency and tearing; nasal discharge, congestion, and sneezing; and cough, sputum production, chest discomfort, wheezing, chest tightness, and dyspnea. Work environments often require levels of physical and mental performance considerably greater than those encountered in daily living. Even in the absence of any permanent impairment, the symptoms listed can interfere with job performance and safety.

Mucous membrane irritation can result in inflammation, which may lead to increased susceptibility to nonspecific irritants and infectious agents. For example, experimental ozone exposure in humans results in increased airway reactivity. Also, studies of exposure to environmental tobacco smoke have shown irritative symptoms and evidence of increased frequency of respiratory tract illnesses in young children and decreased pulmonary function in adults.

The American Thoracic Society has identified several points relevant to the issue of respiratory tract irritation.

1. Does the effect interfere with normal activity of the individual?

2. Are there episodes of identifiable respiratory illness?

3. Does the effect result in an incapacitating illness?

4. Is there permanent respiratory injury?

5. Is there progressive respiratory dysfunction?

Particularly on the job, sensory irritation is clearly relevant to point 1. Mucous membrane irritation is associated with respiratory illnesses, depending on the composition of specific exposure and on the dose, duration, and frequency of exposure. No universally applicable conclusion can be drawn at this time regarding the association between irritative symptoms and permanent injury of dysfunction. Where certain individuals show no measurable impairment after an exposure, even when experiencing irritative symptoms, others may develop identifiable dysfunction.

Aside from the effects of irritation, mucous membrane exposure may result in absorption of a substance, with resultant systemic toxicity. An inflamed mucous membrane may be an even more effective route of absorption, either for the irritant or for other substances. Furthermore, injury to bronchopulmonary membranes can impair removal of particulates from the respiratory system.

22. **The question also arises of whether odorants present material impairment of health. That issue also might arise in the context of other substances. Based on the evidence in the final record concerning this issue, OSHA will determine if the criteria detailed in section IV-C-16 have been met, and take appropriate action. OSHA requests comment on this issue.**

Odors emitted by industrial chemicals often play an important role in occupational safety and health. When odors can be detected before health effects occur, they may provide early warning of exposure. A number of chemicals have strong odors at concentrations which are otherwise minimally toxic. These odors may cause undue health concerns among exposed workers or may create safety hazards by distracting workers from their tasks. Strong odors in the workplace may also mask the presence of other, more toxic substances. Strong odors can produce irritation and/or nausea at high concentrations, although these effects may be reversible following cessation of exposure. Olfactory fatigue often occurs and should be considered a functional impairment that can result in increased worker exposure. Olfactory fatigue can reduce the wearer's ability to sense inadequate respirator performance of air-purifying respirators.

23. **Is there exposure information available which can be supplied which will refine OSHA's estimates of employee exposures and over exposures to the substances being regulated?**

NIOSH is submitting for the current rulemaking all relevant Health Hazard Evaluation Reports (HHEs) to the docket. Appendix C is a comprehensive listing of HHEs being submitted. We also have previously submitted to OSHA a copy of data tapes from the National Occupational Health Survey (NOHS). NIOSH anticipates submitting to OSHA a comprehensive listing of pertinent NIOSH exposure information in our post-hearing comments.

24. **Is there information available which can be supplied to improve or supplement the engineering controls identified as necessary in order to reduce exposure levels? Is there additional cost data which can be supplied to refine the annual costs associated with these controls?**

In addition to the material on engineering feasibility provided to OSHA relating to question 15, NIOSH is continuing to evaluate general engineering feasibility data for these substances in this rulemaking that meet OSHA's definition of a potential occupational carcinogen (29 CFR 1990).

25. **Under what conditions, involving which industrial processes, will respirators be needed during the start up period, for maintenance operations, or where other controls are infeasible in order to protect employees at the proposed exposure levels? Are respirators currently being used under the conditions identified, or would they need to be purchased? Please describe the type of respirator currently in use or needed.**

NIOSH concurs with OSHA's assessment in the Non-Regulatory Alternative Section that personal protective equipment should only be used "where it is impractical to apply engineering or work practice controls, or where these applications will not consistently reduce employee exposures below the proposed PEL's." In these instances, NIOSH recommends that the NIOSH Respirator Decision Logic (Appendix D) be used to select the appropriate respirator.

NIOSH has little quantitative information on which respirators are currently being used under the conditions specified by OSHA. A NIOSH contractor's report ("Preliminary Survey of Existing Data and Economic Overview of Respirator Industry," Granville Corporation, March 10, 1982) is submitted to the docket as Appendix E and provides limited data on the numbers and types of respirators sold in the United States. This report used respirator manufacturers' data on respirator sales in 1980 and published data on workers [i.e., Economic Report of the

President, (U.S.G.P.O., Washington, 1981)] to make some estimates on the number of certified respirators being worn by workers in the U.S. The Granville report estimates that 19.1% of mining, manufacturing, and construction workers wore or had access to certified respirators in 1980. In addition, it was estimated that over 20 million manufacturing workers and almost 4.5 million construction workers, and more than 1 million miners used certified respirators. The Granville report also indicated that SCBAs, "disposables," and particulate and chemical cartridge respirators have "large and roughly equal market shares (ranging from 25 to 30%) in terms of total dollar sales" (Granville Report, p. 40).

26. **As a result of simultaneously regulating many substances, what cost savings will be realized in purchasing new engineering controls? Are alternate engineering controls available to achieve the lower permissible exposure limits being proposed?**

NIOSH has no comment with regard to the costs of purchasing new engineering controls. Alternate engineering control methods are discussed in our responses to questions 15 and 19.

27. **What is the current state of technology control and financing in firms which would need to comply with reduced exposure limits to wood dust?**

In addition to the information provided on the individual chemical comments for Wood Dust (H.S. 1430A and 1430B), several innovative designs and devices have been developed to control wood dust in sawing, cutting, sanding and shaping. These published NIOSH references (Huebener DJ [1987]. Dust controls for a wood shaper. Appl Ind Hyg 2(4):164-169; and Hampl V and Johnston DE [1985]. Control of wood dust from horizontal belt sanding. Am Ind Hyg Assoc J 46(10):567-577) have been submitted to the docket as Appendix F.

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Acetic acid	1002	64-19-7	10	25	15	37	10	25	
Acetic anhydride	1003	108-24-7	C 5	C 20			5	20	
Acetone	1004	67-64-1	750	1780	1000	2375	1,000	2,400	250 ppm (590 mg/m^3) TWA
Acetonitrile - Skin	1005	75-05-8	40	70	60	105	40	70	20 ppm (34 mg/m^3) TWA
Acetylsalicylic acid (Aspirin)	1006	50-78-2		5			None		
Acrolein	1007	107-02-8	0.25	0.3	0.8	0.1	0.25		
Allyl alcohol - Skin	1010	107-18-6	2	5	4	10	2	5	
Allyl chloride	1011	107-5-1	1	3	2	6	1	3	1 ppm (3.1 mg/m^3) TWA; 3 ppm (9.3 mg/m^3) ceiling (15 min)
Allyl glycidyl ether - Skin	1012	106-92-3	5	22	10	44	C 10	C 45	9.6 ppm (45 mg/m^3) ceiling (15 min)
Allyl propyl disulfide	1013	2179-59-1	2	12	3	18	2	12	
Aluminum		7429-90-5							
Alkyls (NOC*)	1015			2			None		
Pyro powders	1017			5			None		
Soluble salts	1018			2			None		
Welding fumes	1019			5			None		

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NIOSH Table N1 - Proposed PELs
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CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Ammonia	1021	7664-41-7	25	18	35	27	50	35	50 ppm (34.8 mg/m^3) ceiling (5 min)
Ammonium chloride fume	1022	12125-02-9		10		20		15	
Atrazine	1029	1912-24-9		5			None		
Bismuth telluride (Se-doped)	1034	1304-82-1		5			None		
Borates, tetra, sodium salts		1303-96-4							
Anhydrous	1036			1			None		
Decahydrate	1037			5					
Pentahydrate	1038			1					
Boron tribromide	1040	10294-33-4	C 1	C 10			None		
Bromacil	1041	314-40-9	1	10			None		
Bromine	1042	7726-95-6	0.1	0.7	0.3	2	0.1	0.7	
Bromine pentaflouride	1043	7789-30-2	0.1	0.7			None		
Butane	1044	106-97-8	800	1,900			None		
2-Butanone (Methyl ethyl ketone;MEK)	1045	78-93-3	200	590	300	885	200	590	200 ppm (590 mg/m^3) TWA
2-Butoxyethanol - Skin	1046	111-76-2	25	120			50	240	
n-Butyl acetate	1047	123-86-4	150	710	200	950	150	710	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Butyl acrylate	1048	141-32-2	10	55			None		
sec-Butyl alcohol	1049	78-92-2	100	305	150	455	150	450	
tert-Butyl alcohol	1050	75-65-0	100	300	150	450	100	300	
n-Butyl alcohol - Skin	1051	71-36-3	C 50	C 150			100	300	
n-Butyl lactate	1053	138-22-7	5	25			None		
o-sec-Butylphenol - Skin	1055	89-72-5	5	30			None		
p-tert-Butyltoluene	1056	98-51-1	10	60	20	120	10	60	
Calcium cyanamide	1058	156-62-7		0.5			None		
Calcium hydroxide	1059	1305-62-0		5			None		
Calcium oxide	1060	1305-78-8		2				5	
Caprolactam Dust	1064	105-60-2		1		3	None		
Carbofuran	1068	1563-66-2		0.1			None		
Carbon dioxide	1069	124-38-9	5,000	9,000	30,000	54,000	5,000	9,000	10,000 ppm (18,000 mg/m^3) TWA; 30,000 ppm (54,000 mg/m^3) ceiling (10 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Carbon disulfide - Skin	1070	75-15-0	10	30			20 ppm TWA 30 ppm Ceiling, 100 ppm Max Ceiling, (30 min)		1 ppm (3 mg/m^3) TWA; 10 ppm (30 mg/m^3) ceiling (15 min)
Carbon monoxide	1071	630-08-0	50	55	400	440	50	55	35 ppm (40 mg/m^3), 8-hr TWA; 200 ppm (229 mg/m^3) ceiling (No defined time)
Carbon tetrabromide	1072	558-13-4	0.1	1.4	0.3	4	None		
Carbonyl fluoride	1074	353-50-4	2	5	5	15	None		
Catechol	1075	120-80-9	5	20			None		
Cesium hydroxide	1077	21351-79-1		2			None		
Chlorine	1079	7782-50-5 (NIC	1 0.5	3 1.5	3 1	9 3)	C 1	C 3	0.5 ppm (1.45 mg/m^3) ceiling (15 min)
Chlorine dioxide	1080	10049-04-4	0.1	0.3	0.3	0.9	0.1	0.3	
1-Chloro-1-nitropropane	1081	600-25-9	2	10			20	100	
Chloroacetyl chloride	1083	79-04-9	0.05	0.2			None		
o-Chlorobenzylidene malononitrile - Skin	1084	2698-41-1	C 0.05	C 0.4			0.05	0.4	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
tert-Butyl acetate		540-88-5	200	950			200	950	
Butylamine - Skin		109-73-9	C 5	C 15			C 5	C 15	
Carbaryl		63-25-2		5				5	5 mg/m^3 TWA reproductive effects; minimum exposure during pregnancy
Chlorinated diphenyl oxide		55720-99-5		0.5		2		0.5	
Chlorine trifluoride		7790-91-2	C 0.1	C 0.4			C 0.1	C 0.4	
Chloroacetaldehyde		107-20-0	C 1	C 3			C 1	C 3	
alpha-Chloroacetophenone		532-27-4	0.05	0.3			0.05	0.3	
Chlorobromomethane		74-97-5	200	1,050	250	1,300	200	1,050	
Chloropicrin		76-06-2	0.1	0.7	0.3	2	0.1	0.7	
Chromium (II) compounds, Cr (Soluble)				0.5				0.5	
Chromium (III) compounds, Cr (Soluble)				0.5				0.5	
Copper Dusts & mists, as Cu		7440-50-8		1				1	
Crotonaldehyde		4170-30-3	2		7		2		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Copper Fume	1101	7440-50-8		0.2				0.1	
Crufomate	1103	299-86-5		5		20	None		
Cyanamide	1104	420-04-2		2			None		
Cyanogen	1105	460-19-5	10	20			None		
Cyanogen chloride	1106	506-77-4	C 0.3	C 0.6			None		
Cyclohexanol - Skin	1107	108-93-0	50	200			50	200	
Cyclohexanone - Skin	1108	108-94-1	25	100			50	200	25 ppm (100 mg/m^3) TWA
Cyclohexylamine	1109	108-91-8	10	40			None		
Cyclonite - Skin	1110	121-82-4		1.5		3	None		
Cyclopentane	1111	287-92-3	600	1,720			None		
Cyhexatin	1112	13121-70-5		5			None		
Decaborane - Skin	1114	17702-41-9	0.05	0.3	0.15	0.9	0.05	0.3	
2,6-di-tert-butyl-p-cresol	1117	128-37-0		10			None		
Diazinon - Skin	1118	333-41-5		0.1			None		
Dibutyl phosphate	1119	107-66-4	1	5	2	10	1	5	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
2-N-Dibutylaminoethanol - Skin	1120	102-81-8	2	14			None		
1,1-Dichloro-1-nitroethane - Skin	1121	594-72-9	2	10			C 10	C 60	
1,3-Dichloro-5,5-dimethyl hydantoin	1122	118-52-5		0.2		0.4		0.2	
1,1-Dichloroethane	1126	75-34-3	200	810	250	1,010	100	400	
Dichloromonofluoromethane	1128	75-43-4	10	40			1,000	4,200	
2,2-Dichloropropionic acid	1130	75-99-0	1	6			None		
Dicrotophos (Bidtin) - Skin	1131	141-66-2		0.25			None		
Dicyclopentadiene	1132	77-73-6	5	30			None		
Diethanolamine	1134	111-42-2	3	15			None		
Diethyl ketone	1135	96-22-0	200	705			None		
Diethyl phthalate	1136	84-66-2		5			None		
Diethylamine	1137	109-89-7	10	30	25	75	25	75	
Diethylene triamine - Skin	1138	111-40-0	1	4			None		
Diisobutyl ketone	1140	108-83-8	25	150			50	290	25 ppm (140 mg/m^3) TWA

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Dimethyl 1,2-dibromo-2,2-dichloroethyl phosphate (Naled Dibrom) - Skin	1141	300-76-5		3				3	
Dimethylaniline (N,N-Dimethylaniline)	1143	121-69-7	5	25	10	50	5	25	
Dinitolmide	1144	148-01-6		5			None		
Dioxathion - Skin	1146	78-34-2		0.2			None		
Diphenylamine	1147	122-39-4		10			None		
Dipropyl ketone	1148	123-19-3	50	235			None		
Dipropylene glycol methyl ether	1149	34590-94-8	100	600	150	900	100	600	
Diquat	1150	85-00-7		0.5			None		
Disulfiram	1151	97-77-8		2			None		
Diuron	1153	330-54-1		10			None		
Divinyl benzene	1154	1321-74-0	10	50			None		
Endosulfan - Skin	1156	115-29-7		0.1			None		
Ethanolamine	1159	141-43-5	3	8	6	15	3	6	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Ethion (Nialate) - Skin	1160	563-12-2		0.4			None		
Ethyl benzene	1162	100-41-4	100	435	125	545	100	435	
Ethyl mercaptan (1-ethanethiol)	1165	75-08-1	0.5	1			C 10	C 25	0.5 ppm (1.3 mg/m^3) ceiling (15 min) Mixtures of thiols to be controlled by calculation of equivalent concentrations
Ethyl silicate	1166	78-10-4	10	85			100	850	
Ethylene chlorohydrin - Skin	1167	107-07-3	C 1	C 3			5	16	
Ethylene glycol dinitrate - Skin	1170	628-96-6	0.05	0.3			0.2	1	0.1 mg/m^3 ceiling (20 min) recommended limit for either substance alone or mixtures
Ethylidene norbornene	1171	16219-75-3	C 5	C 25			None		
N-Ethylmorpholine - Skin	1172	100-74-3	5	23			20	94	
Fenamiphos - Skin	1173	22224-92-6		0.1			None		
Fensulfothion (Dasanit)	1174	115-90-2		0.1			None		
Ferrovanadium dust	1177	12604-58-9		1		3		1	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Fluorotrichloromethane (Trichlorofluoromethane)	1180	75-69-4	C 1,000	C 5,600			None		
Fonofos - Skin	1181	944-22-9		0.1			None		
Furfuryl alcohol - Skin	1184	98-00-0	10	40	15	60	50	200	50 ppm (200 mg/m^3) TWA
Germanium tetrahydride	1186	7782-65-2	0.2	0.6			None		
Glutaraldehyde	1187	111-30-8	C 0.2	C 0.7			None		
Glycidol	1189	556-52-5	25	75			50	150	
Grain dust (oats, wheat, barley)	1190			4, Total particulate			None		
Graphite (natural)	1191	7782-42-5		2.5 Respirable dust (NIC 10 Total dust)			2.5 Respirable dust		
Hexachlorocyclopentadiene	1196	77-47-4	0.01	0.1			None		
Hexafluoroacetone - Skin	1198	684-16-2	0.1	0.7			None		
Hexane (n-Hexane)	1200	110-54-3	50	180			500	1,800	
Hexone (Methyl isobutyl ketone)	1203	108-10-1	50	205	75	300	100	410	50 ppm (200 mg/m^3) TWA
Hexylene glycol	1204	107-41-5	C 25	C 125			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Hydrogen bromide	1206	10035-10-6	C 3	C 10			3	10	
Hydrogen cyanide - Skin	1207	74-90-8	C 10	C 10			10	11	4.7 ppm (5 mg /m^3) ceiling (10 min)
Hydrogen fluoride, as F	1208	7664-39-3	C 3	C 2.5			3		3 ppm (2.5 mg F/m^3) TWA; 6 ppm (5.0 mg F/m^3) ceiling (15 min)
Hydrogenated terphenyls	1210	61788-32-7	0.5	5			None		
2-Hydroxypropyl acrylate	1211	999-61-1	0.5	3			None		
Indene	1212	95-13-6	10	45			None		
Indium & compounds, as In	1213	7440-74-6		0.1			None		
Iodoform	1214	75-47-8	0.6	10			None		
Iron oxide fume as Fe (Fe2O3)	1215	1309-37-1		5				10	
Iron pentacarbonyl as Fe	1216	13463-40-6	0.1	0.8	0.2	1.6	None		
Iron salts, soluble, as Fe	1217			1			None		
Isoamyl alcohol	1218	123-51-3	100	360	125	450	100	360	
Isobutyl alcohol	1219	78-83-1	50	150			100	300	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Isooctyl alcohol - Skin	1220	26952-21-6	50	270			None		
Isophorone	1221	78-59-1	C 5	C 25			25	140	4 ppm (23 mg/m^3) TWA
Isophorone diisocyanate - Skin	1222	4098-71-9 (NIC	0.01 0.005	0.09 0.045)			None		45 µg/m^3 (5 ppb) TWA, 180 µg/m^3 (20 ppb) ceiling (10 min), Diisocyanates
Isopropyl alcohol	1225	67-63-0	400	980	500	1,225	400	980	400 ppm (984 mg/m^3) TWA; 800 ppm (1,968 mg/m^3) ceiling (15 min)
Isopropyl ether	1226	108-20-3	250	1,050	310	1,320	500	2,100	
N-Isopropylaniline - Skin	1229	768-52-5	2	10			None		
Ketene	1231	463-51-4	0.5	0.9	1.5	3	0.5	0.9	
Manganese, as Mn Fume	1236A	7439-96-5		1		3		15	
Manganese cyclopentadienyl tricarbonyl, as Mn - Skin	1237	12079-65-1		0.1			None		
Mercury, as Hg - Skin		7439-97-6							
Aryl & inorganic compounds	1240			0.1				C 0.1	0.05 mg Hg/m^3, 8-hr TWA
Vapor	1241			0.05				C 0.1	0.05 mg Hg/m^3, 8-hr TWA
Alkyl compounds	1242			0.01		0.03		0.01 (C 0.04)	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Methacrylic acid	1244	79-41-4	20	70			None		
Methomyl (Lannate)	1245	16752-77-5		2.5			None		
4-Methoxyphenol	1247	150-76-5		5			None		
Methyl 2-cyanoacrylate	1248	137-05-3	2	8	4	16	None		
Methyl acetate	1249	79-20-9	200	610	250	760	200	610	
Methyl acetylene-propadiene mixture (MAPP)	1250		1,000	1,800	1,250	2,250	1,000	1,800	
Methylacrylonitrile - Skin	1251	126-98-7	1	3			None		
Methyl alcohol - Skin	1252	67-56-1	200	260	250	310	200	260	200 ppm (262 mg/m^3) TWA; 800 ppm (1,048 mg/m^3) ceiling (15 min)
Methyl demeton - Skin	1256	8022-00-2		0.5			None		
Methyl ethyl ketone peroxide	1257	1338-23-4	C 0.2	C 1.5			None		
Methyl formate	1258	107-31-3	100	250	150	375	100	250	
Methyl isoamyl ketone	1260	110-12-3	50	240			None		50 ppm (230 mg/m^3) TWA
Methyl isobutyl carbinol - Skin	1261	108-11-2	25	100	40	165	25	100	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Methyl isopropyl ketone	1262	563-80-4	200	705			None		
Methyl *n*-amyl ketone	1264	110-43-0	50	235			100	465	100 ppm (465 mg/m^3) TWA
Methyl parathion - Skin	1265	298-00-0		0.2			None		0.2 mg/m^3 TWA
Methyl silicate	1266	681-84-5	1	6			None		
alpha-Methyl styrene	1267	98-83-9	50	240	100	485	C 100	C 480	
Methylcyclohexane	1268	108-87-2	400	1,600			500	2,000	
Methylcyclohexanol	1269	25639-42-3	50	235			100	470	
o-Methylcyclohexanone - Skin	1270	583-60-8	50	230	75	345	100	460	
2-Methylcyclopentadienyl manganese tricarbonyl, as Mn - Skin	1271	12108-13-3		0.2			None		
Methylene bis(4-cyclohexylisocyanate)	1272	5124-30-1 (NIC	C 0.01 0.005	C 0.11 0.055)			None		55 µg/m^3 TWA 210 µg/m^3 Ceiling (10 min)
Metribuzin	1275	21087-64-9		5			None		
Mica	1276	12001-25-2		3, Respirable dust		3			
Monocrotophos	1279	6923-22-4		0.25			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Monomethylaniline - Skin (N-Methyl aniline)	1280	100-61-8	0.5	2			2	9	
Morpholine - Skin	1281	110-91-8	20	70	30	105	20	70	
Naphthalene	1282	91-20-3	10	50	15	75	10	50	
Nitric acid	1286	7697-37-2	2	5	4	10	2	5	2 ppm (5 mg/m^3) TWA
p-Nitroaniline - Skin	1287	100-01-6	0.05	3			1	6	
Nitrogen dioxide	1289	10102-44-0	3	6	5	10	C 5	C 9	1 ppm (1.8 mg/m^3) ceiling (15 min)
Nitroglycerin (NG) - Skin	1290	55-63-0	0.05	0.5			C 0.2	C 2	0.1 mg/m^3 ceiling (20 min) recommended limit for either substance alone or mixtures
Nitrotoluene - Skin	1292	99-08-1	2	11			5	30	
Nonane	1293	111-84-2	200	1,050			None		
Octachloronaphthalene - Skin	1295	2234-13-1		0.1		0.3		0.1	
Osmium tetroxide, as Os	1298	20816-12-0	0.0002	0.002	0.0006	0.006		0.002	
Oxalic acid	1299	144-62-7		1		2		1	
Oxygen difluoride	1300	7783-41-7	C 0.05	C 0.1			0.05	0.1	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Paraffin wax fume	1302	8002-74-2		2			None		
Paraquat, respirable sizes	1303	4685-14-7		0.1				0.5	
Pentaborane	1304	19624-22-7	0.005	0.01	0.015	0.03	0.005	0.01	
Perchloryl fluoride	1309	7616-94-6	3	14	6	28	3	13.5	
Phenothiazine - Skin	1313	92-84-2		5			None		
Phenyl ether (vapor)	1314	101-84-8	1	7	2	14	1	7	
Phenylphosphine	1318	638-21-1	C 0.05	C 0.25			None		
Phorate (Thimet) - Skin	1319	298-02-2		0.05		0.2	None		
Phosdrin (Mevinphos) - Skin	1320	7786-34-7	0.01	0.1	0.03	0.3		0.1	
Phosphine	1321	7803-51-2	0.3	0.4	1	1	0.3	0.4	
Phosphoric acid	1322	7664-38-2		1		3		1	
Phosphorus oxychloride	1323	10025-87-3	0.1	0.6	0.5	3	None		
Phosphorus pentasulfide	1324	1314-80-3		1		3		1	
Phosphorus trichloride	1325	7719-12-2	0.2	1.5	0.5	3	0.5	3	
Phthalic anhydride	1326	85-44-9	1	6			2	12	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
m-Phthalodinitrile	1327	626-17-5		5			None		
Picric acid - Skin	1329	88-89-1		0.1		0.3		0.1	
Piperazine dihydrochloride	1330	142-64-3		5			None		
Platinum Metal	1332	7440-06-4		1			None		
Potassium hydroxide	1334	1310-58-3		C 2			None		
Propargyl alcohol - Skin	1335	107-19-7	1	2			None		
Propionic acid	1336	79-09-4	10	30	15	45	None		
Propoxur (Baygon)	1337	114-26-1		0.5			None		
n-Propyl acetate	1338	109-60-4	200	840	250	1,050	200	840	
Propyl alcohol - Skin	1339	71-23-8	200	500	250	625	200	500	
n-Propyl nitrate	1340	627-13-4	25	105	40	170	25	105	
Propylene glycol dinitrate - Skin	1342	6423-43-4	0.05	0.3			None		
Propylene glycol monomethyl ether	1343	107-98-2	100	360	150	540	None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Resorcinol	1346	108-46-3	10	45	20	90	None		
Rhodium		7440-16-6							
Metal and Insoluble compounds, as Rh	1347			1				0.1	
Soluble salts, as Rh	1348			0.01				0.001	
Ronnel	1349	299-84-3		10				15	
Silica -- Amorphous*									
Percipitated silica and silica gel	1353			10				6	
Silicon tetrahydride	1361	7803-62-5	5	7			None		
Silver									
Metal, dust and fume	1362	7440-22-4		0.1				0.01	
Soapstone									
Respirable dust	1363			3			None		
Total dust	1363A			6			6		
The value is for total dust containing no asbestos and <1% free silica.									
Sodium azide	1364	26628-22-8	C 0.1	C 0.3			None		
Sodium bisulfite	1365	7631-90-5		5			None		
Sodium fluoroacetate - Skin	1366	62-74-8		0.05		0.15		0.05	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Sodium hydroxide	1367	1310-73-2		C 2				2	2mg/m^3 ceiling (15 min)
Sodium metabisulfite	1368	7681-57-4		5			None		
Stoddard solvent	1371	8052-41-3	100	525			500	2,900	350 mg/m^3 TWA; 1,800 mg/m^3 ceiling (15 min); Blood and urine monitoring required; action level: 350 mg/m^3 TWA
Styrene, monomer	1372	100-42-5	50	215	100	425	100 ppm TWA, 200 ppm Ceiling, 600 ppm Max Ceiling, (5 min in 3 hr)		50 ppm (213 mg/m^3) TWA; 100 ppm (426 mg/m^3) ceiling
Subtilisins (Proteolytic enzymes as 100% pure crystalline enzyme) (k) Based on "high volume" sampling.	1373	1395-21-7			C 0.00006 (k)		None		
Sulfur dioxide	1375	7446-09-5	2	5	5	10	5	13	0.5 ppm (1.3 mg/m^3) TWA
Sulfur monochloride	1376	10025-67-9	C 1	C 6			1	6	
Sulfur pentafluoride	1377	5714-22-7	C 0.01	C 0.1			0.025	0.25	
Sulfur tetrafluoride	1378	7783-60-0	C 0.1	C 0.4			None		
Sulfuryl fluoride	1379	2699-79-8	5	20	10	40	5	20	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Sulprofos	1380	35400-43-2		1			None		
Talc (containing no asbestos fibers)	1381	14807-96-6		2, Respirable dust			3		
Tantalum	1382	7440-25-7		5 (NIC 10 no asbestos and <1% crystalline silica)		10		5	
Terphenyls	1384	26140-60-3	C 0.5	C 5			C 1	C 9	
Tetraethyl lead, as Pb - Skin	1386	78-00-2		0.1				0.075	
Tetrahydrofuran	1387	109-99-9	200	590	250	735	200	590	
Tetramethyl lead, as Pb - Skin	1388	75-74-1		0.15				0.075	
Tetrasodium pyrophosphate	1389	7722-88-5		5			None		
Thioglycolic acid - Skin	1392	68-11-1	1	4			None		
Thionyl chloride	1393	7719-09-7	C 1	C 5			None		
Tin		7440-31-5							
Organic compounds, as Sn except SnH4, as Sn - Skin	1394			0.1				0.1	0.1 mg Sn/m^3 TWA
Metal, Oxide & inorganic compounds, as Sn	1395			2				2	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Toluene (toluol)	1397	108-88-3	100	375	150	560	200 ppm TWA, 300 ppm Ceiling, 500 ppm Max Ceiling (10 min)		100 ppm (375 mg/m^3), 8-hr TWA; 200 ppm (750 mg/m^3) ceiling (10 min)
Tributyl phosphate	1402	126-73-8	0.2	2.5				5	
1,1,2-Trichloro-1,2,2-trifluoroethane	1403	76-13-1	1,000	7,600	1,250	9,500	1,000	7,600	
Trichloroacetic acid	1404	76-03-9	1	7			None		
1,2,4-Trichlorobenzene	1405	120-82-1	C 5	C 40			None		
Trimellitic anhydride	1409	552-30-7	0.005	0.04			None		Should be handled in the workplace as an extremely toxic substance
Trimethyl phosphite	1410	121-45-9	2	10			None		
Trimethylamine	1411	75-50-3	10	24	15	36	None		
Trimethyl benzene	1412	25551-13-7	25	125			None		
2,4,6-Trinitrotoluene (TNT) - Skin	1413	118-96-7		0.5				1.5	
Triorthocresyl phosphate - Skin	1414	78-30-8		0.1				0.1	
Triphenyl amine	1415	603-34-9		5			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N1 - Proposed PELs
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Tungsten, as W		7440-33-7							
Insoluble compounds	1416			5		10	None		5 mg W/m^3 TWA;
Soluble compounds	1417			1		3	None		1 mg W/m^3 TWA;
n-Valeraldehyde	1420	110-62-3	50	175			None		
Vinyl toluene	1427	25013-15-4	50	240	100	485	100	480	
VM & P Naphtha	1429	8030-30-6	300	1,350			None		350 mg/m^3 TWA 1,800 mg/m^3 ceiling (15 min) Blood and urine monitoring required; action level: 200 mg/m^3 TWA
Xylene (o-, m-, p-isomers)	1431	1330-20-7	100	435	150	655	100	435	100 ppm (434 mg/m^3) TWA; 200 ppm (868 mg/m^3) ceiling (10 min)
m-Xylene alpha, alpha'-diamine - Skin	1432	1477-55-0		C 0.1			None		
Xylidine - Skin	1433	1300-73-8	2	10			5	25	
Zinc chloride fume	1435	7646-86-7		1		2		1	
Zinc oxide fume	1437	1314-13-2		5		10		5	5 mg/m^3 TWA; 15 mg/m^3 ceiling (15 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N2 - Proposed PELs
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Acrylic acid	1009	79-10-7	10	30			None		
		(NIC	2	6)					
n-Butyl glycidyl ether (BGE)	1052	2426-08-6	25	135			50	270	4.4 ppm (30 mg/m^3) ceiling (15 min)
Camphor, synthetic	1063	76-22-2	2	12	3	18	0.3	2	
Caprolactam		105-60-2							
Vapor	1065		5	20	10	40	None		
		(NIC	0.25	1)					
Coal dust <5% quartz	1096			2, Respirable fraction				2.4	
>5% quartz	1097			0.1 Respirable quartz				$10\div(\%SiO_2+2)$	
Disulfoton	1152	298-04-4		0.1			None		
Ethyl bromide	1163	74-96-4	200	890	250	1,110	200	890	
Ethyl ether	1164	60-29-7	400	1,200	500	1,500	400	1,200	
Ethylene glycol vapor	1169	107-21-1	C 50	C 125			None		
Fenthion - Skin	1175	55-38-9		0.2			None		
Fluorine	1179	7782-41-4	1	2	2	4	0.1	0.2	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N2 - Proposed PELs
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Formamide (NIC - skin)	1182	75-12-7 (NIC	20 10	30 15)	30	45	None		
Furfural - Skin	1183	98-01-1	2	8			5	20	
Heptane (n-Heptane)	1194	142-82-5	400	1,600	500	2,000	500	2,000	85 ppm (350 mg/m^3) TWA; (Mixtures not to exceed 350 mg/m^3 TWA); 440 ppm (1,800 mg/m^3) ceiling (15 min) singly or mixtures; Action level set at 200 mg/m^3 for C5-C8 alkanes
Hexane isomers	1201		500	1,800	1,000	3,600			100 ppm (350 mg/m^3) TWA; (Mixtures not to exceed 350 mg/m^3 TWA); 510 ppm (1,800 mg/m^3) ceiling (15 min) singly or mixtures; Action level set at 200 mg/m^3 for C5-C8 alkanes
2-Hexanone (Methyl n-butyl ketone)	1202	591-78-6	5	20			100	410	1 ppm (4 mg/m^3) TWA
Isopropoxyethanol	1223	109-59-1	25	105			None		
Isopropyl acetate	1224	108-21-4	250	950	310	1,185	250	950	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N2 – Proposed PELs
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Isopropylamine	1228	75-31-0	5	12	10	24	5	12	
Manganese tetroxide	1238	1317-35-7		1			None		
Mesityl oxide	1243	141-79-7	15	60	25	100	25	100	10 ppm (40 mg/m^3) TWA
Octane	1296	111-65-9	300	1,450	375	1,800	500	2,350	75 ppm (350 mg/m^3) TWA; (Mixtures not to exceed 350 mg/m^3 TWA); 385 ppm (1,800 mg/m^3) ceiling (15 min) singly or mixtures; Action level set at 200 mg/m^3 for C5-C8 alkanes
Ozone	1301	10028-15-6 (NIC	0.1 C 0.1	0.2 C 0.2)	0.3	0.6	0.1	0.2	
Pentane	1306	109-66-0	600	1,800	750	2,250	1,000	2,950	120 ppm (350 mg/m^3) TWA; (Mixtures not to exceed 350 mg/m^3 TWA); 610 ppm (1,800 mg/m^3) ceiling (15 min) singly or mixtures; Action level set at 200 mg/m^3 for C5-C8 alkanes
2-Pentanone (Methyl propyl ketone)	1307	107-87-9	200	700	250	875	200	700	150 ppm (530 mg/m^3) TWA

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N2 - Proposed PELs
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Silica -- Amorphous* Diatomaceous earth (uncalcined)	1352	68855-54-9		10				6	
m-Toluidine - Skin	1401	108-44-1	2	9			None		
Triethylamine	1408	121-44-8	10	40	15	60	25	100	
Vinyl acetate	1424	108-05-4	10	30	20	60	None		4 ppm (15 mg/m^3) ceiling (15 min)
Zirconium compounds, as Zr	1439	7440-67-2		5		10		5	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
2-Aminopyridine		504-29-0	0.5	2			0.5	2	
n-Amyl acetate		628-63-7	100	530			100	525	
sec-Amyl acetate		626-38-0	125	665			125	650	
Antimony & compounds, as Sb		7440-36-0		0.5				0.5	0.5 mg Sb/m^3 TWA
Antimony trioxide Handling and use, as Sb		1309-64-4		0.5			None		0.5 mg Sb/m^3 TWA
ANTU		86-88-4		0.3				0.3	
Azinphos-methyl - Skin		86-50-0		0.2				0.2	
Barium, soluble compounds, as Ba		7440-39-3		0.5				0.5	
Benzoyl peroxide		94-36-0		5				5	5 mg/m^3 TWA
Biphenyl		92-52-4	0.2	1.5			0.2	1.5	
Boron trifluoride		7637-07-2	C 1	C 3			C 1	C 3	No exposure limit recommended due to the absence of a reliable monitoring method
Bromoform - Skin		75-25-2	0.5	5			0.5	5	
sec-Butyl acetate		105-46-4	200	950			200	950	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
tert-Butyl acetate		540-88-5	200	950			200	950	
Butylamine - Skin		109-73-9	C 5	C 15			C 5	C 15	
Carbaryl		63-25-2		5				5	5 mg/m^3 TWA reproductive effects; minimum exposure during pregnancy
Chlorinated diphenyl oxide		55720-99-5		0.5		2		0.5	
Chlorine trifluoride		7790-91-2	C 0.1	C 0.4			C 0.1	C 0.4	
Chloroacetaldehyde		107-20-0	C 1	C 3			C 1	C 3	
alpha-Chloroacetophenone		532-27-4	0.05	0.3			0.05	0.3	
Chlorobromomethane		74-97-5	200	1,050	250	1,300	200	1,050	
Chloropicrin		76-06-2	0.1	0.7	0.3	2	0.1	0.7	
Chromium (II) compounds, Cr (Soluble)				0.5				0.5	
Chromium (III) compounds, Cr (Soluble)				0.5				0.5	
Copper Dusts & mists, as Cu		7440-50-8		1				1	
Crotonaldehyde		4170-30-3	2		7		2		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Cumene - Skin		98-82-8	50	245			50	245	
Cyclohexane		110-82-7	300	1,050			300	1,050	
Cyclohexene		110-83-8	300	1,015			300	1,015	
Cyclopentadiene		542-92-7	75	200			75	200	
2,4-D		94-75-7		10				10	
Demeton - Skin		8065-48-3	0.01	0.1				0.1	
Diacetone alcohol		123-42-2	50	240			50	240	50 ppm (240 mg/m^3) TWA
Diazomethane		334-88-3	0.2	0.4			0.1	0.4	
Diborane		19287-45-7	0.1	0.1			0.1	0.1	
Dibutyl phthalate		84-74-2		5				5	
o-Dichlorobenzene		95-50-1	C 50	300			C 50	C 300	
Dichlorodifluoromethane		75-71-8	1,000	4,950			1,000	4,950	
1,2-Dichloroethylene		540-59-0	200	790			200	790	
Dichlorotetrafluoroethane		76-14-2	1,000	7,000			1,000	7,000	
Dichlorvos - Skin		62-73-7	0.1	1				1	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
2-Diethylaminoethanol - Skin		100-37-8	10	50			10	50	
Difluorodibromomethane		75-61-6	100	860			100	860	
Diisopropylamine - Skin		108-18-9	5	20			5	20	
Dimethyl acetamide - Skin		127-19-5	10	35			10	35	
Dimethylamine		124-40-3	10	18			10	18	
Dimethylformamide - Skin		68-12-2	10	30			10	30	
Dimethylphthalate		131-11-3		5				5	
Dinitro-o-cresol - Skin		534-52-1		0.2				0.2	0.2 mg/m^3 TWA
Dinitrobenzene (all isomers) - Skin		528-29-0; 99-65-0; 100-25-4; 25154-54-5	0.15	1				1	
Endrin - Skin		72-20-8		0.1				0.1	
EPN - Skin		2104-64-5		0.5				0.5	
Ethyl acetate		141-78-6	400	1,400			400	1,400	
Ethyl alcohol		64-17-5	1,000	1,900			1,000	1,900	
Ethyl amyl ketone		541-85-5	25	130			25	130	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Ethylamine		75-04-7	10	18			10	18	
Ethyl butyl ketone		106-35-4	50	230			50	230	
Ethylenediamine		107-15-3	10	25			10	25	
Ethyl formate		109-94-4	100	300			100	300	
Fluorides, as F				2.5				2.5	2.5 mg F/m^3 TWA
Formic acid		64-18-6	5	9			5	9	
Hafnium		7440-58-6		0.5				0.5	
Hexachloronaphthalene		1335-87-1		0.2				0.2	
sec-Hexyl acetate		108-84-9	50	300			50	300	
Hydrogen chloride		7647-01-0	C 5	C 7			C 5	C 7	
Hydrogen peroxide		7722-84-1	1	1.5			1	1.4	
Hydrogen selenide, as Se		7783-07-5	0.05	0.2			0.05	0.2	
Iodine		7553-56-2	C 0.1	C 1			C 0.1	C 1	
Isoamyl acetate		123-92-2	100	525			100	525	
Isobutyl acetate		110-19-0	150	700	187	875	100	750	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Lindane - Skin		58-89-9		0.5				0.5	
Lithium hydride		7580-67-8		0.025				0.025	
L.P.G. (Liq. petr. gas)		68476-85-7	1,000	1,800			1,000	1,800	
Maleic anhydride		108-31-6	0.25	1			0.25	1	
Methyl acetylene		74-99-7	1,000	1,650	1,250	2,040	1,000	1,650	
Methyl acrylate - Skin		96-33-3	10	35			10	35	
Methylal		109-87-5	1,000	3,100			1,000	3,100	
Methylamine		74-89-5	10	12			10	12	
Methylene bisphenyl isocyanate (Diphenylmethane diisocyanate; MDI)		101-68-8	C 0.02	C 0.2			0.02	0.2	50 µg/m^3 (5 ppb) TWA, 200 µg/m^3 (20 ppb) ceiling (10 min).
Methyl isocyanate - Skin		624-83-9	0.02	0.05			0.02	0.05	
Methyl methacrylate		80-62-6	100	410			100	410	
Nickel Metal		7440-02-0		1				1	
Nicotine - Skin		54-11-5		0.5				0.5	
Nitric oxide		10102-43-9	25	30			25	30	25 ppm (30 mg/m^3) TWA

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Nitrobenzene - Skin		98-95-3	1	5			1	5	
Nitroethane		79-24-3	100	310			100	310	
Nitrogen trifluoride		7783-54-2	10	30			10	29	
1-Nitropropane		108-03-2	25	90			25	90	
Pentachloronaphthalene		1321-64-8		0.5				0.5	
Pentachlorophenol - Skin		87-86-5		0.5				0.5	
Perchloromethyl mercaptan		594-42-3	0.1	0.8			0.1	0.8	
p-Phenylene diamine - Skin		106-50-3		0.1				0.1	
Phosphorus (yellow)		7723-14-0		0.1				0.1	
Phosphorus pentachloride		10026-13-8	0.1	1				1	
Pindone		83-26-1		0.1			None		
Platinum Soluble salts, as Pt		7440-06-4		0.002				0.002	
Propane		74-98-6	E (Single asphyxiant)				1,000	1,800	
Pyrethrum		8003-34-7		5				5	
Pyridine		110-86-1	5	15			5	15	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Quinone		106-51-4	0.1	0.4			0.1	0.4	
Rotenone (commercial)		83-79-4		5				5	
Selenium compounds, as Se		7782-49-2		0.2				0.2	
Selenium hexafluoride, Se		7783-79-1	0.05	0.2			0.05	0.4	
Silver Soluble compounds, as Ag		7440-22-4		0.01				0.01	
Stibine		7803-52-3	0.1	0.5			0.1	0.5	
Strychnine		57-24-9		0.15				0.15	
Sulfotep - Skin		3689-24-5		0.2				0.2	
Sulfur hexafluoride		2551-62-4	1,000	6,000			1,000	6,000	
Sulfuric acid		7664-93-9		1				1	1 mg/m^3 TWA
2,4,5-T		93-76-5		10				10	
Tellurium & compounds, Te		13494-80-9		0.1				0.1	
Tellurium hexafluoride, Te		7783-80-4	0.02	0.2			0.02	0.2	
TEPP - Skin		107-49-3	0.004	0.05				0.05	
1,1,1,2-Tetrachloro-2,2-difluoroethane		76-11-9	500	4,170			500	4,170	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
1,1,2,2-Tetrochloro-1,2-difluoroethane		76-12-0	500	4,170			500	4,170	
Tetrachloronaphthalene		1335-88-2		2				2	
Tetramethyl succinonitrile		3333-52-6	0.5	3			0.5	3	1 ppm (6 mg/m^3) ceiling (15 min); When present as mixtures or with other sources of cyanide, exposure to be considered additive and environmental limit to be calculated
Tetranitromethane		509-14-8	1	8			1	8	
Tetryl - Skin		479-45-8		1.5				1.5	
Thallium Soluble compounds, as Tl		7440-28-0		0.1				0.1	
Thiram		137-26-8		5				5	
Trichloronaphthalene		1321-65-9		5				5	
Trifluorobromomethane		75-63-8	1,000	6,100			1,000	6,100	
Triphenyl phosphate		115-86-6		3				3	
Turpentine		8006-64-2	100	560			100	560	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3A - Established PELs Not Addressed in Current Rulemaking
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Warfarin		81-81-2		0.1				0.1	
Yttrium		7440-65-5		1		3		1	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N3B - Established PELs Not Addressed in Current Rulemaking
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Acetylene tetrabromide		79-27-6	1	15			1	15	
Chlorobenzene		108-90-7	75	350			75	350	
Chromium (II) compounds, Cr (Insoluble)				0.5				1.0	
Chromium (III) compounds, Cr (Insoluble)				0.5				1.0	
Cresol, all isomers - Skin		1319-77-3	5	22			5	22	2.3 ppm (10 mg/m^3) TWA
Manganese dust & compounds		7439-96-5		C5 (NIC 5)				C5	
Molybdenum, as Mo Soluble compounds		7439-98-7		5				5	
Nitromethane		75-52-5	100	250			100	250	
Parathion - Skin		56-38-2		0.1				0.1	0.05 mg/m^3 TWA

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N4 - Nuisance Dusts

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL	PROPOSED TABLE NUMBER**
alpha-Alumina*	1014	1344-28-1		10				15		N2
Aluminum Metal & oxide	1016	7429-90-5		10				15		***
Ammonium sulfamate	1024	7773-06-0		10				15		N1
Barium sulfate*	1031	7724-43-7		10				15		***
Benomyl	1032	17804-35-2		10				15		N2
Bismuth telluride (undoped)	1035	1304-82-1		10				15		***
Boron oxide	1039	1303-86-2		10				15		N1
Calcium carbonate*	1057	1317-65-3		10				15		***
Calcium silicate*	1061	1344-95-2		10				15		***
Calcium sulfate*	1062	7778-18-9		10				15		***
Cellulose (paper fiber)*	1076	9004-34-6		10				15		***
2-Chloro-6-trichloromethyl pyridine (Nitrapyrin)	1082	1929-82-4		10		20		15		N1

*The value is for total dust containing no asbestos and <1% free silica
**The proposed table number that NIOSH has assigned based on an evaluation of the health effects
***NIOSH has not evaluated these chemicals in-depth

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N4 - Nuisance Dusts

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL	PROPOSED TABLE NUMBER**
Clopidol	1095	2971-90-6		10		20		15		N1
Crag Herbicide (Sesone)	1102	136-78-7		10				15		N1
Dicyclopentadienyl iron	1133	102-54-5		10				15		N1
Emery*	1155	112-62-9		10				15		N2
Ferbam	1176	14484-64-1		10				15		N1
Fibrous glass dust	1178			10			Nuisance dust PEL applies, 15 mg/m^3 total dust; 5 mg/m^3 respirable fraction		3 million fibers/ m^3 TWA (fibers $\leq$3.5 µm diameter and $\geq$10 µm length); 5 mg/m^3 TWA (total fibrous glass)	N6B
Glycerin (mist)*	1188	56-81-5		10				15		N2
Graphite (synthetic)*	1191A			10				15		N2
Gypsum*	1192	see HS #1062								***
Kaolin*	1230			10				15		***
Limestone*	1232	see HS #1057								***
Magnesite*	1233	546-93-0		10				15		***

*The value is for total dust containing no asbestos and <1% free silica
**The proposed table number that NIOSH has assigned based on an evaluation of the health effects
***NIOSH has not evaluated these chemicals in-depth

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N4 - Nuisance Dusts

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL	PROPOSED TABLE NUMBER**
Magnesium oxide fume	1234	1309-48-4		10				15		N2
Malathion - Skin	1235	121-75-5		10				15	15 mg/m^3 TWA	N1
Marble*	1239	see HS #1057								***
Methoxychlor	1246	72-43-5		10				15		N6A
Mineral wool fiber*	1277			10				15		N6B
Molybdenum, as Mo Insoluble compounds	1278	7439-98-7		10				15		N2
Nuisance particulates*	1294			10				15		†
Oil mist, mineral (excluding vapor)	1297	8012-95-1		5		10		5		N1
Pentaerythritol*	1305	115-77-5		10				15		***
Perlite*	1310			10						***
Picloram (Tordom)	1328	1918-02-1		10		20		15		N2
Plaster of Paris*	1331	see HS #1062								***

*The value is for total dust containing no asbestos and <1% free silica
**The proposed table number that NIOSH has assigned based on an evaluation of the health effects
***NIOSH has not evaluated these chemicals in-depth
†See testimony

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N4 - Nuisance Dusts

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL	PROPOSED TABLE NUMBER**
Portland cement*	1333	65997-15-1		10				15		***
Rouge*	1351			10				15		N2
Silicon*	1359	7440-21-3		10				15		***
Silicon carbide*	1360	409-21-2		10				15		***
Starch*	1369	9005-25-8		10				15		***
Sucrose*	1374	57-50-1		10				15		N1
Temephos (abate)	1383	3383-96-8		10				15		N1
4,4'-Thiobis(6-tert-butyl-m-cresol)	1391	96-69-5		10				15		N1
Titanium dioxide*	1396	13463-67-7		10				15		N6B
Vegetable oil mists* (except castor oil, cashew nut, or similar irritant oils)	1423			10				15		N1
Zinc stearate*	1434	557-05-1		10				15		N1
Zinc oxide dust*	1438	1314-13-2		10				5	5 mg ZnO/m^3 TWA; 15 mg ZnO/m^3 ceiling (15 min)	N2

*The value is for total dust containing no asbestos and <1% free silica
**The proposed table number that NIOSH has assigned based on an evaluation of the health effects
***NIOSH has not evaluated these chemicals in-depth

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Acetaldehyde	1001	75-07-0	100	180	150	270	200	360	
Asphalt (petroleum) fumes	1028	8052-42-4		5			None		5 mg/m^3 ceiling measured as total particulate (15 min)
Beryllium & compounds, as Be	1033	7440-41-7		0.002,A2			2 µg/m^3 TWA, 5 µg/m^3 Ceiling, 25 µg/m^3 Max Ceiling (30 min)		Not to exceed 0.5 µg Be/m^3
Chlorinated camphene - Skin	1078	8001-35-2		0.5		1		0.5	
Chromic Acid and chromates	1092	7440-47-3		0.05				C 0.1	25 µg/m^3 TWA 50 µg/m^3 ceiling (15 min)
Chromyl chloride	1094	14977-61-8	0.025	0.15				1	Carcinogenic Cr (VI): 1 µg/m^3 TWA;
DDT (Dichlorodiphenyl-trichloroethane)	1113	50-29-3		1				1	Lowest reliably detectable level; 0.5 mg/m^3 TWA
p-Dichlorobenzene	1125	106-46-7	75	450	110	675	75	450	
Epichlorohydrin - Skin	1158	106-89-8	2	10			5	19	Occupational exposure to epichlorohydrin to be minimized

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Ethyl acrylate - Skin	1161	140-88-5	5	20 (NIC 15	25	100 61)	25	100	
Gasoline	1185	8006-61-9	300	900	500	1,500	None		
Hydrazine - Skin	1205	302-01-2	0.1,A2	0.1,A2			1	1.3	0.03 ppm (0.04 mg/m^3) ceiling (120 min)
Methyl bromide - Skin	1253	74-83-9	5	20			20	80	Exposure should be reduced to the lowest feasible level
Methyl chloride	1254	74-87-3	50	105	100	205	100 ppm TWA, 200 ppm Ceiling, 300 ppm Max Ceiling, (5 min in 3 hr)		Exposure to methyl chloride, should be reduced to the lowest feasible level
4,4'Methylene bis(2-chloroaniline) - Skin	1273	101-14-4	0.02,A2	0.22,A2			PEL revoked by OSHA August 1975		3µg/m^3 TWA (lowest detectable limit)
Nickel		7440-02-0							
Soluble or (inorganic) compounds, as Ni	1283			0.1				1	15 µg Ni/m^3 TWA
p-Nitrochlorobenzene	1288	100-00-5 (NIC	0.5 0.1	3 0.6)				1	
2-Nitropropane	1291	79-46-9	10,A2	35,A2			25	90	Reduce exposure to lowest feasible level

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Perchloroethylene	1308	127-18-4	50	335	200	1,340	100 ppm TWA, 200 ppm Ceiling, 300 ppm Max Ceiling, (5 min in 3 hr)		Minimize workplace exposure levels; limit number of workers exposed
Phenyl glycidyl ether (PGE)	1315	122-60-1	1	6			10	60	1 ppm (5 mg/m^3) ceiling (15 min)
Phenylhydrazine - Skin	1317	100-63-0	5,A2	20,A2	10,A2	45,A2	5	22	0.14 ppm (0.6 mg/m^3) ceiling (120 min)
Propylene dichloride	1341	78-87-5	75	350	110	510	75	350	
Propylene oxide	1344	75-56-9	20	50			100	240	
Rosin core solder pyrolysis products, as formaldehyde	1350			0.1			None		0.1 ppm ceiling (15 min)
Silica -- Crystalline									
Quartz	1355	14808-60-7		0.1, Respirable dust			10÷(%SiO_2+2), Respirable dust		50 µg/m^3 TWA, respirable free, silica
Tripoli	1357	1317-95-9		0.1, Respirable dust			10÷(%SiO_2+2), Respirable dust		
Silica, fused	1358	60676-86-0		0.1, Respirable dust			10÷(%SiO_2+2), Respirable dust		
p-Toluidine - Skin	1400	106-49-0	2,A2	9,A2			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Vinyl bromide	1425	593-60-2	5,A2	20,A2			None		Controlled as specified for vinyl chloride in 29 CFR 1910.1017 with eventual goal of zero exposure
Vinylidene chloride	1428	75-35-4	5	20	20	80	None		Controlled as specified for vinyl chloride in 29 CFR 1910.1017 with eventual goal of zero exposure
Welding fumes	1430			5,B2			None		Lowest feasible level
Wood Dust, softwood	1430b			5		10	None		
Zinc chromate, as Cr	1436	13530-65-9	(NIC	0.05,A2 0.01,A1)				0.1	Carcinogenic Cr (VI): 1 µg/m^3 TWA; other Cr (VI): 25 µg/m^3 TWA; 50 µg/m^3 ceiling (15 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Arsine		7784-42-1	0.05	0.2			0.05	0.2	2 µg As/m^3 (0.002 mg As/m^3) ceiling (15 min)
Benzo(a)pyrene		50-32-8		A2			None		
tert-Butyl chromate, as CrO3 - Skin		1189-85-1		C 0.1				C 0.1	1 µg/m^3 TWA
Carbon black		1333-86-4		3.5				3.5	3.5 mg/m^3 TWA; 0.1 mg/m^3 TWA in presence of polycyclic aromatic hydrocarbons
Chlorodiphenyl - Skin (42% Chlorine)		53469-21-9		1		2		1	1 µg/m^3 TWA (the minimum reliably detectable concentration using the recommended sampling and analytical methods)
Chlorodiphenyl - Skin (54% Chlorine)		11097-69-1		0.5		1		0.5	1 µg/m^3 TWA (the minimum reliably detectable concentration using the recommended sampling and analytical methods)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Chromite ore processing (Chromates) as Cr				0.05,A1				1	25 µg/m^3 (0.025 mg/m^3 TWA; 50 µg/m^3 (0.05 mg/m^3 ceiling (15 min) as noncarcinogenic Cr (VI) Carcinogenic Cr (VI): 1 µg/m^3 TWA:
Chromium (VI) compounds, Cr									
Water soluble				0.05				0.5	Carcinogenic Cr (VI): 1 µg/m^3 TWA; other Cr (VI): 25 µg/m^3 TWA; 50 µg/m^3 ceiling (15 min)
Certain water insoluble				0.05,A1					
Chrysene		218-01-9	A2	A2			None		To be controlled as an occupational carcinogen
Coal tar pitch volatiles, as benzene solubles		65996-93-2		0.2,A1				0.2	0.1 mg/m^3 TWA (cyclohexane-extractable fraction)
Dimethyl carbamoyl chloride		79-44-7	A2	A2			None		Reduce exposure to lowest feasible limit
1,1-Dimethylhydrazine - Skin		57-14-7	0.5,A2	1,A2			0.5		0.06 ppm (0.15 mg/m^3) ceiling (120 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6B - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH non-concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Ethyl chloride		75-00-3	1,000	2,600			1,000	2,600	To be handled in the workplace with caution because of structural similarity to carcinogenic chloroethanes
Lead chromate as Cr		7758-97-6		0.05,A2			None		Carcinogenic Cr (VI): 1 µg/m^3 TWA; other Cr (VI): 25 µg/m^3 TWA; 50 µg/m^3 ceiling (15 min)
Methyl hydrazine - Skin		60-34-4	C 0.2,A2	C 0.35,A2			C 0.2	C 0.35	0.04 ppm (0.08 mg/m^3) ceiling (120 min)
Nickel sulfide roasting, fume & dust, as Ni				1,A1			None		15 µg Ni/m^3 TWA
N-Phenyl-beta-naphthylamine		135-88-6	A2	A2			None		Reduce exposure to lowest feasible level
Propane sultone		1120-71-4	A2	A2			None		
o-Tolidine - Skin		119-93-7	A2	A2			None		20 µg/m^3 ceiling (60 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N5 - NIOSH RELs not Included in OSHA Rulemaking

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Acetone cyanohydrin		75-86-5	None				None		1 ppm (4 mg/m^3) ceiling (15 min), Nitriles
Acetylene		74-86-2	E (simple asphyxiant)				None		No exposure >2,500 ppm (2,662 mg/m^3)
Adiponitrile		111-69-3	None				None		4 ppm (18 mg/m^3) TWA Nitriles
n-Butyronitrile		109-74-0	None				None		8 ppm (22 mg/m^3) TWA Nitriles
Cetylmercaptan		2917-26-2	None				None		1-Hexadecanethiol: 0.5 ppm (5.3 mg/m^3) Ceiling (15 min)
Cyclonexylmercaptan		1569-69-3	None				None		Cyclohexanethiol: 0.5 ppm (2.4 mg/m^3) Ceiling (15 min)
Decylmercaptan		143-10-2	None				None		1-Decanethiol: 0.5 ppm (3.6 mg/m^3) Ceiling (15 min)
2,4-Diaminoanisole		615-05-4	None				None		Ca; reduce exposure to lowest feasible level
o-Dianisidine - based dyes		various	None				None		Ca; should be handled in the workplace with caution; exposure should be minimized

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N5 - NIOSH RELs not Included in OSHA Rulemaking

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
bis(2-Dimethylamino-ethyl)ether		3033-62-3	None				None		Exposure be minimized to NIAX Catalyst ESN
Dimethylaminopropionitrile		1738-25-6	None				None		Exposure be minimized to NIAX Catalyst ESN
Dodecylmercaptan		112-55-0	None				None		1-Dodecanethiol: 0.5 ppm (4.1 mg/m^3) Ceiling (15 min)
Enflurane		13838-16-9	None				None		2 ppm (15.1 mg/m^3) Ceiling (1 hr) Waste Anesthetic Gases
Ethylene thiourea		96-45-7	None				None		Ca; should be used in encapsulated form in industry; worker exposure be minimized
Fluroxene		406-90-6	None				None		2 ppm (10.3 mg/m^3) Ceiling (1 hr)
Glycolonitrile		107-16-4	None				None		2 ppm (5 mg/m^3) Ceiling (15 min), Nitriles
Halothane		151-67-7	None				None		2 ppm (16.2 mg/m^3) Ceiling (1 hr)
n-Heptylmercaptan		1639-09-4	None				None		1-Heptanethiol: 0.5 ppm (2.7 mg/m^3) Ceiling (15 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N5 - NIOSH RELs not Included in OSHA Rulemaking

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Hexamethylene diisocyanate (HDI)		822-06-0	None				None		35 µg/m^3 TWA, 140 µg/m^3 Ceiling (10 min), Diisocyanate
n-Hexylmercaptan		111-31-9	None				None		1-Hexanethiol: 0.5 ppm (2.4 mg/m^3) Ceiling (15 min)
Isobutyronitrile		78-82-0	None				None		8 ppm (22 mg/m^3) TWA; Nitriles
Kepone		143-50-0	None				None		Ca; 1 µg/m^3 TWA
Kerosene		8008-20-6	None				None		100 mg/m^3 TWA Refined Petroleum Solvents
Malononitrile		109-77-3	None				None		3 ppm (8 mg/m^3) TWA Nitriles
Methoxyflurane		76-38-0	None				None		2 ppm; (13.5 mg/m^3) Ceiling (1 hr)
Naphthalene diisocyanate (NDI)		25551-28-4	None				None		40 µg/m^3 TWA, 170 µg/m^3 Ceiling, (10 min) Diisocyanate
2-Nitro-naphthalene		581-89-5	None				None		Ca; reduce exposure to lowest feasible level

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N5 - NIOSH RELs not Included in OSHA Rulemaking

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Nitrous oxide		10024-97-2	None				None		25 ppm TWA
n-Nonylmercaptan		1455-21-6	None				None		1-Nonanethiol: 0.5 ppm (3.3 mg/m^3) Ceiling (15 min)
Octadecylmercaptan		2885-00-9	None				None		1-Octadecanethiol; 0.5 ppm (5.9 mg/m^3) Ceiling (15 min)
n-Octylmercaptan		111-88-6	None				None		1-Octanethiol: 0.5 ppm (3.0 mg/m^3) Ceiling (15 min)
Pentachloroethane		76-01-70	None				None		To be handled with caution in the workplace due to similarity to carcinogenic chloroethanes
Pentylmercaptan		110-66-7	None				None		1-Pentanethiol: 0.5 ppm (2.1 mg/m^3) Ceiling (15 min)
Propionitrile		107-12-0	None				None		6 ppm (14 mg/m^3) TWA Nitriles
n-Propylmercaptan		107-03-9	None				None		1-Propanethiol: 0.5 ppm (1.6 mg/m^3) Ceiling (15 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N5 - NIOSH RELs not Included in OSHA Rulemaking

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Succinonitrile		110-61-2	None				None		6 ppm (20 mg/m^3) TWA Nitriles
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)		1746-01-6	None				None		Ca; reduce exposure to lowest feasible level
1,1,1,2-Tetrachloroethane		630-20-6	None				None		To be handled in the workplace with caution due to similarity to carcinogenic Chloroethane
o-Tolidine based dyes		various	None				None		Ca; should be handled in the workplace with caution; minimize exposures
1-Undecanethiol		5332-52-5	None				None		Undecanethiol: 0.5 ppm (3.9 mg/m^3) Ceiling (15 min)
Vinyl fluoride		75-02-5	None				None		1 ppm TWA, 5 ppm Ceiling to be controlled as specified for vinyl chloride in 29 CFR 1910.1017
Vinylidene fluoride		75-38-7	None				None		1 ppm TWA 5 ppm Ceiling (15 min) to be controlled as specified for vinyl chloride in 29 CFR 1910.1017

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6A - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Acrylamide - Skin	1008	79-06-1		0.03,A2				0.3	0.3 mg/m^3 TWA
Amitrole (3-Amino-1,2,4-triazole)	1020	61-82-5		0.2			None		
Aniline & homologues - Skin	1025	62-53-3	2	10			5	19	
Captafol - Skin	1066	2425-06-1		0.1			None		
Captan	1067	133-06-2		5			None		
Carbon tetrachloride - Skin	1073	56-23-5	5,A2	30,A2			10 ppm TWA, 25 ppm Ceiling, 200 ppm Max Ceiling		2 ppm (12.6 mg/m^3) ceiling 45 liter sample (60 min)
Chloroform	1086	67-66-3	10,A2	50,A2			C 50	C 240	2 ppm (9.78 mg/m^3) ceiling 45 liter sample (60 min)
Di-sec-octyl phthalate	1116	117-81-7		5		10		5	Reduce exposure to lowest feasible level
Dichloroacetylene	1123	7572-29-4	C 0.1	C 0.4			None		
Dichloroethyl ether - Skin	1127	111-44-4	5	30	10	60	C 15	C 90	
Dichloropropene - Skin	1129	542-75-6	1	5			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6A - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Diglycidyl ether (DGE)	1139	2238-07-5	0.1	0.5			C 0.5	C 2.8	0.2 ppm (1 mg/m^3) ceiling (15 min)
Dimethyl sulfate - Skin	1142	77-78-1	0.1,A2	0.5,A2			1	5	
Dioxane - Skin	1145	123-91-1	25	90			100	360	1 ppm (3.6 mg/m^3) ceiling (30 min)
Ethylene dichloride	1168	107-06-2	10	40			50 ppm TWA, 100 ppm Ceiling, 200 ppm Max Ceiling (5 min in 3 hr)		1 ppm (4 mg/m^3) TWA; 2 ppm (8 mg/m^3) ceiling (15 min)
Hexachlorobutadiene - Skin	1195	87-68-3	0.02,A2	0.24,A2			None		
Hexachloroethane - Skin	1197	67-72-1	10	100			1	10	Reduce exposure to lowest feasible level
		(NIC	1	10)					
Methyl iodide - Skin	1259	74-88-4	2,A2	10,A2			5	28	Exposure to methyl iodide should be reduced to the lowest feasible level

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6A - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV TWA ppm	TLV TWA mg/m^3	TLV STEL ppm	TLV STEL mg/m^3	PEL ppm	PEL mg/m^3	REL
Nickel carbonyl, as Ni	1284	13463-39-3	0.05	0.35			0.001	0.007	1 ppb (7 $\mu g/m^3$) TWA (lowest detectable level)
Silica -- Crystalline									
Cristobalite	1354	14464-46-1		0.05, Respirable dust			$5\div(\%SiO_2+2)$ Respirable dust		50 $\mu g/m^3$ TWA, respirable free silica
Tridymite	1356	15468-32-3		0.05, Respirable dust			$5\div(\%SiO_2+2)$ Respirable dust		
1,1,2,2-Tetrachloroethane - Skin	1385	79-34-5	1	7			5	35	Reduce exposure to lowest feasible level
Toluene-2,4-diisocyanate (TDI)	1398	584-84-9	0.005	0.04	0.02	0.15	0.02	0.14	Toluene diisocyanate (TDI): 35 $\mu g/m^3$ (5 ppb) TWA, 140 $\mu g/m^3$ (20 ppb) ceiling (10 min)
o-Toluidine - Skin	1399	95-53-4	2,A2	9,A2			5	22	
Trichloroethylene	1406	79-01-6	50	270	200	1,080	100 ppm TWA, 200 ppm Ceiling, 300 ppm Max Ceiling, (5 min in 2 hr)		25 ppm TWA
1,2,3-Trichloropropane - Skin	1407	96-18-4	10,A2	60,A2			50	300	

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6A - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Uranium		7440-61-1							
Insoluble compounds, as U	1418			0.2		0.6		0.25	
Soluble compounds, as U	1419			0.2		0.6		0.05	
Vinyl cyclohexene dioxide - Skin	1426	106-87-6	10,A2	60,A2			None		
Wood Dust, hardwood	1430a			1			None		

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N6A - Proposed PELs That Meet the OSHA Definition of "Potential Occupational Carcinogen"
(NIOSH concurrence)

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Aldrin - Skin		309-00-2		0.25				0.25	Lowest reliably detectable level
Anisidine (o-, p-isomers) - Skin		29191-52-4	0.1	0.5				0.5	
Chlordane - Skin		57-74-9		0.5		2		0.5	
Dieldrin - Skin		60-57-1		0.25				0.25	Lowest reliable detectable level
Dinitrotoluene - Skin		121-14-2		1.5				1.5	Reduce exposure to lowest feasible level
Heptachlor - Skin		76-44-8		0.5				0.5	
Hexamethyl phosphoramide		680-31-9	A2	A2			None		
Propylene imine - Skin		75-55-8	2,A2	5,A2			2	5	
1,1,2-Trichloroethane		79-00-5	10	45			10	45	Reduce exposure to lowest feasible level

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N7 - Proposed PELs as TWAs for which NIOSH Recommends a Ceiling

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Butyl mercaptan	1054	109-79-5	0.5	1.5			10	35	1-Butanethiol: 0.5 ppm (1.8 mg/m^3) ceiling (15 min); mixtures of thiols to be controlled by calculation of equivalent concentrations
Hydrogen sulfide	1209	7783-06-4	10	14	15	21	20 ppm Ceiling; 50 ppm Max Ceiling (10 min)		10 ppm (15 mg/m^3) ceiling (10 min)
Isopropyl glycidyl ether (IGE)	1227	4016-14-2	50	240	75	360	50	240	50 ppm (240 mg/m^3) ceiling (15 min)
Methyl chloroform	1255	71-55-6	350	1,900	450	2,450	350	1,900	350 ppm (1,910 mg/m^3) ceiling (15 min)
Methyl mercaptan	1263	74-93-1	0.5	1			C 10	C 20	1-Methanethiol: 0.5 ppm (1.0 mg/m^3) ceiling (15 min); mixtures of thiols to be controlled by calculation of equivalent concentrations
Petroleum distillates (Naphtha; Rubber solvent)	1312		400	1,600			None		350 mg/m^3 TWA; 1,800 mg/m^3 ceiling (15 min); blood and urine monitoring required; action level: 200 mg/m^3 TWA

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N7 - Proposed PELs as TWAs for which NIOSH Recommends a Ceiling

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Phenyl mercaptan	1316	108-98-5	0.5	2			None		Benzenethiol: 0.1 ppm (0.5 mg/m^3) ceiling (15 min); mixtures of thiols to be controlled by calculation of equivalent concentrations
Vanadium, as V2O5		1314-62-1							
Respirable dust	1421			0.05				0.5 (dust)	0.05 mg/m^3 ceiling (15 min)
Fume	1422			0.05				0.1 (fume)	0.05 mg/m^3 ceiling (15 min)

Tabulation of NIOSH Reviews of Proposed PELs
NIOSH Table N7 - Proposed PELs as TWAs for which NIOSH Recommends a Ceiling

CHEMICAL NAME	HS NUMBER	CAS NUMBER	TLV				PEL		REL
			TWA		STEL				
			ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	
Benzyl chloride		100-44-7	1	5			1	5	5 mg/m^3 ceiling (15 min)
Cyanides, as CN - Skin				5				5	4.7 ppm (5 mg CN/m^3) ceiling (10 min)
Sodium cyanide		151-50-8							
Potassium cyanide		143-33-9							
Hydroquinone		123-31-9		2				2	0.44 ppm (2 mg/m^3) ceiling (15 min)
Phenol - Skin		108-95-2	5	19			5	19	5.2 ppm (20 mg/m^3) TWA; 15.6 ppm (60 mg/m^3) ceiling (15 min)
Phosgene		75-44-5	0.1	0.4			0.1	0.4	0.1 ppm (0.4 mg/m^3) TWA; 0.2 ppm (0.8 mg/m^3) ceiling (15 min)

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

EXPOSURE LIMITS

NIOSH	: 5 mg/m^3 (measured as total particulate) - 15-min ceiling
OSHA PEL (Present)	: --
OSHA PEL (Proposed)	: 5 mg/m^3 TWA
ACGIH TLV	: 5 mg/m^3 TWA

WORKERS: 204,000 (1982) **VOLUME:** 54,000,000,000 lbs (1975)

PEL TESTIMONY:
NIOSH does not concur with the OSHA proposed PEL and also suggests that OSHA label asphalt as a potential occupational carcinogen.

BASIS FOR REL:
The NIOSH REL is based upon the prevention of irritation to the the eyes and respiratory tract of workers, and upon a concern that asphalt fumes can contain carcinogenic components [NIOSH 1977].

CD NOTED EFFECTS **DATE CD:** 1977

Acute	: Eye/respiratory tract irritation
Chronic	: Adverse respiratory effects; pneumonitis; bronchitis
Irritation	: Mucous membranes
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: Tumorigenic - highly variable: dependent upon specific "fraction" and/or derivation of asphalt material

COMMENTS:
There is no new additional information other than the data that were summarized in NIOSH's submission to OSHA's docket on July 25.

REFERENCES:
Baylor CH, Weaver NK [1968]. A health survey of petroleum asphalt workers. Arch Environ Health 17:210-214.

Hammond EC, Selikoff IJ, Lawther PL, Seidman H [1976]. Inhalation of benzpyrene and cancer in man. Ann NY Acad Sci 271:116-124.

Menck HR, Henderson BE [1976]. Occupational differences in rates of lung cancer. JOM 18(12):797-801.

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

REFERENCES:

Milham S Jr [1982]. Occupational mortality in Washington State 1950-1979. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Contract No. 210-80-0088.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to asphalt fumes. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-106

Thayer PS, Menzies KT, von-Thuna PC [1981]. Roofing asphalts, pitch and UVL carcinogenesis. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

RESPONSE TO PEL DOCKET MATERIAL:
Over thirty-five asphalt manufacturers, users, or other representatives of the asphalt industry submitted objections to OSHA's proposed rulemaking on asphalt. The great majority either agreed with the proposed 5 mg/m^3 TWA (at least as a benzene-soluble fraction), or did not refute it. The primary objection centered on OSHA establishing the PEL based upon the "...avoidance of cancer" and that asphalt poses a "significant risk of cancer."

OSHA mistakenly made a statement attributing asphalt as a potential carcinogen because of its physical and chemical similarity to coal tar pitch. OSHA should have stated that both coal tar pitch and asphalt are similar in appearance, have been used interchangeably for roofing, paving and in other industrial applications, and are carcinogenic. The two substances also share another similarity in that they frequently contain the same or similar polynuclear aromatic hydrocarbons (PAH) such as benzo(a)pyrene (BaP), which are known carcinogens. These errors were appropriately noted by many responders.

The National Asphalt Pavement Association (ex. 3-420) stated that temperatures used in the Thayer et al. [1981] report are far in excess of those commonly found in the Hot Mix Asphalt industry; however, a report from the American Standards Testing Bureau (ex. 3-658A) provides data to clarify that hot mix asphalt temperatures are used between 250 - 300° F and higher, but usually avoid temperatures exceeding 600° F (315° C) except in preheating of aggregate. Temperatures used in the Niemeier et al. [1988] study were 232 - 316° C. Niemeier et al. [1988] referred to an Asphalt Institute report which stated the temperature was generally lower than 160° C for paving operations.

The Asphalt Institute (AI) (ex. 3-420) objects to using total particulate as a measure of asphalt fume exposure due to contamination with extraneous particulates. However, AI offers no proof that significant levels of innocuous dusts would be contained in measurements of total particulates.

AI (ex. 3-420) commented on the imperativeness of knowing what is being measured and using a validated method; however, they agree that the benzene soluble method is acceptable.

The AI objects to the adoption of a limit based on avoidance of cancer, and they fail to understand the importance of the toxicological evaluations in animals using solvents to solubilize asphalt or asphalt fractions for skin painting or subcutaneous injection. This method of testing is generally recognized by scientists in testing complex mixtures. They cite the Thayer et al. [1981] study, which was a preliminary report, but fail to recognize the more complete report by Niemeier et al. [1988].

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

RESPONSE TO PEL DOCKET MATERIAL (continued):
Although the AI criticized the NIOSH study for unacceptably high temperatures (316° C) to generate the fumes, Niemeier et al [1988] justified these temperatures based upon an AI report [Thomas and Mukai 1975] which stated that heating in roofing kettle operations is poorly controlled, and commonly the materials are heated as high as 638° C (1000° F) which is well above the recommended kettle temperatures of 204 to 273° C. Niemeier et al. [1988] also studied asphalt fumes generated at temperatures of 232° C and also found these to be carcinogenic in two strains of mice.

In contrast to the AI criticism of the use of unrealistically high dosages of asphalt fume condensates for skin painting, Niemeier et al. [1988] used dosages 25 milligrams or less per treatment, which are well within the common range of dosages used for testing of other complex mixtures [Bingham et al. 1980].

The AI implies that reheating of the asphalt in the Thayer et al [1981] study was unacceptable due to the potential generation of more carcinogenic pyrolysis effluents. Niemeier et al. [1988] demonstrated that ratios of PAH to BaP were very similar to field measurements reported by Malaiyandi et al. [1982].

While the AI is correct in citing various epidemiologic studies which fail "to establish an unconfounded correlation between exposure to asphalt fumes and increased risks of cancer," they fail to recognize a recent Danish study by Wilson [1984]. This study suggests that emissions from an asphalt production plant may have augmented the lung cancer risk in smokers living and working in the immediate vicinity.

Both AI and Niemeier et al. [1988] point to the dissimilarities of petroleum asphalt and coal tar pitch based on chemical composition such as PAH content. However, Niemeier et al. [1988] noted high carcinogenic activity of asphalt fumes in spite of low PAH content, and referenced other scientific opinions that PAHs such as BaP can serve as a guide to carcinogenic potency, however, that the presence or absence does not always account for observed potency, nor can predictions of human cancer risk be made from simple knowledge of PAH levels.

AI's contention that asphalt fumes are not listed as a human carcinogen by IARC fails to recognize the IARC's [1985] determination that there is: sufficient evidence of carcinogenicity in animals for extracts of steam/air refined bitumens; and limited evidence of carcinogenicity in animals of undiluted steam-refined bitumens and for cracking-residue bitumens. The Asphalt Roofing Manufacturers Association (ex. 3-686) agrees with this position. Further, AI fails to recognize that niether the Niemeier et al. [1988] study, nor the preliminary Thayer et al. [1981] study, were available to IARC at the time of this evaluation.

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

RESPONSE TO PEL DOCKET MATERIAL (continued):
Exxon [ex. 3-681] concludes from their review of the literature that "Experimental animal studies have shown that some asphalts and condensed asphalt fumes possess carcinogenic potential when applied to the skin of animals over the course of their lifetime." "These data suggest that a particular asphalt may possess carcinogenic potential for occupationally-exposed individuals under conditions of repeated exposure and poor personal hygiene." "Certain asphalt blends, such as those mixed with aromatic extracts or cracked oils, may have carcinogenic potencies greater than those of other commonly used asphalt preparations. These blends, if used at all, should receive appropriate precautionary labeling. It is particularly important to minimize exposure to the fumes of such asphalt blends." "Attempts to predict the carcinogenicity of a material on the sole basis of its PNA content have not been very successful. The situation is made complex by the presence in petroleum-derived materials of cocarcinogens and tumor-promoters which are not PNAs (This is supported by the NIOSH chemical composition studies on asphalt fumes Belinky et al. [1987]. To date, skin-painting studies in mice have proven to be the most reliable predictors of the potential carcinogenicity of petroleum-derived materials since these tests reflect the integrated biological response to the presence of tumor initiators, promoters and cocarcinogens."

The evidence offered in the last statement appears to contradict the opinions made by AI (ex. 3-420) and the California Asphalt Pavement Association (ex. 3-676) concerning the importance of inhalation experiments to determine the carcinogenicity since "inhalation is the only route in which workers may be exposed in normal paving and roofing operations." Because the majority of animal studies have been performed by utilizing the skin-painting route, NIOSH agrees that the major scientific opinion on route of testing is in line with the Exxon position.

The California Asphalt Pavement Association (ex. 3-676) and the Asphalt Council of California (ex. 3-663) similarly raise the issue that the Thayer et al. [1981] study design is compromised because the design distorts the comparative carcinogenic potential of asphalt and coal tar condensates by adjusting for the BaP concentration. NIOSH notes that this is adequately explained in the full publication of this study [Niemeier et al. 1988]. In addition, mathematical and biological comparisons are made in the most recent report that leads NIOSH to conclude that asphalt fumes should be considered as a potential occupational carcinogen, and exposures should be reduced in accordance with the recommended exposure limit (REL) of 5 mg/m^3 as a ceiling measured as total particulate for any 15-minute period. This is based upon the statement by Niemeier et al. [1988] who noted that asphalt fumes generated during normal roofing operations exhibit about one-fifth the carcinogenic activity as that of coal tar pitch, which is considered to be highly carcinogenic.

It should also be noted that NIOSH did not support the OSHA position in 1982 [NIOSH 1982] that removed asphalt from the coal tar pitch standard.

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

RESPONSE TO PEL DOCKET MATERIAL (continued):
Over twenty representatives of the manufacturers or users of "paving" asphalts argue that the asphalt cements are considerably less harmful than "roofing" asphalts. The National Asphalt Pavement Association submitted a report by the American Standards Testing Bureau, Inc. (Docket 3-658A) detailing the differences between these asphalts. It is stated that the paving asphalts are used at much lower temperatures, thus generating much lower levels of volatiles than those found in roofing asphalt exposures. It is reasonable to conslude from the Niemeier et al. [1988] study that asphalt fume generation during asphalt paving operations will be much lower than those found during roofing operations as simulated in the laboratory. Although no measurements were made at 160° C, the normal temperature of asphalt used during paving operations, the total entrapment rates of fume productions (undiluted with ambient air) are expected to be much lower than those found during simulated roofing operations which range from 4.3 to 51.3 g/m^3 at temperatures ranging from 232 to 316° C.

REFERENCES TO RESPONSE TO PEL DOCKET MATERIAL:
Belinky BR, Cooper CV, Niemeier RW [1986]. Fractionation and analysis of asphalt fumes for carcinogenicity testing. In: Proceedings of the Fourth NCI/EPA/NIOSH Collaborative Workshop: Progress on Joint Environmental and Occupational Cancer Studies. Rockville, MD: Holiday Inn Crowne Plaza Hotel, April 22-23, 1986.

Bingham E, Trosset RP, Warshawsky D [1980]. Carcinogenic potential of petroleum hydrocarbons. J Environ Path Toxicol 3:483-563.

IARC [1985]. Polynuclear aromatic compounds. Part 4. Bitumens, coal-tars and derived products, shale-oils and soots. In: IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 35. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Malaiyandi M, Benedek A, Holko AP, Bancsi JJ [1982]. Measurement of potentially hazardous polynuclear aromatic hydrocarbons from occupational exposure during roofing and paving operations. In: Polynuclear Aromatic Hydrocarbons, Sixth InternationaL Symposium. Cooke M, Dennis AJ, Fisher GL (eds). Columbus, OH: Battelle Press.

Niemeier RW, Thayer PS, Menzies KT et al. [1988]. A comparison of the skin carcinogenicity of condensed roofing asphalt and coal tar pitch fumes. In: Polynuclear Aromatic Hydrocarbons: A Decade of Progress, Tenth International Symposium. Cooke M, Dennis AJ (eds). Columbus, OH: Battelle Press.

NAME: Asphalt Fumes **CAS:** 8052-42-4
CODE: H.S. 1028

REFERENCES TO RESPONSE TO PEL DOCKET MATERIAL (continued):

NIOSH [1982]. NIOSH comments on OSHA coal tar pitch volatiles proposal rule; notice of intention to modify interpretation. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, August 26, 1982.

Thayer PS, Menzies KT, von Thuna PC [1981]. Roofing asphalts, pitch and UVL carcinogenesis. Final report on NIOSH contract 210-78-0035. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

Thomas JF and Mukai M [1975]. Evaluation of emissions from asphalt roofing kettles with respect to air pollution. College Park, MD: The Asphalt Institute Research Report No. 75-2, 21 pp.

Wilson K [1984]. Asphalt production and lung cancer in a Danish village. Lancet (Aug 11):354.

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

EXPOSURE LIMITS

NIOSH	1 ppm (up to 10-hr TWA); 10 ppm (ceiling measurement over 15 min)
OSHA PEL (Present)	20 ppm TWA; 30 ppm STEL; 100 ppm ceiling
OSHA PEL (Proposed)	1 ppm TWA; 10 ppm 15-min STEL
ACGIH TLV	10 ppm (30 mg/m^3) - Skin

WORKERS: 20,000 (1974) **VOLUME:** 711,000,000 lb (1977)
950,000 lbs (SRI 1983)

PEL TESTIMONY:
NIOSH concurred with the OSHA proposed PEL.

BASIS FOR REL:
Adverse cardiovascular and neurotoxic effects on human subjects were demonstrated at over 10 ppm [NIOSH 1977]. Despite the limitations of the available studies, the potential fatal effects suggested that the limit be set at the lowest reliably quantifiable limit.

CD NOTED EFFECTS **DATE CD:** 1977

Acute	Polyneuritis; headaches; vertigo; gastric disturbances
Chronic	Cardiovascular; neurological
Irritation	Eyes
Mutagenic	ND
Teratogenic	Reproductive reports in humans (unconfirmed)
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
The literature on the toxicity of carbon disulfide (CS_2) published since the criteria document is extensive. Over 167 citations appear on the NIOSHTIC data base.

The Hernberg series of studies from Finland, the NIOSH morbidity study from 1983, and the unpublished MacMahon and Monson study submitted to the OSHA air contaminants docket are particularly important. There are some data indicating that there may be reproductive effects in the human female from CS_2 exposure.

COMMENTS:
The significant body of new data on CS_2 dealing with cardiovascular effects requires a critical evaluation by NIOSH to determine an acceptable exposure level.

Additional research contributing to and a critical evaluation of available information dealing with the cardiovascular effects are needed to determine an acceptable exposure level.

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

COMMENTS (continued):
Additional research is needed relative to the specific reproductive effects on female workers. Reports from China [Cai SX and Bao YS 1981] and Finland [Hemminki K and Niemi ML 1982] indicate that gender specific health effects may be occurring.

REFERENCES (partial listing):
Cai SX, Bao YS [1981]. Placental transfer, secretion into mother milk of carbon disulphide and the effects on maternal function of female viscose rayon workers. Indust Health 19(1):15-29.

Hemminki K, Niemi ML [1982]. Community study of spontaneous abortions: Relation to occupation and air pollution by sulfur dioxide, hydrogen sulfide, and carbon disulfide. Int Arch Occup Environ Health 51(1):55-63.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to carbon disulfide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-156.

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

RESPONSE TO PEL DOCKET MATERIAL:
The permissible exposure limit (PEL) for carbon disulfide (CS_2) is 20 ppm that was based on neurotoxic effects. It has been criticized as too high on this basis [ACGIH 1988]. A significant body of research developed since the adoption of the present PEL indicates that there are significant cardiovascular effects associated with exposure to CS_2.

Two recent studies submitted to the docket deal with the cardiovascular effects of CS_2. One is a cohort study reported by Nurminen and Hernberg [1985] involving a fifteen-year (1967 to 1982) follow-up study of 343 Finnish workers exposed to CS_2 in the viscose rayon industry. This study period covers a time in Finland when exposure levels were reduced (around 1972), and the institution of a cardiovascular intervention program that began in 1974. This medical intervention program was based on monitoring the workers for symptoms of increased risk and removing workers at risk from CS_2 exposure. The data indicate that there is a significant risk of arteriosclerotic heart disease (ASHD) at a 20 ppm exposure level, with a 4.7 relative risk of ischemic and other heart disease mortality. Further, the data indicate that risk is substantially decreased with the combined action of reducing exposure and medical removal programs.

The second study by MacMahon and Monson [1988] is a retrospective mortality study of rayon workers in four United States' plants. These four plants represent all of the major United States' rayon producers. An "a priori" cause of death was ASHD (the authors citing the excess of ASHD previously reported in the United Kingdom and Finland). Suicide was also found to be in excess among workers with the heaviest exposure; this association is consistent with other observations [NIOSH 1977].

This study is a massive effort of reporting on 10,418 eligible subjects. Vital status follow-up and death certificate information were collected through the end of June 1983. The collected study data were analyzed using a standard mortality ratio (SMR) analytic approach based on a published and widely used lifetable analysis system developed by Dr. Monson. The study reports an excess of ASHD deaths and suicides among employees who had ever held jobs categorized as having intermediate or heavy exposure. The authors state:

> "For such workers the excess of observed over expected deaths from this cause (ASHD) was 24 percent and is statistically significant ($p < 0.01$)."

Additionally, the study demonstrates an excess of suicides among workers in jobs categorized as heavy exposure with the authors stating:

> "The greatest excess of deaths from suicide also occurred among the workers with the greatest potential for exposure (SMR = 154), and this excess was also statistically significant ($p < 0.05$)."

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

RESPONSE TO PEL DOCKET MATERIAL (continued):
The ability of this study to supply any definitive information about the exposure-response relationship is limited by a lack of exposure data. No quantitative exposure measurements are used by MacMahon and Monson in their study. Instead, they relied on a categorical analysis of the exposure potential associated with job titles. The authors indicated that they relied on "knowledgeable persons" at each location to assign job titles to perceived exposure categories. The authors state that:

> "Although, as already noted, retrospective data on exposure levels in the plants are sparse, it may be assumed that these levels have declined substantially over the years."

The authors of this second study acknowledge that the difficulties experienced in job classification will lead to underestimation of mortality differentials associated with CS_2 exposure.

A review of the other materials included in the hearing docket indicates that there may be substantial data the authors did not have or present, and there are a number of other factors that may also have led to the underestimation of the effect of exposures. However, NIOSH observes that at numerous other points in testimony at the OSHA hearing and in submissions to the OSHA docket, there is extensive data indicating that exposure monitoring was commonplace at all of the plants studied for CS_2. On page 160 of the Inter-Industry Council on Carbon Disulfide's testimony, Mr. Dean testified that personal samples are taken on a daily basis. Several NIOSH surveys [NIOSH 1977a; 1977b; 1977c] indicate that area monitoring was being done in all of the plants prior to 1977, and that some plants had a personal monitoring program also in existence.

Mr. Dean's testimony (p. 163) also indicates that respiratory protection was in use whenever high exposures may be anticipated. The effective level of exposure for workers wearing respiratory protection may be reduced by a factor that is a function of the class of respirator worn. Therefore, the health effect observed may have resulted from levels of CS_2 less than the levels environmentally measured.

Other submissions to the docket lead NIOSH to question MacMahon and Monson's assertion that increased ASHD was associated with the higher exposures occurring in earlier years of employment. Additional data tables (apparently from an earlier version of the MacMahon and Monson paper) were submitted to the OSHA docket in the written testimony of Dr. Hugh Lyle (ex. 3-747-F-1). These additional tables address the year of death and the age at first exposure. These tables indicate that out of a total of 242 deaths observed in the "heaviest or intermediate exposure" groups, 19 deaths occurred prior to 1965, 101 deaths occurred from 1965 to 1974, and 122 deaths occurred from 1975 to the end of the study in 1983. Unfortuantely, these data do not identify deaths by the year of first exposure, and specifically the deaths occurring among workers hired after 1969 when the 20 ppm PEL went into effect. However, it is not at all obvious that the ASHD deaths are associated only with the higher exposures of earlier employment.

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

RESPONSE TO PEL DOCKET MATERIAL (continued):
Additionally, evidence exists that limited medical intervention programs may have existed. The NIOSH surveys [1977a; 1977b; 1977c] suggest that medical intervention programs were in effect in at least some of the four plants. The use of medical removal protocols or pre-employment screening could result in reduced SMRs for the exposed groups and increased SMRs for the control groups. Such programs could lead to an underestimate of risk associated with the current PEL, if workers or potential workers with cardiovascular risk factors were selected out of the workers exposed to CS_2.

The publications concerning the NIOSH morbidity study conducted in 1979 [Fajen et al. 1981; Johnson et al. 1983; Putz-Anderson et al. 1983] supply information on the exposure data available at that time, the industrial practices, and the potential exposures of the nonexposed group used in the MacMahon and Monson study. The reference population in the NIOSH study [1981], which would be a subset of the "nonexposed" group in the MacMahon and Monson study, were potentially exposed to caprolactam, ethylene glycol, dimethylterepthalate, and methanol. Some of these exposures such as methanol may be confounding factors in the mortality experience of the nonexposed groups of the MacMahon and Monson study [NIOSH 1981].

The combined evidence from the Nurminen and Hernberg study [1985], the MacMahon and Monson study, and the information in the docket on the actual practices in the U.S. rayon industry indicate that there is a significant ASHD risk at the present PEL, and that this risk can be substantially reduced at lower exposures. MacMahon and Monson infer that low exposure levels are not associated with a significant risk based on the experience of the "least exposed" workers in their study. Unfortunately, the actual exposure levels experienced by this group are not available. The exposures of the "least exposed" workers can be estimated from the NIOSH surveys [1981] to be approximately 1.5 ppm. However, it should be restated that the relative risk at this exposure may be underestimated due to the confounding effect of existing programs.

The proposed PEL of 1 ppm should be promulgated and CS_2 should be scheduled for immediate 6B rulemaking in order to: 1) more fully determine an appropriate permissible exposure level; 2) develop an appropriate medical intervention program; and 3) to evaluate a dose-rate response which appears consistent with the Nurminen and Hernberg and with the MacMahon and Monson data.

REFERENCES:
ACGIH [1986]. Carbon Disulfide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc.

Fajen J, Albright B, Leffingwell S [1981]. A cross-sectional medical and industrial hygiene survey of workers exposed to carbon disulfide. Scand J Work Environ Health 7(4):20-27.

NAME: Carbon Disulfide (CS_2) **CAS:** 75-15-0
CODE: H.S. 1070

REFERENCES (continued):

Johnson B et al. [1983]. Effects on the peripheral nervous system of workers exposed to carbon disulfide. Neurotoxicology 4(1):53-66.

NIOSH [1977a]. Walk-through survey report of Avtex Fibers, Inc., Front Royal, Virginia. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, IWS 075.15.

NIOSH [1977b]. Walk-through survey report of Courtaulds North America, Incorporated. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, IWS 75-16.

NIOSH [1977c]. Plant observation report and evaluate (PORE) for carbon disulfide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, done under contract by Stanford Research Institute, Menlo Park, CA, NIOSH Contract No. CDC-99-74-31.

Nurminen M and Hernberg S [1985]. Effects of intervention on the cardiovascular mortality of workers exposed to carbon disulphide: A 15-year follow up. Brit J Industr Med 42:32-35.

Putz-Anderson V et al. [1983]. A behavioral examiantion of workers exposed to carbon disulfide. Neurotoxicology 4(1):67-68.

NAME: Carbon Tetrachloride (CCl_4) **CAS:** 56-23-5
CODE: H.S. 1073

EXPOSURE LIMITS

NIOSH	: 2 ppm (12.6 mg/m^3) ceiling (45 liter, 60-min sample)
OSHA PEL (Present)	: 10 ppm 8-hr TWA; 25 ppm acceptable ceiling; 200 ppm maximum ceiling (5 min in 4 hr)
OSHA PEL (Proposed)	: 2 ppm (12.6 mg/m^3); ceiling (60 min)
ACGIH TLV	: 5 ppm (30 mg/m^3); 8-hr TWA (skin) A2 carcinogen

WORKERS: 59,200 (NOES 1981-1983 provisional) 1,380,000 (NOHS 1972-1974) **VOLUME:** 573,000,000 lbs (SRI 1983)

PEL TESTIMONY:
NIOSH agreed with the proposed PEL, but stated that a carcinogen designation should be added to the PEL because the chemical meets the criteria for carcinogenicity established by OSHA (29 CFR 1990.103).

BASIS FOR REL:
The REL of 2 ppm as a 60-min ceiling in a 45-liter sample (the lowest detectable concentration in 1976) was recommended to prevent the adverse effects (liver and eye changes) and materially reduce the risk of cancer from occupational exposure to carbon tetrachloride.

CD NOTED EFFECTS **DATE CD:** June 1976

Acute	: Vision; nausea; vomiting; appetite and weight loss; weakness; eye, nose and throat irritation; skin absorption
Chronic	: Liver and kidney damage
Irritation	: Eyes
Mutagenic	: ND
Teratogenic	: Reproductive effects in animal studies
Carcinogenic	: Animal and human studies with associated liver necrosis

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

1) Nozaki K [1986]. Inhalation bioassay of CCl_4 at 0, 5, 25, or 125 ppm, 6 hr/d, 5 d/wk for 2 years in progress. In: Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity. Volume 12. Ghess MJ et al. (eds.). Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Carbon Tetrachloride (CCl_4) **CAS:** 56-23-5
CODE: H.S. 1073

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.)(continued):

2) IARC [1987]. Overall evaluations of carcinogenicity. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. An updating of IARC Monographs Volume 1 to 42. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

3) ACGIH [1986]. Carbon tetrachloride. In: Documentation of Threshold Limit Values and Biological Exposure Indicies. Cincinnati, OH: American Conference of Governmental Industrial Hygenists, p. 109-110.

4) NTP [1985]. Fourth annual report on carcinogens. Research Triangle Park, N.C.: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, NTP Publication No. 85-001, p. 17 and pp. 112-116.

5) Blair A, Decoufle P, Grauman D [1979]. Causes of death among laundry and dry cleaning workers. Amer J Pub Health 69:508-511.

COMMENTS:

NIOSH [1976] considers CCl_4 to be a potential occupational carcinogen. ACGIH [1986] considers CCl_4 a suspected human carcinogen (appendix A2), but reports that all studies showing CCl_4 to be a liver carcinogen also demonstrate a high incidence of nonmalignant liver damage.

IARC [1987] classified carbon tetrachloride as "possibly carcinogenic to humans" (Group 2B) because there was "sufficient evidence for carcinogenicity in animals" and "inadequate evidence for carcinogenicity in humans." The NTP [1985] listed carbon tetrachloride as a substance "which may be reasonably anticipated to be a carcinogen." Blair et al. [1979] performed a mortality study of laundry and dry cleaning workers exposed to carbon tetrachloride, as well as to trichloroethylene and tetrachloroethylene. A statistically significant proportionate mortality ratio (128) for all malignant neoplasms suggested an increased risk of cancer from exposures to dry cleaning fluids.

The IARC and NTP classifications of CCl_4 as possibly carcinogenic confirm the NIOSH [1976] policy that CCl_4 is a potential occupational carcinogen. CCl_4 meets the criteria for carcinogenicity established by OSHA [29 CFR 1990.103].

REFERENCES:

ACGIH [1986]. Carbon tetrachloride. In: Documentation of Threshold Limit Values and Biological Exposure Indicies. Cincinnati, OH: American Conference of Governmental Industrial Hygenists, p. 109-110.

Blair A, Decoufle P, Grauman D [1979]. Causes of death among laundry and dry cleaning workers. Amer J Pub Health 69:508-511.

IARC [1987]. Overall evaluations of carcinogenicity. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. An updating of IARC Monographs Volume 1 to 42. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Carbon Tetrachloride (CCl_4) **CAS:** 56-23-5
CODE: H.S. 1073

REFERENCES (continued):

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to carbon tetrachloride. Revised. Cincinnati, OH: U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-133.

Nozaki K [1986]. Inhalation bioassay of CCl_4 at 0, 5, 25, or 125 ppm, 6 hr/d, 5 d/wk for 2 years in progress. In: Information Bulletin on the Survey of Chemicals Being Tested for Carcinogenicity. Volume 12. Ghess MJ et al. (eds.). Lyon, France: World Health Organization, International Agency for Research on Cancer.

NTP [1985]. Fourth annual report on carcinogens. Research Triangle Park, N.C.: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, NTP Publication No. 85-001, p. 17 and pp. 112-116.

NAME: Carbon Tetrachloride (CCl_4) **CAS:** 56-23-5
CODE: H.S. 1073

RESPONSE TO PEL DOCKET MATERIAL

In the Blair et al. [1979] mortality study of laundry and drycleaning workers, the statistically significant proportionate mortality ratio (PMR) indicated that the study group had a higher proportion of total deaths due to cancer compared with the U.S. general population. The excess of liver cancers seen in this study, although not statistically significant due to the small number of deaths associated with liver cancer, is consistent with the findings in animal studies on carbon tetrachloride.

In animal studies, carbon tetrachloride produced liver neoplasms in mice and rats after administration by various routes and mammary neoplasms in rats following subcutaneous injection [IARC 1987].

Based on the risk estimates provided in the NPR, the maximum likelihood estimate (MLE) of excess cancer deaths at the present PEL of 10 ppm is 17.9 excess deaths per 1000 exposed workers.

The MLE of excess cancer deaths at 5 ppm (ex. 3-677) is 9.2 cancer deaths per 1000 workers exposed over their working lifetimes.

Reduction of the present PEL to the proposed PEL of 2 ppm as a ceiling will reduce the risk to 3.7 excess deaths per 1000 exposed workers.

NAME: Trichloroethylene (TCE) **CAS:** 79-01-6
CODE: H.S. 1406

EXPOSURE LIMITS

NIOSH	25 ppm (135 mg/m^3) TWA
OSHA PEL (Present)	100 ppm (540 mg/m^3)TWA; 200 ppm (1080 mg/m^3) ceiling; 300 ppm (1620 mg/m^3) peak (5 min in 2 hr)
OSHA PEL (Proposed)	25 ppm (135 mg/m^3) TWA
ACGIH TLV	50 ppm (270 mg/m^3) TWA; 200 ppm (1080 mg/m^3) STEL

WORKERS: 239,000 (NOES 1981-1983, provisional) 2,780,000 (NOHS 1972-1974) **VOLUME:** 258,000,000 lbs (USITC 1981)

PEL TESTIMONY:
NIOSH agreed with the proposed PEL but stated that a carcinogen designation should be added to the PEL because the chemical meets the criteria for carcinogenicity established by OSHA (29 CFR 1990.103).

BASIS FOR REL:
The basis for the NIOSH REL of 25 ppm (the lowest concentration technologically feasible in 1978) as a TWA is the potential for carcinogenicity from occupational exposure. The assessment of trichloroethylene's carcinogenic potential was based on: (1) positive carcinogenicity studies in male and female mice [NCI 1976], (2) positive in-vitro mutagenicity studies, (3) transformation of rat embryo cells into malignant tumor cells, and (4) strong evidence that TCE may be metabolized to an epoxide having electrophillic activity, and the capability to react and bind to cellular macromolecules with potential for induction of carcinogenic lesions.

CD NOTED EFFECTS **DATE CD:** January 1978

Acute	Central nervous system; cardiovascular system; skin; liver and kidneys
Chronic	Liver; kidney; nervous system
Irritation	Skin
Mutagenic	Weak response in Salmonella; yeast and tradescantia assays
Teratogenic	POS (chick embryos); EQUIV (rats); NEG (rats)
Carcinogenic	Liver cancer in mice by gavage and inhalation routes

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
The current NIOSH LOQ (method No. 1022) for TCE is 3 ppm for a 3-L air sample.

NAME: Trichloroethylene (TCE) **CAS:** 79-01-6
CODE: H.S. 1406

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (continued):

1) NTP [1988]. NTP technical report on the toxicology and carcinogenesis studies of trichloroethylene (CAS No. 79-01-6) in four strains of rats (ACI, August, Marshall, Osborne-Mendel) (gavage studies), NTP TR 273. Research Triangle Park, NC: U.S. Department of Heath and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NIH Publication No. 88-2529.

2) IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 364-366.

3) Fukuda K, Takemoto K and Isuruta H [1983]. Inhalation carcinogenicity of trichloroethylene in mice and rats. Indust Health 21:243-254.

4) Henschler D, Romen W, Elsasser HM, Elder E, Radwan Z [1980]. Carcinogenicity study of trichloroethylene by long term inhalation in three animal species. Arch Toxicol 43:237-248.

5) Maltoni C, Lefemine G, Cotti G [1986]. Experimental research on trichloroethylene carcinogenesis. In: Archives of Research on Industrial Carcinogenisis. Volume V. Princeton Scientific Publishing Co.

6) Henschler D, Elsasser HM, Romen W, Elder E [1984]. Carcinogenicity study of trichloroethylene with and without epoxide stabilizers, in mice. J Cancer Res Clin Oncol 107,:149-156.

7) Kimbrough RD, Mitchell FI, Houk VN [1985]. Trichloroethylene: An update. J Toxicol and Environ Health 15:369-383.

COMMENTS:

The NCI [1976] studies to assess the carcinogenicity of trichloroethylene (TCE) used 99% pure TCE, containing 0.19% 1, 2-epoxybutane and 0.09% epichlorohydrin. Hepatocellular carcinomas were induced in male and female mice; none were induced in rats. A subsequent gavage study in four strains of rats was conducted but NTP [1988] determined that the study was inadequate for carcinogenicity because of toxicity and poor survival. Kidney toxicity was observed in all four strains of rats [NTP 1988].

IARC [1987] reviewed all of the above studies and in addition several human epidemiologic studies and determined that there is "limited evidence for carcinogenicity" of TCE in animals and "inadequate evidence for carcinogenicity" in humans. IARC [1987] designated TCE as an "agent not classifiable as to its carcinogenicity to humans" (Group 3).

Oral administration of TCE containing epichlorohydrin as a stabilizer to Swiss mice induced forestomach carcinomas but no liver or lung carcinoma and no increases in forestomach carcinomas were observed after administration of pure amine-base stabilized TCE [Henschler et al. 1984].

NAME: Trichloroethylene (TCE) **CAS:** 79-01-6
CODE: H.S. 1406

COMMENTS (continued):
Inhalation studies with TCE have been conducted in mice, rats and hamsters [Fukuda et al. 1983; Henschler et al. 1980]. In the Fukuda et al. study, TCE caused lung tumors in female mice; in the Henschler et al. study, TCE gave negative results in rats, mice and hamsters. In yet another inhalation study of TCE [Maltoni et al. 1986] using two strains of mice, TCE increased the incidences of liver tumors in males of one strain and in females of the other strain, and of lung tumors in males of one strain and in females of the other strain. In rats, a low incidence of adenocarcinomas of the renal tubules was observed following exposure to TCE by inhalation [Maltoni et al. 1986].

The positive animal carcinogenicity studies indicate that TCE meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990.103. NIOSH [1978] considers this chemical a potential occupational carcinogen. However, a recent review of the literature [Kimbrough et al. 1985] found that there may be a difference in metabolism of TCE between species--namely mice, rats and humans, and that differences exist in TCE's metabolism if low doses are compared to high doses in animals. Because TCE was found to be a potent carcinogen in only one strain of mice, the $B6C3F_1$ and epidemiology studies have been rather limited, Kimbrough et al. [1985] felt that theoretical risks attributed to TCE in the past should be reexamined.

In the NPR page 21013, middle column, last paragraph, lines 8 through 11 are incorrect. The lines should read "NIOSH [1978] recommended a REL of 25 ppm TWA because it regarded TCE as an occupational carcinogen and 25 ppm TWA was the concentration that could readily be achieved at that time using existing engineering control technology."

Although IARC has placed TCE in Group 3, NIOSH stands by its original criteria document interpretation that TCE is a potential occupational carcinogen. TCE meets the criteria for carcinogenicity established by OSHA [29 CFR 1990.103].

REFERENCES:
Fukuda K, Takemoto K, Tsurata H [1983]. Inhalation carcinogenicity of trichloroethylene in mice and rats. Indust Health 21:243-254.

Henschler D, Elsasser HM, Romen W, Elder E [1984]. Carcinogenicity study of trichloroethylene, with and without epoxide stabilizers, in mice. J Cancer Res Clin Oncol 107:149-156.

Henschler D, Romen W, Elsasser HM, Elder E, Radwan Z [1980]. Carcinogenicity study of trichloroethylene by long term inhalation in three animal species. Arch Toxicol 43:237-248.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 364-366.

Kimbrough RD, Mitchell FL, Houk VN [1985]. Trichloroethylene: An update. J Toxicol Environ Health 15:369-383.

NAME: Trichloroethylene (TCE) **CAS:** 79-01-6
CODE: H.S. 1406

REFERENCES (continued):

Maltoni C, Lefemine G, Cotti G [1986]. Experimental research on trichloroethylene carcinogenesis. In: Archives of Research on Industrial Carcinogenesis. Volume V. Princeton Scientific Publishing Co.

NCI [1976]. Carcinogenesis bioassay of trichloroethylene (CAS No. 79-01-6). Bethesda, MD: National Cancer Institute, Division of Cancer Cause and Prevention, DHEW (NIH) Publication No. 76-802.

NIOSH [1978]. Special occupational hazard review with control recommendations for trichloroethylene. Rockville, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NTP [1982]. Carcinogenesis bioassay of trichloroethylene (CAS No. 79-01-6) in F344/N rats and B6C3F1/N mice (gavage studies), NTP TR 243 (board draft). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NIH Publication No. 82-1799 [not peer reviewed and not approved by NTP].

NTP [1988]. NTP technical report on the toxicology and carcinogenesis studies of trichloroethylene (CAS No. 79-01-6) in four strains of rats (ACI, August, Marshall, Osborne-Mendel (gavage studies), NTP TR 273. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NIH Publication No. 88-2529.

NAME: Trichloroethylene (TCE) **CAS:** 79-01-6
CODE: H.S. 1406

RESPONSE TO PEL DOCKET MATERIAL

Subjective effects of headache, fatigue or irritability at exposure concentrations over 40 ppm were established in several studies cited in the ACGIH documentation. The studies of Haas [1960] and Grandjean [1955] reported nervous symptoms among workers exposed 5 years or more to concentrations ranging from 1 to 335 ppm; the frequency of complaints increased when the average exposures exceeded 40 ppm.

Bardodej and Vyskocil [1965] also reported symptoms of TCE poisoning, including tremors, giddiness, anxiety and alcohol intolerance among workers exposed above 40 ppm. Pendergast et al. [1967] established that continuous exposure of animals to 35 ppm TCE caused a slight growth depression.

Reduction of the present PEL to the proposed PEL of 25 ppm will reduce the risk of subjective complaints such as headache, fatigue and irritability, and the risks of liver and kidney toxicity for all workers. There are no data available at this time to suggest that a short-term exposure level above the proposed TWA PEL is necessary to protect workers.

Animal studies have indicated that TCE is a potential carcinogen. Liver tumors in $B6C3F_1$ mice have been associated with oral administration of TCE. "Most recently, research on mechanisms of cancer formation suggests that the observed incidence of liver tumors in $B6C3F_1$ mice is associated with the metabolism of TCE to trichloroacetic acid (TCAA) which in turn induces the formation of peroxisomes in the mouse liver. TCAA is the major metabolite observed for TCE in mice, rats and humans, but the formation of TCAA is much greater in the mouse than in rats or humans" (ex. 3-677). Additionally, TCAA induces the proliferation of peroxisomes in the rodent liver but not in human liver cells (ex. 3-677). In the NTP [1976] studies of carcinogenicity of TCE, the TCE was reported to contain epichlorohydrin. In those studies, NTP [1976] determined that TCE was a positive carcinogen in mice and not in rats. Later studies [NTP 1988] of TCE in 4 strains of rats were inadequate studies. IARC [1987] considers TCE to be a substance not classifiable as to its carcinogenicity (Group 3) based on limited evidence for carcinogenicity in animals and inadequate evidence in humans. NIOSH considers TCE to be a potential occupational carcinogen, "however it is not considered to be a potent one." In light of the uncertainty of the carcinogenicity issue, OSHA proposes adoption of the 25 ppm TWA PEL to substantially reduce occupational risk.

NAME: Acetone **CAS:** 67-64-1
CODE: H.S. 1004

EXPOSURE LIMITS

NIOSH	250 ppm (590 mg/m^3) 10-hr TWA
OSHA PEL (Present)	1000 ppm (2400 mg/m^3) 8-hr TWA
OSHA PEL (Proposed)	250 (590 mg/m^3) 8-hr TWA
ACGIH TLV	750 ppm (1780 mg/m^3) 8-hr TWA; 1000 ppm (2375 mg/m^3) STEL

WORKERS: 694,000 (1981-1983, NOES, provisional); 2,440,000 (1972-1974 NOHS) 2,816,000 (1978 criteria document) **VOLUME:** 123,000,000-1,740,000,000 lbs (1984, USITC)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limit as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
The NIOSH recommendation [NIOSH 1978] of 250 ppm as a 10-hr TWA is based on studies in which human exposures from 250 to 1000 ppm provoked eye and throat irritation, and lung and CNS effects, with the untoward effects becoming decreasingly severe as the concentration decreases. Evidence also indicated that occupational exposure to acetone may lead to accumulation in the body.

CD NOTED EFFECTS **DATE CD:** June 1978

Acute	Skin absorption; narcosis; CNS depression
Chronic	Narcosis; CNS depression; cataracts
Irritation	Eye, nose and throat irritation; skin irritation
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

(1) NTP inhalation teratology study at exposure concentrations of 440, 2200 or 11000 ppm was completed in 1988. The complete final reviewed report should be available in December 1989 (NTP contact is R. Morrissey, Ph.D., FTS 629-5035).

(2) Brown WD, Setzer JV, Dick RB, Phipps FC and Lowry LK (1987): Body burden profiles of single and mixed solvent exposures. J Occup Med 29:877-883.

(3) De Ceaurriz JC, Micillino JC, Bonnet P and Guenier JP (1981): Sensory irritation caused by various industrial airborne chemicals. Toxicology Letters 9:137-143.

NAME: Acetone **CAS:** 67-64-1
CODE: H.S. 1004

COMMENTS:
The NIOSH recommendation is based on the lowest observed effect level (LOEL) of 250 ppm [Ref #18, Matsushita et al., 1969, in criteria document] and a no observed effect level (NOEL) of 100 ppm [Ref 18 in criteria document]. NIOSH [1978] summarized the Matsushita et al. studies in the following statement:

> "A fourth report [18] revealed that several subjects experienced irritation of the eyes, nose, and throat, tension, general weakness, heavy eyes, or lack of energy the morning after 6 hours of exposure to acetone at 1,000 ppm. This study also found the same complaints in those exposed at 500 ppm for 6 hours and the same but fewer complaints in those exposed at 250 ppm for 6 hours. None of the volunteers exposed at 100 ppm had any complaints."

At the air contaminants hearings, day 6, the representatives of the Ketones Program Panel of the Chemical Manufacturers Association stated that the Matsushita et al. study was flawed because the method of generating vapor-air mixtures or of measuring concentrations of airborne acetone were not presented. NIOSH recognized this fact and stated that the study suggests that exposures to acetone at concentrations below 1,000 ppm can cause irritation of the eyes, nose and throat. Thus, an REL of 250 incorporates a safety factor of 4 if only the studies of Raleigh and McGee [(1972), Ref 17 in criteria document] in which 1000 ppm was regarded as the threshold for irritation were used. The safety factor is important because the studies of Brown et al. (1987) confirm the finding of DiVincenzio et al. [(1973) Ref 42 in criteria document] that acetone can accumulate in the body. NIOSH [1978] summarizes the available studies as follows:

> The preponderance of exposure data at concentrations of 1,000 ppm and less leads to the conclusion that some untoward effects will occur in those exposed to acetone at concentrations below 500 ppm. Furthermore, the available evidence indicates that occupational exposure to acetone may lead to its accumulation in the body. It seems reasonable to conclude that a workplace environmental limit of about 250 ppm (590 mg/cu m) should be established."

The CMA representatives referenced the Kane et al. [1980] sensory irritation test of acetone in an animal model. This reference could not be located. However, De Ceaurriz et al. [1981] determined RD_{50} values (a 50% decrease in respiratory rate) for acetone in mice. This study indicates that 235 ppm is 0.01 x the RD_{50} (a concentration at which minimal or no effect would be observed in humans). This prediction confirms that 250 ppm REL is a level at which no irritation would occur.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Acetone **CAS:** 67-64-1
CODE: H.S. 1004

RESPONSE TO PEL DOCKET MATERIAL:
The Ketones Program Panel of the Chemical Manufacturers Association (Docket 8-69), and in testimony on day 6, stated that no reduction in the PEL is necessary to protect workers against sensory irritation. They claimed that four studies [Nelson et al. 1943; Parmeggiani and Sassi 1954; Matsushita et al. 1969; Vigliani and Zurlo 1955] did not support a reduction in the acetone PEL. They stated that due to flaws in contrast, the studies of Oglesby et al. [1949] and Raleigh and McGee [1972] support their position that a PEL of 1000 ppm will protect workers against sensory irritation. The Eastman Kodak Company (Docket 3-661) supported the CMA's Ketones Program Panel position with no additional supporting data.

The Oglesby et al. [1949] study indicated that acclimated workers experienced mild, transient irritation of eyes and nose at concentrations above 2500 to 3000 ppm. The complete study involved 800 workers and medical data from 16 years, but it was not stated how many of those experienced this sensory irritation. In the study of Raleigh and McGee [1972], of 31 individual reports of transient eye irritation reflected in figure 2 of the paper, 4 experienced slight to mild irritation below 1000 ppm (2 having slight irritation at 800 to 900 ppm and 2 having mild irritation at the 800 to less than 1000 ppm concentration). The studies of Matsushita et al. [1969], Nelson et al. [1943], Parmeggiani and Sassi [1954], and Vigliani and Zurlo [1955], although they have recognized inadequacies, confirm that health effects occur at the current PEL of 1000 ppm.

In the sudy of Matsushita et al. [1969], of 25 healthy male students exposed to 0, 100, 250, 500 or 1000 ppm for 6 hours, the authors reported a "majority" exposed to 500 to 1000 ppm had irritation of the nose, eyes, throat and trachea and only a few in the other exposure group had irritation. The study of Nelson et al. [1943], although the exposures were for only 3 to 5 minutes, reported irritation to most of the 10 volunteers at 500 ppm. The study of Parmeggiani and Sassi [1954] indicated that 6 of 7 workers exposed to acetone in the range of 307 to 918 ppm for 3 hours experienced mucosal irritation and CNS disturbances. The study of Viglani and Zurlo [1955], workers exposed at 1000 ppm for 3 hours/day for 7-15 years, and at 700 ppm for an unreported length of time, all had inflammation of the respiratory tract, stomach and duodenum, and occasional dizziness and loss of strength.

The preponderance of exposure data at concentrations 1000 ppm and less leads to the conclusion that sensory irritation will occur in those exposed to acetone at concentrations below 500 ppm. Additionally, available evidence indicates that occupational exposure to acetone may lead to its accumulation in the body. Thus, the proposed level of 250 ppm will reduce the risk of health effects.

NAME: Acetonitrile **CAS:** 75-05-8
CODE: H.S. 1005

EXPOSURE LIMITS

NIOSH	20 ppm (34 mg/m^3) 10-hr TWA
OSHA PEL (Present)	40 ppm (70 mg/m^3)
OSHA PEL (Proposed)	20 ppm (34 mg/m^3) TWA
ACGIH TLV	TWA 40 ppm (70 mg/m^3) STEL 60 ppm (105 mg/m^3) skin notation

WORKERS: 28,206 (1974) **VOLUME:** 135,000,000 lbs (1980)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed reduction of the acetonitrile PEL from 40 ppm to 20 ppm.

BASIS FOR REL:
The 20 ppm REL is based in part on the 1959 human study by Pozzani et al. and a report by Amdur [1959] on occupational fatalities. Human subjects were exposed to 40 ppm acetonitrile for a single 4 hours exposure. Following exposure, one subject experienced slight tightness of his chest. The following day he reported feeling a cooling sensation in his lungs. NIOSH also considered the report of an occupational exposure to acetonitrile by 16 painters (one of whom died). The workers were exposed to an unknown concentration of acetonitrile (used as a paint thinner) in a confined space [Amdur 1959]. There were no futher problems reported after the acetonitrile levels were reduced to 17 ppm. NIOSH concluded that 40 ppm acetonitrile produced minimal health effects in humans and chose a REL of 20 ppm because no observable health effects were produced in humans at 17 ppm [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1978

Acute	Headache; dizziness; vomiting; profuse sweating; loss of consciousness; convulsion; coma; death; 12-hr exposure: chest pains; vomiting; coughing blood; coma; death
Chronic	No typically chronic exposures reported
Irritation	Vapor irritating to eyes, nose, and throat; liquid irritating to skin and eyes
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Two separate mutation assays with Salmonella typhimurium strain TA98, TA100, TA1535, TA1537, and TA1538 did not give any positive reproducible results in any strain [Monsanto 1983; Haskell Lab 1979].

EPA Health Effects Assessment for acetonitrile [1978]. Oral intubation of pregnant hamsters on the eighth gestational day resulted in statistically significant malformations at 300 and 400 mg acetonitrile/kg body weight doses including

NAME: Acetonitrile **CAS:** 75-05-8
CODE: H.S. 1005

NEW DATA SINCE CD: (NTP, IARC, ACGIH, misc. studies, etc.) (Continued)
exencephally, encephalacele, and rib abnormality. Statistically significant fetal resorptions and significant reduction in fetal body weight were reported at doses of 200 and 400 mg/kg [Willhite 1983].

Fetal malformations produced when pregnant hamsters were exposed to 1800, 3800, 5000, or 8000 ppm by inhalation included: exencephaly, encephalocele, and severe axial and skeletal disorders. Average fetal body weights were decreased. A significant increase was seen in fetal abnormalities from dams treated with 5000 and 8000 ppm [Willhite 1983].

Pregnant rabbits were treated with 2, 15, or 30 mg/kg/dy on 6-18 days of gestation. High dose dams showed a significant decrease in weight and a significant decrease in the number of live fetuses per litter [Argus Research Laboratories, Inc. 1984].

Johannsen evaluated the teratogenic effects of acetonitrile in rats and determined that the resorption and postimplatation losses were due to maternal toxicity, and concluded that pregnant individuals exposed to acetonitrile in occupational settings were not at risk [Johannsen et al. 1986].

EPA found insufficient data to estimate carcinogenic potential of acetonitrile after oral or inhalation exposure.

NTP chronic inhalation studies with acetonitrile were begun April 1988. No report on carcinogenic data is available.

COMMENTS:
New data do not indicate a need for reevaluation of the REL based on the limited data available to select the REL for a substance with fatal effects and based on potential teratogenic effects.

REFERENCES:
Amdur ML [1959]. Accidental group exposure to acetonitrile--A clinical study. JOM 1:527-633.

Haskell Lab [1979]. Mutagenic activity in the Salmonella/microsome assay. E.I. du Pont de Nemours & Co. Inc., EPA Document #40-82466002.

Johannsen FR, Levinskas GJ, Berteua PE, Rodwell DE [1986]. Evaluation of the teratogenic potential of three aliphatic nitriles in the rat. Fund Appl Toxicol 7(1):33-40.

Monsanto Co. [1983]. Mutagenicity plate assay: Acetonitrile. EPA/OTS Document #878210772.

NAME: Acetonitrile **CAS:** 75-05-8
CODE: H.S. 1005

REFERENCES (Continued):

NIOSH [1978]. Criteria for a recommended standard....occupational exposure to nitriles. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-212.

Pozzani UC, Carpenter CP, Palm PE, Weil CS, Noir JH, III [1959]. An investigation of the mammalian toxicity of acetonitrile. JOM 1:634-642.

Willhite CC [1983]. Developmental toxicology of acetonitrile in the Syrian golden hamster. Teratology 27(30):313-325.

NAME: Allyl Chloride **CAS:** 107-5-1
CODE: H.S. 1011

EXPOSURE LIMITS

NIOSH	1 ppm (3.1 mg/m^3) TWA; 3 ppm (9.3 mg/m^3) ceiling (15-min sample)
OSHA PEL (Present)	1 ppm (3.1 mg/m^3) TWA
OSHA PEL (Proposed)	1 ppm (3.1 mg/m^3) TWA; 2 ppm (6.2 mg/m^3) STEL (15-min)
ACGIH TLV	1 ppm (3.1 mg/m^3) TWA; 2 ppm (6.2 mg/m^3) STEL (15-min)

WORKERS: 5,000 (1976) **VOLUME:** 450 x 10^6 lbs (1977)

PEL TESTIMONY:
NIOSH testimony at PEL Hearing indicates concurrence with OSHA proposal: 1 ppm (3.1 mg/m^3) TWA; 2 ppm (6.2 mg/m^3) STEL (15-min).

BASIS FOR REL [NIOSH 1976]:
Workers exposed at concentrations of 1-113 ppm of allyl chloride for 16 months had abnormal liver function as determined by serum enzyme activities [Hausler and Lenich 1968]. Eye and nasal irritation were reported at 50-100 ppm, and pulmonary irritation at < 25 ppm, during 5-minute exposures [Shell 1974]. Acute animal inhalation studies at concentrations as low as 290 ppm produced pulmonary and renal damage [Adams et al. 1940], and liver and kidney damage at 8 ppm exposures for 5 weeks, whereas, exposures at 3 ppm for 6 months caused no observable toxic effects [Torkelson 1959].

CD NOTED EFFECTS **DATE CD:** 1976

Acute	Eyes; nasal; pulmonary irritation
Chronic	Liver; kidney; pulmonary pathology
Irritation	Eye, nasal, pulmonary irritation
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Santodonato et al. [1985]; NCI Monograph on potential carcinogenic risk to humans: Allyl chloride. Studies in B6C3F$_1$ mice "indicate that allyl chloride is carcinogenic" (allyl chloride shows tumor initiation ability on mouse skin promoted by phorbol-myristate-acetate). Allyl chloride has shown mutagenic activity in bacterial assay systems. No epidemiologic mortality studies in workers are available, but some studies have shown changes suggestive of early liver damage and polyneuropathy.

NAME: Allyl Chloride **CAS:** 107-5-1
CODE: H.S. 1011

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (continued):
He et al. [1985]: Evidence obtained from epidemiological and clinical studies of occupationally exposed workers in two People's Republic of China factories indicates allyl chloride mainly causes toxic polyneuropathy. At one facility, where exposure to allyl chloride ranged from 2.6 to 6650 mg/m^3 for 2.5 months to 6 years, two-thirds of the workers had symmetrical distal sensory deficits, reduced muscular strength, and electroneuromyographic abnormalities. At the other facility, where allyl chloride exposure ranged from 0 to 25 mg/m^3 for 1 to 4.5 years, workers presented few neurological disorders, but one-half had abnormal electroneuromyographic findings. Toxicological and neuropathological studies in rabbits and mice have given evidence of a pattern of central-peripheral distal axonopathy in peripheral nervous system which has further confirmed the neurotoxicity of allyl chloride in man.

Axelson [1985]: Halogenated alkanes and alkenes and cancer: Epidemiological aspects. Epidemiological and other data related to human cancers and specific chemical compounds are reviewed. Data accumulated to date suggest many of these compounds are mutagenic and carcinogenic and indicate the need for further epidemiologic studies of exposed populations. Except for an increased risk for lung cancer among workers exposed to chloromethyl ethers, no clear cut findings emerge from the data. Most studies fail to indicate an increased cancer risk of any considerable magnitude.

COMMENTS:
Further epidemiological studies of exposed populations and studies to identify possible carcinogenic potential are needed. The new data suggest that the REL and PEL should be reevaluated.

REFERENCES:
Adams EM et al. [1940]. J Ind Hyg Tox 22:79.

Axelson O [1985]. Halogenated alkanes and alkenes and cancer. Epidemiological aspects. Environmental Carcinogens Selected Methods of Analysis, Vol. 7, L. Fishbein and J.K. O'Neill, Editors. Lyon, France: International Agency for Research on Cancer.

Hardin BD et al. [1981]. Testing of selected workplace chemicals for teratogenic potential. Scand J Work Environ Health 7(4):66-75.

Hausler M and Lenich [1968]. Arch Toxicol (Berl) 23:209-214.

He F et al. [1985]. Chronic allyl chloride poisoning. An epidemiology, clinical, toxicological and neuropathological study. Giornale Italiano di Medicine de Lavors 7(1):5-15.

NAME: Allyl Chloride **CAS:** 107-5-1
CODE: H.S. 1011

REFERENCES (Continued):

IARC [1987]. Allyl chloride. IARC monographs on the evaluation of carcinogenetic risks to humans. Supplement 7. Lyon, France: International Agency for Research on Cancer, Volume 36.

John JA et al. [1983]. Teratologic evaluation of inhaled epichlorohydrin and allyl chloride in rats and rabbits. Fund Appl Toxicol 3(5):437-442.

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to allyl chloride. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-204.

Santodonato J et al. [1985]. Final report. Monograph on the potential carcinogenic risk to humans: allyl chloride--final report. Syracuse, NY: Center for Chemical Hazard Assessment, Syracuse Research Corporation, Report No. SRC-TR-84-693.

Shell Chemical Co. [1974]. A compilation of data on allyl chloride prevously reported in literature. Houston, TX: Shell Oil Company, pp. 1-7 (unpublished).

Torkelson TR et al. [1959]. Am Ind Hyg Assoc J 20:217.

NAME: Allyl Glycidyl Ether (AGE) **CAS:** 106-92-3
CODE: H.S. 1012

EXPOSURE LIMITS

NIOSH	15-min ceiling of 9.6 ppm (45 mg/m^3)
OSHA PEL (Present)	10 ppm (ceiling)
OSHA PEL (Proposed)	5 ppm (8-hr TWA); 10 ppm STEL (skin)
ACGIH TLV	5 ppm (22 mg/m^3) - TWA; 10 ppm (44 mg/m^3) - STEL (skin)

WORKERS: 2,800 (1984) **VOLUME:** 1,000 lbs (1984)

PEL TESTIMONY:
NIOSH agrees with the proposed revision of the OSHA PEL.

BASIS FOR REL:
"Limited data available suggests that the current Federal Standard provides adequate margins of safety to prevent systemic effects for AGE inhalation" [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1978

Acute	Irritation (skin & eye); respiratory
Chronic	CNS depression; diarrhea
Irritation	Skin; eyes
Mutagenic	POS (Ames & other systems)
Teratogenic	Reproductive (testicular atrophy)
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Exposure of rats to 5.7 ppm for 15 minutes caused 50% decrease in respiratory rate. A four-day exposure (6 hr/day) at 7.1 ppm AGE produced lesions (necrosis of the respiratory epithelium and complete erosion of the olfactory epithelium) in the nasal cavities of mice [Gagnaire et al. 1987].

COMMENTS:
Since NIOSH agrees with the proposed OSHA-PEL of 5 ppm (TWA) and 10 ppm (STEL) with a skin notation, it seems reasonable that NIOSH should update its REL of 9.6 ppm, 15-minute ceiling. New studies by NTP indicate that exposures to allyl glycidyl ether may be injurious to nasal passages even at concentrations lower than the proposed PEL and may possibly increase the incidence of nasal tumors.

Data from a mouse inhalation study [Gagnaire et al. 1987] indicate that 15-minute exposure at 5.7 ppm AGE causes 50% decrease in respiratory rate. A four-day exposure (6 hrs/day) at 7.1 ppm AGE produced lesions in nasal cavities consisting of necrosis of respiratory epithelium and complete erosion of the olfactory epithelium, without pulmonary injury. Although mice exposed for 9 and 14 days at the 7.1 ppm concentration exhibited much less toxicity in the nasal cavities, as

NAME: Allyl Glycidyl Ether (AGE) **CAS:** 106-92-3
CODE: H.S. 1012

COMMENTS (Continued):
well as a restorative tissue response, the authors questioned that a 5 ppm exposure limit would provide an adequate margin of protection against AGE-induced nasal effects.

An NTP carcinogenicity study was under way in 1984-86 and was scheduled for completion in 1987. Dr. Boorman, principal investigator (FTS 629-3440), informed NIOSH (9/22/88) that tables of results will be available in a month and that a full report will be available in a few months. NTP will send the results and the report to NIOSH as soon as they become available. Dr. Boorman stated that there appears to be an increase in nasal tumors in animals (mice and rats) exposed to allyl glycidyl ether.

REFERENCES
Gagnaire F, Zissu D, Bonnet P and De Ceaurriz J [1987]. Nasal and pulmonary toxicity of allyl glycidyl ether in mice. Toxicology Letters 39:139-145.

NIOSH [1978]. Criteria for a recommended standard....occupational exposure to glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-166.

NAME: Ammonia **CAS:** 7664-41-7
CODE: H.S. 1021

EXPOSURE LIMITS

NIOSH	50 ppm (34.8 mg/m^3) ceiling (5 min)
OSHA PEL (Present)	50 ppm (35 mg/m^3), 8-hr TWA
OSHA PEL (Proposed)	25 ppm (18 mg/m^3) TWA; 35 ppm (27 mg/m^3) STEL
ACGIH TLV	25 ppm (18 mg/m^3) TWA; 35 ppm (27 mg/m^3) STEL

WORKERS: 2,520,000 (1972-1974 NOHS)
430,000 (1981-1983 [NOHS], Provisional)

VOLUME: 32,320,000,000 lbs (1987 C&E News)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limits as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
The 50 ppm 5-min ceiling limit was recommended "to minimize the discomfort felt by some unacclimatized individuals; to restrict the potential for fluctuations to more irritating concentrations; and to ensure that such possibly irritating exposures are brief." An REL as a TWA was felt "inappropriate since it would permit fluctuations to concentrations considerably higher than 50 ppm, and the irritation, or annoying effects were more dependent on concentration than length of exposure." [NIOSH 1974].

CD NOTED EFFECTS **DATE CD:** July 1974

Acute	Respiratory irritation; skin burns; eye irritation
Chronic	Eye irritation; respiratory irritation
Irritation	Skin; eyes; respiratory
Mutagenic	ND
Teratogenic	ND
Carcinogenic	One inconclusive human epidemiological study

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
None. (A translation of a 1984 foreign article that described adrenal cortical system effects in volunteers at 5 mg/m^3 was ordered through the NIOSH library: Kalandarov et al. [1984], Kosm Biol Aviakosm Med. 18(3):75-77.

DOES NIOSH REL NEED TO BE UPDATED? No

COMMENTS:
NIOSH and ACGIH reviewed the same data. From the scant data on human acute exposures, levels below 50 ppm for 5 min (viz. 30 ppm) have produced irritation in

NAME: Ammonia **CAS:** 7664-41-7
CODE: H.S. 1021

COMMENTS (continued):
some individuals. This effect at 30 ppm was judged as subjective by the NIOSH authors in 1974. It was not clear from the ACGIH documentation why the committee chose 35 ppm as a STEL.

The difference between NIOSH and ACGIH limits is a matter of professional judgment. The REL and TLV both appear to be protective, since irritation is the only effect permitted at either level. In a review of the criteria document, Utidjian [1976] stated "In as much as some experimental volunteers have been reported to experience slight irritation of the upper respiratory tract at 50 ppm, and a very few even at 30 ppm, it may be questioned whether the proposed ceiling is quite low enough however."

RESPONSE TO TESTIMONY:
1. The Association of Reproduction Materials Manufacturers (ARMM). Mr. Seeman's, ARMM, comments to docket require no response on the part of NIOSH because ARMM endorses the 1974 NIOSH REL rather than the (ACGIH-TLV) proposed PEL.

2. The International Institute of Ammonia Refrigeration (IIAR). Mr. Speller's, IIAR, comments to the docket contain the IIAR request to keep the current 50 ppm 8-hr TWA PEL with the addition of a 100 ppm STEL (5 min). The NIOSH REL of 50 ppm ceiling (5 min) allows for brief irritation and mild discomfort with no other health effects. Health effects (thickened tracheal epithelium and a decreased number of goblet cells) in weanling pigs continuously exposed for up to 6 weeks at approximately 100 ppm were observed [Doig and Willoughby 1971]. A TWA PEL of 50 ppm for 8-hr exposure will have only a safety factor of 2.

REFERENCES:
Doig PA, Willoughby RA [1971]. Response of swine to atmospheric ammonia and organic dust. J Am Vet Med Assoc 59:1353-1361.

NIOSH [1974]. Criteria for a recommended standard....occupational exposure to ammonia. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 74-136.

Utidjian HMD, West IM [1976]. Recommendations for an ammonia standard. J Occup Med 18:200-205.

NAME: 2-Butanone (MEK) **CAS:** 78-93-3
CODE: H.S. 1045

EXPOSURE LIMITS

NIOSH	200 ppm (590 mg/m^3), 10-hr TWA
OSHA PEL (Present)	200 ppm, 8-hr TWA
OSHA PEL (Proposed)	200 ppm, 8-hr TWA; 300 ppm STEL (15 min)
ACGIH TLV	200 ppm (590 mg/m^3) 8-hr TWA; 300 ppm (885 mg/m^3) STEL

WORKERS: >3,000,000 (1980) **VOLUME:** 468,000,000 lbs (1980)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposal (Table N1).

BASIS FOR REL:
To prevent narcosis and irritation to the eyes, nose, and throat [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1978

Acute	Narcosis and damage to internal organs in animals exposed at high concentrations
Chronic	ND
Irritation	Eyes; Nose; and Throat
Mutagenic	NEG
Teratogenic	One study in rats noted skeletal anomalies in offspring
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Numerous tests for mutagenicity have all been negative. A TSCA Test Submission of a teratology study in rats showed significant differences in skeletal variations between the fetuses of the control and high dose groups. No significant external or soft tissue alterations were observed in any of the fetuses.

COMMENTS:
Although the NIOSH REL of 200 ppm as a 10-hr TWA will protect most workers from irritation of the eyes, nose, and throat, the OSHA proposal to adopt a 15-minute STEL at 300 ppm in addition to a TWA of 200 ppm, should offer more protection from these irritant effects.

An NTP bioassay is planned but has not begun.

NAME: 2-Butanone (MEK) **CAS:** 78-93-3
CODE: H.S. 1045

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: n-Butyl-alcohol **CAS:** 71-36-3
CODE: H.S. 1051

EXPOSURE LIMITS
NIOSH : None
OSHA PEL (Present) : 100 ppm TWA
OSHA PEL (Proposed): 50 ppm CL
ACGIH TLV : Ceiling 50 ppm (150 mg/m^3) - Skin

WORKERS: 1,780,000 (1974) **VOLUME:** 463,000,000 lbs (1977)

PEL TESTIMONY:
The OSHA PEL is based upon three foreign studies cited in the ACGIH documentation that indicate possible hearing loss associated with exposure to n-butyl alcohol.

BASIS FOR REL:
N/A

CD NOTED EFFECTS *N/A **DATE CD:**
Acute :
Chronic :
Irritation :
Mutagenic :
Teratogenic :
Carcinogenic:

*NOTE: NIOSH does not have a criteria document on n-butyl alcohol; however, there is a NIOSH/OSHA Occupational Health Guideline for Butyl Alcohol. The guideline cites mucous membrane irritation and transient eye disorders as important acute effects of exposure. Dermatitis is indicated as an effect of long-term exposure.

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data.

COMMENTS:
Review of recent literature on n-butyl alcohol revealed no data useful in evaluating the proposed PEL. That is, there were no dose response data in either animal or epidemiologic studies. Also, concurrent exposures to other compounds or physical agents were quite frequently found. From the literature it

NAME: n-Butyl-alcohol **CAS:** 71-36-3
CODE: H.S. 1051

COMMENTS (Continued):
is apparent that "higher" concentrations of n-butyl alcohol cause transient corneal lesions and possibly vertigo. The ACGIH documentation cites three foreign studies indicating possible hearing loss associated with exposure to n-butyl alcohol.

NAME: Carbon Dioxide **CAS:** 124-38-9
CODE: H.S. 1069

EXPOSURE LIMITS

NIOSH	10,000 ppm (18,000 mg/m^3) as 10-hr TWA; 30,000 ppm (54,000 mg/m^3) 10-min ceiling
OSHA PEL (Present)	5,000 ppm (9,000 mg/m^3) as 8-hr TWA
OSHA PEL (Proposed)	5,000 ppm TWA with a 30,000 ppm STEL
ACGIH TLV	5,000 ppm (9,000 mg/m^3) as TWA; 30,000 ppm (54,000 mg/m^3) as STEL

WORKERS: 450,000 - 1,300,000 (1976) **VOLUME:** 43,035,000,000 lbs. (1977)

PEL TESTIMONY:
NIOSH concurs with the proposed PEL. OSHA is proposing to add a 30,000 ppm STEL to the existing PEL of 5,000 ppm TWA to protect workers from experiencing elevated short-term exposures.

BASIS FOR REL:
Signs of respiratory difficulty or central nervous system effects [NIOSH 1976].

CD NOTED EFFECTS **DATE CD:** August 1976

Acute	Convulsion; headache; mental confusion; loss of consciousness; eye flicking twitches; perspiration
Chronic	Respiratory acidosis; headaches; depressed ventilation
Irritation	ND
Mutagenic	ND
Teratogenic	Yes, also reproductive effects in animals
Carcinogenic	Yes, as carbonic acid (CO_2 snow) in animals
Organ Systems	CNS; respiratory; cardiovascular, behavioral, blood; neuroendocrine

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No new data have been discovered which would change the assessment made in the criteria document.

COMMENTS:
The majority of the available human data indicate that continuous exposure to 15,000 ppm and 30,000 ppm CO_2 causes changes which are limited to normal renal and respiratory compensatory mechanisms without any adverse symptoms. Additionally, data indicate that even prolonged continuous exposure to 30,000 ppm CO_2 presents no apparent problem during normal activity in specially conditioned and physically fit subjects.

NAME: Carbon Dioxide **CAS:** 124-38-9
CODE: H.S. 1069

REFERENCES:

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to carbon dioxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-194.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

EXPOSURE LIMITS

NIOSH	: 35 ppm (40 mg/m^3) 8-hr TWA; 200 ppm (229 mg/m^3) ceiling (no defined time)
OSHA PEL (Present)	: 50 ppm (55 mg/m^3) 8-hr TWA
OSHA PEL (Proposed)	: 35 ppm (TWA); 200 ppm (ceiling)
ACGIH TLV	: 50 ppm (TWA); 400 ppm STEL

WORKERS: 33,000 - 970,000 (1974) **VOLUME:** 13,245,000,000 lbs (1977)

PEL TESTIMONY:
OSHA proposes NIOSH limits to ensure that carboxyhemoglobin (COHb) levels are less than 5% and thus protect workers who may be at greater risk because of cardiovascular or pulmonary impairment (metabolic effects, carboxyhemoglobinemia). NIOSH concurs with the proposed PEL.

BASIS FOR REL:
The NIOSH criteria document [NIOSH 1972] states the following basis for the NIOSH REL: (1) To prevent acute CO poisoning; (2) to prevent myocardial alterations by maintaining COHb at less than 5%; (3) to prevent adverse behavioral effects.

CD NOTED EFFECTS **DATE CD:** 1972

Acute	: Headache; nausea; vomiting; dizziness; drowsiness; collapse
Chronic	: Cardiovascular; behavioral (human/animal)
Irritation	: ND
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

Mortality/CHD

Atkins EH and Baker EL [1985]
The deaths of two workers with coronary artery disease following exposure to carbon monoxide at work reinforced the authors' appreciation of the hazard of this response to individuals with pre-existing heart disease. Carbon monoxide acts to precipate ischemia by reducing oxygen delivery to the myocardium.

Barnard RJ and Weber JS [1979]
Carbon monoxide levels in twenty-five fires in Los Angeles demonstrated that fire fighters are exposed to levels of CO which could be a serious health hazard, and may be related to the high incidence of heart disease in fire fighters. CO levels ranged from below detectable (greater than 100 ppm) to as high as 3000 ppm. Forty percent had peak values in the 100 to 500 ppm range; 28% in the 501-1000 ppm range; and 20% had peak values greater than 1000 ppm.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (Continued):

Hernberg S et al. [1976]
A prevalence study on angina pectoris, ECG changes, and blood pressure was carried out with 1000 workers with longest time exposure from statistical sample of 20 foundries. Prevalence of angina showed a clear dose-response relationship with regard to CO exposure, but no such trend was found for ECG findings suggestive of chronic heart diseases.

Morris PD et al. [1986]
Various toxic substances were evaluated as potential risk factors for multiple myeloma using a population-based, multicenter case control investigation (698 patients with multiple myelomas, 1683 controls). Authors concluded that special attention should be paid to multiple myeloma in occupational epidemiologic studies of workers exposed to pesticides, paint compounds, and carbon monoxide.

Stern FB et al. [1981]
Effect of exhaust emissions, including chronic exposures to carbon monoxide at low concentrations (10-24 ppm TWA), on motor vehicle examiners was investigated. Authors suggest the slight overall excess of deaths due to cardiovascular diseases (124 observed vs 118.4 expected) is due to CO exposure. The overall excess cancer deaths (52 vs 47.8) may be due to contaminants other than CO. A statistically significant excess of cancer mortality was found for motor vehicle examiners after 30-year latency (13 observed vs 6.9 expected).

Tyroler HA et al. [1987]
Data on the environmental risk factor in coronary artery diseases (CAD) were reviewed. Exposure to certain physical/environmental factors such as extremes of temperature, high noise levels, carbon monoxide and lead were associated with increased risk of CAD morbidity and mortality.

Reproductive Effects

Barlow SM and Sullivan FM [1982]
The available data on reproductive hazards associated with exposure to carbon monoxide are reviewed. Authors conclude exposure to CO during pregnancy is toxic to the embryo and fetus, and maternal exposure to high levels may result in brain damage or death of the fetus.

Buchet JP et al. [1978]
The influence of epidemiological factors (e.g. demographic information, occupational history, etc.) on the exposure of pregnant women and their newborns to lead, mercury, cadmium and carbon monoxide were studied. Newborns of smoking mothers had significantly lower birth weights than newborns of nonsmoking mothers. Low birth weight was related to hemoglobin CO concentrations in newborns.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (Continued):

Fechter LD and Annau Z [1980]
Pregnant rats were exposed to 150 ppm CO in air and examination of offspring showed offspring weighed less at birth, showed reduced growth rates, and performed poorly on negative geotaxis and homing tests.

Gilman AG et al. [1985]
Infants born to women who have survived acute exposure to a high concentration of the gas (CO) while pregnant often display neurological sequelae and there may be gross damage to the brain. Persistent, low levels of COHb in fetus of women who smoke may also reduce mental abilities.

Hemminki K and Vineis P [1985]
Epidemiologic literature regarding the possible association between malformations and 23 exposures or occupations other than pharmaceutical products were analyzed. Carbon monoxide exposures were classified into four levels: high, limited, low, and inadequate. Human data for exposures belonging to "high" and "limited" (CO) were quantitatively compared to animal teratogenicity test of the relevant chemicals.

Hofmann A et al. [1983]
MAK values in relation to pregnancy are discussed. Current classification of teratogenic substances is presented in four groups: 1-known teratogen, 2-probably teratogenic (this category includes carbon monoxide), 3-not teratogenic, 4-needs more study.

Longo LD and Hill EP [1977]
Studies were performed to establish the relation to COHb concentration in the fetus to that of the pregnant mother and inspired CO concentrations in unanesthetized sheep. Findings suggest that the fetuses of pregnant women exposed to 30 ppm CO in air for prolonged exposure, as in industrial exposure, may be exposed to CO levels that are not innocuous.

Lutz A [1977]
To detect the effect of CO on the auditory organ, hearing acuity was studied in 50 workers in the chamber oven department of an oil shale processing plant. A decrease in hearing acuity was detected in 36 workers, of whom 9 had histories of head injuries or middle ear infections which would account for the hearing loss.

Shepard TH [1980]
Exposed rabbits during pregnancy to 180 ppm carbon monoxide. Perinatal death occurred in 43 of 123 treated offspring, but in only one of a control group. The birth weight was approximately 10 g less in the treated group and 3 had defects in extremities.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (Continued):

Neurotoxic/Behavioral Effects

Anger WK and Johnson BL [1985]
The literature on neurotoxic chemicals which cause behavioral changes was reviewed. The estimated population at risk for exposure to CO exceeded that of any other occupational chemical hazard. In one study, exposure to CO was associated with impaired performance on dual task and eye-hand coordination tasks.

Baker EL Jr [1983]
Neurological disorders identified with specific chemical substances are discussed. The acute effects of CO are the most important neurological manifestation; chronic poisoning shows effects of hypoxia on the nervous system.

Binder JW [1980]
Patient with possible visual neurologic effects from CO and retrospective study of pediatric patients with acute diagnosis of CO poisoning are presented. Evidence for conclusion that CO can produce residual neurological injury is included.

Fechter LD et al. [1986]
Data from the literature on effects of CO on the developing brain were reviewed. A sense of behavioral abnormalities has been identified in rats prenatally exposed to CO and an attempt was made to identify target tissues in the brain.

O'Donoghue, JL [1985]
The literature on the neurotoxicity of carbon monoxide was reviewed. Occupational exposure to CO occurred in foundries, mines, tunneling operations, automobile repair shops and garages, and motor vehicles. Inhalation exposure to CO resulted in lower tissue oxygen levels and impairment of brain function.

Carcinogenicity

CO carcinogenicity studies in progress (started January 1985). Conducted by the Department of Microbiology, University of Western Australia, Queen Elizabeth II Medical Center.

COMMENTS:
The new data suggest a reevaluation of the REL and the proposed PEL and strongly support the inference that there is a significant risk of material impairment to health at the present 50 ppm PEL which will be reduced by the proposed 35 ppm PEL.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

REFERENCES:

Anger WK and Johnson BL [1986]. Chemicals affecting behavior neurotoxicity of industrial and commercial chemicals 7(2):463-474.

Atkins EH and Baker EL [1985]. Exacerbation of coronary artery disease by occupational carbon monoxide exposure: A report of two fatalities and a review of the literature. Amer J Ind Med 7(155):73-79.

Baker EL Jr [1983]. Neurological disorders. Environ Occup Med, pgs. 313-327.

Barlow SM and Sullivan FM [1982]. Reproductive hazards of industrial chemicals. London, England: Academic Press, pgs. 178-199.

Barnard RJ and Weber JS [1979]. Carbon monoxide: A hazard to firefighters. Arch Environ Health 34(4):255-257.

Binder JW and Roberts RJ [1980]. Carbon monoxide intoxication in children. Clin Toxicol 16(3):287.

Buchet JP et al. [1978]. Placental transfer of lead, mercury, cadmium and carbon monoxide in women. Environ Res 15(3):494-503.

Fechter LD and Annau Z [1980]. Prenatal carbon monoxide exposure alters behavioral development. Neurobehavior Toxicol 2(1):7.

Gilman AG et al. [1980]. The pharmacological basis of therapeutics. 7th edition. New York, NY: MacMillan Publishing Company, pg. 1643.

Hemminki K and Vineis P [1985]. Extrapolation of the evidence of teratogenicity of chemicals between humans and experimental animals. Teratogen Carcinogen Mutagen 5(4):251-318.

Hernberg S et al. [1976]. Angina pectoris, ECG findings, and blood pressure of foundry workers in relation to carbon monoxide exposure. Scand J Work Environ Health 2(11):54-63.

Hofmann A et al. [1983]. MAK values and pregnancy. Arbertsmedizin Socialmedizin and Praventivmedizin 18(8):181-185.

Longo LD and Hill EP [1977]. Carbon monoxide uptake and elimination in fetal and maternal sheep. Amer J Physiol 232(3):H324-H330.

Lutz A [1977]. On importance of cytologic, luminesent otoneurologic examinations of ear-nose-throat organs in persons Exposed to toxic substances: Detection of early effects of toxic substances. Tullin, Institute of Experimental and Clinical Medicine of the Ministry of Health of the Estonian SSR, pgs. 179-184.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

REFERENCES (Continued):

Morris PD et al. [1986]. Toxic substance exposure and multiple myeloma: A case control study. JNCI 76(6)987-994.

NIOSH [1972]. Criteria for a recommended standard....occupational exposure to carbon monoxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-1100.

O'Donoghue JL [1985]. Neurotoxicity of industrial and commercial chemicals. Volume I, pgs. 51-148.

Shepard TH [1980]. Catalog of teratogenic agents. 3rd edition. Baltimore, MD: Johns Hopkins University Press, pg 53.

Stern FB et al. [1981]. Exposure of motor vehicle examiners to carbon monoxide: A historical perspective mortality study. Arch Environ Health 36:2:54-66.

Tyroler HA et al. [1987]. Task Force 1: Environmental risk factors in coronary artery disease. Circulation 76:(1)(Part 2):I/139-I/144.

NAME: Carbon Monoxide **CAS:** 630-08-0
CODE: H.S. 1071

RESPONSE TO PEL DOCKET MATERIAL:
Two issues emerge from the review of docket materials on carbon monoxide for which we have comments:

Issue 1

Du Pont (ex. 3-660) objected "to a limit set to protect a special population." Caterpillar, Inc. stated (ex. 3-349) that, "PELs should not be set to protect individuals with known diseases."

Response

Based on the work of Brest [1968] which indicated: (1) estimates of more than 500,000 persons in the U.S. sustain silent infarctions each year; (2) approximately 1 percent of all white, middle-aged males in the U.S. develop clinical CHD annually; (3) after age 20, it would be virtually impossible to delineate a control group without atherosclerosis, the NIOSH Criteria Document [1972] on carbon monoxide concludes that: (1) the general worker population in the U.S. is composed of a very significant number of persons with CHD; and further, (2) since the detection of such persons in the absence of overt clinical symptoms is virtually impossible, it is necessary to assume that the average worker has asymptomatic CHD; especially when his first clinical symptom may be sudden death.

The PEL should, therefore, be set to protect the average U.S. worker, assumed to have asymptomatic CHD. This should not be interpreted as a special population or with known disease since all individuals are commonly classified as having asymptomatic CHD.

Issue 2

The American Iron and Steel Institute commented (ex. 3-1123) that, "there is not adequate evidence that exposure to CO at 50 ppm TWA poses a significant risk to workers with heart or pulmonary disease."

Response

In reviewing the 1972 NIOSH criteria document on carbon monoxide, it is clear that evidence exists which demonstrates the initiation or enhancement of deleterious myocardial alterations in workers with CHD who are exposed to CO of sufficient concentration to produce a carboxyhemoglobin (COHb) level of 5 percent. The basis for the NIOSH criteria cites work of Ayers and coworkers conducted in 1969 and 1970 demonstrating restricted blood flow and myocardial lactate production under such exposures, and studies of Knelson in 1972 concerning CO exposure and exercise of patients with angina pectoris. Although exposure to this level of COHb (an amount that an employee engaged in sedentary activity would approach in 8 hours of continuous exposure to 35 ppm of CO) may not protect the employee with clinical symptoms of CHD; it should protect individuals with asymptomatic CHD, common among the U.S. worker population, from developing clinical symptoms.

NAME: Chlorine **CAS:** 7782-50-5
CODE: H.S. 1079

EXPOSURE LIMITS

NIOSH	: 0.5 ppm (1.45 mg/m^3) ceiling (15 min)
OSHA PEL (Present)	: 1 ppm (3 mg/m^3) ceiling
OSHA PEL (Proposed)	: 0.5 ppm (1.45 mg/m^3) ceiling (15 min)
ACGIH TLV	: 1 ppm (0.3 mg/m^3) TWA; 3 ppm (9 mg/m^3) STEL

WORKERS: 150,000 [1981-1983 (NOES), provisional]; 233,000 [1972-1974 (NOES)]

VOLUME: 21,930,000,000 lbs (1987- C & E News)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limit as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
Because there were no retrospective or prospective epidemiological studies upon which to judge the level at which chronic symptoms would begin, and because ocular and respiratory irritation has occurred at exposures of 0.5 ppm for 1 hour or less and conjunctival pain has occurred at approximately 0.5 ppm for 15 minutes, an REL of 0.5 ppm ceiling (15 min) was established to prevent irritation of the skin, eyes, and respiratory tract.

CD NOTED EFFECTS **DATE CD:** May 1976

Acute	: Pulmonary congestion; cardiovascular effects; headache; nausea; vomiting; syncope
Chronic	: Bronchitis; emphysema
Irritation	: Skin; eyes; respiratory; nose; throat
Mutagenic	: None (chlorinating agents caused chemical changes in genetic material of bacteria)
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No information discovered which would change the assessment in the criteria document. CIIT has a full lifetime inhalation study of chlorine in rats and mice in progress. Pathology and final report is expected around March 1989 (contact Jim Popp, Ph.D., at CIIT, Telephone number 919-541-2070).

COMMENTS:
ACGIH, in its 1987 and 1988 Notice of Intended Changes and its TLV documentation [1986], proposed a TLV-TWA of 0.5 ppm with a TLV-STEL of 1 ppm, based on studies of

NAME: Chlorine CAS: 7782-50-5
CODE: H.S. 1079

COMMENTS (Continued):
Barrow [1977; 1982], Anglen [1981], and Rotman [1983]. At the OSHA Air Contaminants hearings, Ralph Smith, representing the Chlorine Institute, endorsed the ACGIH TWA TLV, stating that the NIOSH ceiling REL was based on 3 German papers that did not have scientific merit. The WHO [1984], in its recommended health based occupational exposure limit report on chlorine, recommends a short term limit of 0.5 ppm (15 min) because the threshold level at which disturbing irritation occurred was found to be about 0.5 ppm by 3 investigators. One of these reports was the German paper on which NIOSH [1976] based its 15-min ceiling of 0.5 ppm. The WHO panel also agrees with NIOSH that there are no epidemiological data upon which to base a limit at levels of chlorine below 0.5 ppm. Nevertheless, a tentative 8-hr TWA of 0.25 ppm was recommended by WHO to insure that the short-term limit of 0.5 ppm would occur only rarely. The WHO study group, and NIOSH [1976] regard the significance of the long-term study by Patil [1970] as unclear, because it does not suggest permanent adverse health effects associated with long-term exposure to chlorine. The studies of Anglen [1981] and Rotman [1983], as summarized by the ACGIH, if considered alone, would support the ACGIH TWA TLV of 0.5 ppm with a STEL of 1 ppm. However, in the studies of Rupp and Henschler [1967], exposure to chlorine at concentrations of approximately 0.5 ppm resulted in conjunctival pain in several subjects after 15 minutes; in their second study, subjects reported respiratory irritation after exposure to 0.5 ppm for 25 minutes.

REFERENCES:
Barrow CS et al. [1977]. Comparison of the sensory irritation response in mice to chlorine and hydrogen chloride. Arch Environ Health 29:68-76.

Barrow CS and Steinhagen WH [1982]. Sensory irritation tolerance development to chlorine in F-344 rats following reported inhalation. Toxicol Appl Pharmacol 65:383-389.

Anglen DM [1981]. Doctor dissertation. University of Michigan as cited in ACGIH Documentation of the Threshold Limit Values (1986), pp. 117.1-117.3.

Rotman HH, Fliegelman MJ and Moore T et al. [1983]. Journal of Applied Physiology Respiratory Environmental Exer. Physiology, 54(4) 1120-1124, as cited in ACGIH Documentation of Threshold Limit Values (1986) pgs 117.1-1173.1, 1987.

WHO [1984]. Recommended health based occupational exposure limits for respiratory irritants. WHO Technical Report Series No. 707. Geneva, Switerzland: World Health Organization.

NIOSH (1976). Criteria for a recommended standard....occupational exposure to chlorine. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-170.

Patil LRS, Smith RG, Vorwald AJ, Mooney TF [1970]. The health of diaphragm cell workers exposed to chlorine. Amer Ind Hyg Assoc J 31:678-686.

NAME: Chlorine CAS: 7782-50-5
CODE: H.S. 1079

RESPONSE TO PEL DOCKET MATERIAL:

Significant Health Effects

The studies of Anglen [1981] (ex. 3-828) established that 8-hour exposures of 29 subjects to 1.0 ppm produced significant changes in pulmonary function and increased subjective irritation. Exposures to 0.5 ppm produced no statistically significant changes in pulmonary function and a less severe subjective irritation. Six of 14 of the subjects showed increased mucous secretion from the nose and increased mucous in the hypopharynx at 1 ppm.

The studies of Rotman et al. [1983] also established that significant transient adverse changes in pulmonary function occur at 1 ppm concentration of chlorine.

The CIIT studies of rats (ex. 3-828) exposed at 1, 3, or 9 ppm for 6 weeks found upper and lower respiratory tract inflammation at all levels with a dose response.

The Rupp and Henschler study [1967], although it has been criticized for lack of a defined control group (ex. 3-685), confirms the Anglen (1981), Rotman et al. (1983) and CIIT studies (ex. 3-828) that there is a significant risk of irritation and a risk of respiratory inflammation at the present PEL of 1 ppm ceiling.

Reduction of the current PEL to the proposed PEL of 0.5 ppm ceiling will reduce the risk of respiratory irritation and pulmonary function changes, and minimize the subjective complaints of irritation. No data is available at this time to indicate that a time-weighted average PEL below the proposed ceiling is necessary to protect worker health. A table summarizing responses to the docket for chlorine is attached.

Table 1

Classification of Comments to OSHA Air Contaminants Docket
on Chlorine (H.S. 1079)

Category†	Docket #	Organization	Comments
I (Major)	3-828	The Chlorine Institute	ACGIH Notice of Intended Change (NOI) TWA with STEL based on Anglen [1981] and CIIT subchronic exposures of rats at 1, 3, or 9 ppm
II (Limited)	8-33	The Chlorine Institute	ACGIH NOI TWA with STEL (Testimony on Day 8)
II	3-349	Caterpillar, Inc.	ACGIH TWA with STEL, due to anecdotal experience, without supporting data
II	3-661	Kodak Company	Current OSHA PEL of 1 ppm CL, claims irritation is not a "material impairment of health or functional capacity"
II	3-673	American Foundrymen's Society Inc.	Separate rulemaking
II	3-675	American Cast Materials Association	Separate rulemaking
II	3-897	American Meat Institute	ACGIH NOI TWA with STEL
II	3-677	Vulcan Materials	ACGIH NOI TWA with STEL
II	3-368	American Paper Institute	ACGIH NOI TWA with STEL claims Rupp & Henschler [1967] study had no controls
II	3-1158	*	*

* Not in package
† Category was assigned by contractor to OSHA

NAME: Chloroform **CAS:** 67-66-3
CODE: H.S. 1086

EXPOSURE LIMITS

NIOSH	2 ppm (9.78 mg/m^3) ceiling
OSHA PEL (Present)	50 ppm (250 mg/m^3) ceiling
OSHA PEL (Proposed)	2 ppm (9.78 mg/m^3) STEL (15 min)
ACGIH TLV	10 ppm (50 mg/m^3 A2 - suspect human carcinogen

WORKERS: 95,300 (1982) **VOLUME:** 400,000,000 lbs (1982)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed PEL, but suggests that OSHA add a carcinogen designation because it meets the OSHA definition of a suspect carcinogen.

BASIS FOR REL:
The 2 ppm REL (a lowest feasible limit) is a 1976 update of the 1974 criteria document [NIOSH 1976] and is based upon the National Cancer Institute (NCI) report on the carcinogenesis bioassay of chloroform. According to this report, chloroform ingestion produced malignant kidney tumors in rats and hepatocellular carcinomas in mice.

CD NOTED EFFECTS **DATE CD:** 1974; Revised 1976

Acute	Narcosis; liver and kidney damage
Chronic	CNS depression; irritability; "night fatigue"
Irritation	Localized in mouth, throat, and digestive tract; skin
Mutagenic	ND
Teratogenic	NEG (rats and rabbits)
Carcinogenic	Inconclusive in mice (original criteria document) POS (rats and mice) (updated REL - NCI studies)

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data since the update of the criteria document that suggest a need for a change in the REL.

COMMENTS:
No convincing scientific evidence refuting the NCI bioassays is presented. The current REL of 2 ppm [NIOSH 1974] is consistent with NIOSH policy on dealing with potential occupational carcinogens.

NAME: Chloroform **CAS:** 67-66-3
CODE: H.S. 1086

RESPONSE TO PEL DOCKET MATERIAL:
Dupont and Kodak express concern that NIOSH RELs "are not the consensus of a spectrum of scientific thinking" (Dupont - Docket #3-660), or "are not consensus standards" (Kodak - Docket #3-660). Kodak is most concerned over feasibility of compliance. Neither company provides substantive scientific challenge to the NIOSH REL. Vulcan Materials Co. agrees with the ACGIH recommendation of 10 ppm over NIOSH's REL of 2 ppm. No scientific rationale is provided for this choice.

The American Paper Institute (API) is concerned with the "generic" rulemaking by OSHA (Docket #3-685). The API states that RELs are merely a starting point in the rulemaking process. The bulk of the API argument is presented in copies of two API reports submitted to the Environmental Protection Agency. In these reports, the API attacks several fundamentals of animal testing. Specifically mentioned are the use of oil as a gavage vehicle; tumor production in certain strains of mice; extrapolation of animal data to man; and the use of oral administration versus inhalation.

NAME: Cobalt Carbonyl **CAS:** 10210-68-1
CODE: H.S. 1098

EXPOSURE LIMITS
NIOSH : 0.1* mg/m^3 TWA
OSHA PEL (Present) : None
OSHA PEL (Proposed): 0.1 mg/m^3 TWA
ACGIH TLV : 0.1 mg/m^3 TWA as cobalt

WORKERS: No information **VOLUME:** No information

PEL TESTIMONY:
NIOSH concurred with proposed PEL.

BASIS FOR REL:
NIOSH concluded that, based on available data, there was insufficient evidence to recommend a new standard for cobalt and its compounds.

CD NOTED EFFECTS (Collective Data for Cobalt Compounds) **DATE** : October 1981 OCCUPATIONAL HAZARD ASSESSMENT DOCUMENT

Acute : Respiratory irritation
Chronic : Respiratory disease (bronchitis, emphysema); liver; kidney; heart disease
Irritation : Skin
Mutagenic : ND
Teratogenic : ND
Carcinogenic: Tumors in animals - cobaltous sulfide & chloride

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No specific data found for cobalt carbonyl that would permit assessment of possible health effects from exposure.

DOES NIOSH REL NEED TO BE UPDATED? Yes (Cobalt & its compounds)

COMMENTS:
No specific health data on cobalt carbonyl was presented in the NIOSH 1981 document; however, the collective body of information to date on cobalt compounds warrants reassessment of NIOSH's REL.

NAME: Cobalt Hydrocarbonyl **CAS:** 16842-03-8
CODE: H.S. 1099

EXPOSURE LIMITS

NIOSH	: 0.1* mg/m^3 TWA
OSHA PEL (Present)	: None
OSHA PEL (Proposed)	: 0.1 mg/m^3 TWA
ACGIH TLV	: 0.1 mg/m^3 TWA as cobalt

*The NIOSH REL was taken to be the same as the OSHA PEL at the time of the criteria document [1981].

WORKERS: No information **VOLUME:** No information

PEL TESTIMONY:
NIOSH concurred with proposed PEL.

BASIS FOR REL:
NIOSH concluded that, based on available data, there was insufficient evidence to recommend a new standard for cobalt and its compounds [NIOSH 1981].

CD NOTED EFFECTS (Collective Data for Cobalt Compounds) **DATE** : October 1981 OCCUPATIONAL HAZARD ASSESSMENT DOCUMENT

Acute	: Respiratory irritation
Chronic	: Respiratory disease (bronchitis, emphysema); liver; kidney; heart disease
Irritation	: Skin
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: Tumors in animals--cobaltous sulfide and chloride

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No specific data found for cobalt hydrocarbonyl that would permit assessment of possible health effects from exposure.

COMMENTS:
No specific health data on cobalt hydrocarbonyl was presented in the NIOSH 1981 documents; however, the collective body of information to date on cobalt compounds warrants reassessment of NIOSH's REL.

REFERENCES:
NIOSH [1981]. Occupational hazard assessment--criteria for controlling occupational exposure to cobalt. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 82-107.

NAME: Cobalt **CAS:** 7440-48-4
CODE: H.S. 1100

EXPOSURE LIMITS

NIOSH	: 0.1* mg/m^3 TWA
OSHA PEL (Present)	: 0.1 mg/m^3 TWA
OSHA PEL (Proposed)	: 0.05 mg/m^3 TWA
ACGIH TLV	: 0.05 mg/m^3 TWA

*The NIOSH REL was taken to be the same as the OSHA PEL at the time of the criteria document [1981].

WORKERS: 186,243 (Cobalt) (1974)
1.5 million (cobalt & compounds) (1974)

VOLUME: 16.6 million lbs. consumption (1976)

PEL TESTIMONY:
NIOSH concurred with proposed PEL

BASIS FOR REL:
NIOSH concluded that, based on available data, there was insufficient evidence to recommend a new standard for cobalt and its compounds [NIOSH 1981].

CD NOTED EFFECTS (Collective Data for Cobalt Compounds) **DATE** : October 1981 OCCUPATIONAL HAZARD ASSESSMENT DOCUMENT

Acute	: Respiratory irritation
Chronic	: Respiratory disease (bronchitis, emphysema); liver; kidney; heart disease
Irritation	: Skin
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: Tumors in animals-cobaltous sulfide & chloride

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Animal data is suggestive of a tumorigenic effect from exposure to some cobalt compounds. Recent mortality study reported by Mur et al. is suggestive of a lung cancer risk to cobalt. Study by Kusaka et al. reports an increased risk of developing asthma from exposure to cobalt at concentrations less than 0.05 mg/m^3.

COMMENTS:
Evidence is suggestive of an occupationally induced health risk from exposure to cobalt. This risk may differ between cobalt compounds. The proposed OSHA PEL of 0.05 mg/m^3 for cobalt may not be protective against the development of respiratory diseases.

NAME: Cobalt **CAS:** 7440-48-4
CODE: H.S. 1100

COMMENTS (Continued):

Re: Mur JM et al. [1987]. A cohort mortality study among cobalt and sodium workers in an electrochemical plant. Amer J Ind Med 11:75-81.

Findings: Statistically significant increase ($p < 0.05$) in lung cancer mortality (SMR 4.66) among cobalt production workers.

Limitations:
1) Small number of lung cancer cases observed (4 cases vs. 1 expected)
2) Difficulties in ascertainment of causes of death for the cohort
3) No smoking data
4) No exposure data

Re: Kusaka Y et al. [1986]. Respiratory diseases in hard metal workers: an occupational hygiene study in a factory. Brit J Ind Med 43:474-485.

Findings:
1) Occupationally induced asthma in workers employed in a hard metal factory.
2) Exposure to cobalt reported to be associated with effect.
3) Exposure measurements for cobalt indicated that some workers was exposed to average concentrations below 0.05 mg/m^3.

Limitations:
1) Small number of workers identified with asthma
2) Incomplete occupational histories for some cases
3) Exposures for other metals not ascertained

Re: Shabaan AA et al. [1977]. Fibrosarcomas induced by cobalt chloride (C_oCl_2) in rats. Lab Anim 11:43-46.

Heath JC [1956]. The production of malignant tumors by cobalt in the rat. Br J Cancer 10:668-73.

Heath JC [1960]. The histogenesis of malignant tumors induced by cobalt in the rat. Br J Cancer 14:478-82.

Heath JC, Daniel MR [1962]. The production of malignant tumours by cobalt in the rat--Intrathoracic tumours. Br J Cancer 16:473-78.

Findings: Tumor induction at the injection site.

REFERENCES:

NIOSH [1981]. Occupational hazard assessment--criteria for controlling occupational exposure to cobalt. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 82-107.

NAME: Cyclohexanone **CAS:** 108-94-1
CODE: H.S. 1108

EXPOSURE LIMITS

NIOSH	: 25 ppm (100 mg/m^3), TWA 10-hr
OSHA PEL (Present)	: 50 ppm (200 mg/m^3), TWA 8-hr
OSHA PEL (Proposed)	: 25 ppm (100 mg/m^3), TWA 8-hr (skin)
ACGIH TLV	: 25 ppm (100 mg/m^3), TWA 8-hr (skin)

WORKERS: 34,000 (1981-83, NOES Provisional) **VOLUME:** 795,000,000 lbs (USITC 1984)
839,000 (1972-74, NOHS)
1,1909,000 (1978 CD)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limits as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
Because of the finding that at 50 ppm subjects reported throat irritation and at 75 ppm, most subjects had irritation of eyes, nose and throat, and at 190 ppm rabbits experienced liver and kidney damage after 6-hr exposures, NIOSH recommended that the exposure limit be set at 25 ppm as a 10-hr TWA [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** June 1978

Acute	: Narcosis; CNS depression; liver and kidney effects
Chronic	: Narcosis; CNS depression; liver, kidney, lung effects; cataracts; cardiac muscle effects
Irritation	: Eye, nose and throat irritation; skin irritation
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Lijinsky W, Kovatch RM [1986]. Chronic toxicity study of cyclohexanone in rats and mice. JNCI 77:941-949.

COMMENTS:
The Lijinsky and Kovatch [1986] carcinogenicity study of cyclohexanone was an NTP-initiated study that was not reported in the Technical Report Series because the records of the study were inadequate to fully document all aspects currently included in an NTP technical report. A NIOSH evaluation of the study follows: In 2-yr drinking water studies of cyclohexanone in F344 rats and (C57BL/6 x C3H)F_1 mice, there was equivocal evidence for carcinogenicity of cyclohexanone in male rats as shown by a statistically significant increase in adrenal cortical neoplasms at the low dose (3,300 ppm) and no increase at the higher dose (6,500 ppm). There

NAME: Cyclohexanone **CAS:** 108-94-1
CODE: H.S. 1108

COMMENTS:
was no evidence of carcinogenicity in female rats at either dose. There was equivocal evidence for carcinogenicity in male mice as shown by the increase in hepatocellular adenomas and carcinomas (combined) in the low dose (6,500 ppm) mice and no increase in the higher dose (13,000 ppm) mice. There was some evidence for carcinogenicity in female rats as shown by the statistically significant increase in incidence of lymphoma-leukemias among animals given 6,500 ppm and no increase in incidence at two higher doses (13,000 or 25,000 ppm). The evidence for carcinogenicity is marginal and, in light of the fact that the records were not adequate to fully document all aspects included in an NTP technical report, plus the absence of dose-related, response-elevated cancer was only in low dose groups, and not higher dose groups), cannot be regarded as conclusive for the carcinogenicity of cyclohexanone in animals.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Diisobutyl Ketone **CAS:** 108-83-8
CODE: H.S. 1140

EXPOSURE LIMITS
NIOSH : 25 ppm, 10-hour TWA
OSHA PEL (Present) : 50 ppm, 8-hour TWA
OSHA PEL (Proposed): 25 ppm (150 mg/m^3) 8-hour TWA
ACGIH TLV :

WORKERS: 748,000 **VOLUME:** 5.5 million lbs. (1977)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposal.

BASIS FOR REL:
To prevent irritation of the eyes and nose [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1978
Acute : Lethality in animals exposed to high concentrations
Chronic : Increased liver and kidney weights in exposed animals; also lung congestion
Irritation : Eyes, nose, and throat in humans
Mutagenic : ND
Teratogenic : ND
Carcinogenic: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data to suggest updating the REL.

COMMENTS:
The present REL appears to be protective.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Dipropylene Glycol Monomethyl Ether (DPGME) **CAS:** 34590-94-8
CODE: H.S. 1149

EXPOSURE LIMITS

NIOSH	: No REL
OSHA PEL (Present)	: 100 ppm TWA (skin) [1974]
OSHA PEL (Proposed)	: 100 ppm TWA; 150 ppm STEL (skin)
ACGIH TLV	: 100 ppm (600 mg/m^3); TWA (skin)
	150 ppm (900 mg/m^3) STEL (skin)

WORKERS: 52,536 (NIOSH 1974) **VOLUME:** 5,500,000 lbs (1977)

PEL TESTIMONY:
NIOSH concurs with the proposed PEL. OSHA believes that the proposed limits will reduce the risk of CNS effects and irritation that may exist when workers are exposed for short periods above the 100 ppm PEL; OSHA is also proposing a skin notation because of evidence that DPGME is cutaneously absorbed in lab animals.

BASIS FOR REL:
There is no REL.

NOTED EFFECTS (Information from TDB Data Base) **DATE CD:** There is no CD.

Acute	: Respiratory paralysis; CNS effects
Chronic	: CNS diseases; lung diseases
Irritation	: Mucous membranes (eyes & respiratory tract)
Mutagenic	: ND
Teratogenic	: Not a teratogen
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No previous criteria document.

COMMENTS:
NIOSH is currently developing a criteria document on the glycol ethers. RELs will be proposed for ethylene glycol monoethyl ether (EGEE), ethylene glycol monomethyl ether (EGME), ethylene glycol monobutyl ether (EGBE), and their acetates. An REL for the remaining glycol ethers will also be addressed.

The attached sheet contains information on the effects exerted by DPGME via inhalation exposure [Landry and Yano 1984]. DPGME is of low acute toxicity; the rat oral LD_{50} is 5.7 g/kg and the rat dermal LD_{50} is 9.5 g/kg [NIOSH 1978].

NAME: Dipropylene Glycol Monomethyl Ether (DPGME) CAS: 34590-94-8
CODE: H.S. 1149

COMMENTS (Continued):
Results of the Miller et al. study [1985] indicate that DPGME is metabolized via the same routes to the same types of metabolites--propylene glycol, and sulfate and glucuronide conjugates of DPGME--as previously identified for PGME [Miller et al. 1983]. In view of this, one might expect DPGME to exert the same effects as PGME (1-methoxy-2-propanol). The Landry and Yano study [1984] further indicates that at the concentrations tested, DPGME exerted no teratogenic or reproductive effects. It would therefore seem prudent to apply the same PEL to both compounds.

REFERENCES:
Landry TD, Yano BL [1984]. Dipropylene glycol monomethyl ether: a 13-week inhalation toxicity study in rats and rabbits. Fund Appl Toxicol 4(4):612-617.

Miller RR, Hermann EA, Calhoun LL et al. [1985]. Metabolism and disposition of dipropylene glycol monomethyl ether (DPGME) in male rats. Fundam Appl Toxicol 5(4):721-726.

NIOSH [1978]. Registry of toxic effects of chemical substances. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

ATTACHMENT TO
DIPROPYLENE GLYCOL MONOMETHYL ETHER (DPGME)
CAS: 34590-94-8
H.S. 1149

Toxic Effects of DPGME

Sex	Species	Route of Administration: Dose)	Effects	Reference
M F	Rat Mouse	Inhalation: 50, 140 or 330 ppm 6 hr/day for 9 days	Small increase in liver weight (rat at 50 and 140 ppm); increased liver weight (mouse at 330 ppm)	Landry & Yano [1984]
M,F	Rat	Inhalation: 15, 50, or 200 ppm 6 hr/day, 5 days/week, for 13 weeks	No effects	Landry & Yano [1984]

NAME: Ethyl Mercaptan **CAS:** 75-08-1
CODE: H.S. 1165

EXPOSURE LIMITS
NIOSH : 0.5 ppm (1.3 mg/m^3) as a 15-min ceiling
OSHA PEL (Present) : 10 ppm (26 mg/m^3) ceiling
OSHA PEL (Proposed): 0.5 ppm; 8-hr TWA
ACGIH TLV : 0.5 ppm; 8-hr TWA

WORKERS: 38,711 [NOHS] **VOLUME:** >1 metric ton [SRI 1975]

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed reduction of the ethyl mercaptan PEL from a 10 ppm ceiling to a 0.5 ppm 8-hour TWA. (See Comments Section below).

BASIS FOR REL:
The 1978 NIOSH criteria document [NIOSH 1978] states the following: "The major concern...is their potential for causing irritation to mucosal surfaces and possible effects on the central nervous system. Initial signs and symptoms . . . are irritation of the eyes, nose and throat, as well as headache and nausea. Delirium has also been observed. The neurologic effects due to thiol poisoning are manifested as confusion, muscular weakness culminating in paralysis, respiratory changes leading to respiratory failure, mild to severe cyanosis, and changes in the central and autonomic nervous systems."

NOTED EFFECTS **DATE CD:** September 1978
Acute : See Basis For REL section above.
Chronic : ND
Irritation : Slight to moderate
Mutagenic : ND
Teratogenic : ND
Carcinogenic: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No significant new data were found.

COMMENTS:
Ethyl mercaptan was inadvertantly omitted from inclusion in Table N7 of the NIOSH testimony. Since methyl and butyl mercaptans were cited in that table, it is recommended that ethyl mercaptan (H.S. 1165) be included. The NIOSH criteria document recommends a 0.5 ppm ceiling limit.

NAME: Ethyl Mercaptan **CAS:** 75-08-1
CODE: H.S. 1165

REFERENCES:
NIOSH [1978]. A recommended standard for occupational exposure to....n-alkane mono thiols, cyclohexanethiol and benzenethiol. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-213.

NAME: Ethylene Dichloride **CAS:** 107-06-2
CODE: H.S. 1168

EXPOSURE LIMITS

NIOSH	1 ppm TWA; 2 ppm CL (15 min)
OSHA PEL (Present)	50 ppm TWA; 100 ppm CL (5 min in any 3 hrs); 200 ppm peak
OSHA PEL (Proposed)	1 ppm TWA; 2 ppm STEL
ACGIH TLV	10 ppm (40 mg/m^3) TWA

WORKERS: 1,350,000 **VOLUME:** 17,000,000,000 lbs (1977)

PEL TESTIMONY:
None.

BASIS FOR REL:
The REL is based on preventing cancer. Ethylene dichloride was found to cause cancer in male and female rats and mice [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** September 1978

Acute	Kidney and liver damage
Chronic	Liver; kidney; heart; brain; lung
Irritation	Eyes
Mutagenic	POS (in many tests)
Teratogenic	NEG (in one study)
Carcinogenic	NCI (clear evidence in animals); IARC (sufficient evidence in animals; limited evidence in humans)

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No significant new information was found to reevaluate the REL.

DOES NIOSH REL NEED TO BE UPDATED? No

COMMENTS:
NIOSH recommends that ethylene dichloride be considered an occupational carcinogen. The NIOSH REL [1978] for ethylene dichloride is 1 ppm TWA, with a 2 ppm ceiling (15 min). These levels are the lowest levels that may be reliably measured. OSHA proposes to adopt the NIOSH REL as the PEL for this substance. The present OSHA PEL for ethylene dichloride is 50 ppm TWA, a 100 ppm ceiling (maximum duration of 5 minutes in any 3 hours), and a 200 ppm peak; these limits were derived from limits recommended by the American National Standards Institute. The ACGIH TLV [1986] for ethylene dichloride is 10 ppm TWA. ACGIH reviewed the NIOSH REL but felt ethylene dichloride "clearly belongs to the group of hepatoxic halogenated hydrocarbons", and felt 10 ppm was protective. No comments were made in the documentation regarding the bioassay leading to the carcinogen classification by NIOSH.

NAME: Ethylene Dichloride **CAS:** 107-06-2
CODE: H.S. 1168

COMMENTS (Continued):
The NCI bioassay tested ethylene dichloride in one experiment in mice and one in rats by gavage in corn oil. In mice, it produced lung neoplasms and lymph system cancers in animals of both sexes, liver cancer in males, and mammary and uterine cancers in females. In rats, it produced cancers of the forestomach in male animals, mammary neoplasm in females, and hemangiosarcomas in animals of both sexes. It was concluded that there is sufficient evidence for the carcinogenicity of ethylene dichloride in experimental animals. IARC [1979] concluded that "There is sufficient evidence that ethylene dichloride is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable for practical purposes to regard ethylene dichloride as if it presented a carcinogenic risk to humans."

REFERENCES:
ACGIH [1986]. Ethylene Dichloride. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: Amer Conf of Gov Ind Hyg, Inc., p. 252-3

IARC [1979]. Some halogenated hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 429-442.

NCI [1978]. Bioassay of 1,2-Dichloroethane for Possible Carcinogenicity. Technical Report #55. U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, DHEW Publication No. (NIH) 78-1361.

NIOSH [1978]. Current intelligence bulletin #25: Ethylene dichloride. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-149.

NAME: Furfuryl Alcohol **CAS:** 98-00-0
CODE: H.S. 1184

EXPOSURE LIMITS

NIOSH	50 ppm (200 mg/m^3), 10-hour TWA
OSHA PEL (Present)	50 ppm (200 mg/m^3), 8-hour TWA
OSHA PEL (Proposed)	10 ppm (40 mg/m^3) TWA, 15 ppm STEL (Skin)
ACGIH TLV	10 ppm (40 mg/m^3) TWA; 15 ppm (60 mg/m^3) STEL (Skin)

WORKERS: 11,600 (1976) **VOLUME:** 100,000,000 lbs.

PEL TESTIMONY:
NIOSH concurs with the proposed revision of the PEL. In the proposed air contaminants standard, OSHA believes that severe lacrimation observed in a foundry study was due to 15.8 ppm furfuryl alcohol and not to presence of formaldehyde. OSHA thus proposes a 10 ppm TWA, 15 ppm STEL, and a skin notation.

BASIS FOR REL:
CNS effects; irritation of skin, respiratory tract, and eyes. The REL, is based on the hypothesis that severe lacrimation noted in a foundry study was due to the presence of formaldehyde [NIOSH 1979].

CD NOTED EFFECTS **DATE CD:** March 1979

Acute	Death; intoxication; visual disturbances
Chronic	ND
Irritation	Skin; eyes; respiratory
Mutagenic	ND (was negative in sister chromatid exchange assay) [1985]
Teratogenic	ND
Carcinogenic	ND--Planned by NTP.
Organ Systems	CNS; skin; eyes; cardiac; liver; kidney; respiratory

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Cockcroft DW et al. [1980]. Asthma caused by occupational exposure to a furan-based binder system. J Allergy and Clin Immun 66(6):458-463.

A case of asthma induced by sensitization to volatile reaction products of a furan-based binder system was described. A 50-year-old mold maker was treated for severe asthma 2 weeks after beginning work with a furan-based binder system. Rhinorrhea and lacrimation occurred transiently at the time of pouring molds while a pungent odor was evident. Dyspnea, chest tightness, wheezing and cough developed 2.5 to 4.0 hours later. The molds were prepared by mixing sand with a resin containing furfuryl alcohol (98000), paraformaldehyde (110883), and xylene (1330207), and a catalyst containing sulfuric acid (7664939), phosphoric acid (7664382) and butyl alcohol (71363). A work exposure test was carried out during which the peak flow rate (PFR) was measured every 2 hours at home and at work over a 15-day period. The patient was exposed to the furan-based binder system for 2 intervals during the test. On the first occasion he was exposed for 35 minutes on 2 different days and had a mild recurrence of chest symptoms with a transient decrease in PFR. On the second occasion, he

NAME: Furfuryl Alcohol **CAS:** 98-00-0
CODE: H.S. 1184

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

was exposed for 20 to 60 minutes on 4 consecutive days and had a marked reduction in PFR. Treatment with salbutamol and prednisone was required. Occupation-type provocation tests were conducted in the laboratory on 13 nonconsecutive days. The patient developed a late asthmatic response after exposure to one or more products of the reaction of furfuryl alcohol resin with acid catalyst, furfuryl alcohol with sulfuric acid, and furfuryl alcohol with butyl alcohol. Bronchial response to inhaled histamines increased 2- to 3-fold after exposure to furfuryl alcohol with butyl alcohol. No changes were produced by the same exposures in a previously nonexposed asthmatic with similar bronchial responsiveness to histamine.

Gomez-Arrova S et al. [1985]. In vitro and occupational induction of sister-chromatid exchanges in human lymphocytes with furfuryl alcohol and furfural. Mut Res 156(3):233-238.

The genetic effects of furfuryl alcohol (98000) and furfural (98011) in cultured human lymphocytes and in the lymphocytes of occupationally-exposed workers were determined. Cultures of peripheral blood from four healthy individuals were made. Subjects were interviewed and background data on such variables as exposure to x-rays, chemical agents, drugs, viral infections, use of tobacco and alcohol, age, and area of residence were tabulated. Peripheral blood samples were obtained from six workers occupationally exposed; heparinized blood was cultured at 37° C. A dose of 4 milligrams per milliliter colchicine was added to 70 hours, and 2 hours later the cells were harvested. Slides were smeared, air dried, and stained. Cells were analyzed for C-mitosis and tetraploidy. Furfural was a strong inducer of sister chromatid exchanges (SCE), while furfuryl alcohol did not increase SCE frequencies significantly. Furfural also damaged spindle fibers, while furfuryl alochol did not. Furfural stimulated cell division, increasing the mitotic index. The analysis of SCE in workers occupationally exposed showed no significant difference to the comparisons. The authors concluded that although these compounds did not cause genetic damage in the exposed workers, results obtained in in vitro studies suggest that these solvents must be used with caution.

COMMENTS:

NIOSH based its REL on the consideration that severe lacrimation was not due to furfuryl alcohol--OSHA disputes this and is proposing a new PEL. OSHA indicates that more severe adverse effects would occur at that level of formaldehyde (0.33 ppm) and therefore suggests that the health effects observed at 15.8 ppm are due to exposure to furfuryl alcohol.

NAME: Furfuryl Alcohol **CAS:** 98-00-0
CODE: H.S. 1184

COMMENTS (Continued):
The material includes two NIOSH investigations in the criteria document. Opal [1973] does not clarify if lacrimation is due to furfuryl alcohol, formaldehyde, or both. The material does not indicate that formaldehyde causes severe effects at 0.33 ppm as OSHA implies. Based on available literature, there is no need for NIOSH to update its REL. A carcinogenicity study of furfuryl alcohol is being planned by NTP.

REFERENCES:
Cockcroft DW et al. [1980]. Asthma caused by occupational exposure to a furan-based binder system. J Allergy and Clin Immun 66(6):458-463.

Gomez-Arrova S et al. [1985]. In vitro and occupational induction of sister-chromatid exchanges in human lymphocytes with furfuryl alcohol and furfural. Mut Res 156(3):233-238.

NIOSH [1979]. Criteria for a recommended standard....occupational exposure to furfural alcohol. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 79-133.

NAME: Methyl Isobutyl Ketone (Hexone) (MIBK) **CAS:** 108-10-1
CODE: H.S. 1203

EXPOSURE LIMITS

NIOSH	50 ppm, 10-hr TWA
OSHA PEL (Present)	100 ppm, 8-hr TWA
OSHA PEL (Proposed)	50 ppm TWA; 75 ppm STEL, 8-hr TWA
ACGIH TLV	50 ppm (205 mg/m^3), 8-hr TWA; 75 ppm (300 mg/m^3) STEL

WORKERS: 1,853,000 **VOLUME:** 150,000,000 lbs (1984)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposal.

BASIS FOR REL:
To prevent CNS effects and irritation [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1978

Acute	CNS depression
Animal/Sub-Chronic	Kidney damage and increased kidney and liver weight
Irritation	Produced irritation in workers exposed to MIBK at concentrations of 80-500 ppm
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Nothing significant. Confirmation of previous study results.

COMMENTS:
Although the NIOSH REL should protect most workers, OSHA's proposal to adopt a STEL in addition to a TWA should afford workers added protection from the acute effects of MIBK.

REFERENCES:
NIOSH [1977]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Hydrogen Cyanide **CAS:** 74-90-8
CODE: H.S. 1207

EXPOSURE LIMITS

NIOSH	: Ceiling of 4.7 ppm (10-min sampling period) (5 mg/m^3) as CN
OSHA PEL (Present)	: 10 ppm TWA (skin)
OSHA PEL (Proposed)	: 4.7 ppm ceiling
ACGIH TLV	: 10 ppm ceiling, skin

WORKERS: 1,000 (NOHS 1977) **VOLUME:** 310,000 short tons (1973)

PEL TESTIMONY:
Although NIOSH concurred with the OSHA proposed PEL, NIOSH also noted in Table N7 that "OSHA adopt the NIOSH ceiling values to provide the most appropriate degree of health protection" for potassium cyanide and sodium cyanide. (No H.S. listed).

BASIS FOR REL:
The REL is based largely on an epidemiologic study by Ghawabi [1976], showing an increase in symptoms of headache, weakness, throat irritation, vomiting, dyspnea, lacrimation, colic, and nervousness among workers exposed for an average of 7.5 years to cyanide concentrations ranging from 4.2 - 12.4 ppm. [Other papers support these data [Colla 1978; Radojicic 1973; Saia et al. 1970; Clairmont 1960].

CD NOTED EFFECTS **DATE CD:** October 1976

Acute	: Cytochrome oxidase inhibition; cellular anoxia; and death
Chronic	: RBC alterations; taste & smell changes; and precordial pain (See "Basis for REL").
Irritation	: **Corrosive potential**
Mutagenic	: **ND**
Teratogenic	: **ND**
Carcinogenic	: **ND**

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There is no new data to suggest updating the REL.

DOES NIOSH REL NEED TO BE UPDATED? **No**

COMMENTS:
Data cited in the NIOSH criteria document warrant consideration of a skin notation for HCN and cyanide salts. The NIOSH criteria document also includes REL's for potassium, sodium, and calcium cyanide salts. NIOSH previously suggested that OSHA consider PELs for these substances.

NAME: Hydrogen Fluoride **CAS:** 7664-39-3
CODE: H.S. 1208

EXPOSURE LIMITS

NIOSH	: 2.5 mg F/m^3 (3 ppm), 10-hr TWA; 5 mg F/m^3 (6 ppm) as a 15-minute ceiling
OSHA PEL (Present)	: 3 ppm, 8-hr TWA (2.5 mg/m^3)
OSHA PEL (Proposed)	: 3 ppm, 8-hr TWA (2.5 mg/m^3); C 6 ppm (15 minutes)
ACGIH TLV	: C 3 ppm (2.5 mg/m^3) as F

WORKERS: 100,000 (1976) **VOLUME:** 592,000,000 lbs (1977)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed change of the hydrogen fluoride PEL of 3 ppm as an 8-hr TWA to add a STEL of 6 ppm (15 minutes).

BASIS FOR REL:
NIOSH REL for hydrogen fluoride is based on irritation of eyes, skin, respiratory tract, and potential increases in bone density due to skeletal fluorosis [NIOSH 1976].

CD NOTED EFFECTS **DATE CD:** 1976

Acute	: Eyes; dermal; systemic; respiratory
Chronic	: Skeletal
Irritation	: Upper respiratory tract
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new significant data.

COMMENTS:
New data reviewed are supportive of the REL.

REFERENCES:
NIOSH [1976]. Criteria for a recommended standard....occupational exposure to hydrogen fluoride. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-103.

NAME: Isophorone **CAS:** 78-59-1
CODE: H.S. 1221

EXPOSURE LIMITS

NIOSH	: 4 ppm (23 mg/m^3), TWA 10-hr
OSHA PEL (Present)	: 25 ppm (140 mg/m^3), TWA 8-hr
OSHA PEL (Proposed)	: 4 ppm (23 mg/m^3), TWA 8-hr
ACGIH TLV	: 5 ppm (25 mg/m^3) ceiling

WORKERS: 11,800 (1981-1983, NOES, Provisional)
1,000,000 (1972-1974 NOHS)
1,507,000 (1978 CD)

VOLUME: 6,050,000 lbs (1977 TSCAPP)
>5,000 lbs (1976 SRI)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limits as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
Based on studies in which (1) eye, nose and throat irritation occurred in humans at 25 ppm with a no observed effect level (NOEL) of 10 ppm; (2) liver and kidney changes occurred in animals at 50 ppm with a NOEL of 25 ppm; and (3) fatigue and malaise was experienced by workers at exposures of 5-8 ppm with a NOEL of 1-4 ppm, NIOSH recommended a limit of 4 ppm as a 10-hr TWA [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** June 1978

Acute	: Narcosis; CNS depression
Chronic	: Narcosis; CNS depression; liver, kidney and lung effects
Irritation	: Eye, nose and throat irritation; skin irritation
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

1. NTP [1986]. Toxicology and carcinogenesis studies of isophorone (CAS No. 78-51-1) in F344/N Rats and B6C3F$_1$ Mice (Gavage Studies). NTP Technical Report Series No. 291. January 1986 (NIH Publication No. 86-2547). U.S. DHHS, PHS, NIH, National Toxicology Program Research Triangle Park, North Carolina.

2. Moran EJ, Rogers-Back AM, Yang LL, Leffert JJ and Clerke JJ [1984]. L5178Y TK+/- Mouse lymphoma mutagenesis assay of isophorone, Final report 9/18/84. Study performed by Microbiological Associates, Bethesda, Maryland for the Chemical Manufacturers Association, Washington, D.C.

NAME: Isophorone **CAS:** 78-59-1
CODE: H.S. 1221

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.) (continued):

3. Moran EJ, Putman DL, Sandberg EM and Melhorn JM [1984a]. Activity of Isophorone in the Micronucleus Cytogenic Assay in Mice, Final Report; 9/17/84. Study performed by Microbiological Associates, Bethesda, Maryland for the Chemical Manufacturers Association, Washington, D.C.

4. Traul KA, Hinz YP, and Kapp RW [1984]: Inhalation teratology study in rats and mice of isophorone, Final report 11/20/84. Submitted to the Chemical Manufacturers Association, Washington, D.C., through Exxon Biomedical Sciences, East Millstone, New Jersey by Bio/Dynamics, East Millstone, New Jersey.

DOES NIOSH REL NEED TO BE UPDATED? No

COMMENTS:
In the NTP study [NTP 1986] there was some evidence of carcinogenicity of isophorone in male F344/N rats as shown by the occurrence of renal tubular cell adenomas and adenocarcinomas in animals given 250 or 500 mg/kg per day. Carcinomas of the preputial gland were also observed at increased incidence in male rats given 500 mg/kg. There was no evidence of carcinogenicity in female F344/N rats given 250 or 500 mg/kg per day. There was equivocal evidence of carcinogenicity of isophorone in male $B6C3F_1$ mice as shown by increased incidence of hepatocellular adenomas or carcinomas (combined) and mesenchymal tumors in the integumentary system of animals given 500 mg/kg per day and by an increase in malignant lymphomas in animals given 250 mg/kg per day. There was no evidence of carcinogenicity of isophorone in female $B6C3F_1$ mice given 250 or 500 mg/kg per day. Results of Chemical Manufacturers Association (CMA)-sponsored studies for mutagenicity [Moran 1984] and teratogenicity [Traul 1984] were negative. In NTP-reported [1986] mutagenicity tests, isophorone was not mutagenic in strains TA100, TA1535, TA1537, or TA98 of Salmonella typhimurium in the presence or absence of Arochlor 1254-induced male rat or male hamster liver S9. It was weakly mutagenic in the mouse L5178Y/TK+/i assay in the absence of S9; it was not tested in the presence of S9. It induced sister-chromatid exchanges in the absence of S9 in Chinese hamster ovary cells; it did not induce sister-chromatid exchanges in the presence of Aroclor 1254-induced male rat liver S9, and it did not induce chromosomal aberrations.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to diisocyanates. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-215.

NAME: Isophorone Diisocyanate (IPDI) **CAS:** 4098-71-9
CODE: H.S. 1222

EXPOSURE LIMITS

NIOSH	: 0.005 ppm TWA (10-hr); 0.02 ppm CL (10-min)
OSHA PEL (Present)	: None
OSHA PEL (Proposed)	: 0.005 ppm TWA (8-hr); 0.02 ppm CL (10-min) skin
ACGIH TLV	: 0.005 ppm (0.045 mg/m^3) - Skin

WORKERS: 6,400 (1972) **VOLUME:** No information

PEL TESTIMONY:
NIOSH agrees with OSHA's proposed PEL.

BASIS FOR REL:
The current REL is based on respiratory effects, sensitization, and pulmonary irritation. The information is primarily derived from experience and studies of toluene diisocyanate (TDI).

CD NOTED EFFECTS **DATE CD:** September 1978

Acute	: Sensitization; asthmatic response; nausea, vomiting
Chronic	: Pulmonary sensitization
Irritation	: Respiratory; skin; eyes
Mutagenic	: NEG (Salmonella) [NTP 1986]
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No specific information was found on isophorone diisocyanate. NTP [1986] tested TDI and found tumorigenic responses in both rats and mice. IARC [1986] concluded that there was sufficient evidence for the carcinogenicity of TDI in experimental animals.

DOES NIOSH REL NEED TO BE UPDATED? No

COMMENTS:
The NIOSH REL [1978] for isophorone diisocyanate (IPDI) is 0.005 ppm (0.045 mg/m^3) as a TWA with a 10-min ceiling of 0.02 ppm (0.18 mg/m^3). The REL is based primarily on respiratory effects associated with exposure to toluene diisocyanate (TDI).

The ACGIH TLV [1986] is based on IPDI having similar toxicological actions to TDI. Therefore, the TLV assigned to TDI is to be applied to IPDI. There is no current OSHA PEL for IPDI. OSHA proposed that a 0.005 ppm TWA and a 0.02 ppm ceiling (10-min) with a skin designation be adopted for IPDI.

NAME: Isophorone Diisocyanate (IPDI) **CAS:** 4098-71-9
CODE: H.S. 1222

COMMENTS (Continued):
A recent study by NTP [1986] of chronic effects in animals has produced evidence that cancer is associated with exposure to commercial grade TDI (an 80:20 mixture of 2,4- and 2,6-TDI) and to a TDI hydrolysis product, 2,4-TDA. In the NTP study [1986], treatment of rats and mice of both sexes by gavage to commercial grade TDI resulted in tumor induction, primarily in the pancreas and liver in male and female rats, and in female mice. The tumorigenic responses observed in both rats and mice treated with TDI meet the criteria of the OSHA cancer policy [29 CFR 1990] for classifying a substance as a potential occupational carcinogen. NIOSH is in the process of developing a Current Intelligence Bulletin (CIB) on this subject.

Although the carcinogenic potential of IPDI has not been determined, it would seem that, since the REL and TLV have been based on the toxicological properties of TDI, the recommendation should be considered as an interim level to be applied to IPDI until adequate testing information is available.

REFERENCES:
ACGIH [1986]. Isophorone diisocyanate. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 334(86).

IARC [1986]. Some chemicals used in plastics and elastomers. IARC Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1978]. A recommended standard for occupational exposure to....diisocyanates. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-125.

NTP [1986]. NTP technical report on the toxicology and carcinogenesis studies of commercial grade 2,4 (80%)- and 2,6 (20%)-toluene diisocyanate (CAS No. 26471-62-5) in F344/N rats and B6C3F$_1$ mice (gavage studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NTP TR 251, NIH Publication No. 86-2507.

NAME: Isopropyl Alcohol **CAS:** 67-63-0
CODE: H.S. 1226(5)

EXPOSURE LIMITS

NIOSH	400 ppm (984 mg/m^3) TWA; 800 ppm (1,968 mg/m^3) 15-min (ceiling)
OSHA PEL (Present)	400 ppm (984 mg/m^3), 8-hr TWA
OSHA PEL (Proposed)	400 ppm TWA; 500 ppm STEL
ACGIH TLV	400 ppm (980 mg/m^3) TWA; 500 ppm (1,225 mg/m^3) STEL

WORKERS: 5,000,000 (1976) **VOLUME:** 786,000,000 lb (1977)
500,000,000 lb (1983)

PEL TESTIMONY:
NIOSH concurs with the proposed PEL. The STEL is being added to reduce the risk of irritation and narcotic effects at the higher short-term concentrations permitted by the TWA alone. The addition of the STEL will reduce this risk.

BASIS FOR REL:
Mild irritation of the eyes, nose, and throat has occurred in people inhaling isopropyl alcohol at 400 and 800 ppm for 3-5 minutes; even at 800 ppm, these effects were not severe. This report is used to substantiate the need for a workplace exposure limit where minimal irritation occurs. Therefore, a TWA of 400 ppm was recommended with a ceiling level of 800 ppm, at which minimal irritation occurs [NIOSH 1976].

CD NOTED EFFECTS **DATE CD:** 1976

Acute	Inhalation; coma; drowsiness; headache; decreased blood flow
Chronic	Drying & cracking of skin
Irritation	Skin; eyes; throat
Mutagenic	ND
Teratogenic	ND (see comments)
Carcinogenic	Possible cancer threat in certain manufacturing process
Organ systems	Liver degeneration; CNS

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Carcinogenic determination: Indefinite [IARC 15:223-37, 1977]. There is no cancer hazard based on epidemiological data IARC [1987] Supplement 7. The overall evaluation is that isopropyl alcohol is not classifiable as to its carcinogenicity in humans; there is inadequate evidence. Weil et al. [1952], cited in the criteria document [NIOSH 1976], exposed mice to isopropyl alcohol in air. There was no increase in incidence of tumors.

DOES NIOSH REL NEED TO BE UPDATED? No

NAME: Isopropyl Alcohol **CAS:** 67-63-0
CODE: H.S. 1226(5)

COMMENTS:
As part of a teratological evaluation of several alcohols, groups of 15 pregnant Sprague-Dawley rats were exposed to 10,000, 7,000, and 3,500 ppm n-propanol or isopropanol were administered by inhalation to for 7 hrs/day on gestation days 1-19. The dams were killed on day 20. Half of the fetuses were examined for skeletal defects and the others for visceral defects using the Wilson technique. The highest concentration of n-propanol produced only minimal maternal toxicity, as indicated by observation and by measurement of weight gain and feed and water intake. In contrast, the same concentration of isopropanol produced narcosis in the dams, retarded body-weight gain, and reduced the food intake. At 7,000 ppm isopropanol, body-weight gain was retarded but there were no other observable effects in the dams. Following exposure to 10,000 ppm of either alcohol, there were significant ($P \leq 0.05$) increases in resorptions and decreases in fetal weights compared with the control groups. Fetal weights were also reduced significantly following exposure to 7,000 ppm of either alcohol and to 3,500 ppm isopropanol. Significantly more litters had malformations following exposure to 10,000 or 7,000 ppm of either alcohol, but these effects were seen only in the presence of maternal toxicity. At 3,500 ppm, no detectable teratogenic effects were produced by either solvent [Nelson BK et al. (1988).

REFERENCES:
IARC [1987]. IARC Monograph Supplement 7:229.

IARC [1977]. IARC monographs on the evaluation of carcinogenic risk of chemicals to man. IARC Monographs 15:223. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Nelson BK, Brightwell WS, MacKenzie-Taylor DR, Khan A, Burg JA Weigel WW [1988]. Teratogenicity of n-propanol and isopropanol administered at high inhalation concentrations to rats. Fd Chem Tox 26(3):247-254.

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to isopropyl alcohol. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. DHEW (NIOSH) Publication No. 76-142.

NAME: Mercury (Vapor) **CAS:** 7439-79-6
CODE: H.S. 1240

EXPOSURE LIMITS

NIOSH	: 0.05 mg/m^3, 8-hr TWA
OSHA PEL (Present)	: 0.1 mg/^{3}, acceptable ceiling
OSHA PEL (Proposed)	: 0.05 mg/m^3, 8-hr TWA (skin)
ACGIH TLV	: 0.05 mg/m^3, 8-hr TWA (skin)

WORKERS: 65,400 (NOES, 1981-83 Provisional) **VOLUME:** 2,290,000 (1982, SRI)
24,400 (NOHS, 1972-74)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed. For this chemical the available documentation appeared to support the proposed exposure limit as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
The REL [NIOSH 1973] is based on long-term studies in which workers, exposed at 0.1 mg/m^3 and less, experienced mercury intoxication (central nervous system signs). In several of the studies, cases of toxicity were associated with concentrations between 0.005 and 0.06 mg/m^3. Because the effects could not be correlated with exposures with a high degree of confidence, due to lack of valid sampling and analytical techniques in these studies, a specific exposure level for the onset of toxic responses could not be readily identified. NIOSH concluded that the prudent occupational health considerations would indicate the highest acceptable exposure is 0.05 mg/m^3.

CD NOTED EFFECTS **DATE CD:** August 1973

Acute	: Pneumonitis; bronchitis; chest pain; dyspnea; coughing; stomatitis; gingivitis
Chronic	: CNS effects (including tremor, hyperactivity and loss of appetite); salivation; diarrhea
Irritation	: Skin and eyes
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: Sarcomas at the i.p. injection site

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

WHO [1980]
Recommended Health-Based Limits in Occupational Exposure to Heavy Metals-5 Inorganic Mercury. World Health Organization Technical Report Series 647, Geneva, pp. 102-115.

ACGIH [1986]
Mercury. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 358-359.

NAME: Mercury (Vapor) **CAS:** 7439-79-6
CODE: H.S. 1240

NEW DATA SINCE CD (Continued):

Anger WK and Johnson BL [1985]
Chemicals affecting behavior in neurotoxicity of industrial and commercial Chemicals, Volume I, Chapter 3. J.L. O'Donoghue, ed. Boca Raton, FL: CRC Press Inc.

Roels H, Abdeladim I, Ceulemans E and Lauwerys R [1987]
Relationships between the concentrations of mercury in air and in blood or urine in workers exposed to mercury vapor. Annals Occup Hyg 31:135-145.

COMMENTS:

At the air contaminants hearings, Dr. Richard Henderson, representing the Chlorine Institute, stated that the two unpublished studies at the Oak Ridge, TN, Y-12 plant, in which no health effects were observed at air concentrations up to 0.2 mg Hg/m^3, did not support the proposal for a PEL of 0.05 mg/m^3 TWA. Dr. Henderson felt that a standard of 0.05 mg/m^3 based largely on environmental sampling is too strict to apply when personal sampling is used in compliance efforts. Dr. Henderson and Dr. Melius, Director of Occupational Health and Environmental Epidemiology for the New York State Department of Health, also wanted OSHA to incorporate biological monitoring as part of the mercury health standard. The Y-12 plant studies were not available for review. However, the studies in the NIOSH (1973) criteria document support an air concentration of less than 0.1 mg/m^3 TWA. Additionally, the World Health Organization [WHO 1980] and ACGIH [1986], recommend limits of 0.025 mg/m^3 and 0.05 mg/m^3 TWA, respectively, which are based on the same studies as cited in the criteria document. ACGIH [1986] and WHO [1980] considered many studies in which the concentration of mercury in air was compared with the concentrations in urine and symptoms of CNS involvement and found that the relationship of airborne mercury to urinary mercury levels is uncertain. Anger and Johnson [1985], after reviewing all the literature available on the neurotoxicity studies of mercury, also concluded that the relationship of urinary mercury to airborne mercury concentrations is uncertain.

In a recent study [Roels, et al. 1987], the use of ratios of mercury in air to mercury in urine of 1:2, considered reliable by WHO [1980], was disputed. Roels et al. [1987] concluded that the ratio should be 1:1.2 at exposure levels of 0.05 mg/m^3. Roels et al. [1987] also concluded that the mercury concentration in urine should not exceed 56 ug/l based on early signs of kidney changes, hand tremors, and disturbances in psychological performance. Thus, the WHO recommendation of 0.025 mg/m^3 was questioned and a limit of 0.04 mg/m^3 was proposed.

In light of the uncertainty surrounding the measurement of concentrations of mercury vapor in air and of mercury in urine at these low levels, the present REL appears to be a prudent choice. However, all new information from studies that appear in the future should be periodically evaluated to confirm this REL.

NAME: Mercury (Vapor) **CAS:** 7439-79-6
CODE: H.S. 1240

REFERENCES:

NIOSH [1973]. Criteria for a recommended standard....occupational exposure to mercury. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-11024

NAME: Methyl Alcohol **CAS:** 67-56-1
CODE: H.S. 1252

EXPOSURE LIMITS

NIOSH	200 ppm (10-hr TWA); 800 ppm (15-min ceiling)
OSHA PEL (Present)	200 ppm
OSHA PEL (Proposed)	200 ppm (TWA); 250 ppm (STEL) - Skin
ACGIH TLV	200 ppm (260 mg/m^3) TWA; 250 ppm (310 ppm mg/m^3) - STEL (Skin)

WORKERS: 1,050,000 (NOES), 2,060,000 (NOHS) **VOLUME:** 7,780,000 lbs 1977
7,330,000 lbs 1986

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed PEL of 200 ppm (8-hr TWA), and 250 ppm STEL with a skin notation

BASIS FOR REL:
"No information has been found to warrant a modification of the existing limit of 200 ppm." [NIOSH 1987a] "A ceiling limit of 800 ppm based on a 15-minute sampling period is proposed on the basis of good practice." [NIOSH 1976]

CD NOTED EFFECTS **DATE CD:** 1976

Acute	CNS; dyspnea; gastrointestinal; blindness
Chronic	CNS; visual impairment
Irritation	Eyes; skin; respiratory
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Mutagenic (mouse lymphocytes, C. cervisae) [NIOSH 1987b]; Teratogenic (congenital malformations in rats) [Nelson et al. 1985].

COMMENTS:
Since NIOSH agreed with the proposed PEL of 200 ppm (TWA) and 250 ppm (STEL), NIOSH should reevaluate its 15-minute ceiling of 800 ppm.

The ACGIH and the NIOSH criteria document cite a study by Kingsley and Hirsch (1954-55) which indicates severe and recurrent headaches in workers exposed to methyl alcohol in concentrations between 200-350 ppm. Also, ACGIH cites a paper by Henson (1960), which reports headaches among workers exposed to 300 ppm. Therefore, an REL of 200 ppm may be only marginally protective.

NAME: Methyl Alcohol **CAS:** 67-56-1
CODE: H.S. 1252

COMMENTS (Continued):
Additionally, there appears to be no justification for a ceiling of 800 ppm. It appears that data are more supportive of the OSHA and ACGIH STEL of 250 ppm. Since NIOSH agreed with the OSHA PEL proposal, it seems reasonable to update the NIOSH recommended ceiling.

The EPA [1988a] has proposed an RFD (reference dose, formerly ADI) of 0.5 mg/kg/day based on unpublished EPA oral study data in rats [1988b]. The adverse effect observed was a decrease in brain weight in rats treated with 2500 mg/kg/day. The RFD of 0.5 mg/kg/day was derived by applying National Academy of Sciences (NAS) suggested uncertainty factors.

A series of new studies deal with mutagenicity, teratogenicity, biological monitoring, chronic toxicity and exposures. Bauchann and Angerer [1979] studied 20 workers employed in a printing office at 3 different work places (methanol concentrations of 85, 101, and 134 ppm) to determine whether the concentration of formic acid in blood or urine and methanol content of alveolar air permit the estimation of ethanol exposure. They concluded that the increase of formic acid concentration in blood during the shift is the most useful parameter for monitoring methanol-exposed persons.

Ferry et al. [1980] investigated the effects of methanol exposures by monitoring urinary and blood concentrations of methanol and formic acid. They concluded that measuring urinary concentrations of methanol and formic acid is adequately sensitive for measurements of occupational exposure, and they cautioned that exposures resulting in urine concentrations of >10 mg/ml could be hazardous.

Frederic et al. [1984] investigated occupational hazards associated with the use of spirit duplicators in teachers aides. Symptoms that were significantly more frequent in aides than in teachers were blurred vision, headaches, dizziness, nausea, and skin problems. Among aides, the case attack rate increased with increased time spent per week at the duplication machine. Methanol concentration sampled at 21 duplicators ranged from 365-3080 ppm without ventilation system, and from 80-1340 ppm when ventilation systems were on.

Heinrich and Angerer [1982] correlated methanol exposures in occupational settings with the urine concentrations. They estimated that 8-hour exposure at 200 ppm corresponds to methanol content in urine of 40 mg/l.

Henzi [1984] reported two cases of chronic methanol poisoning with clinical symptoms of multiple sclerosis. No estimates of exposures were described in the abstract.

Nelson et al. [1985] administered methanol by inhalation to pregnant rats for 7 hours/day on days 1-19 of gestation. Malformations were observed in fetuses of the 10,000 ppm group while no effects were observed in fetuses of the 5,000 ppm group.

NAME: Methyl Alcohol **CAS:** 67-56-1
CODE: H.S. 1252

COMMENTS (Continued):
Panchenko et al. [1977] studied effects of industrial factors in the development of cerebral artherosclerosis in workers at a methanol plant. No details of the study are in the abstract.

The above studies seem to warrant careful review, since the information available in the abstracts deals with data that may affect RELs.

REFERENCES

Bauchann K, Angerer J. [1979]. Occupational chronic exposure to organic solvents. Int Arch Occup Environ Health 42(3-4):241-250.

Carson et al. [1982]. Methanol health effects. NTIS/PB-160797, 71 pp.

EPA [1988a]. Reportable quantity document for methanol. Cincinnati, OH: U.S. Environmental Protection Agency, Publication No. ECAO-CIN-R423.

EPA [1988b]. Methanol. Integrated risk information system (IRIS). Online. Cincinnati, OH: U.S. Environmental Protection Agency.

Frederick et al. [1984]. Investigation and control of occupational hazards associated with the use of spirit duplicators. ACGIH Journal, 45:51-55.

Heinrich R, Angerer J. [1982]. Occupational chronic exposure to organic solvents. Chapter 10. Biological Monitoring parameters for methanol exposure. Int Arch Occup Environ Health 50(4):341-350.

Henzi H. [1984]. Chronic methanol poisoning with the clinical and pathological-anatomical features of multiple sclerosis. Med Hypothesis 13(1):63-75.

Kasparov et al. [1985]. Hygienic studies of a gasoline-methanol mixture. Khim Tekhnol Top, Masel 11:43-44.

Nelson et al. [1985]. Teratological assessment of methanol and ethanol at high inhalation levels in rats. Fundam Appl Toxicol 5(4):727-736.

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to methyl alcohol. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-148.

NIOSH [1987a]. Respirator decision logic. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-108.

Olson RJ. [1983]. Occupational eye disorders. Env Occup Med, pp. 367-372.

NAME: Methyl Alcohol **CAS:** 67-56-1
CODE: H.S. 1252

REFERENCES:

Panchenko et al. [1977]. Effect of industrial factors in the development of cerebral artheriosclerosis in workers in methanol plant. Vrach Delo 4:109-113.

NIOSH [1987b]. Registry of toxic effects of chemical substances. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 87-114.

Sedivec et al. [1981]. Biological monitoring of persons exposed to methanol vapors. Int Arch Occup Environ Health 48(3):257-272.

NAME: Methyl Isoamyl Ketone (MiAK) **CAS:** 110-12-3
CODE: H.S. 1260

EXPOSURE LIMITS
NIOSH : 50 ppm, 10-hr TWA
OSHA PEL (Present) : None
OSHA PEL (Proposed): 50 ppm TWA, 8-hr TWA
ACGIH TLV : 50 ppm (240 mg/m^3), 8-hr TWA

WORKERS: 19,000 (1972-1973) **VOLUME:** 1,000 lbs (1975)

PEL TESTIMONY:
NIOSH concurs with OSHA proposal.

BASIS FOR REL:
Based on analogy with structurally similar ketones, eg, methyl isobutyl ketones [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1977
Acute : ND
Chronic : ND
Irritation : Mild skin irritation
Mutagenic : ND
Teratogenic : ND
Carcinogenic: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
None, except for some acute lethality data.

COMMENTS:
None

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Methyl n-Amyl Ketone **CAS:** 110-43-0
CODE: H.S. 1264

EXPOSURE LIMITS

NIOSH	100 ppm (465 mg/m^3) - 10-hr TWA
OSHA PEL (Present)	100 ppm; 8-hr TWA
OSHA PEL (Proposed)	100 ppm; 8-hr TWA
ACGIH TLV	50 ppm (235 mg/m^3) - 8-hr TWA

WORKERS: 67,000 (1975) **VOLUME:** 1,000 lbs (1975)

PEL TESTIMONY:
NIOSH concurred with the OSHA proposal not to change the current PEL of 100 ppm TWA.

BASIS FOR REL:
To prevent narcosis and irritation to the eyes, nose, and throat in exposed workers [NIOSH 1978].

CD NOTED EFFECTS **DATE CD:** 1977

Acute	Narcosis; respiratory congestion
Chronic	ND
Irritation	Mucous membrane and skin irritation in animals
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
One study found no neurologic impairment in rats and monkeys exposed 6 hrs/day, 5 days/wk at concentrations of 131 and 1025 ppm. Gross and histopathology revealed no untoward effects.

COMMENTS:
The concentration at which methyl n-amyl ketone begins to produce irritation in humans is not known. NIOSH determined, by analogy with the other straight chain ketones, that 100 ppm TWA should prevent irritation in most workers. The ACGIH, reviewing the same data, thought it prudent to add an additional safety factor and recommended a TLV of 50 ppm as a TWA concentration.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: Methyl Parathion **CAS:** 298-00-0
CODE: H.S. 1265

EXPOSURE LIMITS

NIOSH	: 0.2 mg/m^3 (10-hr TWA) - Skin
OSHA PEL (Present)	: No limit
OSHA PEL (Proposed)	: 0.2 mg/m^3 (8-hr TWA) - Skin
ACGIH TLV	: 0.2 mg/m^3 (TWA) - Skin

WORKERS: 150,000 (1975) **VOLUME:** 54,00,000 lbs (1975)

PEL TESTIMONY:
NIOSH concurs with the proposed OSHA PEL.

BASIS FOR REL:
Based on the estimate that methyl parathion is one-fourth as toxic as parathion for which the REL = 0.05 mg/m^3. "In the absence of solid evidence that it would be unsafe, and on the basis of the relatively safe work history of methyl parathion, NIOSH recommends a TWA workplace environmental limit of 0.2 mg/m^3." [NIOSH 1976]

CD NOTED EFFECTS **DATE CD:** 1976

Acute	: Numbness; dizziness; severe perspiration; vomiting; diarrhea; headache; visual disturbances; death
Chronic	: CNS; peripheral nervous system; endocrine; liver; cardiac; stomach; pulmonary
Irritation	: ND
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
NCI [1979] - negative; IARC [1982] - noncarcinogen (Group 3); Mutagenic (DNA damage, sister-chromatid exchange (SCE) - hamster lungs, human lymphocytes, mice lymphocytes, Ames test); Teratogenic (craniofacial and musculoskeletal abnormalities, fetal death, behavioral in offspring) [See references attached].

COMMENTS:
The current REL for methyl parathion was derived by assuming that it is four times less toxic than parathion and, therefore, its REL can be four times higher than that of parathion (REL = 4 x 0.05 mg/cu m = 0.2 mg/cu m). However, a reevaluation of the data utilized for development of the parathion criteria document is in order. Because the REL for methyl parathion was derived from the REL for parathion, the REL for methyl parathion should also be reevaluated.

EPA [1984] proposed an ADI (acceptable daily intake) of 0.004 mg/kg/day. If a worker breathes 1.5 cu m/h for 10 hours/day, this intake would correspond to air concentration of 0.02 mg/cu m, a number 10 times lower than the REL. Recently, EPA

NAME: Methyl Parathion **CAS:** 298-00-0
CODE: H.S. 1265

COMMENTS (Continued):
[1988] reviewed the chronic toxicity of methyl parathion and derived a reference dose (RfD) (formerly ADI) of 0.00025 mg/kg/day. This value was derived from an unpublished Monsanto oral study [1983] in rats in which a dose of 0.25 mg/kg/ day reduced acethylcholinesterase (AChE), hemoglobin, hematocrit and red blood cell (RBC) count.

A series of new references deal with dermal exposures, toxicity, mutagenicity and developmental effects.

REFERENCES:
EPA [1983]. Reportable quantity document for methyl parathion. ECAO-CIN-R1114.

EPA [1984]. Health and environmental effects profile for methyl parathion. ECAO-EPA/600/X-84/329.

EPA [1988]. Methyl parathion. IRIS.

Fan AMM [1981]. Effects of pesticides on immune competency: influence of methyl parathion and Carbofuran on immunological responses to Salmonella typhimurium infection. Diss Abstr Int B 41(8):2962.

Finley EL et al. [1979]. Reduction of methyl parathion residues on clothing by delayed field reentry and laundering. Bull Environ Comtam Toxicol 22(4/5):598-605.

Ghisolfi et al. [1983]. A case of retinal degeneration in a man exposed to organophosphorus pesticides. G Ital Med Lav 5(4):187-188.

Gupta et al. [1985]. Brain cholinergic, behavioral, and morphological development in rats exposed in utero to methyl parathion. Toxicol Appl Pharmacol 77(3):405-413.

Gupta et al. [1984]. Health hazards in pesticide formulators exposed to a combination of pesticides. Ind J Med Res 79:666-672.

Hasan M and Khan NA [1985]. Methyl parathion induced dose-related alteration in lipid levels and lipid peroxidation in various regions of rat brain and spinal chord. Ind J Exp Biol 23(3):141-144.

Kummer R and Van Sittert NJ [1986]. Field studies from the application of two organophosphorus insecticide formulations by hand-held ULV to cotton. Tox Letters 33(1/3):7-24.

Molnar J et al. [1980]. Acute inhalation toxicity of orgranophosphate esters. Egeszsegtudomany 24(2):173-178.

Munn et al. [1985]. A comparative study of pesticide exposure in adults and youth migrant field workers. Arch Environ Health 40(4):215-220.

NAME: Methyl Parathion **CAS:** 298-00-0
CODE: H.S. 1265

REFERENCES (Continued):

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to methyl parathion. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-106.

Rashid KA and Mumma RO [1984]. Genotoxicity of methyl parathion in short-term bacterial test systems. J Environ Sci Health 40(4):215-220.

Skinner C and Dilgore W [1978]. Development of an animal model for prediction of agricultural field reentery hazard. Tox Appl Pharmacol 45(1):234.

Wicker GW et al. [1979]. Exposure of field workers to organophosphorus insecticides: Sweet corn and peaches. Arch Environ Contam Toxicol 8:175-182.

Yu YD et al. [1984]. Studies on the mutagenicity and teratogenicity of methyl parathion. Environ Sci Res 31:842-3.

NAME: Methylene Bis-(4-Cyclohexylisocyanate) (Dicyclohexylmethane 4,4'-Diisocyanate) **CAS:** 5124-30-1 **CODE:** H.S. 1272

EXPOSURE LIMITS

NIOSH	: 0.005 ppm, 10-hr TWA; 0.02 ppm CL (10-min)
OSHA PEL (Present)	: None
OSHA PEL (Proposed)	: 0.01 ppm (ceiling)
ACGIH TLV	: 0.01 ppm (0.055 mg/m^3), 8-hr TWA*

*ACGIH has a notice of intended change to 0.005 ppm TWA)

WORKERS: 7,000 (1972) **VOLUME:** 5,500,000 (1977)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed PEL.

BASIS FOR REL:
The current REL is based on respiratory effects, sensitization, and pulmonary irritation. The information is primarily derived from experience and studies of toluene diisocyanate (TDI) and methylene biphenyl isocyanate (MDI).

CD NOTED EFFECTS **DATE CD:** September 1978

Acute	: Sensitization; asthmatic response; nausea
Chronic	: Pulmonary irritation; vomiting; headache
Irritation	: Pulmonary; eye; skin
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No specific new information was found on methylene bis-(4-cyclohexylisocyanate). NTP [1986] tested TDI and found tumorigenic responses in rats and mice. IARC [1986] concluded that there was sufficient evidence for the carcinogenicity of TDI in experimental animals. Information since the criteria document has shown that this chemical is not a sensory irritant like TDI, but that it depresses respiration by producing pulmonary irritation [Weyel 1985].

COMMENTS:
The NIOSH REL [NIOSH 1978] for methylene bis-(4-cyclohexylisocyanate) is 0.005 ppm (0.055 mg/m^3 as a TWA with a 10-min ceiling of 0.02 ppm (0.21 mg/m^3). The REL is based primarily on respiratory effects associated with exposure to MDI and TDI. The ACGIH TLV [1988] is 0.005 ppm TWA concentration, the same as TDI. There is no current OSHA PEL for methylene bis-(4-methylhexylisocyanate). OSHA has proposed that the 0.01 ppm ceiling be promulgated as the PEL, which is the TLV that was in

NAME: Methylene Bis-(4-Cyclohexylisocyanate) (Dicyclohexylmethane 4,4'-Diisocyanate) **CAS:** 5124-30-1 **CODE:** H.S. 1272

COMMENTS (Continued):
effect in 1987-88. Since the inception of the PEL project, ACGIH has adopted a TWA of 0.005 ppm, TWA (1988-89) in place of the 0.01 ceiling which was the TLV at the time of preparation of the PEL project documentation.

A recent study by NTP [1986] of chronic effects in animals has produced evidence that cancer is associated with exposure to commercial grade TDI (an 80:20 mixture of 2,4- and 2,6-TDI) and to a TDI hydrolysis product, 2,4-TDA. In the NTP study [1986], treatment of rats and mice of both sexes by gavage to commercial grade TDI resulted in tumor induction, primarily in the pancreas and liver in male and female rats, and in female mice. The tumorigenic responses observed in both rats and mice treated with TDI meet the criteria of the OSHA cancer policy [29 CFR 1990] for classifying a substance as a potential occupational carcinogen. NIOSH is in the process of developing a Current Intelligence Bulletin (CIB) on this subject.

Because the REL and TLV for methylene bis-(4-cyclohexylisocyanate) have been based on the toxicological properties of TDI, the recommended REL should be considered as an interim level to be applied to methylene bis-(4-cyclohexylisocyanate) until adequate testing information is available.

REFERENCES:
ACGIH [1986]. Methylene Bis-(4-cyclohexylisocyanate). In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 392.5(86).

IARC [1986]. Some chemicals use in plastics and elastomers. IARC Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1978]. A recommended standard for occupational exposure to....diisocyanates. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-215.

NTP [1986]. NTP technical report on the toxicology and carcinogenesis studies of commercial grade 2,4 (80%)- and 2,6 (20%)-toluene diisocyanate (CAS No. 26471-62-5) in F344/N rats and B6C3F$_1$ mice (gavage studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NTP TR 251, NIH Publication No. 86-2507.

NAME: Nitric Acid **CAS:** 7697-37-2
CODE: H.S. 1286

EXPOSURE LIMITS

NIOSH	: 2 ppm (5 mg/m^3) 10-hr TWA
OSHA PEL (Present)	: 2 ppm (5 mg/m^3) 8-hr TWA
OSHA PEL (Proposed)	: 2 ppm TWA; 4 ppm STEL
ACGIH TLV	: 2 ppm (5 mg/m^3) 8 hr TWA; 4 ppm (10 mg/m^3) - STEL

WORKERS: 130,000 to 540,000 (1983) **VOLUME:** 19,530,000,000 lbs (1977)
15,480,000,000 lbs (1984)

PEL TESTIMONY:
NIOSH concurs with the proposed PEL revision. The addition of a STEL will protect workers against the risk of irritation, chronic pulmonary disease, and dental corrosion that potentially exist at the excersion levels permitted by the TWA alone.

BASIS FOR REL:
In the absence of data showing toxic effects in humans and animals exposed to nitric acid at and below 2 ppm, it is recommended that the current federal standard of 2 ppm be continued as a TWA for up to 10 hours/day and 40 hours/week [NIOSH 1976].

CD NOTED EFFECTS **DATE CD:** 1976

Acute	: Opacification of cornea; ulceration of all membranes and tissues; dental erosion
Chronic	: Bronchitis; chemical pneumonitis
Irritation	: Skin; eye; upper respiratory tract
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data to indicate an update of the REL.

COMMENTS:
The existing data needs to be reevaluated as to the effects of excursions above a 2 ppm TWA level.

REFERENCES:
NIOSH [1976]. Criteria for a recommended standard....occupational exposure to nitric acid. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-141.

NAME: Nitrogen Dioxide **CAS:** 10102-44-0
CODE: H.S. 1289

EXPOSURE LIMITS

NIOSH	: 1 ppm (1.8 mg/m^3) (15-min ceiling)
OSHA PEL (Present)	: 5 ppm (9.0 mg/m^3) (ceiling)
OSHA PEL (Proposed)	: 1 ppm (1.8 mg/m^3) STEL (15 min)
ACGIH TLV	: 3 ppm (6 mg/m^3) TWA; 5 ppm (10 mg/m^3) STEL

WORKERS: 25,000 **VOLUME:** 116 x 10^7 lbs

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed reduction of the nitrogen dioxide PEL from C 5 ppm to STEL 1 ppm.

BASIS FOR REL:
The NIOSH REL of 1 ppm (15-min ceiling) for nitrogen dioxide is based on human studies [NIOSH 1976]. A slight reduction in lung capacity was found in 70 men who were exposed to 0.4 to 2.7 ppm of nitrogen oxides for 6-8 hours daily for 4-6 years. A number of cases of chronic bronchitis were seen in this group of men [Kosmider et al. 1972].

Vigdortschik et al. [1937] reported cases of chronic bronchitis and emphysema among 127 workers exposed to nitrogen dioxide levels below 2.8 ppm. NIOSH further considered the study by Abe in 1967 which reported the findings of a 40% decrease in effective lung compliance in healthy adult males compared to measurements of lung compliance in the same men prior to inhalation exposure for 10 minutes of 4-5 ppm nitrogen dioxide. Expiratory and inspiratory maximum viscous resistance increased after exposure. NIOSH also reviewed the works of Von Nieding et al. [1971, 1973] who reported significant increases in airway resistance in healthy adults exposed at 5 ppm for 15 minutes, and chronic bronchitis patients exposed at 1.5 ppm for 15 minutes, respectively. NIOSH concluded that the toxic hazard associated with nitrogen dioxide during continuous exposure is determined by the peak and not by the average concentration of exposure [NIOSH 1976].

CD NOTED EFFECTS **DATE CD:** 1976

Acute	: *See below
Chronic	: *See below
Irritation	: Conjunctivitis; pharyngitis; pulmonary edema
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: *See below

Acute: (Epidemiologic studies in humans may not entirely eliminate or consider the effects of secondary exposures.) Limited exposure to nitrogen dioxide has been reported as follows: 62 ppm/2 hr - laryngeal irritation; 25-100 ppm/2 hr - mucosal irritation, increased pulse, and respiratory rates; 158 ppm/10 min - coughing, irritation of nasal and laryngeal mucosa, larimation, headache, nausea and vomiting; 2.0-10.3 ppm (length of exposure unknown) - methemoglobin level increase

NAME: Nitrogen Dioxide **CAS:** 10102-44-0
CODE: H.S. 1289

CD NOTED EFFECTS (Continued)
in blood; 1.5-5.0 ppm/15 min - increased airway resistance, decrease in arterial oxygen tension and increase of end-expiratory arterial pressure; bronchiolitis in 4 firemen exposed to leak of nitrogen dioxide--three recovered completely after 6-7weeks, but one had residual effects of progressive decrease in vital capacity, increase in residual volume. Maximal breathing capacity and lung compliance decreased as well as a decrease in arterial oxygen partial pressure, indicating uneven ventilation with obstructive and restrictive impairment.

Severe exposure to, and the acute effects of, nitrogen dioxide in man are clearly established (although the critical concentration of nitrogen dioxide is not known): irritant cough, mild headache, mild dyspnea, remission of symptoms for up to 12 hours before onset of acute and potentially fatal pulmonary edema, and possible death. Patients may relapse into a second attack of acute dyspnea, cyanosis, cough, and fever. The relapse may be more protracted than the initial attack and also may be fatal. This complex disease process is suspected to be due to a pathological condition of the lungs called bronchiolitis fibrosa obliterans.

Chronic: Working lifetime of exposure at 38-345 ppm nitrogen dioxide resulted in impairment of lung function: forced expiratory volume and vital capacity reduced, total lung capacity and residual volume increased.

Carcinogenic: Wagner et al. suggested in the report of a long-term study in mice that nitrogen dioxide might be tumor-promoting. Although incidence of tumors in 49 mice exposed at 5 ppm/6 hr/dy, 5 dy/wk, for 12-16 months was greater than the tumor incidence in controls, the difference was not statistically significant [Wagner et al. 1965]. Henschler and Ross reported that mice exposed intermittently at 40 ppm nitrogen dioxide for 18 months showed no evidence of increased tumor incidence. In another study, Henschler and Ross reported presence of adenomatous changes in hamsters exposed continuously at 40 ppm nitrogen dioxide for 16 months. This report did not show data to allow comparison with controls [Henschler and Ross 1968]. Kuschner and Laskin presented their findings in carcinogenic studies with 100 rats and 96 hamsters exposed to nitrogen dioxide at about 25 ppm/6 hr/dy, 5 dy/wk for 646 days. Results were similar between controls and exposed animals except for an adenocarcinoma in one exposed rat [Kuschner and Laskin 1973].

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Toxicity: Levels of nitrogen dioxide were measured in 4 diesel bus garages, and workers were given questionnaires and pulmonary function tests. Acute symptoms were eye irritation, labored breathing, chest tightness and wheeze (smoking was associated with cough and wheeze). No significant changes were demonstrated in pulmonary function. Authors concluded that nitrogen dioxide exposure was below 1.5 ppm and apparently this concentration is below the threshold for producing measurable reduction in lung function [Gamble et al. 1987].

Eighteen non-smoking normal subjects were exposed at 2 ppm nitrogen dioxide gas for 1 hr/1 wk. Lung function tests included forced vital capacity, forced expiratory volume in one second, partial expiratory flow at 40% of vital capacity, functional

NAME: Nitrogen Dioxide **CAS:** 10102-44-0
CODE: H.S. 1289

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.)(Continued):
residual capacity, and specific airway conductance. Tests were made before and after exposure. No significant changes were noted in lung function tests after nitrogen dioxide exposure [Mohsenin 1988].

In a review on pulmonary connective tissue in occupational lung disease, the author concluded that the exact mechanism(s) by which nitrogen dioxide destroys connective tissue is not known, but lung damage is caused by the formation of free radicals [Riley DJ 1984].

The World Health Organization reviewed the results of cross-sectional occupational health surveys of small groups of workers intermittently exposed at relatively low concentrations of nitrogen dioxide. Lung function alterations are observed in man after exposure at concentrations as low as 3 mg/m^3. The authors recommended a short-term exposure limit of 1.8 mg/m^3 of nitrogen dioxide for worker health protection. A time-weighted 8-hour average exposure of 0.9 mg/m^3 was recommended to protect against chronic effects of continuous exposure [1984].

Female mice were exposed at 10 ppm nitrogen dioxide for 2 hours for 5 weeks, for up to 30 weeks. Chronic exposure to nitrogen dioxide suppressed the immune responses. Tumors were less successfully rejected by exposed mice than by untreated controls [Holt 1979].

Developmental Studies: Rats exposed at low levels of nitrogen dioxide resulted in lengthening of the estrous cycle, decrease in litter size, and decrease in birth weight. Embryolethal, embryotoxic, and teratogenic effects were seen in the offspring of pregnant rats exposed during pregnancy [Barlow 1982].

Mutagenicity: The synthesis of protein UmuC was induced in a dose responsive manner by *E. coli* exposed at concentrations of 60, 120, 180, and 240 ul/l of nitrogen dioxide. The authors concluded that nitrogen dioxide was mutagenic [Kosaka et al. 1986].

Nitrogen dioxide significantly increased the mutation frequencies and induced chromosomal aberrations (chromatid gaps and breaks) in primary lung cells from rats exposed in vivo at doses of 8 and 27 ppm [Isomura K 1984]. Plating efficiencies appeared low.

The oncogenic response of A/J mice was investigated by exposure at 1, 5, or 10 ppm of nitrogen dioxide for 6 hr/dy, for 5 dy/wk, for 6 months. Lungs were observed for tumors. Increased tumor production was only significant at 10 ppm of nitrogen dioxide by comparison to controls.

COMMENTS:
New data do not indicate a need for REL revision.

NAME: Nitrogen Dioxide **CAS:** 10102-44-0
CODE: H.S. 1289

REFERENCES:

Abe M [1967]. Effects of nixed NO_2-SO_2 gas on human pulmonary functions--Effects of air pollution on the human body. Bull Tokyo Med Dent Univ 14:415-433.

Adkins B, Jr. [1986]. Oncogenic response of strain A/J mice to inhaled chemicals. Journal of Toxicology and Environmental Health 17:113-322.

Barlow SM and Sullivan FM [1982]. Nitrogen Dioxide. Reproductive Hazards of Industrial Chemicals; London, England Academic Press 5:417-421.

Gamble J, Jones W, Minshall S [1987]. Epidemiological-environmental study of diesel bus garage workers: acute effects of nitrogen dioxide and respirable particulate on the respiratory system. Environmental Research 42(1):201-214.

Henschler D and Ross W [1965]. Lung cancer from nitrous gas. Arch Experimental Pathology and Pharmacology 250:256-257.

Holt PG, Finlay-Jones LM, Keast D, Papadimitrou JM [1979]. Immunological function in mice chronically exposed to nitrogen oxides (NO). Environmental Research 19(1):154-162.

Isomura K, Chikahira M, Teranishi K, Hamada K [1984]. Induction of mutations and chromosome aberrations in lung cells following in vivo exposure of rats to nitrogen dioxide. Mutation Research 136:119-125.

Kosaka H, Yamamoto K, Oda Y, Uozumi M [1986]. Induction of SOS functions by nitrogen dioxide in E. coli with different DNA-repair capacities. Mutation Research 162:1-5.

Kosmider S, Ludyga K, Misiewitsch A, Drozdz M, Sagan J [1972]. Experimental and clinical investigations of the emphysmatous effects of nitrogen oxides. Zentralbl Arbeitsmed 22:362.

Mohsenin V [1988]. Airway responses to 2.0 ppm nitrogen dioxide in normal subjects. Arch Environmental Health. 43(3):24246.

NIOSH [1976]. Criteria for a recommended standard....oxides of nitrogen (nitrogen dioxide and nitric oxide). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute of Occupational Safety and Health, Publication No. 76-149.

Ross W, Henschler D [1968]. Absence of any carcinogenic effect of nitrous gas in the golden hamster. Experimentia 24:55.

Riley DJ [1984]. Pulmonary connective tissue in occupational lung disease. Contemporary Issues in Pulmonary Disease 2(137):1-23.

NAME: Nitrogen Dioxide **CAS:** 10102-44-0
CODE: H.S. 1289

REFERENCES (Continued):

Vigdortschik NA, Andreeva EC, Matussevitsch IZ, Nikulina MM, Grumina LM, Striter VA [1937]. The symptomatology of chronic poisoning with oxides of nitrogen. Journal of Industrial Hyg Toxicol 19:469-473.

Von Nieding G, Krekeler H [1971]. Protective action of atropine, meclastin and orciprenaline on provocation tests with NO_2 in healthy subjects and patients with chronic non-specific bronchitis. Int Atch Arbeitsmed 29:55-63.

Von Nieding G, Krekeler H, Fuchs R, Wagner HM, Koppenhagen K [1973]. Studies of the acute effects of NO_2 on lung function--Influence on diffusion, perfusion, and ventilation in the lungs. Int Arch Arbeitsmed 31:61-72.

Wagner WD, Cuncan BR, Wright PG, Stokeinger HE [1965]. Experimental study of threshold limit of NO_2. Arch Environmental Health 10:455-466.

NAME: Nitroglycerin (NG)
[Ethylene Glycol Dinitrate (EGDN)]*

CAS: 55-63-0 [628-96-6]*
CODE: H.S. 1290 [H.S. 1170]*

EXPOSURE LIMITS

NIOSH	: 0.01 ppm (0.1 mg/m^3); CL (20 min) [0.02 ppm (0.1 mg/m^3) CL 20 min]*
OSHA PEL (Present)	: 0.2 ppm (2 mg/m^3); CL (Skin) [0.2 ppm (1 mg/m^3); CL (Skin)]*
OSHA PEL (Proposed)	: 0.01 ppm (0.1 mg/m^3) CL [0.02 ppm (0.1 mg/m^3) CL]*
ACGIH TLV	: 0.05 ppm (0.5 mg/m^3); TWA (Skin) [0.05 ppm (0.3 mg/m^3); TWA (Skin)]*

WORKERS: 12,300 (1972-1974, NOHS)
1,270 (1981-1983, NOES Provisional)

VOLUME: 11,000,000 lbs (1977)

PEL TESTIMONY:
NIOSH concurred with the PEL being proposed by OSHA. The available documentation appeared to support the proposed exposure limits as adequate to protect workers from recognized health hazards.

BASIS FOR REL:
NIOSH [1978] recommended one standard for workplace exposure to NG, ethylene glycol dinitrate (EGDN), or a mixture of these two compounds because equal masses of NG and EGDN yield very nearly equal masses of nitrite ion on hydrolysis. The ceiling limit of 0.1 mg/m^3 is based on the study of Trainor and Jones [1966], in which workers exposed to or below 0.1 mg/m^3 will not develop vasodilation, as indicated by development of headaches. NIOSH also considered the retrospective study of long-term workplace exposure to NG and/or EGDN in Sweden [Hogstedt and Axelson 1977], in which dynamite workers were found to be more likely to die from heart disease than other men in the same country, in establishing its recommendation for the short term exposure level. NIOSH [1978] stated: This standard should also protect against the development of angina pectoris, other signs or symptoms of cardiac ischemia or heart damage, and against sudden death, as a result of working with NG or EGDN, since all of these results seem to be related to compensatory vasoconstriction induced by repeated exposure to NG or EGDN and revealed by withdrawal to the vasodilatory activity of these substances during weekends or other periods of absence from regular exposure. Headaches appear to be the most sensitive and specific indicator of vasodilation in workers initially exposed to these compounds. Apparently workers initially exposed at concentrations of NG:EGDN averaging 0.36 mg/cu m (range 0.1-0.53 mg/cu m) can develop headaches [Trainor and Jones 1966].

CD NOTED EFFECTS **DATE CD:** 1978

Acute	: Skin absorption; headache; dizziness; nausea; vasodilation
Chronic	: Cardiovascular
Irritation	: ND
Mutagenic	: One inconclusive study of NG and EGDN in E. coli

NAME: Nitroglycerin (NG) [Ethylene Glycol Dinitrate (EGDN)]* **CAS:** 55-63-0 [628-96-6]* **CODE:** H.S. 1290 [H.S. 1170]*

CD NOTED EFFECTS (Continued)

Teratogenic : One casual observation of weak children born to wives of dynamite workers

Carcinogenic: Benign tumors in female mice given NG in their drinking water

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No information discovered which would change the assessment in the criteria document.

COMMENTS:
On page 21088 of the Federal Register, middle column, 8th line, 1st paragraph of H.S. 1290, the TWA for NG mg/m^3 is incorrect. It should be "0.5 mg/m^3" not "0.05 mg/m^3". On page 21088, right column, 3rd paragraph, 7th line is incorrect. The sentence should read, "ACGIH's present limit is 0.05 ppm as a TWA (0.3 mg/m^3 for EGDN and 0.5 mg/m^3 for NG). Also, the next sentence (page 21088, right column, 3rd paragraph, 8th line) is incorrect. It should read, "Since worker deaths have occurred at or near the current TLV, OSHA proposes..." Also note that in the NPR (page 21088), NG and EGDN were considered together.

In an interim report on mortality due to cardiovascular disease and other causes among a cohort of nitroglycerin workers, Reeve et al. [1983a, 1983b], stated that the results of the epidemiological study of this cohort of workers at the Radford Army Ammunitions Depot (RAAD) suggest an association between nitroglycerin exposure and cardiovascular disease mortality. Atmospheric concentrations of nitroglycerin at most work stations were stated to be near or below an 0.02 ppm (0.2 mg/m^3) 8-hr TWA which was the ACGIH TLV at that time. It was also stated that the records of the facility showed that over the years, numerous improvements in ventilation had been made, so that the concentrations of NG measured were at lower levels. Thus, historical levels were higher than those measured. In a NIOSH Health Hazard Evaluation Report [NIOSH 1980] on the RAAD, which was the basis for the epidemiological study, nine personal and general air samples had concentrations of NG ranging from nondetectable to 0.89 mg/m^3. The NIOSH limit of detection (LOD) for nitroglycerin:EGDN at that time was 6 ug/m^3 (10-L air sample) [NIOSH 1977], and the LOQ was 30 ug/m^3 (10-L air sample).

REFERENCES:
Hogstedt C, Axelson O [1977]. Nitroglycerin-nitroglycol exposure and the mortality in cardiovascular diseases among dynamite workers. J Occup Med 19:675-678.

NIOSH [1977]. P & CAM 203 Nitroglycerin and EGDN. In: NIOSH Manual of Analytical Methods, 2nd edition. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-157-A.

NAME: Nitroglycerin (NG) [Ethylene Glycol Dinitrate (EGDN)]* **CAS:** 55-63-0 [628-96-6]* **CODE:** H.S. 1290 [H.S. 1170]*

REFERENCES:

NIOSH (1978). Criteria for a recommended standard....occupational exposure to nitroglycerin and ethylene glycol dinitrate. Cincinnati, OH: U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. DHEW (NIOSH) Publication No. 78-167.

NIOSH [1980]. Health hazard evaluation report of the Radford Army Ammunition Plant, Hercules Inc., Radford, Virginia. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, HE No. 79-19-740.

Reeve GR, Bloom TF, Rinsky RA, Smith AB [1983a]. Interim Report: Mortality due to cardiovascular disease and other causes among a cohort of nitroglycerin workers. NIOSH unpublished report.

Reeve GR, Bloom TF, Rinsky RA, Smith AB [1983b]. Cardiovascular disease among nitroglycerin workers. Abstract for presentation to the Society for Epidemiological Research. Amer J Epidem 118:418.

Trainor DC, Jones RC [1966]. Headaches in explosive magazine workers. Arch Environ Health 12:231-234.

NAME: Nitroglycerin (NG) [Ethylene Glycol Dinitrate (EGDN)]* **CAS:** 55-63-0 [628-96-6]* **CODE:** H.S. 1290 [H.S. 1170]*

RESPONSE TO PEL DOCKET MATERIAL:
The study of Trainor and Jones [1966] established that exposures to EGDN:Nitroglycerin vapors at a mean concentration of 0.5 mg/m^3 for 25 minutes was sufficient to produce decreased blood pressure and slight headaches in 6 of 7 volunteers in a controlled study. The NIOSH [1980, 1983, ex. 3-749) studies at the Radford Army Ammunitions Depot, although measurements of concentrations of nitroglycerin were not available on a retrospective basis, established that exposures to nitroglycerin at current concentrations of from 0.03 mg/m^3 to 0.89 mg/m^3 are suggestive of mortality due to cardiovascular disease. The study of Trainor and Jones [1966] also established that workers at a munitions plant developed headaches when exposed to EGDN:NG concentrations between 0.1 and 0.53 mg/m^3 (an average of 0.36 mg/m^3).

Reduction of the current PEL to the proposed PEL of 0.1 mg/m^3 ceiling will reduce the risk of throbbing headaches or decreases in blood pressure, which will in turn possibly prevent more serious effects on the cardiovascular system. No data is available at this time that indicates that a time-weighted average PEL below the proposed ceiling is necessary to protect worker health.

The evidence in NIOSH [1978] criteria document indicates that percutaneous absorption (ex. 3-661 and 3-678) is a significant route of exposure. Thus, the skin notation with the current PEL is maintained.

NAME: Propylene Glycol Monomethyl Ether (PGME) **CAS:** 107-98-2
CODE: H.S. 1343

EXPOSURE LIMITS

NIOSH	: There is no REL
OSHA PEL (Present)	: No current standard
OSHA PEL (Proposed)	: 100 ppm TWA; 150 ppm STEL
ACGIH TLV	: 100 ppm (360 mg/m^3) TWA; 150 ppm (540 mg/m^3) STEL

WORKERS: 26,419 **VOLUME:** No information

PEL TESTIMONY:
NIOSH concurs with proposed PEL. The proposed PELs for PGME of 100 ppm TWA and 150 ppm STEL are designed to protect workers from experiencing the objectionable odor and the eye irritation associated with PGME exposure.

BASIS FOR REL:
There is no current NIOSH REL.

NOTED EFFECTS **DATE CD:** No CD

Acute	: Respiratory depression
Chronic	: CNS depression
Irritation	: Eyes; nose; throat
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new significant data.

COMMENTS:
NIOSH is in the process of developing a criteria document on the glycol ethers. RELs will be proposed for ethylene glycol monomethyl ether (EGME), ethylene glycol monoethyl ether (EGEE), ethylene glycol monobutyl ether (EGBE), and their acetates. The REL proposed for EGBE and its acetate will also be proposed for the remaining glycol ethers.

PGME (1-methoxy-2-propanol) has been examined by inhalation exposure in a variety of laboratory animals [Miller et al. 1981; Landry et al. 1983; Hanley et al. 1984]. The results indicate that PGME exerted no testicular effects and was not teratogenic at exposure levels up to 3000 ppm (see the attached table). PGME is also low in acute toxicity; the rat oral LD_{50} is 6.6 g/kg; larger doses caused deaths from anesthesia.

NAME: Propylene Glycol Monomethyl Ether (PGME) **CAS:** 107-98-2
CODE: H.S. 1343

COMMENTS (Continued):
The urinary metabolites of PGME have been identified as propylene glycol (1,2-propanediol), and sulfate and glucuronate conjugates of PGME [Miller et al. 1983]. Although OSHA has specified the alpha isomer of PGME, another isomeric form of PGME is the beta or 2-methoxy-1-propanol. The major metabolite of the beta isomer is 2-methoxypropionic acid; a glucuronide conjugate was also identified [Miller et al. 1986].

Commercial PGME sold in the U.S. is usually a mixture of the two isomers, consisting of 95% alpha isomer with the balance being the beta isomer. Although the two isomers are metabolized differently, there is a substantial toxicologic data base which clearly shows that the commercial PGME (2 to 5% beta isomer) has a low degree of biological activity.

REFERENCES:
Hanley et al. [1984]. Fund Appl Tox 4:784-794.

Landry et al. [1983]. Fund Appl Tox 3:627-630.

Miller et al. [1984]. Env Health Persp 57:233-239.

Miller RR, Hermann EA, Langvardt PW, McKenna MJ, Schwetz BA [1983]. Tox Appl Pharm 67:229-237.

Miller RR, Langvardt PW, Calhoun LL, et al. [1986]. Tox Apply Pharm 83:170-177.

ATTACHMENT TO
PROPYLENE GLYCOL MONOMETHYL ETHER (PGME)
CAS: 107-98-2
H.S. 1343

Toxic Effects of PGME

Sex	Species	Route of Administration: Dose	Effects	Reference
M M	Rat Mouse	Inhalation: 300, 1000, or 3000 ppm 6 hrs/day for 9 of 11 days	No microscopic testicular changes	Miller et al. [1981]
M	Rat	Inhalation: 300 ppm 6 hrs/day, 5 days/week, for 13 weeks	No effects	Landry et al. [1983]
F	Rat	Inhalation: 1000 or 3000 ppm 6 hrs/day, 5 days/week, for 13 weeks	CNS depression; increase in liver weight; hepatocellular hypertrophy (3000 ppm)	Landry et al. [1983]
F	Rat	Inhalation: 500, 1500, or 3000 ppm on g·d 6-15	Fetotoxicity (3000 ppm)	Hanley et al. [1984]
F	Rabbit	Inhalation: 500, 1500, or 3000 ppm on g·d 6-18	Mild lethargy in dams on first 2 days of exposure	Hanley et al. [1984]
M,F	Rat Rabbit	Inhalation: 300, 1000, or 3000 ppm 6 hrs/day, 5 days/week, for 13 weeks.	Increased liver weights (rats - 3000 ppm)	Miller et al. [1984]

NAME: Sodium Hydroxide (NaOH) **CAS:** 1310-73-2
CODE: H.S. 1367

EXPOSURE LIMITS

NIOSH	: 2 mg/m^3 as a 15 min. ceiling
OSHA PEL (Present)	: 2 mg/m^3, 8 hr - TWA
OSHA PEL (Proposed)	: 2 mg/m^3 as a ceiling limit
ACGIH TLV	: 2 mg/m^3 ceiling

WORKERS: 1.100,000 - 2,100,000 (1974) **VOLUME:** 40,473,000,000 tons (1977)

PEL TESTIMONY:
NIOSH concurs with the proposed revision of the PEL. OSHA is proposing a ceiling limit of 2 mg/m^3.

BASIS FOR REL:
The REL for airborne sodium hydroxide serves to protect against the irritation of the respiratory tract from sodium hydroxide aerosols [NIOSH 1975].

CD NOTED EFFECTS **DATE CD:** 1975

Acute	: Burns (eyes & skin)
Chronic	: Pneumonitis; esophogeal stenosis; temporary hair loss
Irritation	: Eyes; skin; respiratory tract
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND
Organ Systems	: Gastrointestinal; respiratory

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
No information found which would change the assessment made in the criteria document.

COMMENTS:
There is no additional information available since the publication of the criteria document.

REFERENCES:
NIOSH [1975]. Criteria for a recommended standard....occupational exposure to sodium hydroxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-105.

NAME: Stoddard Solvent **CAS:** 8052-41-3
CODE: H.S. 1371

EXPOSURE LIMITS

NIOSH	: 350 mg/m^3 (60 ppm) TWA; 1800 mg/m^3 ceiling - 15-min sample
OSHA PEL (Present)	: 500 ppm (2900 mg/m^3) TWA
OSHA PEL (Proposed)	: 100 ppm (525 mg/m^3) TWA
ACGIH TLV	: 100 ppm (525 mg/m^3) TWA

WORKERS: 75,000 (1977) **VOLUME:** 150 x 10^6 gallons (1964)

PEL TESTIMONY:
OSHA's proposed PEL is based on toxicities of major components of stoddard solvent (pentane and trimethyl benzene) with >65% C_{10} or higher hydrocarbons, <20% aromatic content. NIOSH testimony at the PEL hearing indicated concurrence with OSHA's proposal.

BASIS FOR REL:
NIOSH REL on refined petroleum solvents is based on equivalent neuropathic toxicity for all C_5-C_8 alkanes [NIOSH 1977].

NOTED EFFECTS **DATE CD:** 1977

Acute	: Irritation in humans (eyes, nose, and throat)
Chronic	: Dermatitis in humans; kidney effects in animals
Irritation	: Irritation in humans (eyes, nose, and throat)
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Neurobehavioral changes which occur following short-duration exposures to solvents are reported at concentrations between those which provide irritant effects and narcosis [Dick 1988]. Human performance changes measured by present-day neurobehavioral tests rarely occur below recommended limits.

Five cases of ulcerative and erythematous lesions on the genitals and buttocks occurred among workers whose coveralls had been dry-cleaned using stoddard solvent. Results were consistent with irritant contact dermatitis [Nethercott et al. 1980].

COMMENTS:
Very few studies specific to stoddard solvent appear in the literature; most reflect exposure to "organic solvents." Stoddard solvent is currently being tested for carcinogenicity by the American Petroleum Institute (started August 1985).

NAME: Stoddard Solvent **CAS:** 8052-41-3
CODE: H.S. 1371

REFERENCES

Dick RB [1988]. Short duration exposures to organic solvents: The relationship between neurobehavioral test results and other indicators. Neurotoxicol Teratol 10(1):39-50.

Nethercott JR et al. [1980]. Genital ulceration due to stoddard solvent. J Occup Med 22(8):549-52.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to Alkanes (C_5-C_8). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-151.

NIOSH - OCTOBER 1988

NAME: Styrene **CAS:** 100-42-5
CODE: H.S.1372

EXPOSURE LIMITS

NIOSH	: 50 ppm (213 mg/m^3) 10-hr TWA; 100 ppm (426 mg/m^3) CL (15 min)
OSHA PEL (Present)	: 100 ppm 8-hr TWA; 200 ppm CL 600 ppm peak
OSHA PEL (Proposed)	: 50 ppm 8-hr TWA; 100 ppm STEL (15 min)
ACGIH TLV	: 50 ppm 8-hr TWA; 100 ppm STEL (15 min)

WORKERS: 224,250 (1987) **VOLUME:** 8,200,000,000 lbs (1987)

PEL TESTIMONY:
NIOSH concurs with the proposed OSHA PEL of 50 ppm based on NIOSH's evaluation of the neurotoxic effects of styrene. The Styrene Information and Research Center (SIRC) objects to (1) styrene being regulated as a carcinogen, and (2) the feasibility of compliance with the new PEL for certain processes.

BASIS FOR REL:
To prevent CNS effects (depression); acute irritation of the eyes and respiratory tract; chromosome changes in lymphocytes of workers; primary skin irritation.

CD NOTED EFFECTS **DATE CD:** September 1983

Acute	: Irritation of eyes, nose, respiratory tract, and skin; CNS depression
Chronic	: Irritation; kidney/liver weight increases
Irritation	: Yes
Mutagenic	: NEG (in most test systems - chromosomal aberrations lymphocytes)
Teratogenic	: NEG (in animal studies - limited human data inconclusive)
Carcinogenic	: NEG (or inconclusive in animal or epidemiologic studies)

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data since the criteria document to suggest changing the REL.

COMMENTS:
The SIRC contends that OSHA is wrong in regulating styrene as a "potent" carcinogen. SIRC attacks the OSHA interpretations of two animal and two epidemiologic investigations on the carcinogenicity of styrene. Objections to the animal studies [Jersey et al. 1978; NCI 1979] include faulty study design, poor controls, and high mortality. Objections to the epidemiologic studies [McMichael et al. 1976; Meinhardt et al. 1982] include the lack of identification of styrene as the causative agent or the lack of identification of other confounding exposures (to other organic and inorganic chemicals involved in these processes).

NIOSH would note that the Meinhardt [1982] study was not a study of styrene, but a study of styrene-butadiene in the synthetic rubber industry.

NAME: Styrene **CAS:** 100-42-5
CODE: H.S.1372

COMMENTS:
Also, SIRC believes that OSHA has over-interpreted or misinterpreted the results of both studies. Finally, SIRC objects that none of the negative data from "good" animal and epidemiologic studies was presented by OSHA. Even upon a minimal review of the large data base on styrene, it is clear that the SIRC contention that styrene is not a proven carcinogen, either in animals or in humans, is valid. The NIOSH position remains that there seems to be little basis from experimental animal investigations or epidemiologic studies to conclude at this time that styrene is carcinogenic.

There is sufficient evidence to indicate that styrene presents a significant risk of neurotoxic effects at the present PEL of 100 ppm which will be reduced by the proposed PEL of 50 ppm.

REFERENCES:
Jersey GC et al. [1978]. Two-year chronic inhalation toxicity and carcinogenicity study on monomeric styrene in rats. Final report. Report from Dow Chemical U.S.A.

McMichael AJ, Spirtas R, Gamble JF, Tousey PM [1976]. Mortality among rubber workers: Relationship to specific jobs. J Occup Med 18(3):178-184.

Meinhardt TJ, Lemen RA, Crandall MS, Young RJ [1982]. Environmental epidemiologic investigations of styrene-butadiene rubber industry. Scand J Work Environ Health 8:250-259.

NCI [1979]. Bioassay of styrene for possible carcinogenicity. Bethesda, MD: National Cancer Institute, National Institutes of Health, DHEW Publication No. (NIH) 79-1741.

NIOSH [1983]. Criteria for a recommended standard....occupational exposure to styrene. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 83-119.

NAME: Sulfur Dioxide **CAS:** 7446-09-5
CODE: H.S. 1375

EXPOSURE LIMITS

NIOSH	: 0.5 ppm (1.3 mg/m^3); 10-hr TWA
OSHA PEL (Present)	: 5 ppm; 8-hr TWA
OSHA PEL (Proposed)	: 2 ppm; 5 ppm STEL
ACGIH TLV	: 2 ppm (5 mg/m^3); 5 ppm (10 mg/m^3) STEL

WORKERS: 600,000 (1977) **VOLUME:** 490,000,000 lbs (1985)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed PEL.

BASIS FOR REL:
The current REL of 0.5 ppm is a 1977 update of the 1974 criteria document REL of 2 ppm. The current REL is based upon 3 epidemiologic studies [Archer and Gillam 1978; Canada Ministry of Health 1976; Smith et al. 1977] showing chronic respiratory disease associated with exposures of 0.4 ppm to 4 ppm SO_2 [NIOSH 1977].

CD NOTED EFFECTS **DATE CD:** 1974; Revised 1977

Acute	: Multiple upper respiratory effects
Chronic	: Multiple upper respiratory effects; pulmonary changes
Irritation	: Respiratory
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: Inconclusive in animals; the suggestion that SO_2 may be a promoter or co-carcinogen is not supported by epidemiological data

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data since the update of the criteria document that suggest a need for a change in the REL.

COMMENTS:
The Corn Refiners Association (CRA) critique of the methodology of the three epidemiological studies cited by NIOSH is unconvincing, but the CRA presents a valid argument that the SO_2 exposures in the corn refining industry (and possibly other food processing industries) are limited to relatively pure SO_2 and not the more injurious mixed exposure of particulates and sulfates/sulfites. The NIOSH REL of 0.5 ppm (which is based upon studies investigating mixed exposures) is therefore probably inappropriate for this industry. However, no convincing argument was presented showing that chronic exposures to concentrations approaching 5 ppm SO_2 would not cause chronic respiratory impairment.

NAME: Sulfur Dioxide **CAS:** 7446-09-5
CODE: H.S. 1375

REFERENCES:

Archer VE, Gillam JD [1978]. Chronic sulfur dioxide exposure in a smelter. II. Indices of chest disease. J Occup Med 20(2):88-95.

Ministry of Health [1976]. Chronic obstructive lung disease among persons employed for ten years and more in the converter plant of the International Nickel Co. of Canada, Copper Cliff, Ontario, Canada.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to sulfur dioxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 74-111.

Smith TJ, Peters JM, Reading JC, Castle CH [1977]. Pulmonary impairment from chronic exposure to sulfur dioxide in a smelter. Am Rev Respir Dis 116(1):31-39.

NAME: Sulfur Dioxide **CAS:** 7446-09-5
CODE: H.S. 1375

RESPONSE TO PEL DOCKET MATERIAL:
Representatives of the Corn Refiners Association (CRA) complain of a lack of time to adequately respond to the proposed rulemaking [Docket #8-65]. They object to OSHA's blanket incorporation of TLVs as the proposed PELs. They suggest that the ACGIH documentation is out of date. They state that a large-scale epidemiologic [Burgess et al. 1977 (unpublished)] study of a corn wet milling plant showed that exposures of less than 5 ppm SO_2 could not be proved to cause respiratory disease or disability. The CRA presents a detailed attack of the three epidemiologic studies [Archer and Gillam 1978; Canada Ministry of Health 1976; Smith et al. 1977] that were the basis of the updated NIOSH REL. The methodology is questioned (e.g., the use of improper equipment, inappropriate sampling/analytical techniques, improper use of respirators, bias in the same population, etc.). Also, the CRA asserts that the studies did not measure atmospheres representative of the corn refining industry. The CRA states that the epidemiologic studies looked at smelters where the atmospheres contained metallic or metallic/sulfur particulates, and sulfates and sulfites (by-products of combustion). The CRA presents details on the characterization of the corn refining industry in which exposure is virtually limited to SO_2 exposure alone. They contend that this is very important because one of the epidemiologic studies states that "...since SO_2 is usually accompanied by particulates...in occupational exposures, it would appear that a standard for SO_2 should be set with the consideration that other sulfur oxides and particulates may accompany it." The CRA therefore believes that the corn refining industry as well as the grape, berry, wine, and other food processing industries should not be included under a "mixed standard" because exposures to the relatively pure gaseous form of SO_2 in these industries are the results of evaporation of SO_2 from a sulfurous acid/water mixture and are not a result of combustion. The CRA presents an epidemiologic study of five corn refining plants that shows no chronic respiratory impairment to workers exposed to concentrations of less than 5 ppm SO_2 (geometric mean concentration 0.85 ppm).

Other industry representatives (American Cast Metals Association, American Foundrymen's Society, American Iron and Steel Institute, BP America, Inc., Magma Copper Co. - Docket numbers 3-675, 3-673, 3-1123, 8-57, and 8-9, respectively) also complain of the lack of time allowed for adequate response to the proposed rulemaking. They present statistical information on the negative impact the rulemaking will have on the industry. They detail high cost estimates to the industry for compliance with the new PEL, and they show how compliance with the 5 ppm STEL is a practical infeasibility. They present information on how much the industry has already achieved in recent years to protect the worker through technology and work practices.

NAME: Tin (Organic) **CAS:** 7440-31-5
CODE: H.S. 1394

EXPOSURE LIMITS

NIOSH	: 0.1 mg Sn/m^3, TWA 10-hr
OSHA PEL (Present)	: 0.1 mg/m^3, TWA 8-hr
OSHA PEL (Proposed)	: 0.1 mg/m^3, TWA 8-hr
ACGIH TLV	: 0.1 mg/m^3, 0.2 STEL, TWA - Skin

WORKERS: 30,000 (1974) **VOLUME:** 50,000,000 lb (1975)

PEL TESTIMONY:
NIOSH concurs with the proposed OSHA PEL of 0.1 mg/m^3 as an 8-hr TWA, but believes that toxicity data warrant inclusion of a skin notation.

BASIS FOR REL:
The NIOSH criteria document [1976] states that, "human and animal toxicity data neither support nor negate the current federal (OSHA) standard, which was set by analogy with mercury, selenium, and thallium. NIOSH therefore recommends that the current standard of 0.1 mg/cu m, as tin, as a TWA concentration limit be retained for all organotin compounds..."

CD NOTED EFFECTS (Organotin Compounds) **DATE CD:** November 1976

Acute	: CNS effects including headache, nausea, weakness, visual; liver & kidney
Chronic	: Respiratory irritation (pulmonary edema); liver & kidney
Irritation	: Skin & respiratory
Mutagenic	: NEG (dominant lethal)
Teratogenic	: No information
Carcinogenic	: NEG (2 studies--1 oral & 1 dermal)

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
There are no new data since the criteria document that suggest a need for a change in the REL.

COMMENTS:
Post-criteria document data do not add much to earlier information. There are many organotin compounds having varying degrees of toxicity; however, the trialkyl tins are generally more toxic than the dialkyl tins which are more toxic than the monoalkyl tins. There is little epidemiologic information relating specific exposure levels to observed toxicity. In addition, there are very few animal inhalation studies found in the literature (especially chronic, carcinogenic or reproductive studies.

NAME: Tin (Organic) **CAS:** 7440-31-5
CODE: H.S. 1394

REFERENCES:

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to organotin compounds. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-115.

NAME: Toluene **CAS:** 108-88-3
CODE: H.S. 1397

EXPOSURE LIMITS

NIOSH	100 ppm (375 mg/m^3) TWA; 200 ppm (750 mg/m^3) ceiling - 10 min
OSHA PEL (Present)	200 ppm (750 mg/m^3) TWA; 300 ppm ceiling; 500 ppm peak (10 min in 8 hr)
OSHA PEL (Proposed)	100 ppm (TWA); 150 ppm (STEL - 15 min)
ACGIH TLV	100 ppm (TWA) (375 mg/m^3); 150 ppm 150 ppm (560 mg/m^3) STEL

WORKERS: 3,972,080 **VOLUME:** 1.54 x 10^{12} gal. (1982)

PEL TESTIMONY:
OSHA proposed reduced TWA and STEL to prevent liver, blood, nervous system effects. NIOSH testimony concurs with OSHA proposed PEL.

BASIS FOR REL:
NIOSH REL to prevent CNS effects, liver effects, (blood effects likely associated to exposure to benzene contained in solvent mixtures also containing toluene) [NIOSH 1973].

CD NOTED EFFECTS **DATE CD:** 1973

Acute	Eye & skin irritation; headache; fatigue; narcosis
Chronic	CNS; liver; kidney
Irritation	Eye & skin irritation; headache; fatigue; narcosis
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
NTP is presently conducting a carcinogenesis assay.

Several recent studies indicate measurable biological changes in liver function at 100 ppm [Seiji et al. 1987] but not at 46 ppm [Yin et al. 1987]. Other studies showed subjective complaints and lowered performance on psychological test scores [Baelum et al. 1985; Hanninen et al. 1987]. There is also some suggestion of reproductive effects at occupational exposure levels [McDonald JC 1987].

COMMENTS:
The new data, particularly regarding neurobehavioral effects, warrant reevaluation of the REL. There are significant health effects at the present PEL of 200 ppm which will be reduced by the proposed PEL of 100 ppm.

NAME: Toluene **CAS:** 108-88-3
CODE: H.S. 1397

REFERENCES:

Baelum J et al. [1985]. Response of solvent exposed printers and unexposed controls to six-hour toluene exposure. Scand J Work Environ Health 11(4):271-280.

Hanninen H et al. [1987]. Physiological reformance, toluene exposure and alcohol consumption in Rotogravure printers. International Archives of Occupational and Environmental Health 59(5):475-483.

McDonald JC [1987]. Chemical exposures to work in early pregnancy and congenital defects: a case-referent study. Brit J Ind Med 44(8)527-533.

NIOSH [1973]. Criteria for a recommended standard....occupational exposure to toluene. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 73-11023.

Seiji K et al. [1987]. No biologically significant changes in liver function after occupational exposure to toluene at over-OEL levels. Industrial Health 25(3):163-167.

Yin S et al. [1987]. Symptoms and signs of workers exposed to benzene, toluene or the combination. Industrial Health 25(3):113-130.

NAME: Trimellitic Anhydride **CAS:** 552-30-7
CODE: H.S. 1409

EXPOSURE LIMITS

NIOSH	: No REL; but should be "handled as an extremely toxic agent in the workplace."
OSHA PEL (Present)	: None
OSHA PEL (Proposed)	: 0.005 ppm (0.04 mg/m^3) 8-hr TWA
ACGIH TLV	: 0.005 ppm (0.04 mg/m^3) 8-hr TWA

WORKERS: 11,309 (NOHS) (1977) **VOLUME:** 2.27 metric tons (1977)

PEL TESTIMONY:
NIOSH concurs with the OSHA proposed adoption of a 0.005 ppm (8-hour TWA) for trimellitic anhydride.

BASIS FOR REL:
It is extremely toxic and irritating, and "can cause severe pulmonary edema, immunological sensitization and asthma symptoms" [NIOSH 1978].

CIB #21 NOTED EFFECTS **DATE CIB:** February 3, 1978

Acute	: Extremely toxic; skin & pulmonary sensitizer; pulmonary effects including asthma
Chronic	: ND
Irritation	: POS
Mutagenic	: NEG (in 6 strains of Salmonella typhimurium [+S9])
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
1) Negative mutagen (Ames) [NTP 1987].

2) Negative developmental toxicity screen [Hardin et al. 1987].

3) TSCA 8(e) report of significant health risk [EPA 1980].

COMMENTS:
There are no new data to suggest updating the CIB.

NAME: Trimellitic Anhydride **CAS:** 552-30-7
CODE: H.S. 1409

REFERENCES:

EPA [1980]. Section 8e [Toxic Substances Control Act] on trimellitic anhydride. Washington, DC: Environmental Protection Agency, Office of Toxic Substances, EPA Document Control #8EHQ-0379-0280.

Hardin BD, Schuler RL, Burg JR, Booth GM, Hazelden KP, MacKenzie KM, Piccirillo VJ, Smith KN [1987]. Evaluation of 60 chemicals in a preliminary developmental toxicity test. Teratogen Carcinogen Mutagen 7:29-48.

NIOSH [1978]. Current intelligence bulletin #21: Trimellitic anhydride (TMA). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-121.

NTP [1987]. Trimellitic anhydride. Research Triangle Park, NC: National Toxicology Program, NTP results report, 112 pages.

NAME: Tungsten (Insoluble & Soluble) **CAS:** 7440-33-7
CODE: H.S. 1416

EXPOSURE LIMITS

NIOSH	: 5 mg W/m^3 TWA (Insoluble); 1 mg W/m^3 TWA (Soluble) *See below
OSHA PEL (Present)	: None
OSHA PEL (Proposed)	: 5 mg/m^3 TWA; 10 mg/m^3 STEL (insoluble) as W; 1 mg/m^3 TWA; 3 mg/m^3 STEL (soluble) as W
ACGIH TLV	: Same as OSHA Proposed PEL

WORKERS: 4,900 - 18,300 (1976) **VOLUME:** 48,000,000 lbs (1977)

PEL TESTIMONY:
NIOSH concurred with OSHA PEL.

BASIS FOR REL:
Insoluble tungsten compounds--lung tissue reactions (reversible) similar to that noted for nuisance dusts. Soluble tungsten compounds--acute toxicity found to be 3.5 times greater than that for insoluble compounds; soluble compounds found to cause systemic effects involving the gastrointestinal tract and CNS in guinea pigs. When more than 2% cobalt or 0.3% nickel are contained in tungsten carbide, then the respective NIOSH REL for cobalt and nickel apply [NIOSH 1977].

CD NOTED EFFECTS **DATE CD:** September 1977

Acute	: ND
Chronic	: Lung damage (insoluble compounds)/gastrointestinal tract and CNS (soluble compounds)
Irritation	: Skin (insoluble compounds)
Mutagenic	: ND
Teratogenic	: ND
Carcinogenic	: ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Most of the reported health data are associated with workers exposed concomitantly to cobalt or nickel.

COMMENTS:
Although the NIOSH RELs for insoluble and soluble tungsten are based on limited health and exposure data, there does not appear to be any new data that would support a change in this position.

NAME: Tungsten (Insoluble & Soluble) **CAS:** 7440-33-7
CODE: H.S. 1416

***NOTE--OTHER NIOSH RELs APPLY:**
a) When dust from cemented tungsten carbide has >2% cobalt -- 0.1 mg Co/m^3 TWA
b) When dust from cemented tungsten carbide has >0.3% nickel -- 15 ug Ni/m^3 TWA

REFERENCES:
NIOSH [1977]. Criteria for a recommended standard....Occupational exposure to tungsten and cemented tungsten carbide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-227.

NAME: Dimethylbenzene [Xylenes (o,p,m isomers)] **CAS:** 1330-20-7
CODE: H.S. 1431

EXPOSURE LIMITS

NIOSH	100 ppm (435 mg/m^3) TWA; 200 ppm (870 mg/m^3) Ceiling - 10 min sample
OSHA PEL (Present)	100 ppm TWA
OSHA PEL (Proposed)	100 ppm TWA; 150 ppm (655 mg/m^3) STEL - 15 min.
ACGIH TLV	100 ppm TWA; 150 ppm STEL - 15 min.

WORKERS: 1.0 to 3.6 million (1974) **VOLUME:** 658 million gal. (1982)

PEL TESTIMONY:
OSHA proposed both a TWA and STEL to prevent narcosis, blood effects, and irritant effects. NIOSH testimony indicates concurrence with the OSHA proposed PEL.

BASIS FOR REL:
NIOSH REL should prevent irritating and narcotizing properties [NIOSH 1975].

CD NOTED EFFECTS **DATE CD:** 1975

Acute	Eyes; nose; throat; skin irritation
Chronic	Central nervous system; blood; liver; kidney
Irritation	See acute
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

Neurobehavioral

Hastings GP et al. [1984]. Human sensory response to selected petroleum hydrocarbons. Adv Mod Environ Tox 6:255-270.

Subjects exposed for 30 minutes to mixed xylenes at 1 to 4 times the TLV levels reported a higher incidence of eye irritation, and rate of eyeblink compared to controls. There were no significant differences in respiration rates or tests of pyschomotor function.

Holmberg PC and Nurmen M [1980]. Am J Indust Med 1:167.

CNS defects were more common in children of mothers exposed to organic solvents and dusts during pregnancy. Hydroencephaly occurred in children of mothers exposed to toluene, xylene, and white spirit during the manufacture of rubber products.

NAME: Dimethylbenzene [Xylenes (o,p,m isomers)] **CAS:** 1330-20-7
CODE: H.S. 1431

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

Kilburn KH et al. [1985]. Neurobehavioral and respiratory symptoms of formaldehyde and xylene exposure in histology technicians. Arch Environ Health 40(1554):229-233.
Disturbances of memory, mood, equilibrium and sleep that occurred simultaneously with headache and indigestion were experienced more frequently among 76 women working in histology who had daily exposure to formaldehyde (0.2-1.9 ppm) and xylene (3.2-102 ppm) than in 56 unexposed female clerical workers in the same hospitals. Neurobehavioral symptoms were accompanied by irritation of the eyes, upper airways and trachea.

Klancke DN et al. [1982]. An outbreak of xylene intoxication in a hospital. Am J Ind Med 3(1552):173-178.
An outbreak of illness in 15 hospital employees was associated with exposure to xylene discarded down a sink drain in a pathology laboratory. Symptoms included headache, nausea, vomiting and dizziness; duration of illness ranged from 2-48 hours.

Olson BA [1982]. Effects of organic solvents on behavior of workers in the paint industry. Neuro Tox Terat 4(6):703-708.
Effects of exposure to organic solvents on CNS function were investigated in 47 paint workers exposed for >10 years at concentrations of solvents >TLV values; xylene and toluene were dominant. Exposed workers performed less well than the comparison group on tests of simple reaction time, perceptual speed, and short-term memory.

Seppalainen AM et al. [1978]. Neurophysiological effects of long term exposure to a mixture of organic solvents. Scand J Work Environ Health 4:304-314.
Effect of long term exposure (1-40 yr) to low concentrations of organic solvents (1.7 to 30.6 ppm) including toluene, xylene butylacetate and white-spirit on the nervous system in 102 car painters was investigated. Authors conclude while a relatively high frequency of abnormal EEGs was present in painters and nonexposed engineers (32 vs. 37), slightly slowed nerve conduction velocities were found only among car painters (12 of 59 vs. 0 of 53).

Reproductive-Teratogenic

Balogh T et al. [1982]. Egeszsegtudomany 26(1):42-8.
Rats exposed to xylene @ 230, 1900 or 3360 mg/m^3 from day 7-14 of pregnancy showed no maternal toxicity. However, bone formation was retarded in fetuses at all exposures. The incidence of post implantation fetal loss increased.

Hudak A and Ungvary G [1978]. Embryotoxic effects of benzene and its methyl derivatives: toluene and xylene. Toxicology 2(1):55-63.
Embryotoxic effects were evaluated in fetuses of adult rats exposed continuously at 1000 mg/m^3 xylene during days 9-14 of gestation. No teratogenic effects resulted, however embryotoxic retardation of fetal development was shown (low fetal weight and retarded skeletal development).

NAME: Dimethylbenzene [Xylenes (o,p,m isomers)] **CAS:** 1330-20-7
CODE: H.S. 1431

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):

International Labor Office [1983]. Encyclopedia of Occupational Health and Safety. Vols. I & II. Geneva, Switzerland, p.2335.

Women are liable to suffer from menstrual disorders and affected by pathological pregnancy conditions (toxicosis, danger of miscarriage, hemorrhage during child birth) and infertility when exposed to xylene concentrations which exceeded exposure limits.

Marks TA et al. [1982]. J Toxicol Environ Health 9(1):97-105.

Pregnant outbred albino mice received by gavage a xylene mixture on days 6-15 of gestation. At 3.6 mg/kg/day, xylene killed 12 of 36 dams and caused smaller average weight gain during pregnancy. Fetuses from dams treated @ 204 ml/kg/day had average weights significantly lower than control fetuses. At 2.4-3.6 ml/kg/day, greater average. % malformed fetuses occurred, mostly cleft palate.

Mirkova E et al. [1983]. J Hyg Epidemiol Microbiol Immunol 27(3):337-43.

In rats, exposure to 50 or 500 mg/m^3 resulted in embryotoxic and teratogenic effects. The brain, liver, lung and heart were affected. The number of post implantation losses increased by 9.7 and 168%, respectively with exposure to 50/500 mg/m^3. The incidence of fetal skeletal abnormalities was increased by 62 and 177%, respectively.

Overman DO [1981]. Teratology 23:56A.

Hamsters received xylene topically for 2 hours between days 7 and 11 of gestation. Fetal size and weight decreased and incidence of prenatal deaths increased. Fetal hemorrhage and gastroschisis were noted. No malformations were found in controls.

Genotoxicity/Mutagenicity

Dean, BJ [1985]. Recent findings on the genetic toxicology of benzene, toluene, xylenes, and phenols. Mutat Res 154(3):153-181.

Negative results were observed in Salmonella mutagenicity assay and in mouse lymphoma LS179Y thymidinekinase forward mutation assay, and in chromosome damage in bone marrow cells after i.p. dosing with xylene. Xylene was inactive in Escherichia coli and Bacillus subtilis DNA microsuspension assays. Xylene failed to induce SCE in cultured human lymphocytes. Xylene was observed to induce a low frequency of recessive lethals in Drosophilia.

Haglund U et al. [1980]. Chromosome aberrations and sister chromatid exchanges in Swedish paint industry workers. Scand J Work Environ Health 6(1554):291-298.

Workers in the Swedish paint industry exposed to a mixture of organic solvents, mainly containing xylene or toluene, were investigated for genotoxic effects. No difference in the frequency of SCE; 0.192 and 0.193 per chromosome, respectively, was noted in peripheral lymphocytes of the exposed group of 17 workers and then matched reference group.

NAME: Dimethylbenzene [Xylenes (o,p,m isomers)] **CAS:** 1330-20-7
CODE: H.S. 1431

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
NTP [1981]. Technical report on the toxicology and carcinogenesis of Xylenes (Mixed) (Draft). NTP TR 327, p. 5.

Xylenes were not mutagenic when tested with or without metabolic activation in Salmonella typhimurium strains TA 100, TA 135, TA 97, or TA 98 with the preincubation protocol.

Pap M and Varga C [1987]. Sister chromatid exchanges in peripheral lymphocytes of workers occupationally exposed to xylenes. Mutation Research 187(4):223-225.

A study of sister chromatid exchanges (SCEs) in peripheral lymphocytes of workers occupationally exposed to xylene in a Hungarian chemical factory was conducted involving 2 groups of workers (23 each) and 1 control group (34). Exposures were estimated at 47-56 mg/m^3 for >9 yr. Mean SCE frequencies were 8.7 and 8.8 SCEs/cell in the cohort vs. 8.5 in the control. Authors conclude that xylene or its metabolites have not shown a genotoxic effect.

Cancer

NTP [1986]. Technical report on the toxicology and carcinogenesis of xylenes (Mixed) (Draft). NTP-TR-327, pp. 4-6.

Two-year toxicology and carcinogenesis studies were conducted by administering 0, 250 or 500 mg/kg xylenes in corn oil by gavage to groups of 50 F344/N rats of each sex, 5 days/wk for 103 weeks. Groups of 50 B6C3F1 mice of each sex were administered 0, 500 or 1000 mg/kg xylenes on the same schedule. Body weights of the high dose male rats were 5-8% lower than controls after week 59. Hyperactivity lasting 5-30 minutes was observed after dosing in high dose mice beginning after week 4 thru week 103. Under the conditions of these 2-year gavage studies, there was no evidence of carcinogenicity of xylenes (mixed) in male and female rats @ 250 and 500 mg/kg or in male or female mice @ 500 or 1000 mg/kg.

COMMENTS:
The new data, particularly regarding reproductive effects, may warrant a reevaluation of the REL.

REFERENCES:
Balogh T et al. [1982]. Egeszsegtudomany 26(1):42-8.

Dean, BJ [1985]. Recent findings on the genetic toxicology of benzene, toluene, xylenes, and phenols. Mutat Res 154(3):153-181.

Haglund U et al. [1980]. Chromosome aberrations and sister chromatid exchanges in Swedish paint industry workers. Scand J Work Environ Health 6(1554):291-298.

NAME: Dimethylbenzene [Xylenes (o,p,m isomers)] **CAS:** 1330-20-7
CODE: H.S. 1431

REFERENCES:

Hastings GP et al. [1984]. Human sensory response to selected petroleum hydrocarbons. Adv Mod Environ Tox 6:255-270.

Holmberg PC and Nurmen M [1980]. Am J Indust Med 1:167.

Hudak A and Ungvary G [1978]. Embryotoxic effects of benzene and its methyl derivatives: toluene and xylene. Toxicology 2(1):55-63.

International Labor Office [1983]. Encyclopedia of Occupational Health and Safety. Vols. I & II. Geneva, Switzerland, p.2335.

Kilburn KH et al. [1985]. Neurobehavioral and respiratory symptoms of formaldehyde and xylene exposure in histology technicians. Arch Environ Health 40(1554):229-233.

Klancke DN et al. [1982]. An outbreak of xylene intoxication in a hospital. Am J Ind Med 3(1552):173-178.

Marks TA et al. [1982]. J Toxicol Environ Health 9(1):97-105.

Mirkova E et al. [1983]. J Hyg Epidemiol Microbiol Immunol 27(3):337-43.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to xylene. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-168.

NTP [1981]. Technical report on the toxicology and carcinogenesis of Xylenes (Mixed) (Draft). NTP TR 327, p. 5.

NTP [1986]. Technical report on the toxicology and carcinogenesis of xylenes (Mixed) (Draft). NTP-TR-327, pp. 4-6.

Olson BA [1982]. Effects of organic solvents on behavior of workers in the paint industry. Neuro Tox Terat 4(6):703-708.

Overman DO [1981]. Teratology 23:56A.

Pap M and Varga C [1987]. Sister chromatid exchanges in peripheral lymphocytes of workers occupationally exposed to xylenes. Mutation Research 187(4):223-225.

Seppalainen AM et al. [1978]. Neurophysiological effects of long term exposure to a mixture of organic solvents. Scand J Work Environ Health 4:304-314.

NAME: Zinc Oxide (Fume) **CAS:** 1314-13-2
CODE: H.S. 1437

EXPOSURE LIMITS

NIOSH	5 mg ZnO/m^3 TWA; 15 mg ZnO/m^3 ceiling (15-min)
OSHA PEL (Present)	5 mg/m^3 as ZnO fume
OSHA PEL (Proposed)	5 mg/m^3 TWA; 10 mg/m^3 STEL
ACGIH TLV	5 mg/m^3 TWA; 10 mg/m^3 STEL

WORKERS: 660,000 - 1.7 million (1974) **VOLUME:** 1.4 billion lbs (1977)

PEL TESTIMONY:
NIOSH concurred with OSHA proposed PEL.

BASIS FOR REL:
Based on metal fume fever reported for workers exposed to zinc oxide fume. Similar respiratory effects (nasopharyngitis & laryngitis) noted in workers exposed to zinc oxide powder. Although exposure data were limited, NIOSH concluded that it was appropriate to retain the OSHA PEL of 5 mg/m^3 and to recommend a ceiling limit of 15 mg/m^3 [NIOSH 1975].

CD NOTED EFFECTS **DATE CD:** 1975

Acute	Metal fume fever
Chronic	Pneumonia; sclerosis of bronchial tissue; atrophic mucosal changes in respiratory tract
Irritation	ND
Mutagenic	ND
Teratogenic	ND
Carcinogenic	ND

NEW DATA SINCE CD (NTP, IARC, ACGIH, misc. studies, etc.):
Most of the more recent studies pertain to workers exposed to zinc oxide fume as a result of welding. Because of concomitant exposures in welding, it is not possible to associate any specific health effect from these data with exposure to zinc oxide.

COMMENTS:
There doesn't appear to be any new data to justify revision of the NIOSH REL. NIOSH's ceiling concentration of 15 mg/m^3 (15 min) and OSHA's proposed STEL of 10 mg/m^3 appear to be arbitrary in their selection, but are intended to prevent pathological tissue changes in the lung from acute exposures.

NAME: Zinc Oxide (Fume) **CAS:** 1314-13-2
CODE: H.S. 1437

REFERENCES:
NIOSH [1975]. Criteria for a recommended standard....occupational exposure to zinc oxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-104.

NAME: Acrylic Acid

CAS: 79-10-7
CODE: H.S. 1009

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
10 ppm 30 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 10 ppm (skin) 30 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
On Notice of Intended Change - 2 ppm TWA (6 mg/m^3)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 54,400 (1982) **VOLUME:** 735 million (1983) POUNDS

TOXICITY:
Human Irritant (skin, eye, respiratory) **Animal** Irritant (skin, eye, respiratory); degenerative nasal cells

MUTAGENICITY:
Human -- **Other** NEG (Salmonella)
POS (mouse lymphoma cells)

TERATOGENICITY:
Human -- **Animal** POS (rats - skeletal, embryotoxicity)

CARCINOGENICITY:
IARC : **Human** No adequate data **Animal** No adequate data
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA does not have a current PEL for acrylic acid. The proposed PEL of 10 ppm (30 mg/m^3) is adopted from the current ACGIH TLV [ACGIH 1980], which is based on nasal and eye irritation. In the revised ACGIH documentation on acrylic acid, ACGIH [1986] proposed a TLV (TWA) of 2 ppm (6 mg/m^3) with a skin notation based on new studies demonstrating degeneration of olfactory mucosa in mice at 5 ppm [Miller et al. 1981], changes in pulmonary function in rodents [Silver et al. 1981], and skin absorption in animal studies [ACGIH 1986]. Based on the ACGIH notice of intended change to 2 ppm TWA, NIOSH does not support the proposed PEL of 10 ppm TWA.

NAME: Acrylic Acid **CAS:** 79-10-7
CODE: H.S. 1009

REFERENCES:

ACGIH [1980]. Acrylic Acid. In: Documentation of the threshold limit values. 4th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 9.

ACGIH [1986]. Acrylic Acid. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 14.1-14.3.

Miller RR, Ayres JA, Jersey GC, McKenna MJ [1981]. Inhalation toxicity of acrylic acid. Fund Appl Toxicol 1:271-277.

Silver EG, Leith DE, Murphy SD [1981]. Potentiation by triorthotolyl phosphate of acrylate ester-induced alterations in respiration. Toxicology 22:193-203.

NAME: n-Butyl Glycidyl Ether

CAS: 2426-08-6
CODE: H.S. 1052

PEL CURRENT:
50 ppm 270 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
25 ppm 135 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
25 ppm 135 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) 5.6 ppm 30 mg/m^3 (ceiling - 15-min)

PRODUCTION WORKERS: 19,900 (1972) **VOLUME:** 6,600,000 (1977) POUNDS

TOXICITY:
Human Irritant and sensitive **Animal** Rat (testicular atrophy)

MUTAGENICITY:
Human -- **Other** POS (Salmonella and mouse dominant lethal)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Current Intelligence Bulletin #29 (1978), Criteria Document (1978)

COMMENTS:
The original NIOSH REL [NIOSH 1978a] of 5.6 ppm (30 mg/m^3) was reaffirmed in NIOSH Current Intelligence Bulletin #29 [NIOSH 1978b]. In this bulletin, a toxicity study was described in which testicular effects were found in rats exposed to only 75 ppm. Although the numbers were small, the effects are considered "real," in that good dose-response information was produced, i.e., higher levels produced similar toxicity but at a higher rate. Also, at least four other glycidyl ethers have produced similar toxicity. This study provided a no-observed effect level of 38 ppm. Based upon OSHA's own philosophy--see p. 20987 of the Federal Register notice, and considering the positive findings of BGE as an animal mutagen, the proposed PEL of 25 ppm is not protective, especially to the potentially sensitive individual.

NAME: n-Butyl Glycidyl ether

CAS: 2426-08-6
CODE: H.S. 1052

REFERENCES:

NIOSH [1978a]. A recommended standard for occupational exposure to....glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-166.

NIOSH [1978b]. Current intelligence bulletin #29: Glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 79-104.

NAME: Camphor, synthetic

CAS: 76-22-2
CODE: H.S. 1063

PEL CURRENT:
0.3 ppm 2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
2 ppm 12 mg/m^3 (TWA) 3 ppm 18 mg/m^3 (STEL)

TLV:
2 ppm 12 mg/m^3 (TWA) 3 ppm 18 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 572,000 (1972) **VOLUME:** 1,331,000 (1977) POUNDS

TOXICITY:
Human Irritation - eye and nose; No effect - 2 ppm **Animal** Irritation - eye and respiratory (mouse)

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The current PEL of 2 mg/m^3 should be retained (which is incorrectly printed in the OSHA document for Camphor (Synthetic), H.S. No. 1063, p. 21029, as 2 ppm). The TLV of 2 ppm (12 mg/m^3) is based on the Gronka et al. [1969] reference which reports worker exposures and related symptoms ranging from 24-194 mg/m^3 (significant effects) and 2.5-3.5 mg/m^3 (slight eye irritation and afternoon drowsiness). The report, based on the "minimal eye irritation," recommended revision of the TLV from 2 mg/m^3 to 12 mg/m^3. Data in the reported study do not identify with an extrapolation to 12 mg/m^3, nor are the slight eye irritation and drowsiness at 2.5-3.5 mg/m^3 to be ignored.

NAME: Camphor, synthetic

CAS: 76-22-2
CODE: H.S. 1063

REFERENCES:
Gronka PA, Bobkoskie RL, Tomchick GJ, Rakow AB [1969]. Camphor exposures in a packaging plant. Am Ind Hyg Assoc J 30:276-279.

NAME: Caprolactam **CAS:** 105-60-2
CODE: H.S. 1065

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 20 mg/m^3 (TWA) -- ppm 40 mg/m^3 (STEL)

TLV:
0.22 ppm or 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(vapor) (combined vapor and aerosol)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 105,602 (1972) **VOLUME:** 1,030 million (1984) POUNDS

TOXICITY:
Human Skin, eye, & respiratory irritant **Animal** Convulsant; eye, respiratory irritant

MUTAGENICITY:
Human -- **Other** POS (Drosophila)

TERATOGENICITY:
Human -- **Animal** NEG (Rat, rabbit)

CARCINOGENICITY:
IARC : **Human** No evidence **Animal** No evidence
NTP : **Human** NEG **Animal** NEG
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA did not have a PEL for caprolactam vapor. The proposed PEL of 20 mg/m^3 with STEL of 20 mg/m^3 is apparently based on an old ACGIH value of 20 mg/m^3 for caprolactam vapor [ACGIH 1982]. However, 1986 ACGIH documentation lists TLV (TWA) of 1 mg/m^3 for combined vapor and aerosol of caprolactam and 0.22 ppm if present as a vapor. The proposed change in the 1986 TLV to 1 mg/m^3 was recommended to prevent early signs of irritation in some workers. Based on available human exposure responses, the proposed PEL does not appear to provide a sufficient margin of safety to caprolactam vapor [EPA 1988; Ferguson et al. 1973; ACGIH 1986]. Therefore, it seems reasonable to adopt the ACGIH [1986] value of 0.22 ppm or 1 mg/m^3 as OSHA's PEL value [ACGIH 1986].

NAME: Caprolactam **CAS:** 105-60-2
CODE: H.S. 1065

REFERENCES:

ACGIH [1982]. Caprolactam. In: Documentation of the threshold limit values and biological exposure indices. 4th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 64-65.

ACGIH [1986]. Caprolactam. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 96.

EPA [1988]. Health and environmental effects document for caprolactam. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment. Final draft report ECAO-CIN-G018.

Ferguson WS, Wheeler DD [1973]. Caprolactam vapor exposures. Am Ind Hyd Assoc J 34:384-389.

NAME: Coal dust (< 5% quartz) **CAS:** None
CODE: HS 1096

PEL CURRENT:
-- ppm 2.4 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 2.0 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 2.0 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 87,736 (OSHA 1988) **VOLUME:** -- POUNDS

TOXICITY:
Human Respiratory irritant; silicosis; PMF; bronchitis **Animal** Pneumoconiosis [Karagianes 1981]

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human Limited (IARC 1987) **Animal** POS (see HS 1355, silica)
NTP : Human -- **Animal** --
NIOSH: (Suspected of gastrointestinal tumors - see comments)
ACGIH: --

NIOSH DATE: Criteria Document (1975); Mine Ventilation Testimony to MSHA (1988)

COMMENTS:
OSHA has proposed two different limits for coal dust differentiated on the basis of crystalline silica content. NIOSH supports the proposed reduction of the present OSHA limits but is concerned that significant levels of risk remain at the levels proposed by OSHA.

Respirable quartz and coal mine dust both present significant health hazards and it is the NIOSH position that all coal dust areas be monitored for both coal dust and respirable quartz. It is generally recognized that respirable quartz will average less than 1/3 of the total quartz [ACGIH 1986] and a respirable quartz limit alone will not necessarily control the total coal mine dust exposure in quartz-bearing coal. A coal dust limit alone will obviously not control the respirable quartz concentration. NIOSH,

NAME: Coal dust (< 5% quartz) **CAS:** None
CODE: HS 1096

COMMENTS: (Continued)
therefore, has made identical replies to coal dust (< 5% quartz) HS 1096 and coal dust (> 5% quartz) HS 1097.

The data for coal dust cited by OSHA are considerably dated. Current data indicates that the risk of developing pulmonary massive fibrosis from a coal mine dust exposure is at least 11.9 per thousand workers for bituminous coal and higher for anthracite coal [Hurley et al. 1987]. Coal dust exposure is also suspected of being related to an increased risk of gastrointestinal cancers as reported in Occupational Respiratory Diseases [NIOSH 1986].

The Mine Safety and Health Administration (MSHA) currently regulates coal mine dust to standard of 2.0 mg/m^3. The MSHA standard [30 CFR 70.100] is enforced in conjunction with an X-ray surveillance program and worker removal provisions, 39 CFR 90 et seq., which are more protective than the proposed OSHA standard.

The concentration of respirable quartz in coal dust is highly variable and should be monitored in all coal dust exposures. Respirable quartz is a significant etiologic agent in coal workers pneumoconiosis, and exposure to respirable quartz can result in silicosis of the lung. The International Association for Research on Cancer has found there is limited human data and sufficient animal data indicating that respirable quartz is carcinogenic [IARC 1987].

NIOSH recommends an REL of 0.050 mg/m^3 for respirable quartz [NIOSH 1974]. The NIOSH position on the respirable quartz REL is discussed in detail in the criteria document attached to HS 1355, silica.

In summary, NIOSH recommends that the coal dust exposures be monitored for both respirable quartz and coal dust. NIOSH recommends that respirable silica be limited to 0.050 mg/m^3 and the OSHA consider the IARC data on the carcinogenicity of respirable crystalline silica in determining the appropriate carcinogen designation for quartz-bearing coal dust. NIOSH further suggests that a significant level of risk may remain at the proposed permissible exposure level for coal dust.

REFERENCES:
ACGIH [1986]. Silica, crystalline - quartz. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 523-524.

Hurley JF, Maclaren WM [1987]. Dust-related risks of radiological changes in coal miners over a 40-year working life: Report on work commissioned by NIOSH. Edinburgh, Scotland: Institute of Occupational Medicine, Report #TM/87/09.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs, Volumes 1 to 42. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Coal dust (< 5% quartz)

CAS: None
CODE: HS 1096

REFERENCES: (Continued)

Karagianes MT, Palmer RF, Busch RH [1981]. Effects of inhaled diesel emmissions and coal dust in rats. Am Indus Hyg Assoc J 42:382-391.

NIOSH [1974]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication 75-120.

NIOSH [1986]. Occupational respiratory diseases. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Respiratory Disease Studies, Appalachian Laboratory for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-102.

NAME: Coal dust (> 5% quartz) **CAS:** None
CODE: H.S. 1097

PEL CURRENT:
-- ppm $\frac{10}{\%SiO_2+2}$ mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.1* mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 0.1* mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm 0.05* mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
*respirable silica

PRODUCTION WORKERS: 16,956 (OSHA 1988) **VOLUME:** -- POUNDS

TOXICITY:
Human Respiratory irritant; silicosis; PMF; bronchitis **Animal** Pneumoconiosis [Karagianes 1981]

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human Limited (IARC 1987) **Animal** POS (see HS 1355, silica)
NTP : Human -- **Animal** --
NIOSH: (Suspected of gastrointestinal tumors - see comments)
ACGIH: --

NIOSH DATE: Criteria Document (1975); Mine Ventilation Testimony to MSHA (1988)

COMMENTS:
OSHA has proposed two different limits for coal dust differentiated on the basis of crystalline silica content. NIOSH supports the proposed reduction of the present OSHA limits but is concerned that significant levels of risk remain at the levels proposed by OSHA.

Respirable quartz and coal mine dust both present significant health hazards and it is the NIOSH position that all coal dust areas be monitored for both coal dust and respirable quartz. It is generally recognized that respirable quartz will average less than 1/3 of the total quartz [ACGIH 1986] and a respirable quartz limit alone will not necessarily control the total coal mine dust exposure in quartz-bearing coal. A coal dust limit alone will obviously not control the respirable quartz concentration. NIOSH.

NAME: Coal dust (> 5% quartz) **CAS:** None
CODE: H.S. 1097

COMMENTS: (Continued)
therefore, has made identical replies to coal dust (< 5% quartz) HS 1096 and coal dust (> 5% quartz) HS 1097.

The data for coal dust cited by OSHA are considerably dated. Current data indicates that the risk of developing pulmonary massive fibrosis from a coal mine dust exposure is at least 11.9 per thousand workers for bituminous coal and higher for anthracite coal [Hurley et al. 1987]. Coal dust exposure is also suspected of being related to an increased risk of gastrointestinal cancers as reported in Occupational Respiratory Diseases [NIOSH 1986].

The Mine Safety and Health Administration (MSHA) currently regulates coal mine dust to standard of 2.0 mg/m^3. The MSHA standard [30 CFR 70.100] is enforced in conjunction with an X-ray surveillance program and worker removal provisions, 39 CFR 90 et seq., which are more protective than the proposed OSHA standard.

The concentration of respirable quartz in coal dust is highly variable and should be monitored in all coal dust exposures. Respirable quartz is a significant etiologic agent in coal workers pneumoconiosis, and exposure to respirable quartz can result in silicosis of the lung. The International Association for Research on Cancer has found there is limited human data and sufficient animal data indicating that respirable quartz is carcinogenic [IARC 1987].

NIOSH recommends an REL of 0.050 mg/m^3 for respirable quartz [NIOSH 1974]. The NIOSH position on the respirable quartz REL is discussed in detail in the criteria document attached to HS 1355, silica.

In summary, NIOSH recommends that the coal dust exposures be monitored for both respirable quartz and coal dust. NIOSH recommends that respirable silica be limited to 0.050 mg/m^3 and the OSHA consider the IARC data on the carcinogenicity of respirable crystalline silica in determining the appropriate carcinogen designation for quartz-bearing coal dust. NIOSH further suggests that a significant level of risk may remain at the proposed permissible exposure level for coal dust.

REFERENCES:
ACGIH [1986]. Silica, crystalline - quartz. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 523-524.

Hurley JF, Maclaren WM [1987]. Dust-related risks of radiological changes in coal miners over a 40-year working life: Report on work commissioned by NIOSH. Edinburgh, Scotland: Institute of Occupational Medicine, Report #TM/87/09.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs, Volumes 1 to 42. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Coal dust (> 5% quartz)

CAS: None
CODE: H.S. 1097

REFERENCES: (Continued)

Karagianes MT, Palmer RF, Busch RH [1981]. Effects of inhaled diesel emmissions and coal dust in rats. Am Indus Hyg Assoc J 42:382-391.

NIOSH [1974]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health. DHEW (NIOSH) Publication 75-120.

NIOSH [1986]. Occupational respiratory diseases. Morgantown, WV: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Respiratory Disease Studies, Appalachian Laboratory for Occupational Safety and Health. DHHS (NIOSH) Publication No. 86-102.

NAME: Disulfoton

CAS: 298-04-4
CODE: H.S. 1152

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 165 (1972) **VOLUME:** 5.0 x 10^6 (1972) POUNDS

TOXICITY:
Human POS (respiratory) **Animal** Muscarinic symptoms of organophosphorus

MUTAGENICITY:
Human POS (in human fibroblasts) **Other** POS (Salmonella/E. coli)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The acute oral LD_{50} for male rats was 6.8 mg/kg, and the acute dermal LD_{50} was 15 mg/kg. The acute oral LD_{50} for female rats was 2.3 mg/kg, while the acute dermal LD_{50} was 6.0 mg/kg [Gaines 1969; see Table 9, page 529]. Brodeur and DuBois [1963] administered disulfoton intraperitoneally: the LD_{50} for weanling rats was 5.4 mg/kg, and for adults the LD_{50} was 9.4 mg/kg. These results demonstrate that disulfoton is almost as toxic via the skin as when administered internally. The 1986 TLV [ACGIH 1986] includes a "skin" notation for disulfoton, and the proposed OSHA PEL should be revised to include a "skin" notation.

NAME: Disulfoton

CAS: 298-04-4
CODE: H.S. 1152

COMMENTS (continued):
Some mistakes were found in the documentation of the TLV and the proposed PEL, and they are noted here for clarity's sake. In the Gaines [1969] article (Table 5, page 525), the acute dermal LD_{50} for male rats is recorded as 25 mg/kg. However, the confidence limits (13-17 mg/kg) suggest that the 25 mg/kg number is not accurate. Also the same information is recorded in Table 9 (page 529), which gives 15 mg/kg as the acute dermal LD_{50} for male rats. The mistake in Table 5 was repeated both in the ACGIH documentation and the proposed OSHA documentation. The correct value for the acute dermal LD_{50} (15 mg/kg) is more supportive of the need for a "skin" notation.

Additionally, in the OSHA documentation (p. 21152) the following statement is found: "The acute oral LD_{50}s for male and female rats are reported as 6.8 mg/kg and 2.3 mg/kg, respectively" [Brodeur and DuBois 1964]. These values (6.8 mg/kg and 2.3 mg/kg) were actually reported by Gaines [1969].

In summary, the errors in documentation should be corrected and the proposed PEL should be revised to include a "skin" notation.

REFERENCES:
ACGIH [1986]. Disulfoton. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 226.

Brodeur J, DuBois KP [1963]. Comparison of acute toxicity of anticholinesterase insecticides to weanling and adult male rats. Proc Soc Exptl Biol Med 114:509.

Gaines TB [1969]. Acute toxicity of pesticides. Toxicology and Applied Pharmacology 14:515-534.

NAME: Ethyl Bromide **CAS:** 74-96-4
CODE: H.S. 1163

PEL CURRENT:
200 ppm 890 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
200 ppm 890 mg/m^3 (TWA) 250 ppm 1110 mg/m^3 (STEL)

TLV:
200 ppm 890 mg/m^3 (TWA) 250 ppm 1110 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 196 (1974) **VOLUME:** 5,500,000 (1977) POUNDS

TOXICITY:
Human Respiratory irritation **Animal** Respiratory irritation; liver, kidney toxicity

MUTAGENICITY:
Human -- **Other** POS (Salmonella)
NEG (Salmonella) (NTP)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** Research done--data/results not available yet
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The ACGIH TLV committee [1986] stated that, "A review of the adequacy of the 200 ppm time-weighted TLV and the 250 ppm STEL would seem to be in order, although the use of ethyl bromide may not be, at present, very great." Clayton and Clayton [1982] state (regarding the TLV) that there are "...very few data to support this or any other value." This appears to be true. However, in rats exposed 4 hours daily for 6 months to 540 ppm, there was some evidence of liver injury and disrupted liver function [Karimullna and Gizatullina 1969]. While one cannot extrapolate exposures with any confidence, questions can be raised regarding the adequacy of the proposed standard (200 ppm for 8 hours with a 250 ppm STEL), given that 540 ppm x 4 hours daily is

NAME: Ethyl Bromide

CAS: 74-96-4
CODE: H.S. 1163

COMMENTS (continued):
hazardous. In summary, while there is inadequate data on ethyl bromide, there is reason to question whether the current TLV will adequately protect the workers.

Regarding potential carcinogenicity, the 1984 NTP inhalation study with rats and mice at 100, 200, or 400 ppm is scheduled for peer review no earlier than October 1988.

REFERENCES:
ACGIH [1986]. Ethyl Bromide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 245.

Clayton G, Clayton F (eds.) [1982]. Patty's Industrial Hygiene and Toxicology (3rd rev. ed.). Vol. 2B. New York, NY: John Wiley & Sons, pp. 3483-3486.

Karimullina NK, Gizatullina AA [1969]. Effect of ethyl bromide on the liver. Farmakol Toksikol 32(2):165-167.

NAME: Ethyl Ether

CAS: 60-29-7
CODE: H.S. 1164

PEL CURRENT:
400 ppm 1200 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
400 ppm 1200 mg/m^3 (TWA) 500 ppm 1500 mg/m^3 (STEL)

TLV:
400 ppm 1200 mg/m^3 (TWA) 500 ppm 1500 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,670,000 (1972) **VOLUME:** 47,100,000 (1977) POUNDS

TOXICITY:
Human Irritant (skin, eye); narcosis; anesthesia **Animal** Irritant (skin, eye, respiratory)

MUTAGENICITY:
Human -- **Other** POS (3 tests)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
ACGIH set a TLV of 400 ppm TWA and a 500 ppm STEL based upon workers developing a tolerance to irritation at that level [ACGIH 1986]. Nelson et al. [1943] tested human subjects for a period of 3 to 5 minutes for sensory responses to ethyl ether and reported, "Complaints of nasal irritation began at 200 ppm. Three hundred was objectionable as a working atmosphere." It was further suggested that 100 ppm was the highest concentration which the majority of subjects estimated satisfactory for 8-hour exposure and 200 ppm was a level which produced nasal irritation in a majority of subjects. The author stated that the study reported is "not sufficient" to act as a basis for new limits. However, it would appear that a 400 ppm TWA would protect workers from systemic effects, but may not prevent irritation to some individuals.

NAME: Ethyl Ether

CAS: 60-29-7
CODE: H.S. 1164

REFERENCES:

ACGIH [1986]. Ethyl Ether. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 259.

Nelson KW, Ege JF (Jr), Ross M, Woodman LE, Silverman L [1943]. Sensory response to certain industrial solvent vapors. J Ind Hyg Tox 25:282.

NAME: Ethylene Glycol (EG) **CAS:** 107-21-1
CODE: H.S. 1169

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) 50 ppm 125 mg/m^3 (ceiling)

TLV:
-- ppm -- mg/m^3 (TWA) 50 ppm 125 mg/m^3 (ceiling)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,810,000 (1982) **VOLUME:** 4.52 billion (1987) POUNDS

TOXICITY:
Human Upper respiratory irritant **Animal** Moderate to severe eye irritation

MUTAGENICITY:
Human -- **Other** NEG (salmonella), NEG (mouse lymphoma), NEG (cytogenicity)(NTP)

TERATOGENICITY:
Human -- **Animal** POS (rat and mouse)

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Ethylene Glycol Vapors (EG)

OSHA currently does not have a PEL and proposes a 50 ppm ceiling as the new PEL as recommended by the ACGIH. In the NIOSH review of EG we have found positive rat and mouse teratogenicity for oral administration of EG reported by Lamb et al. [1985], Price et al. [1985], and Hardin et al. [1987]. The summary statement by C. Price is germane to OSHA's consideration of PELs:

> "The lack of apparently serious maternal effects at the lowest dose which produced malformation in both species, as well as the severity and frequency of

NAME: Ethylene Glycol (EG) **CAS:** 107-21-1
CODE: H.S. 1169

COMMENTS (continued):

fetal defects at higher doses, suggest that EG may carry a selective risk to the embryo and should be considered a potential development hazard in situations where major EG exposure is likely to occur."

The interpretation of the human (volunteers) inhalation exposure study by Wills et al. [1974], as indicating a 50 ppm ceiling (125 mg/m^3) TLV is questioned. Review of the reported study indicates the most common complaint was irritation of the upper respiratory tract during the 30 days, 20-22 hours per day exposures at mean daily concentrations ranging from 3 to 67 mg/m^3 (1.4-27 ppm) and the irritative phenomena became common when the concentration was raised to about 140 mg/m^3 (56 ppm). Despite the significantly erratic exposure concentrations during the 30 days of "continuous" exposure, the reported irritation would indicate that a 50 ppm limit does not offer sufficient protection from respiratory irritation. Because of the potential teratogenicity and the known respiratory irritation at the proposed level, NIOSH suggests that OSHA reconsider the proposed PEL.

In addition, the OSHA Summary of Toxicology should be corrected to read for the Wills et al. study [page 21035 of the Federal Register notice, 2nd column, 19 lines from the top]: "In a human inhalation study, Wills and colleagues [1974] reported that volunteers exposed to the aerosol from 20 to 22 hours per day for 4 weeks, at mean daily concentrations between 3 and 67 mg/m^3 (1.4-27 ppm) complained of throat irritation, and on occasion mild headache and lower back pain."

REFERENCES:

Hardin BD, Schuler RL, Burg JR, Booth GM, Hazelden KP, MacKenzie KM, Piccirillo VJ, Smith KN [1987]. Evaluation of 60 chemicals in a preliminary developmental toxicity test. Teratogenesis Carcinog Mutagen 7:29-48.

Lamb JC IV, Maronpot RR, Gulati DK, Russel VS, Hommel-Barnes L, Sabharwal PS [1985]. Reproductive and deveopmental toxicity of ethylene glycol in the mouse. Toxicol Appl Pharmacol 81:100-112.

Price CJ, Kimmel CA, Tyl RW, Marr MC [1985]. The developmental toxicity of ethylene glycol in rats and mice. Toxicol Appl Pharmacol 81:113-127.

Wills JH, Coulston F, Harris ES, McChesney EW, Russell JC, Serrone DM [1974]. Inhalation of aerosolized ethylene glycol by man. Clin Tox 7(5):463-476.

NAME: Fenthion

CAS: 55-38-9
CODE: H.S. 1175

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 2,030 (1982) **VOLUME:** 1,000,000 (1974) POUNDS

TOXICITY:
Human Cholinesterase inhibitor; CNS Animal Cholinesterase inhibitor; cancer

MUTAGENICITY:
Human -- Animal POS (sister-chromatid exchange in hamster cells [lungs])
NEG (AMES test)

TERATOGENICITY:
Human -- Animal POS (embryotoxicity; fetal anomality)

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal NEG (rats & female mice)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA has no current PEL for fenthion. The proposed PEL of 0.2 mg/m^3 with a SKIN notation is the adopted ACGIH TLV [ACGIH 1986].

NCI [1979], based on its Carcinogenesis Technical Report No. 103, concluded that under the conditions of its bioassay, fenthion was not carcinogenic for male or female rats or for female mice. The significantly increased incidence of sarcomas, fibrosarcomas, and especially rhabdomyosarcomas of the integumentary system in male mice suggested that the test chemical was carcinogenic in these animals.

NAME: Fenthion

CAS: 55-38-9
CODE: H.S. 1175

COMMENTS: (Continued)
In the Federal Register (p. 21176), OSHA indicated that no mutagenic, carcinogenic, or reproductive effects have been reported for fenthion. However, positive mutagenicities have been reported [Chen et al. 1985] and embryotoxicity and fetal abnormalities have been reported [Budreau et al. 1973]. The NCI data should be considered in this standard-setting process.

NIOSH does not have an LOQ for fenthion because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Fenthion. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 267-268.

Budreau CH, Singh RP [1973]. Teratogenicity and embryotoxicity of demeton and fenthion in CF #1 mouse embryos. Toxicol Appl Pharmacol 24:324-332.

Chen HH, Sirianni SR, Huang CC [1985]. Sister chromatid exchanges in Chinese hamster cells treated with seventeen organophosphorus compounds in the presence of a metabolic activation system. Environ Mutag 4:621-624.

NCI [1979]. Bioassay of Fenthion for Possible Carcinogenicity. No. 103, Washington, DC: U.S. Department of Health, Education and Welfare, Public Health Service, National Institutes of Health.

NAME: Fluorine

CAS: 7782-41-4
CODE: H.S. 1179

PEL CURRENT:
0.1 ppm 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
1 ppm 2 mg/m^3 (TWA) 2 ppm 4 mg/m^3 (STEL)

TLV:
1 ppm 2 mg/m^3 (TWA) 2 ppm 4 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 8,340 (1982) **VOLUME:** 11,700,000 (1977) POUNDS

TOXICITY:
Human: Severe eye, mucous membrane, skin irritant; pulmonary edema
Animal: Eye, skin, mucous membrane irritant; pulmonary edema; kidney pathology

MUTAGENICITY:
Human: --
Other: --

TERATOGENICITY:
Human: --
Animal: --

CARCINOGENICITY:
IARC : Human: -- Animal: --
NTP : Human: -- Animal: --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The ACGIH documentation in support of 1 ppm level consists of: Part 1, a critique of the original animal data; Part 2, an evaluation of the Lyon study [1962]; and Part 3, comments on the Ricca study [1970].

Part 1

The original animal studies conducted by Stokinger et al. [ACGIH 1986] and Ericksen [ACGIH 1986] studied the long-term chronic of exposure to elemental fluorine gas. The documentation compares these to later studies [Keplinger et al. 1968] concluding that the later animal data suggests a higher tolerance.

NAME: Fluorine

CAS: 7782-41-4
CODE: H.S. 1179

COMMENTS (continued):
In the Ricca study [1970], cited by the ACGIH, Ricca compares the Keplinger data to the data of Stokinger and that of Ericksen and finds them to be in agreement. In considering these studies, it is very important to note that both Keplinger and Ricca state that their experiments are focused on short-term exposures in order to evaluate the effects of fluorine for single short-term exposures.

Part 2

The Lyon study [1962] is reported by the ACGIH as "a seven year study of 61 fluorine exposed workers" showing "a lack of significant medical findings in workers exposed to fluorine for seven years to indicated atmospheric exposures far in excess of 0.1 ppm" [ACGIH 1986]. It is also stated that the study consisted of 2,535 urine fluorine determinations revealing an average daily urine concentration of 1.1 mg/liter.

The Lyon study is reported in the Journal of Occupational Medicine [JOM 1962]. It is not a study conducted on 61 workers constantly exposed to high levels of fluorine but is, instead, a compilation of data on workers who may have had some short-term exposure to fluorine.

Lyon describes his cohort as consisting of 57 chemical workers and 4 supervisors. He further says "exact doses to individuals cannot be established but the group includes: (1) individuals who normally spent 50-60% of their daily work time for periods of 7-9 months in the area, and (2) individuals who spent as little as 10% of their daily time in the area but who did this almost continuously..."

A cursory analysis of this cohort would indicate that workers who spent 7 to 9 months in an area in 7 years (84 months) spent only 10% of their daily work time there in the study period.

The report also indicates that reliable techniques for differentiating between fluorine and HF were not available, so odor was relied on to characterize a sample as fluorine.

The data available to determine fluorine exposure consists of fluorine samples taken at the fluorine generator, and not related to exposure of any specific individuals in the cohort, and further not related to the actual fluorine concentration in the breathing zone or work area of any individual. Ricca [1970] in reporting on this study notes that the exposures reported were from 5 to 30 minutes in duration.

The medical data reported is ambiguous. The statement is made "In keeping with established plant practice of utilizing bio-assay techniques to assist in evaluation of those toxins excreted in the urine, 2,535 determinations of urinary fluorine were made." It is not clear if this is a total number of samples for the entire plant or samples for the 61 worker cohort over the seven years. The average value is reported for the 61 worker cohort for the entire seven-year period as 1.1 mg/liter. This average is not characterized as an average daily urine, as it was reported by the ACGIH. Since it appears that none of these workers spent more than 10% of their daily work time in the fluorine area over the entire sample period, this number is of little value.

NAME: Fluorine

CAS: 7782-41-4
CODE: H.S. 1179

COMMENTS (continued):
The health records of the entire cohort are compared to the entire population for the plant for the years 1956 through 1958. The size of the control group is indicated in a footnote to be 2139 workers, not 3000 workers as reported by ACGIH. Since 90% of the cohort may not have been working in the fluorine area in any given year, the value of this data is, at best, questionable.

It is also important to note that the medical data presented by Lyon is footnoted as being "illness and absence for non-occupational conditions only."

The American Industrial Hygiene Association noted the Lyon paper in updating their Hygiene Guide on fluorine in 1964 but did not raise their limit from 0.1 ppm.

Part 3

The Ricca study [1970] is again characterized by the author as a search for short-term toxicity limits for emergency situations. This study is incorrectly cited in the documentation. Ricca does not recommend a TLV (despite the incorrect notation appearing in the abstract of the article) but proposes two levels of emergency limits: an emergency limit of 25 ppm for 5 minute exposures, and an emergency tolerance limit of 15 ppm for 10 minutes. It must be noted that Ricca associates a risk of 20% with the exposure limit and a risk of 10% with the tolerance limit. Ricca also states that his limit is proposed as a disaster control guideline for single exposures to be repeated only with approval of a competent physician.

Conclusion

Although the present fluorine limit may represent a conservative position, there is no data existing to support raising the limit. The Lyon study is severely limited and a review of the actual paper indicates it has far less value than reported in the ACGIH documentation. All the animal data reported is, in fact, consistent with the original exposure data on which the 0.1 ppm level was based.

NIOSH recommends that the current PEL of 0.1 ppm be retained, based on the available toxicity and irritancy data.

REFERENCES:
ACGIH [1986]. Fluorine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 274.

Keplinger ML, Suissa LW [1968]. Toxicity of fluorine short-term inhalation. Am Ind Hyg Assoc J 20:10-18.

Lyon JS [1962]. Observations on personnel working with fluorine at a gaseous diffusion plant. J Occup Med 4:4:199-201.

NAME: Fluorine **CAS:** 7782-41-4
CODE: H.S. 1179

REFERENCES (continued):
Ricca PM [1970]. A survey of the acute toxicity of elemental fluorine. Am Ind Hyg Assoc J 30:22-29.

NAME: Formamide

CAS: 75-12-7
CODE: H.S. 1182

PEL CURRENT:

--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PEL PROPOSED:

20	ppm	30	mg/m^3 (TWA)	30	ppm	45	mg/m^3 (STEL)

TLV:

(skin) 10	ppm	15	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

REL:

--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PRODUCTION WORKERS: 6,512 (1972)

VOLUME: Probably >1000 (1975) POUNDS

TOXICITY:
Human Moderately irritating to skin and mucous membranes
Animal Skin/eye irritation; weight loss; gastritis; malnutrition; testicular toxin

MUTAGENICITY:
Human --
Other NEG (Salmonella); DL (on test) [NTP 1986]

TERATOGENICITY:
Human --
Animal POS (mouse) [Gleich 1974]

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA has no current PEL for formamide and the proposed PEL is 20 ppm, with a proposed 15-minute STEL of 30 ppm. In the documentation for the proposed PEL, OSHA states that "The ACGIH recommends a TLV-TWA of 20 ppm and a TLV-STEL of 30 ppm for this clear, viscous, odorless liquid." ACGIH [1986], however, recently lowered the TLV for formamide to 10 ppm (with a "skin" notation and no STEL), stating that the evidence "...indicated caution in departing too far from the TLV of dimethyl formamide and repeated dose studies indicate the chemicals to be quite similar."

NAME: Formamide **CAS:** 75-12-7
CODE: H.S. 1182

COMMENTS (continued):
ACGIH [1986] also stated that "A skin notation is recommended since the material can produce systemic effects following dermal exposure." A study by Gleich [1974] demonstrated that mice could absorb sufficient formamide through the skin to produce embryotoxicity and teratogenicity.

Kennedy [1986] recently reviewed the literature on formamide and its monomethyl and dimethyl derivatives. The following table is adapted from his review:

	Formamide LD_{50} (g/kg)	Dimethyl formamide LD_{50} (g/kg)
guinea pig (i.p.)	1.25	4
mouse (p.o.)	3.2	3.8-6.8
mouse (i.v.)	5.1	2.8-3.7
mouse (i.p.)	4.6-7.4	1.1-6.2
rat (p.o.)	6.0-6.1	2.2-3.0
rat (dermal)	>13.5	4-17
rat (i.v.)	5.6	3.0
rat (i.p.)	5.7-5.9	1.4-4.8

[Adapted from Kennedy 1986]

Examination of these values suggests that the acute toxicity (based on LD_{50}'s) of formamide is similar to that of dimethylformamide, which has a current and proposed PEL of 10 ppm, with a "skin" notation. Based on these comparisons, the PEL for formamide should not exceed 10 ppm with a "skin" notation, since there is inadequate evidence that formamide is less toxic than its dimethyl derivative.

REFERENCES:
ACGIH [1986]. Formamide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 278(86).

Gleich J [1974]. The influence of simple acid amides on fetal development of mice. Arch Exp Path Pharmak 282:Suppl R25.

Kennedy GL, Jr [1986]. Biological effects of acetamide, formamide, and their monomethyl and dimethyl derivatives. CRC Critical Reviews in Toxicology 17(2):129-182.

NAME: Furfural

CAS: 098-01-1
CODE: H.S. 1183

PEL CURRENT:
(skin) 5 ppm | 20 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 2 ppm | 8 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(skin) 2 ppm | 8 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 110,000 (1982) **VOLUME:** 132,000,000 (1977) POUNDS

TOXICITY:
Human Headache; Irritation (eye and respiratory) **Animal** Irritation (eye and respiratory); liver toxicity

MUTAGENICITY:
Human -- **Other** POS (Salmonella; cytogenetics; mouse lymphoma)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** NTP assay (gavage) currently in path review
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
NIOSH HHE 73-18-171 [NIOSH 1975] found that furfural concentrations ranging between approximately 5 and 16 ppm led to toxic effects of an irritant nature at a grinding wheel company. Korenman and Resnik [1930] showed that concentrations between 1.9 and 14 ppm led to headaches, itching throat, and red/weeping eyes. It would appear that reducing the PEL from 5 to 2 ppm is a necessary change. It is uncertain if a limit of 2 ppm will fully protect workers from the irritant effects of furfural. Also, OSHA should follow-up on the NTP assay with regard to a possible carcinogenic response in exposed animals.

NAME: Furfural

CAS: 098-01-1
CODE: H.S. 1183

REFERENCES:

Korenman IM, Resnik IB [1930]. Arch f Hyg 104:344.

NIOSH [1975]. Health hazard evaluation determination report no. 73-18-171: Pacific Grinding Wheel Co., Marysville, Washington. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NAME: n-Heptane

CAS: 142-82-5
CODE: H.S. 1194

PEL CURRENT:
500 ppm 2000 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
400 ppm 1600 mg/m^3 (TWA) 500 ppm 2000 mg/m^3 (STEL)

TLV:
400 ppm 1600 mg/m^3 (8-hr TWA) 500 ppm 2000 mg/m^3 (STEL)

REL:
85 ppm 350 mg/m^3 (10-hr TWA) 440 ppm 1800 mg/m^3 (ceiling - 15-min)

PRODUCTION WORKERS: 1,190,000 (1972) **VOLUME:** 373,000,000 (1977) POUNDS

TOXICITY:
Human Neuropathy Animal --

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
In a 1977 criteria document on alkanes (C_5-C_8) NIOSH proposed a REL of 350 mg/cu m as a TWA concentration for up to a 10-hr work shift [NIOSH 1977]. The alkanes included in the NIOSH recommendations are the straight and branched chain aliphatic isomers of pentane, hexane, heptane, and octane. This concentration is equivalent to approximately 120 ppm of pentane, 100 ppm of hexane, 85 ppm of heptane, or 75 ppm of octane. If a worker is exposed to a mixture of C_5-C_8 alkanes, total alkane exposure should not be greater than 350 mg/cu m. In addition, NIOSH recommended that employees should not be exposed to pentane, hexane, heptane, or octane at ceiling concentrations greater than 1,800 mg/cu m as determined over a 15 minute-sampling time. This concentration is equivalent to approximately 610 ppm pentane, 510 ppm hexane, 440 ppm heptane, or 385 ppm octane. These recommended exposure limits are based on the conclusion that acute

NAME: n-Heptane CAS: 142-82-5
CODE: H.S. 1194

COMMENTS (continued):
intoxication by these alkanes involves a transient central nervous system depression and that chronic intoxication may involve a more persistent and insidious effect, polyneuropathy. Polyneuropathy has been attributed to n-hexane, but exposure of humans to n-hexane alone has not been described. The NIOSH recommendation is based on the belief that polyneuropathy may be caused by other alkanes (or mixtures of alkanes) and their isomers.

As the basis for the REL, NIOSH relied heavily on 2 studies. In a report by Gaultier et al. [1973], 5 workers in a belt manufacturing shop developed polyneuropathy as a result of exposure to a solvent which contained 80% pentane, 14% heptane, and only 5% hexane. The authors concluded that pentane and heptane might also cause polyneuropathy.

Truhaut et al. [1973] exposed rats to technical grade hexane and to technical grade heptane. Exposure to these alkanes resulted in the development of similar types of neurologic damage. In most workplaces, workers will be exposed to a technical grade of alkanes and other solvents rather than to a single alkane isomer.

The ACGIH in its documentation of the TLVs for these alkanes [ACGIH 1986], claims that NIOSH ignored the work of DiVincenzo et al. [1976], who concluded that the neurotoxicities of n-hexane and methyl butyl ketone are due to the fact that both substances are metabolized to the same neurotoxic compounds. ACGIH goes on to say that "n-hexane is unique, among the alkanes, in its neurotoxicity." Yet in their documentation for pentane they state "in view of the one report by Gaultier et al. however, the possibility that chronic exposure to high concentrations may lead to polyneuropathy cannot be ruled out altogether."

NIOSH did consider the work of DiVincenzo et al. [1976] who did demonstrate that in guinea pigs, both n-hexane and MnBK are metabolized to similar neurotoxic compounds. None of the other alkanes were tested, however.

It has also been found that other organic solvents such as MEK have the ability to potentiate the neurotoxicity of n-hexane. According to Spencer et al. [1980], "MEK also appears to be able to induce neuropathy in humans exposed to subneurotoxic levels of n-hexane." Spencer goes on to state, ". . . it would appear prudent to minimize human exposure to mixed solvents containing any neurotoxic hexacarbon compounds."

OSHA proposes the adoption of the TLVs for these alkanes. It also proposes the adoption of a separate PEL for hexane isomers other than n-hexane. The severity of polyneuropathy warrants a cautious approach in setting workplace exposure limits. Because workers are normally exposed to a variety of alkane isomers and other solvents, it is not justified to set the exposure limit for hexane isomers at a higher concentration than for n-hexane. The RELs would afford more protection from the development of polyneuropathy.

NAME: n-Heptane

CAS: 142-82-5
CODE: H.S. 1194

COMMENTS (continued):
Should sufficient evidence be developed demonstrating that of these C_5-C_8 alkanes only n-hexane has the ability to produce polyneuropathy, then NIOSH will give strong consideration to a revision in its recommendations.

REFERENCES:
ACGIH [1986]. n-Heptane. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 297.

DiVincenzo GD, Kaplan CJ, Dedinas J [1976]. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, and methyl ethyl ketone in guinea pig serum and their clearance. Toxicol Appl Pharmacol 36:511-522.

Gaultier M, Rancurel G, Piva C, Efthymioc M-L [1973]. Polyneuritis and aliphatic hydrocarbons. Journal Europeen de Toxicologie 6:294-96.

NIOSH [1977]. A recommended standard for occupational exposure to....Alkanes (C_5-C_8). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-151.

Spencer PS, Schaumburg HH, Sabri MI, Veronesi B [1980]. The enlarging view of hexacarbon neurotoxicity. In: CRC Critical Reviews in Toxicology.

Truhaut R, Lagett P, Piat G, Phu-Lich N, Dutertre-Catella H, Huyen VN [1973]. Preliminary electrophysiologic results following experimental poisoning with technical hexane and heptane in white rats. Arch Mal Prof 34(7/8):417-426.

NAME: Hexane Isomers

CAS: None
CODE: H.S. 1201

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
500 ppm 1800 mg/m^3 (TWA) 1000 ppm 3600 mg/m^3 (STEL)

TLV:
500 ppm 1800 mg/m^3 (TWA) 1000 ppm 3600 mg/m^3 (STEL)

REL:
100 ppm 350 mg/m^3 (TWA) 510 ppm 1800 mg/m^3 (ceiling - 15-min)

PRODUCTION WORKERS: 2,000,000 (hexane) (1972-73) **VOLUME:** -- POUNDS

TOXICITY:
Human Neuropathy **Animal** --

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
In a 1977 criteria document on alkanes (C_5-C_8) NIOSH proposed a REL of 350 mg/cu m as a TWA concentration for up to a 10-hr work shift [NIOSH 1977]. The alkanes included in the NIOSH recommendations are the straight and branched chain aliphatic isomers of pentane, hexane, heptane, and octane. This concentration is equivalent to approximately 120 ppm of pentane, 100 ppm of hexane, 85 ppm of heptane, or 75 ppm of octane. If a worker is exposed to a mixture of C_5-C_8 alkanes, total alkane exposure should not be greater than 350 mg/cu m. In addition, NIOSH recommended that employees should not be exposed to pentane, hexane, heptane, or octane at ceiling concentrations greater than 1,800 mg/cu m as determined over a 15 minute-sampling time. This concentration is equivalent to approximately 610 ppm pentane, 510 ppm hexane, 440 ppm heptane, or 385 ppm

NAME: Hexane Isomers

CAS: None
CODE: H.S. 1201

COMMENTS (continued):
octane. These recommended exposure limits are based on the conclusion that acute intoxication by these alkanes involves a transient central nervous system depression and that chronic intoxication may involve a more persistent and insidious effect, polyneuropathy. Polyneuropathy has been attributed to n-hexane, but exposure of humans to n-hexane alone has not been described. The NIOSH recommendation is based on the belief that polyneuropathy may be caused by other alkanes (or mixtures of alkanes) and their isomers.

As the basis for the REL, NIOSH relied heavily on 2 studies. In a report by Gaultier et al. [1973], 5 workers in a belt manufacturing shop developed polyneuropathy as a result of exposure to a solvent which contained 80% pentane, 14% heptane, and only 5% hexane. The authors concluded that pentane and heptane might also cause polyneuropathy.

Truhaut et al. [1973] exposed rats to technical grade hexane and to technical grade heptane. Exposure to these alkanes resulted in the development of similar types of neurologic damage. In most workplaces, workers will be exposed to a technical grade of alkanes and other solvents rather than to a single alkane isomer.

The ACGIH in its documentation of the TLVs for these alkanes [ACGIH 1986], claims that NIOSH ignored the work of DiVincenzo et al. [1976], who concluded that the neurotoxicities of n-hexane and methyl butyl ketone are due to the fact that both substances are metabolized to the same neurotoxic compounds. ACGIH goes on to say that "n-hexane is unique, among the alkanes, in its neurotoxicity." Yet in their documentation for pentane they state "in view of the one report by Gaultier et al. however, the possibility that chronic exposure to high concentrations may lead to polyneuropathy cannot be ruled out altogether."

NIOSH did consider the work of DiVincenzo et al. [1976] who did demonstrate that in guinea pigs, both n-hexane and MnBK are metabolized to similar neurotoxic compounds. None of the other alkanes were tested, however.

It has also been found that other organic solvents such as MEK have the ability to potentiate the neurotoxicity of n-hexane. According to Spencer et al. [1980], "MEK also appears to be able to induce neuropathy in humans exposed to subneurotoxic levels of n-hexane." Spencer goes on to state, ". . . it would appear prudent to minimize human exposure to mixed solvents containing any neurotoxic hexacarbon compounds."

OSHA proposes the adoption of the TLVs for these alkanes. It also proposes the adoption of a separate PEL for hexane isomers other than n-hexane. The severity of polyneuropathy warrants a cautious approach in setting workplace exposure limits. Because workers are normally exposed to a variety of alkane isomers and other solvents, it is not justified to set the exposure limit for hexane isomers at a higher concentration than for n-hexane. The RELs would afford more protection from the development of polyneuropathy.

NAME: Hexane Isomers

CAS: None
CODE: H.S. 1201

COMMENTS (continued):
Should sufficient evidence be developed demonstrating that of these C_5-C_8 alkanes only n-hexane has the ability to produce polyneuropathy, then NIOSH will give strong consideration to a revision in its recommendations.

REFERENCES:
ACGIH [1986]. Hexane Isomers. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 307.

DiVincenzo GD, Kaplan CJ, Dedinas J [1976]. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, and methyl ethyl ketone in guinea pig serum and their clearance. Toxicol Appl Pharmacol 36:511-522.

Gaultier M, Rancurel G, Piva C, Efthymioc M-L [1973]. Polyneuritis and aliphatic hydrocarbons. Journal Europeen de Toxicologie 6:294-96.

NIOSH [1977]. A recommended standard for occupational exposure to....Alkanes (C_5-C_8). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-151.

Spencer PS, Schaumburg HH, Sabri MI, Veronesi B [1980]. The enlarging view of hexacarbon neurotoxicity. In: CRC Critical Reviews in Toxicology.

Truhaut R, Lagett P, Piat G, Phu-Lich N, Dutertre-Catella H, Huyen VN [1973]. Preliminary electrophysiologic results following experimental poisoning with technical hexane and heptane in white rats. Arch Mal Prof 34(7/8):417-426.

NIOSH - JULY 1988

NAME: 2-Hexanone (Methyl n-butyl ketone) **CAS:** 591-78-6
CODE: H.S. 1202

PEL CURRENT:
100 ppm 410 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
5 ppm 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
5 ppm 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
1 ppm 4 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 170,849 (1972) **VOLUME:** 1,056 (1975) POUNDS

TOXICITY:
Human Neuropathy **Animal** Neuropathy

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: 1978 (Criteria Document)

COMMENTS:
NIOSH, ACGIH, and OSHA all agree as to the ability of 2-hexanone (Mn-BK) to produce peripheral neuropathy in both animals and humans at exposure concentrations less than 100 ppm.

The NIOSH REL of 1.0 ppm (10-hr TWA) is based primarily on an epidemiologic study of an outbreak of neurologic disease among workers in a printed fabrics plant. This study reported that of 1,157 exposed workers, 86 developed verified cases of neuropathy. 2-Hexanone was suspected as the neurotoxic agent because it had only recently been introduced into the process.

NAME: 2-Hexanone (Methyl n-butyl ketone) **CAS:** 591-78-6
CODE: H.S. 1202

COMMENTS (continued):
An I.H. survey revealed that mean concentrations of 2-hexanone in the print department (where most cases occurred) were 6, 9, and 36 ppm depending upon location. Air concentrations ranged from 1 to 156 ppm with the mean and mode below 10 ppm. One work location had a concentration of 2-hexanone of 2.5 ppm.

The ACGIH [ACGIH 1986] states that poor work practices, such as eating in the work area and using solvent-soaked rags to clean equipment and hands, makes it difficult to assess the worker exposure resulting from the cutaneous and oral routes of entry. In the Criteria Document, NIOSH acknowledges that dermal contact may have contributed to the worker's exposure, but believes that inhalation was the primary mode of exposure [NIOSH 1977].

NIOSH believes that the 2.5 ppm concentration measured at one work station cannot be ruled out as contributing to the development of neuropathy. Because of the severity of the toxic effects of exposure to this compound and the indications that the nerve damage may not be completely reversible, a cautious approach is needed. Thus, a REL of 1.0 ppm as a TWA concentration is deemed appropriate.

Many organic solvents including MEK are typically used in printing operations. Saida et al., and others have shown that MEK and possibly other solvents can potentiate the neurotoxicity of 2-hexanone.

The REL provides a greater safety factor than the TLV based on potential irreversibility of nerve damage.

REFERENCES:
ACGIH [1986]. Methyl n-Butyl Ketone. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 378-379.

NIOSH [1978]. A recommended standard for occupational exposure to....Ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

NAME: 2-Isopropoxyethanol

CAS: 109-59-1
CODE: H.S. 1223

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
25 ppm 105 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
25 ppm 105 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,360 (1982) VOLUME: -- POUNDS

TOXICITY:
Human -- Animal Hemoglobinuria; anemia;

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
At high levels, isopropoxyethanol produces severe hematological effects in experimental animals [Carpenter et al. 1965; Gage 1970]. The TLV documentation [ACGIH 1986] reported "minimal" blood changes (osmotic fragility of red blood cells) occurring in animals exposed at 25 ppm (the proposed PEL). These effects must be accepted as valid in light of the good dose-response information provided by other studies showing similar toxicity. Therefore, OSHA's own expressed philosophy (see p. 20987 of the Federal Register notice) suggests that a more conservative value be established for isopropoxyethanol.

NAME: 2-Isopropoxyethanol **CAS:** 109-59-1
CODE: H.S. 1223

REFERENCES:

ACGIH [1986]. 2-Isopropoxyethanol. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 335.

Carpenter CP, Pozzani UC, Weil CS, Nail JH, Keck GA, Smyth HF [1956]. The toxicity of butyl cellosolve solvent. Arch Indus Health 14:114-131.

Gage JC [1970]. The subacute inhalation toxicity of 109 industrial chemicals. Brit J Ind Med 27:1-18.

NAME: Isopropyl Acetate

CAS: 108-21-4
CODE: H.S. 1224

PEL CURRENT:
250 ppm 950 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
250 ppm 950 mg/m^3 (TWA) 310 ppm 1185 mg/m^3 (STEL)

TLV:
250 ppm 950 mg/m^3 (TWA) 310 ppm 1185 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,185,600 (1972) **VOLUME:** 30,000,000 (1977) POUNDS

TOXICITY:
Human Eye irritant **Animal** Eye and skin irritant; narcosis

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The ACGIH established a TLV of 250 ppm, with a 310 ppm STEL based on the Silverman et al. [1946] report that eyes of human subjects were irritated by 200 ppm. Higher concentrations were required to affect the nose and throat. In reviewing the Silverman et al. [1946] paper, it was recommended "that at 200 ppm the majority of subjects experienced some degree of eye irritation; hence, 100 ppm was selected as a sensory limit for 8 hour exposures." The other reference in the TLV documentation on the toxicity by von Oettingen [1960], indicated that the Silverman paper indicated "They consider 100 ppm as maximum acceptable concentration for eight hours exposure." It would appear that a lower PEL would be in order for this chemical to protect exposed workers from the risk of eye and respiratory irritation.

NAME: Isopropyl Acetate

CAS: 108-21-4
CODE: H.S. 1224

REFERENCES:

ACGIH [1986]. Isopropyl Acetate. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 336.

Silverman L, Schulte HF, First MW [1946]. Further studies on sensory response to certain industrial solvent vapors. J Ind Hyg Tox 28:262-266.

von Oettingen WF [1960]. The aliphatic acids and their esters: Toxicity and potential dangers. AMA Arch Ind Health 21:28.

NAME: n-Isopropylamine **CAS:** 75-31-0
CODE: H.S. 1228

PEL CURRENT:
5 ppm 12 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
5 ppm 12 mg/m^3 (TWA) 10 ppm 24 mg/m^3 (STEL)

TLV:
5 ppm 12 mg/m^3 (TWA) 10 ppm 24 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 7,530 (1982) **VOLUME:** 480,000 (1984) POUNDS

TOXICITY:
Human Eye & respiratory irritant Animal Eye & respiratory irritant

MUTAGENICITY:
Human -- Animal NEG (Salmonella)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: --

COMMENTS:
Isopropylamine is an irritant of the eyes, mucous membrane, and skin. The current OSHA PEL and TLV is 5 ppm TWA [ACGIH 1986], based primarily on humans who had experienced irritation of nose and throat after brief exposure to 10 to 20 ppm [Fassett undated]. The current OSHA proposal will add a STEL of 10 ppm to the current TWA of 5 ppm. At 5 to 10 ppm, its ammonia-like odor is definite and, therefore, it has good warning properties [Patty 1963]. The Patty [1963] reference is based on unpublished observations by Fassett and Eastman Kodak Company. It would be useful to obtain the unpublished observations by Fassett and Eastman Kodak Company to review prior to a final PEL determination.

NAME: n-Isopropylamine **CAS:** 75-31-0
CODE: H.S. 1228

REFERENCES:

ACGIH [1986]. Isopropylamine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 338.

Fassett DW [undated]. Laboratory of industrial medicine. Rochester, NY: Eastman Kodak Co. Unpublished observations.

Patty FA [1963]. Industrial hygiene and toxicology. Volume II, Toxicology. Fassett DW, Irish DD (eds.). New York, NY: Interscience Publishers.

NAME: Manganese Tetroxide

CAS: 1317-35-7
CODE: H.S. 1238

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 34,400 (1972) **VOLUME:** Not available POUNDS

TOXICITY:
Human Neuropathic effects Animal --

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal TD_{LO} = 23 gm/kg in mice (oral route) reproductive effects; only one study

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The proposed PEL and the TLV appear to be based on the effects observed [Smyth et al. 1973] for 2/3 fume exposure victims (those who suffered from chronic manganism), that were exposed to an average concentration of 13.3 mg/m^3 for five years. The third victim worked where the air concentration was less than 1 mg/m^3 (suggesting hypersusceptibility of that individual to manganese poisoning). Other workers in similar positions to the 1 mg/m^3 exposed victim and those exposed to 1 to 3.6 mg/m^3 showed no signs or effects of manganism. Because of the small sample size, more comprehensive studies are needed. Based on OSHA's own philosophy (stated on p. 20987 in the Federal Register notice), and considering the positive finding at 1 mg/m^3, the proposed PEL of 1 mg/m^3 may not be protective, especially to the potentially sensitive individual.

NAME: Manganese Tetroxide **CAS:** 1317-35-7
CODE: H.S. 1238

COMMENTS: (Continued)
REFERENCES:
Smyth IT, Ruhf RC, Whitman NE, Dugan T [1973]. Clinical manganism and exposure to manganese in the production and processing of ferromanganese alloy. J Occup Med 15:101-109.

NAME: Mesityl Oxide

CAS: 141-79-7
CODE: H.S. 1243

PEL CURRENT:
25 ppm 100 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
15 ppm 60 mg/m^3 (TWA) 25 ppm 100 mg/m^3 (STEL)

TLV:
15 ppm 60 mg/m^3 (TWA) 25 ppm 100 mg/m^3 (STEL)

REL:
10 ppm 40 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 6,480 (1972) VOLUME: 46,000,000 (1975) POUNDS

TOXICITY:
Human Irritant (liver, kidney) Animal Irritant (liver, kidney); narcosis

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
In 1958, ACGIH [1971] established a TLV for mesityl oxide of 25 ppm TWA based upon liver and kidney damage in rats and guinea pigs exposed to 100 ppm [Smyth et al. 1942], and reported eye irritation at 25 ppm and nasal irritation at 50 ppm in humans [Silverman et al. 1946].

NIOSH reviewed the works of Smyth and Silverman, plus the report of Specht et al. [1940] which stated that the eye irritation caused by mesityl oxide may be more serious than that caused by lower ketones. NIOSH established a 10 ppm TWA for mesityl oxide based on this information in the Ketones Criteria Document [NIOSH 1978].

NAME: Mesityl Oxide

CAS: 141-79-7
CODE: H.S. 1243

COMMENTS (continued):
In 1981, ACGIH [1986] revised the TLV based on a review of the NIOSH Criteria Document in which it indicated that, "The Committee concurs with the viewpoint (NIOSH) that the TLV for mesityl oxide reflect its greater systemic toxicity in comparison with that of the majority of saturated ketones as well as its irritant effects." The TLV was reduced to 15 ppm, TWA with a STEL of 25 ppm.

The OSHA presentation of this data appears to credit the ACGIH review of the data for establishing 15 ppm TWA, and a 25 ppm STEL although NIOSH reviewed the same data and recommended a 10 ppm TWA. The rationale that OSHA offers for choosing the TLV with a STEL as being more protective than the lower REL is not justified. It would seem most prudent to adopt the more protective NIOSH REL with the ACGIH TLV STEL of 25 ppm.

REFERENCES:
ACGIH [1971]. Mesityl oxide. In: Documentation of the threshold limit values for substances in workroom air. 3rd edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 152.

ACGIH [1986]. Mesityl oxide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 361.

NIOSH [1978]. A recommended standard for occupational exposure to....Ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

Silverman L, Schulte HF, First MW [1946]. Further studies on sensory response to certain industrial solvent vapors. J Indus Hyg Tox 28(6):262-266.

Smyth HF, Seaton J, Fischer L [1942]. Response of guinea pigs and rats to repeated inhalation of vapors of mesityl oxide and isophorone. J Indus Hyg Tox 24(3):46-50.

Specht H, Miller JW, Valaer PJ, Sayers RR [1940]. Acute response of guinea pigs to the inhalation of ketone vapors. Washington, DC: U.S. Public Health Service, National Institute of Health, Bulletin No. 176.

NAME: Octane **CAS:** 111-65-9
CODE: H.S. 1296

PEL CURRENT:
500 ppm 2350 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
300 ppm 1450 mg/m^3 (TWA) 375 ppm 1800 mg/m^3 (STEL)

TLV:
300 ppm 1450 mg/m^3 (TWA) 375 ppm 1800 mg/m^3 (STEL)

REL:
75 ppm 350 mg/m^3 (TWA) 385 ppm 1800 mg/m^3 (ceiling - 15 min)

PRODUCTION WORKERS: 1,040,000 (1972) **VOLUME:** 11,000,000 (1977) POUNDS

TOXICITY:
Human Neuropathy **Animal** --

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
In a 1977 criteria document on alkanes (C_5-C_8) NIOSH proposed a REL of 350 mg/cu m as a TWA concentration for up to a 10-hr work shift [NIOSH 1977]. The alkanes included in the NIOSH recommendations are the straight and branched chain aliphatic isomers of pentane, hexane, heptane, and octane. This concentration is equivalent to approximately 120 ppm of pentane, 100 ppm of hexane, 85 ppm of heptane, or 75 ppm of octane. If a worker is exposed to a mixture of C_5-C_8 alkanes, total alkane exposure should not be greater than 350 mg/cu m. In addition, NIOSH recommended that employees should not be exposed to pentane, hexane, heptane, or octane at ceiling concentrations greater than 1,800 mg/cu m as determined over a 15 minute-sampling time. This concentration is equivalent to approximately 610 ppm pentane, 510 ppm hexane, 440 ppm heptane, or 375 ppm

NAME: Octane

CAS: 111-65-9
CODE: H.S. 1296

COMMENTS (continued):
octane. These recommended exposure limits are based on the conclusion that acute intoxication by these alkanes involves a transient central nervous system depression and that chronic intoxication may involve a more persistent and insidious effect, polyneuropathy. Polyneuropathy has been attributed to n-hexane, but exposure of humans to n-hexane alone has not been described. The NIOSH recommendation is based on the belief that polyneuropathy may be caused by other alkanes (or mixtures of alkanes) and their isomers.

As the basis for the REL, NIOSH relied heavily on 2 studies. In a report by Gaultier et al. [1973], 5 workers in a belt manufacturing shop developed polyneuropathy as a result of exposure to a solvent which contained 80% pentane, 14% heptane, and only 5% hexane. The authors concluded that pentane and heptane might also cause polyneuropathy.

Truhaut et al. [1973] exposed rats to technical grade hexane and to technical grade heptane. Exposure to these alkanes resulted in the development of similar types of neurologic damage. In most workplaces, workers will be exposed to a technical grade of alkanes and other solvents rather than to a single alkane isomer.

The ACGIH in its documentation of the TLVs for these alkanes [ACGIH 1986], claims that NIOSH ignored the work of DiVincenzo et al. [1976], who concluded that the neurotoxicities of n-hexane and methyl butyl ketone are due to the fact that both substances are metabolized to the same neurotoxic compounds. ACGIH goes on to say that "n-hexane is unique, among the alkanes, in its neurotoxicity." Yet in their documentation for pentane they state "in view of the one report by Gaultier et al. however, the possibility that chronic exposure to high concentrations may lead to polyneuropathy cannot be ruled out altogether."

NIOSH did consider the work of DiVincenzo et al. [1976] who did demonstrate that in guinea pigs, both n-hexane and MnBK are metabolized to similar neurotoxic compounds. None of the other alkanes were tested, however.

It has also been found that other organic solvents such as MEK have the ability to potentiate the neurotoxicity of n-hexane. According to Spencer et al. [1980], "MEK also appears to be able to induce neuropathy in humans exposed to subneurotoxic levels of n-hexane." Spencer goes on to state, ". . . it would appear prudent to minimize human exposure to mixed solvents containing any neurotoxic hexacarbon compounds."

OSHA proposes the adoption of the TLVs for these alkanes. It also proposes the adoption of a separate PEL for hexane isomers other than n-hexane. The severity of polyneuropathy warrants a cautious approach in setting workplace exposure limits. Because workers are normally exposed to a variety of alkane isomers and other solvents, it is not justified to set the exposure limit for hexane isomers at a higher concentration than for n-hexane. Adoption of the RELs would afford more protection from the development of polyneuropathy.

NAME: Octane

CAS: 111-65-9
CODE: H.S. 1306

COMMENTS (continued):
Should sufficient evidence be developed demonstrating that of these C_5-C_8 alkanes only n-hexane has the ability to produce polyneuropathy, then NIOSH will give strong consideration to a revision in its recommendations.

REFERENCES:
ACGIH [1986]. Octane. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 448.

DiVincenzo GD, Kaplan CJ, Dedinas J [1976]. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, and methyl ethyl ketone in guinea pig serum and their clearance. Toxicol Appl Pharmacol 36:511-522.

Gaultier M, Rancurel G, Piva C, Efthymioc M-L [1973]. Polyneuritis and aliphatic hydrocarbons. Journal Europeen de Toxicologie 6:294-96.

NIOSH [1977]. A recommended standard for occupational exposure to....Alkanes (C_5-C_8). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-151.

Spencer PS, Schaumburg HH, Sabri MI, Veronesi B [1980]. The enlarging view of hexacarbon neurotoxicity. In: CRC Critical Reviews in Toxicology.

Truhaut R, Lagett P, Piat G, Phu-Lich N, Dutertre-Catella H, Huyen VN [1973]. Preliminary electrophysiologic results following experimental poisoning with technical hexane and heptane in white rats. Arch Mal Prof 34(7/8):417-426.

NAME: Ozone

CAS: 10028-15-6
CODE: H.S. 1301

PEL CURRENT:
0.1 ppm 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
0.1 ppm 0.2 mg/m^3 (TWA) 0.3 ppm 0.6 mg/m^3 (STEL)

TLV:
0.1 ppm 0.2 mg/m^3 (TWA) 0.3 ppm 0.6 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 72,137 (1982) **VOLUME:** 151,105,500 (1977) POUNDS

TOXICITY:
Human Irritant (respiratory & eye); pulmonary edema; headache
Animal Respiratory irritant; lung fibrosis (thickening of alveolar septa); pulmonary edema; increases susceptibility to respiratory infections

MUTAGENICITY:
Human --
Other On test (Salmonella [NTP]); POS (cytogenetics)

TERATOGENICITY:
Human --
Animal Neonatal mortality (mice)

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Ozone is a chemical capable of inducing serious adverse health effects at low exposure concentrations, tenths of a part per million (ppm), with the susceptibility of exposed humans appearing to be at least equal to that of the most susceptible animal species [Griswold et al. 1957; Brinkman et al. 1958; Jaffe 1967; Stokinger 1957]. In view of these reported toxicological data and in recognition of ozone as a radiomimetic agent

NAME: Ozone

CAS: 10028-15-6
CODE: H.S. 1301

COMMENTS (continued):
capable of inducing premature aging changes (including thickening of alveolar septa) and an increased susceptibility or exacerbation of respiratory disease of bacterial or viral origin [Stokinger et al. 1957; Stokinger 1965] following exposures approximating 0.2 to 1 ppm, it is recommended that the proposed PEL be revised downward from the intended 0.1 ppm TWA and 0.3 ppm STEL. The ACGIH TLV [ACGIH 1986] has been placed on the 1987-88 Notice of Intended Changes [ACGIH 1987] for a 0.1 ppm ceiling value (C 0.1 ppm). NIOSH agrees with this approach.

REFERENCES:
ACGIH [1986]. Ozone. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 453.

ACGIH [1987]. Threshold limit values and biological exposure indices for 1987-1988. Notice of intended changes for 1987-88. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 41.

Brinkman R, Lamberts HB [1958]. Ozone as a possible radiomimetic gas. Nature 181:1202-1203.

Griswold SS, Chambers LA, Motley HL [1957]. Report of a case of exposure to high ozone concentrations for two hours. Arch Ind Hlth 15:108-110.

Jaffe L [1967]. The biological effects of ozone on man and animals. Am Ind Hyg Assoc J 28:267-277.

Stokinger HE [1957]. Evaluation of the hazards of ozone and oxides of nitrogen. Arch Ind Hlth 15:181-190.

Stokinger HE [1965]. Ozone toxicology. Arch Env Hlth 10:719-731.

Stokinger HE, Wagner WD, Dobrogorski OJ [1957]. Ozone toxicity studies. III. Chronic injury to lungs of animals following exposure at a low level. Arch Ind Hlth 16:514-520.

NAME: Pentane **CAS:** 109-66-0
CODE: H.S. 1306

PEL CURRENT:
1000 ppm 2950 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
600 ppm 1800 mg/m^3 (TWA) 750 ppm 2250 mg/m^3 (STEL)

TLV:
600 ppm 1800 mg/m^3 (TWA) 750 ppm 2250 mg/m^3 (STEL)

REL:
120 ppm 350 mg/m^3 (TWA) 610 ppm 1800 mg/m^3 (ceiling - 15-min)

PRODUCTION WORKERS: 44,000 (1972-73) **VOLUME:** 6,000,000 (1977) POUNDS

TOXICITY:
Human: Neuropathy; narcosis; respiratory tract irritant Animal: --

MUTAGENICITY:
Human: -- Other: --

TERATOGENICITY:
Human: -- Animal: --

CARCINOGENICITY:
IARC : Human: -- Animal: --
NTP : Human: -- Animal: --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
In a 1977 criteria document on alkanes (C_5-C_8) NIOSH proposed a REL of 350 mg/cu m as a TWA concentration for up to a 10-hr work shift [NIOSH 1977]. The alkanes included in the NIOSH recommendations are the straight and branched chain aliphatic isomers of pentane, hexane, heptane, and octane. This concentration is equivalent to approximately 120 ppm of pentane, 100 ppm of hexane, 85 ppm of heptane, or 75 ppm of octane. If a worker is exposed to a mixture of C_5-C_8 alkanes, total alkane exposure should not be greater than 350 mg/cu m. In addition, NIOSH recommended that employees should not be exposed to pentane, hexane, heptane, or octane at ceiling concentrations greater than 1,800 mg/cu m as determined over a 15 minute-sampling time. This concentration is equivalent to approximately 610 ppm pentane, 510 ppm hexane, 440 ppm heptane, or 385 ppm

NAME: Pentane

CAS: 109-66-0
CODE: H.S. 1306

COMMENTS (continued):
octane. These recommended exposure limits are based on the conclusion that acute intoxication by these alkanes involves a transient central nervous system depression and that chronic intoxication may involve a more persistent and insidious effect, polyneuropathy. Polyneuropathy has been attributed to n-hexane, but exposure of humans to n-hexane alone has not been described. The NIOSH recommendation is based on the belief that polyneuropathy may be caused by other alkanes (or mixtures of alkanes) and their isomers.

As the basis for the REL, NIOSH relied heavily on 2 studies. In a report by Gaultier et al. [1973], 5 workers in a belt manufacturing shop developed polyneuropathy as a result of exposure to a solvent which contained 80% pentane, 14% heptane, and only 5% hexane. The authors concluded that pentane and heptane might also cause polyneuropathy.

Truhaut et al. [1973] exposed rats to technical grade hexane and to technical grade heptane. Exposure to these alkanes resulted in the development of similar types of neurologic damage. In most workplaces, workers will be exposed to a technical grade of alkanes and other solvents rather than to a single alkane isomer.

The ACGIH in its documentation of the TLVs for these alkanes [ACGIH 1986], claims that NIOSH ignored the work of DiVincenzo et al. [1976], who concluded that the neurotoxicities of n-hexane and methyl butyl ketone are due to the fact that both substances are metabolized to the same neurotoxic compounds. ACGIH goes on to say that "n-hexane is unique, among the alkanes, in its neurotoxicity." Yet in their documentation for pentane they state "in view of the one report by Gaultier et al. however, the possibility that chronic exposure to high concentrations may lead to polyneuropathy cannot be ruled out altogether."

NIOSH did consider the work of DiVincenzo et al. [1976] who did demonstrate that in guinea pigs, both n-hexane and MnBK are metabolized to similar neurotoxic compounds. None of the other alkanes were tested, however.

It has also been found that other organic solvents such as MEK have the ability to potentiate the neurotoxicity of n-hexane. According to Spencer et al. [1980], "MEK also appears to be able to induce neuropathy in humans exposed to subneurotoxic levels of n-hexane." Spencer goes on to state, ". . . it would appear prudent to minimize human exposure to mixed solvents containing any neurotoxic hexacarbon compounds."

OSHA proposes the adoption of the TLVs for these alkanes. It also proposes the adoption of a separate PEL for hexane isomers other than n-hexane. The severity of polyneuropathy warrants a cautious approach in setting workplace exposure limits. Because workers are normally exposed to a variety of alkane isomers and other solvents, it is not justified to set the exposure limit for hexane isomers at a higher concentration than for n-hexane. Adoption of the RELs would afford more protection from the development of polyneuropathy.

NAME: Pentane

CAS: 109-66-0
CODE: H.S. 1306

COMMENTS (continued):
Should sufficient evidence be developed demonstrating that of these C_5-C_8 alkanes only n-hexane has the ability to produce polyneuropathy, then NIOSH will give strong consideration to a revision in its recommendations.

REFERENCES:
ACGIH [1986]. Pentane. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 463.

DiVincenzo GD, Kaplan CJ, Dedinas J [1976]. Characterization of the metabolites of methyl n-butyl ketone, methyl iso-butyl ketone, and methyl ethyl ketone in guinea pig serum and their clearance. Toxicol Appl Pharmacol 36:511-522.

Gaultier M, Rancurel G, Piva C, Efthymioc M-L [1973]. Polyneuritis and aliphatic hydrocarbons. Journal Europeen de Toxicologie 6:294-96.

NIOSH [1977]. A recommended standard for occupational exposure to....Alkanes (C_5-C_8). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-151.

Spencer PS, Schaumburg HH, Sabri MI, Veronesi B [1980]. The enlarging view of hexacarbon neurotoxicity. In: CRC Critical Reviews in Toxicology.

Truhaut R, Lagett P, Piat G, Phu-Lich N, Dutertre-Catella H, Huyen VN [1973]. Preliminary electrophysiologic results following experimental poisoning with technical hexane and heptane in white rats. Arch Mal Prof 34(7/8):417-426.

NAME: 2-Pentanone (Methyl Propyl Ketone) **CAS:** 107-87-9
CODE: H.S. 1307

PEL CURRENT:
200 ppm 700 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
200 ppm 700 mg/m^3 (TWA) 250 ppm 875 mg/m^3 (STEL)

TLV:
200 ppm 700 mg/m^3 (TWA) 250 ppm 875 mg/m^3 (STEL)

REL:
150 ppm 530 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1050 (1982) **VOLUME:** -- POUNDS

TOXICITY:
Human Eye, skin, respiratory irritant; narcosis **Animal** Nose and eye irritation; narcosis

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
The OSHA proposed PEL (and ACGIH TLV) and NIOSH REL are based on the same animal studies. OSHA considered the NIOSH REL but concluded "that the combination of a 200 ppm TWA and a 250 ppm STEL is more protective" than the NIOSH 150 ppm REL. The Criteria Document on Ketones [NIOSH 1978] stated, "It is believed that an extrapolation from the data of Specht et al. [1940] to the findings of Nelson et al. [1943] is appropriate. Nelson et al. [1943] reported that 100 ppm (350 mg/cu m) of methyl ethyl ketone produced slight irritation in volulnteers. Interpretation of the data of Specht et al. [1940], suggests that methyl n-propyl ketone is at least as irritating as methyl ethyl ketone. Thus, it is believed that a slight reduction in the current Federal standard of 700 mg/cu m (200 ppm) is warranted to protect employees from irritation to the eyes, nose, and throat. Therefore, an exposure limit for methyl n-propyl ketone of 150 ppm (530 mg/cu m) for up to a 10-hour TWA concentration in a 40-hour workweek is recommended."

NAME: 2-Pentanone (Methyl Propyl Ketone) **CAS:** 107-87-9
CODE: H.S. 1307

COMMENTS:
NIOSH recommends that OSHA adopt the NIOSH REL of 150 ppm as a TWA and further that they adopt the ACGIH STEL of 250 ppm.

REFERENCES:
NIOSH [1978]. Criteria for a recommended standard....occupational exposure to ketones. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-173.

Nelson KW, Ege Jr JF, Ross M, Woodman LE, Silverman L [1943]. Sensory response to certain industrial solvent vapors. J Ind Hyg and Toxicol 25:282-285.

Specht H, Miller JW, Walaer PJ, Sayers RR [1940]. Acute response of guinea pigs to the inhalation of ketone vapors. Washington, D.C.: Federal Security Agency, Public Health Service, National Institute of Health, NIH Bulletin No. 176.

NAME: Silica, Amorphous - Diatomaceous Earth

CAS: 6885-54-9
CODE: H.S. 1352

PEL CURRENT:
-- ppm | 20 mppcf (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
-- ppm | 6 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
-- ppm | 10* mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )
*(total dust < 1% quartz)

REL:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 780 (1974) **VOLUME:** 5.34 x 10^8 (1974) POUNDS

TOXICITY:
Human Fibrosis Animal Fibrosis

MUTAGENICITY:
Human -- Animal --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human NEG (inadequate evidence) Animal NEG (inadequate evidence)
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
In the IARC Monograph, vol. 42, the World Health Organization states, "There is inadequate evidence for the carcinogenicity of amorphous silica to experimental animals." "There is inadequate evidence for the carcinogenicity of amorphous silica to humans." [IARC 1987].

Biological effects are associated with accumulations of dust-laden pulmonary macrophages and alveolar epithelization without corrective tissue proliferation [Tebbens and Beard 1957].

NAME: Silica, Amorphous - Diatomaceous Earth

CAS: 6885-54-9
CODE: H.S. 1352

COMMENTS (continued):
The proposed PEL is given as a TWA mass concentration of 6 mg/m^3 rather than as a particle concentration (mppcf) of 20 mppcf.

The PEL should identify amorphous silica - diatomaceous earth (DE) of < 1.0% quartz (or crystalline silicas) since naturally-occurring DE usually contains some degree of quartz (up to approximately 3%) which may produce health effects other than those associated with the non-contaminated DE.

REFERENCES:
IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Tebbens BD, Beard RR [1957]. Experiments on diatomaceous earth pneumoconiosis. AMA Archives of Industrial Hygiene 16:55-63.

NIOSH - JULY 1988

NAME: m-Toluidine **CAS:** 108-44-1
CODE: H.S. 1401

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 2 ppm 9 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 2 ppm 9 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 2,900 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human -- Animal Methemoglobinemia

MUTAGENICITY:
Human -- Other NEG (in vitro)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The existing TLV and proposed OSHA PEL is 2 ppm for m-toluidine. It has been reported that air concentrations of 40 ppm can cause severe toxic effects in persons exposed for 60 minutes [Goldblatt 1955].

Animal experiments designed to determine the carcinogenic potential of m-toluidine were inconclusive [Weisburger et al. 1978]. There were insufficient experimental details reported to allow an evaluation of the significance of the results. However, in that report, both o-toluidine and p-toluidine were found to be carcinogenic. Meta-toluidine is an isomer of orth- and para-toluidine. They are all aromatic amines. OSHA should consider this information in its final rulemaking.

NAME: m-Toluidine

CAS: 108-44-1
CODE: H.S. 1401

COMMENTS (continued):
The NIOSH LOQ (Method No. 2002 - no NIOSH validation) for m-Toluidine is 0.15 ppm (150 L).

REFERENCES:
Goldblatt MW [1955]. Research in industrial health in the chemical industry. Br J Indus Med 12:1-20.

Weisburger EK, Russfield AB, Homburger F, Boger E, Van Dongen CG, Chu KC [1978]. Testing of twenty-one environmental aromatic amines or derivatives for long-term toxicity or carcinogenicity. J Environ Pathol Toxicol 2:325-356.

NAME: Triethylamine

CAS: 121-44-8
CODE: H.S. 1408

PEL CURRENT:
25 ppm 100 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
10 ppm 40 mg/m^3 (TWA) 15 ppm 60 mg/m^3 (STEL)

TLV:
10 ppm 40 mg/m^3 (TWA) 15 ppm 60 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 39,600 (1982) **VOLUME:** 7,300,000 (1977) POUNDS

TOXICITY:
Human Lung, skin, eye irritation Animal Lung, skin, eye irritant; corneal damage; CNS

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Brieger and Hodes [1951] found that rabbits exposed to approximately 50 ppm (47.56 ± 7.83) triethylamine for 7 hrs/day, 5 days/wk for 6 weeks showed peribronchial infiltration of the lungs with occasional focal collection of lymphocytic cells, and slight thickening of the vascular walls. Also, there was a slight parenchymatous degeneration in the liver and, more significantly, there were multiple punctate erosions of the corneal epithelium and corneal edema. In this same study, a 100 ppm exposure produced "striking muscular degeneration" of the heart.

NAME: Triethylamine

CAS: 121-44-8
CODE: H.S. 1408

COMMENTS (continued):
Most significantly, Akesson et al. [1985] found that workers exposed to as low as 18 mg/m^3 (less than one-half the proposed PEL) experienced visual disturbances and corneal edema. In another study by Akesson et al. [1986], workers exposed over a range of 4 to 24 mg/m^3 experienced "blue haze" (foggy vision with a blue tint). These findings should be considered in the final determination for a new PEL.

REFERENCES:
Akesson B, Bengtsson M, Floren I [1986]. Visual disturbances after industrial triethylamine exposure. Int Arch Occup Environ Health 57:297-302.

Akesson B, Floren I, Skerfving S [1985]. Visual disturbances after experimental human exposure to triethylamine. Br J Ind Med 42:848-850.

Brieger H, Hodes, WA [1951]. Toxic effects of exposure to vapors of aliphatic amines. AMA Arch Ind Hyg Occup Med 3:287-291.

NAME: Vinyl Acetate

CAS: 108-05-4
CODE: H.S. 1424

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
10 ppm 30 mg/m^3 (TWA) 20 ppm 60 mg/m^3 (STEL)

TLV:
10 ppm 30 mg/m^3 (TWA) 20 ppm 60 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) 4 ppm 15 mg/m^3 (ceiling - 15-minutes)

PRODUCTION WORKERS: 102,000 (1974) **VOLUME:** 2,500,000,000 (1987) POUNDS

TOXICITY:
Human Skin & respiratory irritation **Animal** Eye irritation

MUTAGENICITY:
Human -- **Other** POS (salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** inadequate evidence **Animal** inadequate evidence
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
The ACGIH TLV of 10 ppm TWA, 20 ppm STEL [ACGIH 1986], and the NIOSH REL of 4 ppm [NIOSH 1978], 15-minute ceiling, are both based on respiratory irritation from the same epidemiologic report [Deese et al. 1969]. NIOSH based its REL on protecting the most sensitive worker from possible adverse effects.

NAME: Vinyl Acetate

CAS: 108-05-4
CODE: H.S. 1424

REFERENCES:

ACGIH [1986]. Vinyl acetate. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 621.

Deese DE, Joyner RE [1969]. Vinyl acetate: A study of chronic human exposure. Amer Ind Hyg Assoc J 30:449-457.

NCI [1985]. Monograph on human exposure to chemicals in the workplace: Vinyl acetate. Bethesda, MD: National Cancer Institute, Division of Cancer Etiology, Contract NO1-CP-26002-03.

NIOSH [1978]. A recommended standard for occupational exposure to....Vinyl acetate. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-205.

NAME: Zirconium Compounds

CAS: 7440-67-7 (Zirconium)
10026-11-6 (Zirconium Tetrachloride)

CODE: H.S. 1439

PEL CURRENT:

-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:

-- ppm 5 mg/m^3 (TWA) -- ppm 10 mg/m^3 (STEL)

TLV:

-- ppm 5 mg/m^3 as Zr (TWA) -- ppm 10 mg/m^3 as Zr (STEL)

REL:

-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: --

VOLUME: >900,000,000 (Patty) POUNDS (world excluding U.S.)

TOXICITY:

Human Underarm granulomas from NaZr as a deodorant spray

Animal Blood effects, mortality (ZrC14)

MUTAGENICITY:

Human --

Other --

TERATOGENICITY:

Human --

Animal --

CARCINOGENICITY:

IARC : Human -- **Animal** --

NTP : Human -- **Animal** --

NIOSH: --

ACGIH: --

NIOSH DATE:

COMMENTS:

In general, the zirconium compounds are relatively non-toxic. Zirconium tetrachloride (ZT) appears to be an exception. ZT liberates hydrochloric acid on contact with water (therefore, on contact with mucous membranes as well). Following a 60-day exposure to ZT at a concentration of 6 mg Zr/mg^3 (6 hours/day, 5 days/week), dogs showed a decrease "of borderline significance" in the amount of hemoglobin in the blood and in the red blood count [Spiegl et al. 1956]. At this same exposure, there was increased mortality in rats and guinea pigs. Because this concentration is close to the proposed OSHA standard of 5 mg/m^3 (10 mg/m^3 STEL), and because mortality occurred at this concentration, NIOSH recommends that zirconium tetrachloride not be included in the

NAME: Zirconium Compounds

CAS: 7440-67-7 (Zirconium)
10026-11-6 (Zirconium Tetrachloride)

CODE: H.S. 1439

COMMENTS (continued):
generic standard for zirconium compounds, as Zr, but rather, should be considered for a separate PEL. The proposed PEL should be identified as: zirconium compounds (excluding zirconium tetrachloride, $ZrOCl_2$, CAS: 10026-11-6.

NIOSH does not have an LOQ for zirconium compounds because there is no NIOSH validated method.

REFERENCES:
Spiegl CJ, Calkins MC, DeVoldre JJ, Scott JK, Steadman LT, Stokinger HE [1956]. Inhalation toxicity of zirconium compounds. I. Short-term studies. Rochester, NY: The University of Rochester, Atomic Energy Project, Contract W-7401-eng-49.

NAME: Acetylene Tetrabromide (Tetrabromoethane) CAS: 79-27-6
CODE: H.S. None

PEL CURRENT:
1 ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
1 ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
1 ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 440 (1972) VOLUME: "probably" >5000 (1972) POUNDS

TOXICITY:
Human CNS/liver Animal CNS/lung/liver/kidneys

MUTAGENICITY:
Human -- Other POS (Salmonella)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Hollingsworth et al. [1963] found that when several species (rats, guinea pigs, rabbits, and mice) were exposed at an average concentration of 4 ppm of acetylene tetrabromide 7 hours/day, 5 days/week, for 180 days, the liver and lungs of rodents showed slight histological changes and liver weight increase in rats. None of the animals were injured by an average exposure concentration of 1.1 ppm.

However, the reaction of humans to acetylene tetrabromide may be unique [Van Haaften 1969]. A chemist suffered near fatal liver injury after only one day of exposure. A re-creation of his work produced a concentration of 1 to 2 ppm of acetylene tetrabromide with a 10-minute peak exposure of approximately 16 ppm (the odor is objectionable with

NAME: Acetylene Tetrabromide **CAS:** 79-27-6
CODE: H.S. None

COMMENTS (continued):
concentrations higher than 1 to 2 ppm) [Van Haaften 1969]. Other workers, who were in the area intermittently, complained of slight irritation of the eyes and nose and developed headaches after a couple of hours (there was also some exposure in the lab to dibromoethane, but the man working specifically with this chemical did not become ill).

ACGIH [1986] states (regarding the 1 ppm TLV) that "...workers exposed to concentrations of tetrabromoethane approaching this value should be kept under medical surveillance." There is reason to question whether a PEL of 1 ppm is sufficiently protective for workers.

One study [Brem et al. 1974] suggested that the chemical's ability to devitalize cells may have masked its mutagenicity. When applied to the skin of mice three times per week, 1,1,2,2-tetrabromoethane produced forestomach papillomas (four) in three mice out of thirty ($p<0.05$) [Van Duuren et al. 1979]. While neither ACGIH nor OSHA considers it a carcinogen (ACGIH cites the Van Duuren 1979 report), this study suggests caution in the use of the chemical until further testing can be done. Since tetrabromoethane can also be very toxic in humans [Van Haaften 1969], consideration should also be given to a "skin" notation.

REFERENCES:
ACGIH [1986]. Acetylene Tetrabromide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 9.

Brem H, Stein AB, Rosenkranz HS [1974]. The mutagenicity and DNA-modifying effect of haloalkanes. Cancer Res 34:2576-2579.

Hollingsworth RL, Rowe VK, Oyen F [1963]. Toxicity of acetylene tetrabromide determined on experimental animals. Am Ind Hyg Assoc J 24:28-35.

Van Duuren BL, Goldschmidt BM, Loewengart G, Smith AC, Melchionne S, Seldman I, Roth D [1979]. Carcinogenicity of halogenated olefinic and aliphatic hydrocarbons in mice. J Nat Cancer Inst 63(6):1433-1439.

Van Haaften AB [1969]. Acute tetrabromoethane (acetylene tetrabromide) intoxication in man. Am Ind Hyg Assoc J 30:251-256.

NAME: Chlorobenzene (Monochlorobenzene) **CAS:** 108-90-7
CODE: H.S. None

PEL CURRENT:
75 ppm 350 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
75 ppm 350 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
75 ppm 350 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 741,000 (1972) **VOLUME:** 284,000,000 (1980) POUNDS

TOXICITY:
Human: CNS effects; eye and nasal irritant
Animal: Eye and nose irritant; narcotic effects; liver and kidney toxicity

MUTAGENICITY:
Human: --
Other: NEG (Salmonella); POS (mouse lymphoma)

TERATOGENICITY:
Human: --
Animal: --

CARCINOGENICITY:
IARC : Human: -- Animal: --
NTP : Human: -- Animal: NEG (female rat; male and female mouse, gavage); POS (male rat, gavage)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Chlorobenzene was not included in the proposed rule because OSHA does not propose to change the PEL. The current PEL and ACGIH-TLV are based on a chronic inhalation study of rats, rabbits, and guinea pigs, in which no effects were noted at 200 ppm [Irish 1963], and on the recommendation of Cook [1945] to use 75 ppm as the maximum allowable concentration. Cook [1945] based his recommendation on an earlier list of toxic limits

NAME: Chlorobenzene (Monochlorobenzene) CAS: 108-90-7
CODE: H.S. None

COMMENTS (continued):
for various substances [Brandt 1943]. ACGIH [1986] did not consider the 24-week inhalation study of chlorobenzene in rats and rabbits [NIOSH 1977]. Statistical analysis of the data from that study suggests some treatment-related effects on the red cell parameters in the rats at 75 ppm. (In chronic gavage studies [NTP 1985], carcinogenic effects were not observed in female rats or in male or female mice. There was an increased occurrence of neoplastic nodules of the liver in the high dose male rats, providing "some but not clear evidence of carcinogenicity of chlorobenzene in male rats.")

The NIOSH [1977] study provided a lowest observed effect level of 75 ppm. Based upon OSHA's own philosophy (Federal Register notice, p. 20987) and considering the positive findings of chlorobenzene in the rat inhalation study, the proposal to retain the 75 ppm PEL is not protective, especially to the potentially sensitive individual.

REFERENCES:
ACGIH [1986]. Chlorobenzene. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 123.

Brandt AD [1943]. Engineering control of air contamination of the working environment. In: Manual of industrial hygiene and medical service in war industries. Gafafer WM (ed.). Philadelphia, PA: W.B. Saunders Company, pp. 264-265.

Cook WA [1945]. Maximum allowable concentrations of industrial atmospheric contaminants. Ind Med 14(11):936-946.

Irish DD [1963]. Halogenated hydrocarbons: II. Cyclic. In: Industrial Hygiene and Toxicology. Volume II. Toxicology. Patty FA (ed.). New York, NY: Interscience Publishers, pp. 1333-1335.

NIOSH [1977]. Toxic evaluation of inhaled chlorobenzene (monochlorobenzene). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, Division of Biomedical and Behavioral Sciences, NTIS PB-276-623.

NTP [1985]. NTP technical report on the toxicology and carcinogenesis studies of chlorobenzene (CAS No. 108-90-7) in F344/N rats and B6C3F$_1$ mice (gavage studies). U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NTP TR 261, NIH Publication No. 86-2517.

NAME: Cresol

CAS: 1319-77-3
CODE: H.S. None

PEL CURRENT:				
(skin) 5 ppm	(skin) 22 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
PEL PROPOSED:				
-- ppm	-- mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
TLV:				
(skin) 5 ppm	(skin) 22 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
REL:				
2.3 ppm	10 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	

PRODUCTION WORKERS: 1,260,000 (1974) **VOLUME:** 120,000,000 (1984) POUNDS

TOXICITY:
Human Skin; liver; kidney; pancreas Animal CNS; liver; kidney; pancreas; respiratory; vascular; skin; eyes

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
The OSHA PEL and the ACGIH TLV [ACGIH 1986] both have identical exposure limits of 5 ppm (22 mg/m^3), TWA, with a skin notation; therefore, this chemical is not being considered for revision. However, NIOSH has established an REL of 2.3 ppm (10 mg/m^3), TWA, which should be considered in the revision of the OSHA standards. In 1952, ACGIH [ACGIH 1986] established a 5 ppm TWA based on cresol's analagous toxicity to phenol. The toxicity of cresol compared to phenol was considered in two studies [Fairhall 1957; Hamilton et al. 1949]. It was believed the 5 ppm level would protect against irritation, and kidney and liver damage. NIOSH [1978] established a 2.3 ppm, TWA. NIOSH reported that although the data indicates similarities in toxicity between cresol

NAME: Cresol

CAS: 1319-77-3
CODE: H.S. None

COMMENTS (continued):
and phenol when they are given by several routes of exposure, some evidence suggests that cresol is more toxic by inhalation [Uzhdavini et al. 1972]. Deichmann et al.'s [1963] findings agreed with Uzhdavini concerning the adverse effects of cresol below 20 mg/m^3.

The NIOSH REL is more protective than the current OSHA PEL or TLV.

REFERENCES:
ACGIH [1986]. Cresol. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 148.

Deichmann WB, Keplinger ML [1963]. In: Industrial Hygiene and Toxicology, vol. II. Fassett DW, Irish DD (eds.). New York, NY: Interscience Publishers, p. 1390.

Fairhall LT [1957]. Industrial Toxicology, 2nd ed. Baltimore, MD: Williams & Wilkins Co.

Hamilton A, Hardy HL [1949]. Industrial Toxicology, 2nd ed. New York, NY: Hoeber, Inc.

NIOSH [1978]. Criteria for a recommended standard....Occupational exposure to cresol. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-133.

Uzhdavini ER, Astafyeua IK, Mamayeva AA, Bakhtizina GZ [1972]. Inhaled toxicity of o-cresol. Tr Ufim Nauchno-Issled Inst Gig Profzabol 7:115-119.

NAME: Manganese and Compounds (metal dust and compounds) **CAS:** 7439-96-5
CODE: H.S. None

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm 5 mg/m^3 (ceiling)

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
*-- ppm -- mg/m^3 (TWA) -- ppm 5 mg/m^3 (ceiling)
*Notice of intended change 1987-88 to 5 mg/m^3, as Mn, TWA

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 172,000 (1983) **VOLUME:** 800,000,000 (1985) POUNDS

TOXICITY:
Human CNS; lungs; neurological; neurobehavioral; metal fume fever Animal CNS; pneumonitis; hematologic alterations

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal NEG (rat)

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The ACGIH TLV [1980] and OSHA PEL presently are 5 mg/m^3 as a ceiling value. Therefore, this chemical was not included in the OSHA NPR. However, ACGIH [1986] has proposed a "Notice of Intended Change" to a 5 mg/m^3, as Mn, airborne concentration as a TWA rather than a ceiling. The reasoning for their change is that manganese is a chronic toxin, therefore, a TWA is more appropriate since ceilings are only to be used for irritants and other substances for which immediate health effects are observed after only a brief exposure.

It has also been noted that, since the time the TLV was established, an epidemiological study [Roels et al. 1985] has found human effects at TWA below 5 mg/m^3. Therefore,

NAME: Manganese and Compounds (metal dust and compounds) **CAS:** 7439-96-5
CODE: H.S. None

COMMENTS (continued):
5 mg/m^3 as a TWA or ceiling is questionably high. OSHA should consider that the limit for manganese metal dust and compounds corresponds to the proposed PEL for manganese fume of 1 mg/m^3, as Mn, TWA, with a 3 mg/m^3 STEL.

REFERENCES:
ACGIH [1980]. Manganese and Compounds. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 250.

ACGIH [1986]. Manganese and Compounds. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 354-355.

Roels H, Sarhan MJ, Hanotiau I, de Fays M, Genet P, Bernard A, Buchet JP, Lauwery R [1985]. Preclinical toxic effects of manganese is workers from a Mn salts and oxides producing plant. The Sci of the Total Environ 42:201-206.

NAME: Molybdenum (Soluble Compounds) **CAS:** 7439-98-7
CODE: H.S. None

PEL CURRENT:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 5 (as Mo) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 61,108 (1982) **VOLUME:** 18,800,000 (1977) POUNDS

TOXICITY:
Human Biochemical alterations; joint pains; headache **Animal** Muscular incoordination; diarrhea; anemia; reduced growth rate; liver & kidney toxicity; respiratory tract irritant

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
As for the insoluble molybdenum compounds, the reviews of published literature on the soluble compounds by Browning [1961], Stokinger [1981], and Friberg and Lener [1986] provide a comprehensive evaluation of the available data. Fairhall's [1945] experimental data and review of the literature through 1943 provides additional insight.

The predominant literature on the toxicity of molybdenum compounds relates to the chemical and its role in nutritional and biochemical interactions. Data identified with occupational exposures to the soluble compounds of molybdenum indicate a higher degree of toxicity with the soluble forms than with the insoluble although the preciseness of

NAME: Molybdenum (Soluble Compounds) CAS: 7439-98-7
CODE: H.S. 1278

COMMENTS: (Continued)
these interpretations may be open to question. As stated in the ACGIH TLV Documentation for molybdenum [1986], "Unfortunately, none of the work provides the type of data from which a threshold limit might be firmly set or from which one might be easily extrapolated" and, "On this very tenuous basis," (the available data) "a time-weighted average TLV of 5 mg Mo/m^3 is suggested for the more soluble and active molybdenum compounds,...." Walravens et al. [1979] in a recent report on biochemical abnormalities in workers exposed to molybdenum dust (molybdenum (MoO_3) and other soluble oxides of molybdenum) concluded that, "since absorption of Mo from dust particles was demonstrated in the present study, the question arises of whether the present 8-hr TWA (5 mg Mo/m^3) is safe. "Further studies are needed on workers exposed to soluble Mo dusts to determine whether high plasma and urinary levels of Mo are accompanied by adverse health effects."

In the absence of suitable data to support different limits for soluble and insoluble Mo, NIOSH recommends that no distinction be made based on solubility. There is evidence that the existing PEL of 5 mg Mo/m^3 is not protective. NIOSH therefore recommends that OSHA schedule Mo for in-depth evaluation.

REFERENCES:
ACGIH [1986]. Molybdenum. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 415.

Browning E [1961]. Molybdenum. In: Toxicity of industrial metals. Chapter 25. London, England: Butterworths Publishing Co., pp. 212-216.

Fairhall LT, Dunn RC, Sharpless NE, Pritchard EA [1945]. The toxicity of molybdenum. Federal Security Agency, U.S. Public Health Service, Public Health Bulletin No. 293.

Friberg L, Lener J [1986]. Molybdenum. In: Handbook on the toxicity of metals. 2nd edition. Volume II: Specific metals, Chapter 17. New York, NY: Elsevier Science Publishers, pp. 446-461.

Stokinger HE [1981]. Molybdenum. In: Patty's industrial hygiene and toxicology. Third revised edition. New York, NY: John Wiley & Sons, pp. 1807-1820.

Walravens PA, Moure-Eraso R, Solomons CC, Chappell WR, Bentley G [1979]. Biochemical abnormalities in workers exposed to molybdenum dust. Arch Environ Health 34:302-308.

NAME: Nitromethane **CAS:** 75-52-5
CODE: H.S. None

PEL CURRENT:
100 ppm 250 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
100 ppm 250 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
100 ppm 250 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 838,000 (1972) **VOLUME:** >1000 (SRI 1975) POUNDS

TOXICITY:
Human Mild respiratory irritant/ narcotic **Animal** Thyroid weight increase (rabbit); liver toxicity (rat)

MUTAGENICITY:
Human -- **Other** NEG (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** NTP prechronic tests to be available in fall 1989
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The proposed and current OSHA PEL is 100 ppm. Lewis et al [1979] showed that the serum thyroxine (T4) was depressed at all intervals measured (one, three, and six months) in rabbits exposed to either 98 or 745 ppm of nitromethane. These depressions were statistically significant after six months at both exposure concentrations, and statistically significant after one month at the higher concentration. The thyroid glands of rabbits exposed to 745 ppm for six months were increased in weight. This article was not cited by ACGIH [1986] and OSHA is not proposing to change the PEL, so there is no evidence that this study has been considered by either ACGIH or OSHA. The authors of this NIOSH contract study concluded that "A standard of 100 ppm for

NAME: Nitromethane **CAS:** 75-52-5
CODE: H.S. None

COMMENTS (continued):
nitromethane would appear to offer a satisfactory margin of safety for workers exposed to nitromethane, provided thyroid activity is monitored and proves unaffected." In light of the reported thyroid effects, there is reason to question whether a PEL of 100 ppm is sufficiently protective for workers. (In addition, the NTP inhalation study (on test) should be monitored for available data.)

REFERENCES:
ACGIH [1986]. Nitromethane. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 439.

Lewis TR, Ulrich CE, Busey WM [1979]. Subchronic inhalation toxicity of nitromethane and 2-nitropropane. J Environ Pathol Toxicol 2(5):233-249.

NAME: Parathion **CAS:** 56-38-2
CODE: H.S. None

PEL CURRENT:
-- ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm 0.05 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 9,061 (1972); Potentially exposed 250,000 (NIOSH 1976) **VOLUME:** 8.6 million (1982) POUNDS

TOXICITY:
Human Cholinesterase inhibitor; CNS; respiratory depression **Animal** CNS; respiratory depression; cholinesterase inhibitor

MUTAGENICITY:
Human -- **Other** Weakly POS (Salmonella); EQUIV (cytogenetics)

TERATOGENICITY:
Human -- **Animal** Fetotoxic (rat)

CARCINOGENICITY:
IARC : Human Insufficient data **Animal** Inadequate evidence
NTP : Human -- **Animal** NEG (mouse); suggestive (one rat strain)
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1976)

COMMENTS:
OSHA did not propose any changes in its current PEL for parathion of 0.1 mg/m^3, with a skin notation. This value is the same as the TLV-TWA proposed by ACGIH, also with a "skin" notation [ACGIH 1986].

NIOSH's REL, proposed in its criteria document of 1976 [NIOSH 1976], is 0.05 mg/m^3. This value was derived from a human ingestion study, assuming that the safe ingestion dose is 3.5 mg/day [Reider et al. 1969]. According to NIOSH, this corresponds to a safe inhalation dose of 0.7 mg/day, because parathion is approximately 5 times more toxic by

NAME: Parathion CAS: 56-38-2
CODE: H.S. None

COMMENTS (continued):
inhalation than by ingestion. Assuming ventilation rate of 1.5 m^3/hour for a 10-hour working day, the REL is $\frac{0.7}{15}$ = 0.05 mg/m^3.

Even though the REL is a factor of 2 lower than the proposed PEL and TLV, the REL itself may not be sufficiently protective. An animal study in rats and in dogs (unpublished study described in the NIOSH criteria document [NIOSH 1976]) had demonstrated >30% decrease in acethylcholinesterase activity of red blood cells and plasma in rats exposed to 0.01 mg/m^3 of parathion in air for 7 hours/day, 5 days/week for 6 weeks. Dogs were more sensitive, and in dogs, similar effects occurred after 2 weeks at 0.01 mg/m^3.

Measurements in humans have demonstrated that exposure to parathion powder and mist results in far greater exposure via dermal route than via inhalation. For example, Durham et al. [1972] evaluated comparative dermal and respiratory exposures of workers subjected to the mist from an airblast spray machine during parathion application in orchards, by measuring total p-nitrophenol, one of the metabolites of parathion. The results showed that dermal absorption exceeded that by respiration by several times when regular work clothes were worn. Wolfe et al. [1978] studied exposure of pesticide formulating plant workers to parathion. Dermal contamination was measured by attaching absorbent pads to various parts of worker's body, and respiratory exposure by placing special filter pads in respirator cartridges. Potential exposure calculations were based on the use of minimum protection (no respirator, shirt with short sleeves and open collar, no hat, no gloves and the assumption that the clothing worn gave complete protection of body areas covered). The results showed that when no protective clothing was worn, dermal absorption exceeded that by the respiratory route by approximately 100 times.

Parathion has the dubious distinction of being the pesticide most frequently involved in fatal poisonings [Murphy 1986].

IARC [1983] had recommended that the maximum acceptable daily intake for man should not exceed 0.005 mg/kg/day. Assuming body weight of 70 kg and respiration rate of 15 m^3 in a 10-hour work day, this would correspond to 0.02 mg/m^3 level.

EPA [1987] derived an RfD (reference dose, formerly known as acceptable daily intake) of 0.006 mg/kg/day from human study in CBI (confidential business information) files. This is essentially the same value given by WHO.

NCI [1979] studied possible carcinogenicity of parathion in a dietary study in female and male rats (Osborne-Mendel) and mice ($B6C3F_1$). In mice, no tumors occurred in either sex at incidences that were significantly higher in the dosed groups than in the corresponding control groups. In the male and female rats receiving parathion in their diet, there was a higher incidence of cortical tumors of the adrenal, suggesting that parathion may be carcinogenic to this strain of rats.

NAME: Parathion **CAS:** 56-38-2
CODE: H.S. None

COMMENTS (continued):
IARC [1983] reviewed parathion and concluded that "there is inadequate evidence to evaluate the carcinogenicity of parathion to experimental animals." Also, "the available data are insufficient to evaluate the carcinogenicity of parathion to humans."

NIOSH recommends that OSHA adopt the NIOSH REL of 0.05 mg/m^3 and maintain a "skin" designation.

NIOSH does not have an LOQ for parathion because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Parathion. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 458.

Durham WF, Wolfe HR, Elliot JW [1972]. Absorption and excretion of parathion by spraymen. Arch Environ Health 24:382-387.

EPA [1987]. Health effects assessment for parathion. Cincinnati, OH: U.S. Environmental Protection Agency, Enviornmental Criteria and Assessment Office. Final draft report ECAO-CIN-H101.

IARC [1983]. Miscellaneous pesticides. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 30. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Murphy SD [1986]. Toxic effects of pesticides. In: Casarett and Doull's Toxicology. Klaassen CD, Amdus MO, Doull J (eds.). MacMillan Publishing Co.

NCI [1979]. Bioassay of parathion for possible carcinogenicity. Technical Report Series No. 70. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, HEW Publication (NIH) No. 79-1320.

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to parathion. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, HEW Publication (NIOSH) No. 76-190.

Reider JA, Moeller HC, Puletti EJ, Swader JI [1969]. Toxicity of parathion, systox, octamethyl pyrophosphoramide, and methyl parathion in man. Toxicol Appl Pharmacol 14:603-611.

Wolfe HR, Staiff DC, Armstrong JF [1978]. Exposure of pesticide formulating plant workers to parathion. Bull Environ Contam Toxicol 20:340-343.

NAME: Emery

CAS: 57407-26-8
CODE: H.S. 1155

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) (less than 1% quartz) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 32,200 (1982) **VOLUME:** -- POUNDS

TOXICITY:
Human Skin and respiratory irritation Animal Rats (lipoid pneumonia [exposed to Al_2O_3])

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA is proposing to limit exposure to emery (primarily aluminum oxide) with a PEL of 10 mg/m^3 due to its low toxicity. OSHA cites the documentation used in support of ACGIH's TLV of 10 mg/m^3 for emery [ACGIH 1986]. OSHA's proposed PEL of 10 mg/m^3 total dust may not prevent chronic respiratory disease based on the toxicologic data [Stacy et al. 1959; Stanton et al. 1981] reported for aluminum oxide (see NIOSH's statement on alpha-alumina).

NAME: Emery

CAS: 57407-26-8
CODE: H.S. 1155

COMMENTS (continued):
Note: The CAS #112-62-9 given by OSHA and ACGIH for emery (Al_2O_3) is incorrect. The CAS #112-62-9 is for methyl ester oleic acid. The correct CAS # for emery is 57407-26-8. Emery is primarily composed of aluminum oxide and may be associated with other impurities such as mica, gneiss, granite, or magnetite.

REFERENCES:
ACGIH [1986]. Emery. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 229.

Stacy BD, King EJ, Harrison CV [1959]. Tissue changes in rats' lungs caused by hydroxides, oxides and phosphates of aluminum and iron. J Path Bact 77:417-426.

Stanton MF, Layard M, Tegeris A, Miller E, May M, Morgan E, Smith A [1981]. Relation of particle dimension to carcinogenicity in amphibole asbestos and other fibrous minerals. JNCI 67(5):965-975.

NAME: Fibrous Glass Dust

CAS: None
CODE: H.S. 1178

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(3 fibers/cc; 3.5 um or less in diameter and greater than 10 um in length)

PRODUCTION WORKERS: 200,000 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human Pulmonary and skin irritation **Animal** Lung fibrosis; sarcomas and mesotheliomas (abdomen)

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: Fibrosis in animals; respiratory tract irritation in humans
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
ACGIH has adopted a nuisance dust (10 mg/m^3) TLV for fibrous glass [ACGIH 1986]. NIOSH [1977] proposed a TWA REL of 5 mg/m^3 for total fibrous glass dust with a 3 fibers/cc limit on fibers having a diameter equal or less than 3.5 um, and a length equal to or greater than 10 um based on small diameter fibers producing fibrosis in animals and respiratory tract irritation in humans.

OSHA proposes to adopt the NIOSH total dust level of 5 mg/m^3 but not adopt the 3 fibers/cc level. Conflicting information is available concerning the carcinogenicity of man-made fibers.

NAME: Fibrous Glass Dust

CAS: None
CODE: H.S. 1178

COMMENTS (continued):
Published experimental evidence demonstrates that fibrous glass has the same potential for inducing cancer as asbestos fibers of the same dimensions [Stanton et al. 1981]. Recently published epidemiological data [Enterline et al. 1987] indicate that there has been a risk of lung cancer in people employed in both the rock or slag wool and glass wool sectors of the man-made mineral fiber industry amounting to some 25% above normal 30 years after first employment. Furthermore, it is likely that man-made mineral fibers may have about the same carcinogenic potential as asbestos fibers of the same dimensions, and that levels of 0.2 fibers/cc or less in industry are unlikely to produce a measurable risk after 20 years of exposure [Doll 1987].

It is highly unlikely that the TLV of 10 mg/m^3 or the proposed PEL of 5 mg/m^3 is protective. At this time, the NIOSH recommendation of 3 fibers/cc is a significantly better alternative. It is likely, however, that even the 3 fibers/cc standard will not provide the degree of protection that OSHA believes is necessary for worker health, and that reduction of the PEL to 0.2 fibers/cc, as was suggested at the Man-made Mineral Fibers Conference, will be necessary to protect workers from the development of lung cancer.

The NIOSH LOQ (Method No. 7400) for fibrous glass dust is 0.04 fibers/cc (1000 L).

REFERENCES:
ACGIH [1986]. Fibrous Glass Dust. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 270-272.

Doll R [1987]. Symposium on MMMF, Copenhagen, October 1986: Overview and conclusions. Ann Occup Hyg 31(4B):805-819.

Enterline PE, Marsh GM, Henderson V, Callahan C [1987]. Mortality update of a cohort of U.S. man-made mineral fibre workers. Ann Occup Hyg 31(4B):625-656.

NIOSH [1977]. A recommended standard for occupational exposure to....fibrous glass. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-152.

Stanton MF, Layard M, Tegeris A, Miller E, May M, Morgan E, Smith A [1981]. Relation of particle dimension to carcinogenicity in amphibole asbestoses and other fibrous minerals. JNCI 67(5):965-975.

NAME: Glycerin (Mist)

CAS: 56-81-5
CODE: H.S. 1188

PEL CURRENT:

--	ppm	15	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PEL PROPOSED:

--	ppm	10	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

TLV:

--	ppm	10	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

REL:

--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PRODUCTION WORKERS: 1,570,000 (1982) **VOLUME:** 336,000,000 [1977] POUNDS

TOXICITY:

Human: Mucous membrane and eye irritant; high concentration-hemolysis; hemoglobinuria and renal failure

Animal: Rat oral LD_{50} - 12.6 g/kg; Rabbit - dermal 500 mg/24 hrs - irritation

MUTAGENICITY:

Human: DNA inhibition in lymphocyte/somatic cells.

Other: NEG (Salmonella - NTP)

TERATOGENICITY:

Human: NEG

Animal: Rat intratesticular TD_{LO} 280 mg/kg - paternal reproductive effects. TD_{LO} 1600 mg/kg - reproductive fertility effects

CARCINOGENICITY:

IARC :	Human	--	Animal	--
NTP :	Human	--	Animal	--
NIOSH:		--		
ACGIH:		--		

NIOSH DATE:

COMMENTS:

OSHA proposes a PEL of 10 mg/m^3 for glycerin (mist) based on the ACGIH interpretation that no ill effects are likely to occur at exposures below 10 mg/m^3 since it is easily metabolized and excreted. However, in a study reported by Wiebe et al. [1984], the intratesticular injection of glycerin in rats resulted in antispermatogenic activity. Rats given a single injection of less than 200 ug glycerin resulted in arrested spermatogenesis and the elimination of spermatogenic cells from seminiferous

NAME: Glycerin (Mist)

CAS: 56-81-5
CODE: H.S. 1188

COMMENTS: (Continued)
tubules within one week and persisted for at least 73 days. These data suggest that the proposed PEL of 10 mg/m^3 for nuisance particulates may not be protective against possible adverse reproductive effects.

REFERENCES:
Wiebe JP and Barr KJ [1984]. The control of male fertility by 1,2,3-trihydroxypropane (THP; Glycerol): rapid arrest of spermatogenesis without altering libido, accessory organs, gonadal steroidogenesis, and serum testosterone, LH and FSH. Contraception 29 No. 3:291-301.

NAME: Graphite (Synthetic, Total Dust)

CAS: None
CODE: H.S. 1191A

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(less than 1% quartz)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Irritant Animal --

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA proposes a PEL of 10 mg/m^3 for synthetic graphite based on limited evidence of pneumoconiosis. This proposed limit is in contrast to the 2.5 mg/m^3 (respirable dust) PEL assigned to natural graphite. Although substantially more evidence exists documenting pneumoconiosis with exposure to natural graphite, NIOSH believes there is no justification to have different PELs for the natural and synthetic graphites. The case study reported by Lister et al. [1972] suggests that synthetic graphite exposure without concurrent quartz exposure is capable of producing pneumoconiosis. No quantitative exposure data exists for synthetic or natural graphite to permit an assessment of a dose/response relationship. However, OSHA's proposed PEL of 2.0 mg/m^3 (respirable) for coal dust to prevent pneumoconiosis appears to be an appropriate limit for controlling exposure to graphite. NIOSH is also concerned about the potential hazards

NAME: Graphite (Synthetic, Total Dust)

CAS: None
CODE: H.S. 1191A

COMMENTS (continued):
that may be associated with exposure to synthetic graphite fibers. A report by Zumwalde et al. [1980] on the release of graphite fibers from composite graphite materials suggests that exposure to respirable-sized fibers may pose a respiratory hazard. OSHA should, at a minimum, apply the NIOSH REL of 3 fibers/cm^3 for fibrous glass to control exposure to fibrous graphite.

REFERENCES:
Lister WB, Wimborne D [1972]. Carbon pneumoconiosis in a synthetic graphite worker. Br J Ind Med 29:108-110.

Zumwalde RD, Harmison LT [1980]. Carbon/graphite fibers: Environmental exposures and potential health implications. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Surveillance, Hazard Evaluations, and Field Studies, December 1980.

NAME: Magnesium Oxide Fume

CAS: 1309-48-4
CODE: H.S. 1234

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 849,000 (1972) **VOLUME:** 4,330,000,000 (1977) POUNDS

TOXICITY:
Human Skin/eye irritation; metal fume fever--MgO fume **Animal** Histiocytic lymphomas

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: --

COMMENTS:
OSHA proposes to limit exposure to 10 mg/m^3 for MgO based on toxicological evidence that MgO is an inert dust. However, in a study reported by Stenback et al. [1973] to determine the synergistic action between the carcinogen diethylnitrosamine and MgO, Al_2O_3, or carbon instilled intratracheally in the respiratory tract of Syrian golden hamsters; magnesium oxide alone induced a significantly large number of lymphomas when given a dose of 2 mg intratracheally weekly for 30 weeks. Histiocytic-type lymphomas were observed in 30% of the animals administered MgO; no lymphomas were induced in those animals administered diethylnitrosamine and MgO. Spontaneous histiocytic lymphomas have

NAME: Magnesium Oxide Fume

CAS: 1309-48-4
CODE: H.S. 1234

COMMENTS (continued):
been reported in Syrian golden hamsters at a much lower percentage (2%). NIOSH concludes from this information that the proposed PEL may not be protective and that there may be a carcinogenic risk.

Proposed Analytical Method: OSHA ID 121 (validated), Detection limit-4 ug/m^3 (480 L volume)

REFERENCES:
Stenback FG, Ferrero A, Shubik P [1973]. Synergistic effects of diethylnitrosamine and different dusts on respiratory carcinogenesis in hamsters. Cancer Res 33:2209-2214.

NAME: Methoxychlor **CAS:** 72-43-5
CODE: H.S. 1246

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(Nuisance dust limit)

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 151,760 **VOLUME:** -- POUNDS

TOXICITY:
Human Skin and eye irritant **Animal** LD_{50} - rat oral is 6,000 mg/kg

MUTAGENICITY:
Human -- **Other** POS

TERATOGENICITY:
Human -- **Animal** Fetotoxicity/reproductive

CARCINOGENICITY:
IARC : Human -- **Animal** Inadequate evidence (1974); no evidence (1979)
NTP : Human -- **Animal** NEG (1978)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA proposes a PEL of 10 mg/m^3 for methoxychlor to limit the risk of skin and eye irritation as an inert dust. Several ingestion studies with methoxychlor using several species of animals have been reported to be negative for cancer. However, a review of those studies by Reuber [1980] suggests that methoxychlor may be carcinogenic for the liver in two strains of mice and Osborne-Mendel rats, and possibly for the liver of dogs. Cancer of the testis in BALB/c male mice, bone of B6C3F$_1$ female mice, and the ovary of Osborne-Mendel female rats were indicated to be statistically increased when compared to nonexposed controls. When benign and malignant tumors were combined at specific organs (e.g., liver, ovary) in each study, the incidence of neoplasms was found to be statistically increased when compared to controls. The number of neoplasms were

NAME: Methoxychlor **CAS:** 72-43-5
CODE: H.S. 1246

COMMENTS (continued):
often found to increase with dose at a statistically significant rate. Exposure to methoxychlor has also been shown to inhibit spermatogenesis in male rats and folliculogenesis in female rats when administered doses of 100 and 200 mg/kg/day per body weight [Bal 1984]. NIOSH believes the toxicological evidence demonstrates that exposure to methoxychlor is more hazardous than that indicated by OSHA and, thus should not be treated as a chemical with a low level of toxicity.

The NIOSH LOQ (Method No. S371) for methoxychlor is 0.07 mg/m^3 (720 L) and 1.6 mg/m^3 (30 L - short-term sample).

REFERENCES:
Bal HS [1984]. Effect of methoxychlor on reproductive systems of the rat (41861). Proceedings of the Society for Experimental Biology and Medicine 176:187-196.

Reuber MD [1980]. Carcinogenicity and toxicity of methoxychlor. Environmental Health Perspectives 36:205-219.

NAME: Mineral Wool Fiber

CAS: None
CODE: H.S. 1277

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 43,000 (1972) **VOLUME:** 38 x 10^8 (1982) POUNDS

TOXICITY:
Human -- **Animal** POS/NEG (carcinogen)

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** Limited evidence **Animal** Limited evidence
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
ACGIH has adopted a nuisance dust (10 mg/m^3) TLV for mineral or rock wool [ACGIH 1986]. NIOSH does not have a recommendation for mineral wool.

OSHA proposes to adopt the ACGIH TLV of 10 mg/m^3. Published experimental evidence demonstrates that all durable fibers of the same physical dimensions have similar carcinogenic potential regardless of their chemical compositions [Stanton et al. 1981]. Recently published animal experiments show that rock wool fibers can produce mesotheliomas after intraperitoneal injections [Pott et al. 1987]. Epidemiologic studies [Enterline et al. 1987] have shown a statistically significant increase in the incidence of lung cancer in production workers exposed to mineral wool fibers (rock/slag

NAME: Mineral Wool Fiber **CAS:** None
CODE: H.S. 1277

COMMENTS (continued):
wool fibers). A dose-response increase in lung cancer was also demonstrated when several variables were controlled for, including cigarette smoking. This increase in incidence of lung cancer is about 25%-35% above background, and has occurred at fiber exposure levels below 2 fibers/cc. It is likely that man-made mineral fibers may have about the same carcinogenic potential as asbestos fibers of the same dimensions, and that levels of 0.2 fibers/cc or less in industry are unlikely to produce a measurable risk after 20 years of exposure [Doll 1987].

It is highly unlikely that the TLV of 10 mg/m^3 or the proposed PEL of 10 mg/m^3 is protective. Instead, OSHA should consider a fiber standard, rather than a weight standard, just as it has for asbestos. To provide the degree of protection that OSHA believes is necessary for worker health, Sir Richard Doll [1987] suggested at the Man-Made Mineral Fibers Conference in Copenhagen in 1986 that the PEL should be 0.2 fibers/cc.

NIOSH does not have an LOQ for mineral wool fiber because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Fibrous Glass Dust. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 270-272.

Doll R [1987]. Symposium on MMMF, Copenhagen, October 1986: Overview and conclusions. Ann Occup Hyg 31(4B):805-819.

Enterline PE, Marsh GM, Henderson V, Callahan C [1987]. Mortality update of a cohort of U.S. man-made mineral fibre workers. Ann Occup Hyg 31(4B):625-656.

NIOSH [1977]. A recommended standard for occupational exposure to....fibrous glass. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-152.

Pott F, Ziem U et al. [1987]. Carcinogenicity studies on fibers, metal compounds and some other dusts in rats. Exp Pathol 32:129-152.

Stanton MF, Layard M, Tegeris A, Miller E, May M, Morgan E, Smith A [1981]. Relation of particle dimension to carcinogenicity in amphibole asbestoses and other fibrous minerals. JNCI 67(5):965-975.

NAME: Molybdenum (Insoluble Compounds) **CAS:** 7439-98-7
CODE: HS 1278

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 (as Mo) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 (as Mo) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 172,000 (1982) **VOLUME:** 18,800,000 (1977) POUNDS

TOXICITY:
Human Irritation, pneumoconiosis **Animal** Respiratory irritation, pneumoconiosis

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Relatively little information has been reported on the toxicity of insoluble molybdenum compounds in experimental animals or from industrial experiences. The ACGIH TLV Documentation [1986] cites two published reports [Fairhall et al. 1945; Mogilevskaya 1950] that have some bearing on the insoluble or slightly soluble compounds. **Browning** [1961], Stokinger [1981], and Friberg and Lener [1986] provide reviews of the published literature on the toxicology of molybdenum.

Although the consensus of reviewers' comments on available data indicate that the insoluble molybdenum compounds have a low order of toxicity, there is room to doubt the appropriateness of the proposed PEL of 10 mg Mo/m^3. The TLV Documentation [1986] states that "Unfortunately, none of the work provides the type of data from which

NAME: Molybdenum (Insoluble Compounds)

CAS: 7439-98-7
CODE: HS 1278

COMMENTS: (Continued)
a threshold limit might be firmly set or from which one might be easily extrapolated;...." A reference [Mogilevskaya 1963] cited in Friberg and Lener [1986] (but not located in Chemical Abstracts or other searches) stated that "Pneumoconiosis with X-ray findings and subjective symptoms has been reported in 3 out of 19 workers exposed to metallic molybdenum and molybdenum trioxide" (slightly soluble compound). "Exposure varied between 1 and 19 mg/m^3 for 4-7 years." Molybdenum (insoluble) should not be identified as an "inert" or "nuisance" particulate or dust.

In the absence of suitable data to support different limits for soluble and insoluble Mo, NIOSH recommends that no distinction be made based on solubility. There is evidence that the existing PEL of 10 mg Mo/m^3 is not protective. NIOSH therefore recommends that OSHA schedule Mo for in-depth evaluation.

REFERENCES:
ACGIH [1986]. Molybdenum. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 415.

Browning E [1961]. Molybdenum. In: Toxicity of industrial metals. Chapter 25. London, England: Butterworths Publishing Co., pp. 212-216.

Fairhall LT, Dunn RC, Sharpless NE, Pritchard EA [1945]. The toxicity of molybdenum. Federal Security Agency, U.S. Public Health Service, Public Health Bulletin No. 293.

Friberg L, Lener J [1986]. Molybdenum. In: Handbook on the toxicity of metals, 2nd edition. Volume II: Specific metals, Chapter 17. New York, NY: Elsevier Science Publishers, pp. 446-461.

Stokinger HE [1981]. Molybdenum. In: Patty's industrial hygiene and toxicology. Third revised ed., New York, NY: John Wiley & Sons, pp. 1807-1820.

Mogilevskaya OG [1950]. Characteristics of molybdenum as an industrial poison. Gigiena i Sanit 12:18-22.

NAME: Picloram

CAS: 1918-02-1
CODE: H.S. 1328

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm 20 mg/m^3 (STEL)

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm 20 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
Group III Pesticide

PRODUCTION WORKERS: 2040 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human -- Animal liver and kidney damage

MUTAGENICITY:
Human -- Other NEG (Salmonella); inconclusive (Drosophila); POS (cytogenetics)

TERATOGENICITY:
Human NEG Animal NEG

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal NEG (mice or male rats); equivocal (female rat [benign liver tumors])
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
OSHA proposes a TWA limit of 10 mg/m^3 and a 15-minute STEL of 20 mg/m^3 for picloram. This PEL is being proposed to minimize the risk of systemic effects, such as liver and kidney damage. In an NCI study [NCI 1978], 50 Osborne-Mendel rats and 50 B6C3F$_1$ mice of each sex were administered picloram in the diet for 80 weeks (7,437 or 14,875 ppm for the rats and 2,531 or 5,062 ppm for the mice). Mean body weights of high dose rats were lower than those of the matched controls early in the study, but were higher at the end of the study; body weights of mice were unaffected. Late in the study, rough hair coats, diarrhea, pale mucous membranes, alopecia, and abdominal

NAME: Picloram

CAS: 1918-02-1
CODE: H.S. 1328

COMMENTS (continued):
distention occurred to a greater degree in both treated rats and mice than in the controls. All surviving rats and mice were sacrificed at 113 and 90 weeks, respectively. There was a significant dose-related increase of hepatic nodules (considered to be benign tumors) in the treated female rats only. NCI [NCI 1978] concluded that "under the conditions of the bioassay, the findings are suggestive of the ability of the compound to induce benign tumors in the livers of female Osborne-Mendel rats." Picloram was not carcinogenic in mice or male rats. NIOSH concludes that picloram is not a nuisance particulate and is not without toxic effects.

Proposed Analytical Method: OSHA (in-house), Detection Limit-0.03 mg/m^3 (60-L volume); no NIOSH method.

REFERENCES:
NCI [1978). Bioassay of picloram for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, Technical Report Series No. 23, DHEW Publication No. (NIH) 78-823.

NAME: Rouge (total dust) **CAS:** None
CODE: H.S. 1351

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) (less than 1% quartz) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Respiratory irritant; pneumoconiosis **Animal** Lung tumor; cocarcinogen

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** Sufficient: haematite mining with radon exposure **Animal** Inadequate: haematite and ferric oxide
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: --

COMMENTS:
OSHA proposes a PEL of 10 mg/m^3 for rouge (ferric oxide) based on the absence of evidence demonstrating any effects of exposure in either animals or humans. Although IARC [1987] concluded that ferric oxide was not carcinogenic in animals, they did conclude that based on epidemiological evidence, exposure to haematite dust (ferric oxide) increased the risk of lung cancer in miners. This evidence is consistent with the data reported by Warshawsky et al. [1984], in which ferric oxide intratracheally administered to the lungs of rabbits also exposed to benzo[a]pyrene (BaP), enhances the

NAME: Rouge (total dust)

CAS: None
CODE: H.S. 1351

COMMENTS (continued):
metabolic activation of BaP as well as acts as a carrier for penetration and retention of BaP in the lung. Based on the cocarcinogenic evidence of ferric oxide as reviewed by Niemeier [1986], the data warrants the reduction of exposure below 10 mg/m^3. The airborne-size characteristics of the material in the workplace should be assessed before determining the appropriate analytical method.

REFERENCES:
IARC [1987]. Haematite and ferric oxide: Ferric oxide (group 3), haematite (group 3), underground haematite mining with exposure to radon (group 1). IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 216-219.

Niemeier RW, Mulligan LT, Rowland J [1986]. Cocarcinogenicity of foundry silica sand in hamsters. In: Silica, silicosis and cancer: Controversy in occupational medicine. Cancer Research Monographs. Eds.: Goldsmith DF, Winn DM, Shy CM, 2:(12):215-227.

Warshawsky D, Bingham E, Niemeier RW [1984]. The effects of a cocarcinogen, ferric oxide, on the metabolism of benzo[a]pyrene in the isolated perfused lung. J Toxicol Environ Health 14:191-209.

NAME: Titanium Dioxide

CAS: 13463-67-7
CODE: H.S. 1396

PEL CURRENT:

--	ppm	15	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PEL PROPOSED:

--	ppm	10	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

TLV:

--	ppm	10	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

REL:

--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PRODUCTION WORKERS: 3,445,205 (1972) **VOLUME:** 2 billion POUNDS

TOXICITY:

Human Respiratory and skin irritant **Animal** TD_{LO} 360 mg/kg - rats intramuscular; neoplastic effects

MUTAGENICITY:

Human -- **Other** --

TERATOGENICITY:

Human -- **Animal** --

CARCINOGENICITY:

IARC : Human -- **Animal** --
NTP : Human -- **Animal** NEG (mouse/rat [oral in diet])
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:

OSHA proposes a PEL 10 mg/m^3 for titanium dioxide to prevent those effects associated with exposure to inert dusts. NCI [1978] reported on a carcinogenicity bioassay in which mice and rats of each sex were fed TiO_2 at either a dose of 2,500 ppm or 5,000 ppm for 103 weeks. NCI concluded that TiO_2 was not carcinogenic by this route of administration. In a more recent inhalation study reported by Lee at al. [1985], rats were exposed to TiO_2 (1.5 to 1.7 um MMD) at concentrations of 10, 50, and 250 mg/m^3 for 6 hrs/day, 5 days/week, for 2 years. Rats of both sexes exposed to all concentrations had significant increases in broncho/bronchiolar pneumonia and alveolar cell hyperplasia. Rats of both sexes exposed at the highest dose had a statistically significant increase in bronchioloalveolar adenomas; female rats (13 of 74 rats) exposed

NAME: Titanium Dioxide

CAS: 13463-67-7
CODE: H.S. 1396

COMMENTS (continued):
at the highest dose also had a statistically significant increase in squamous cell carcinomas when compared to nonexposed controls (0 of 77 rats). Although exposure to TiO_2 was high in the highest dose group, the effects observed for all dose groups suggest that TiO_2 is biologically active and should not be treated as an inert dust. The statistically significant increase in adenomas and carcinomas observed in the high dosed group of rats meets the OSHA criteria for a "potential occupational carcinogen" (29 CFR 1990). NIOSH recommended that OSHA label titanium dioxides as a potential occupational carcinogen.

Proposed NIOSH Analytical Method: Gravimetric, LOD - 0.02 mg/m^3

REFERENCES:
Lee KP, Trochimowicz HF, Reinhardt CF [1985]. Pulmonary response of rats exposed to titanium dioxide (TiO_2) by inhalation for two years. Toxicol Appl Pharmacol 79:179-192.

NCI [1978]. Bioassay of titanium dioxide for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institute of Health, NIH Pub. No. 78-1347.

NAME: Zinc Oxide Dust

CAS: 1314-13-2
CODE: H.S. 1438

PEL CURRENT:
-- ppm 15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm 5 mg/m^3 (TWA) -- ppm 15 mg/m^3 (ceiling-15-min.)

PRODUCTION WORKERS: 932,896 (1972) **VOLUME:** ZnO - 254,000 POUNDS

TOXICITY:
Human Zinc oxide fume and powder - metal fume fever; skin irritation **Animal** Metal fume fever

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1975)

COMMENTS:
NIOSH [1975] transmitted to the Department of Labor, OSHA, its recommendations for a standard on exposure to zinc oxide. NIOSH recommended an exposure limit of 5 mg/m^3 as a 10-hour TWA and a ceiling limit of 15 mg/m^3 determined by a 15-minute sample. This recommendation was based on preventing metal fume fever associated with exposure to ZnO fume or dust. Subsequent data reported by Gupta et al. [1986] and Lam et al. [1985] suggest that exposure to zinc oxide may be more hazardous than previously recognized. Gupta et al. [1986] found that 50 mg of zinc oxide dust intratracheally injected into guinea pigs caused an elevation of alkaline phosphatase and lactate dehydrogenase. The presence of lactate dehydrogenase activity in the airways fluid is considered to be an indicator of acute toxicity. The study reported by Lam et al. [1985] exposed guinea

NAME: Zinc Oxide Dust

CAS: 1315-13-2
CODE: H.S. 1438

COMMENTS (continued):
pigs to 5 mg/m^3 zinc oxide for 3 hrs/day for 6 days. Decreases in lung volume persisted 72 hours after termination of exposure and there were fibroblasts present in the interstitial infiltrates. This evidence suggests that chronic exposure to 5 mg/m^3 of ZnO may cause respiratory disease. NIOSH recommends that exposure to ZnO be limited to less than 5 mg/m^3.

REFERENCES:
Gupta S, Pandey SD, Misra V, Viswanathan PN [1986]. Effect of intratracheal injection of zinc oxide dust in guinea pigs. Toxicology 38:197-202.

Lam HF, Conner MW, Rogers AE, Fitzgerald S, Amdur MO [1985]. Functional and morphologic changes in the lungs of guinea pigs exposed to freshly generated ultrafine zinc oxide. Toxicol Appl Pharmacol 78:29-38.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to zinc oxide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-104.

NAME: Acrylamide

CAS: 79-06-1
CODE: H.S. 1008

PEL CURRENT:
-- ppm (skin) 0.3 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.03 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.3 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
A2 (suspected human carcinogen)

REL:
-- ppm 0.3 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 9,800 (1982, NOHS) **VOLUME:** 86,100,000 (1983, USITC) POUNDS

TOXICITY:
Human Skin irritation; central and peripheral nervous system effects; skin absorption
Animal Eye and skin irritation; central and peripheral nervous system damage; skin absorption; cancer (various)

MUTAGENICITY:
Human --
Other EQUIV (Salmonella); POS (cytogenetics)

TERATOGENICITY:
Human --
Animal Testicular effects and sperm reduction in mice and rats

CARCINOGENICITY:
IARC : **Human** No adequate data **Animal** Sufficient evidence
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: Suspected human carcinogen - A2

NIOSH DATE: Criteria Document (1976)

COMMENTS:
OSHA and ACGIH [1986] considered the positive carcinogenicity studies in mice and rats [Johnson 1986; Bull 1984]. The NIOSH REL [1976] was based on the neurotoxic effects of acrylamide in animals and man. IARC [1986] evaluated the same animal studies and determined that there is "sufficient evidence for carcinogenicity of acrylamide in animals." These data indicate that acrylamide meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH presently does not have a validated analytical method for acrylamide.

NAME: Acrylamide **CAS:** 79-06-1
CODE: H.S. 1008

REFERENCES:

ACGIH [1986]. Acrylamide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 12-13.

Bull RJ, Robinson M, Laurie RD, Stoner CD, Greisiger E, Meier JR, Stober J [1984]. Carcinogenic effects of acrylamide in SENCAR and A/J mice. Cancer Res 44:107-111.

IARC [1986]. Some chemicals used in plastics and elastomers. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 41-66.

Johnson KA, Garzinski SJ, Bodner KM, Campbell RA, Wolf CH, Friedman MA, Mast RW [1986]. Chronic toxicity and oncogenicity study on acrylamide incorporated in the drinking water of Fischer 344 rats. Toxicol Appl Pharmacol 85:154-168.

NIOSH [1976]. Criteria for a recommended standard....occupational exposure to acrylamide. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-112.

NAME: Amitrole (3-Amino-1,2,4-Triazole) **CAS:** 61-82-5
CODE: H.S. 1020

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 0.2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 82 (1972) **VOLUME:** 800,000 consumption (1985 EPA) POUNDS

TOXICITY:
Human Skin irritant **Animal** Cancer (thyroid, pituitary, liver in mouse and rat)

MUTAGENICITY:
Human -- **Other** NEG (Salmonella, mouse lymphoma, Drosopohila)
POS/NEG (cytogenetics)

TERATOGENICITY:
Human -- **Animal** POS (chick yolk sacs)

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Sufficient evidence (rat, mouse)
NTP : **Human** -- **Animal** Chronic feeding studies completed (no report)
NIOSH: --
ACGIH: Removed the A2 designation

NIOSH DATE:

COMMENTS:
Amitrole, an anti-thyroid compound, induced tumors or hyperplasia in the thyroid glands of rats [Jukes and Shaffer 1960; Steinhoff et al. 1983] and mice [Innes et al. 1969]. It produced pituitary tumors in rats [Steinhoff et al. 1983] and hepatomas in mice [Innes et al. 1969]. An epidemiological study of Swedish railroad workers [Axelson and Sundell 1974] and a follow-up study [Axelson et al. 1980] found a possible relationship

NAME: Amitrole (3-Amino-1,2,4-Triazole) **CAS:** 61-82-5
CODE: H.S. 1020

COMMENTS (continued):
between exposure to a combination of amitrol and phenoxy acids (such as 2,4-D and 2,4,5-T) and an increased overall tumor morbidity and mortality but the aspects of causal relationships to specific agents remain unclear. Amitrole is not teratogenic in rats nor is it mutagenic in a wide variety of standard mutation bioassays. The ACGIH [1986] removed its A2 carcinogen designation primarily because they determined that "since malignancies of the thyroids in rats required continuous dosing with hormonal imbalances, a carcinogenic risk to workers is deemed unlikely." The scientific data do not support removing the A2 designation and do indicate that amitrole meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. In addition, at the proposed PEL of 0.2 mg/m^3 as a TWA, the OSHA risk assessment shows the maximum likelihood estimate of risk to be 13/1000 workers. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

On page 21191 of the Federal Register (29 CFR 1910), OSHA states that "NIOSH recommends a 10-hour TWA of 0.3 mg/m^3 for amitrole." No NIOSH documentation on amitrole exists.

NIOSH does not have an LOQ for amitrole because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Amitrole. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 25.

Axelson O, Sundell L [1974]. Herbicide exposure, mortality and tumor incidence. An epidemiological investigation on Swedish railroad workers. Work Environm Hlth, No. 1, 11:21-28.

Axelson O, Sundell L, Andersson K, Edling C, Hogstedt C, Kling H [1980]. Herbicide exposure and tumor mortality. An updated epidemiologic investigation on Swedish railroad workers. Scand J Work Environ Health, No. 1, 6:73-79.

Innes JRM, Ulland BM, Valerio MG, Petrucelli L, Fishbein L, Hart ER, Pallotta AJ, Bates RR, Falk HL, Gart JJ, Klein M, Mitchell I, Peters J [1969]. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: a preliminary note. Journal of the National Cancer Institute 42(6):1101-1114.

Jukes TH, Shaffer CB [1960]. Antithyroid effects of aminotriazole. Science 132:296-297

Steinhoff D, Weber H, Mohr U, Boehme K [1983]. Evaluation of amitrole (aminotriazole) for potential carcinogenicity in orally dosed rats, mice, and golden hamsters. Toxicol Appl Pharmacol 69:161-169.

NAME: Aniline and Homologues

CAS: 62-53-3
CODE: H.S. 1025

PEL CURRENT:
(skin) 5 ppm | 20 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 2 ppm | 8 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(skin) 2 ppm | 8 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 19,276 (1982) **VOLUME:** 900 million (1983) POUNDS

TOXICITY:
Human Methemoglobinemia; eye and skin irritant; liver toxicity; CNS **Animal** Cancer; methemoglobinemia

MUTAGENICITY:
Human -- **Other** POS (Mouse lymphoma; cytogenetics)
NEG (Salmonella; Drosophila)

TERATOGENICITY:
Human -- **Animal**

CARCINOGENICITY:
IARC : **Human** NEG (Inadequate evidence) **Animal** POS/NEG (Limited evidence)
NTP : **Human** -- **Animal** Deferred
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Currently, OSHA's PEL is 5 ppm with skin notation and no STEL. The proposed PEL is 2 ppm (skin) because of possible toxic effects at 5 ppm. No STEL is proposed. This is adopted from ACGIH TLV value of 2 ppm [ACGIH 1986]. ACGIH recommended deletion of STEL until additional toxicological data become available.

Carcinogenicity of aniline has been long disputed. Early industrial experience indicated an increase in bladder cancers in workers exposed to aniline, but this has been later attributed to other chemicals. Ekman and Strombeck [1949] observed keratosis and proliferation of the bladder epithelium up to papilloma formation.

NAME: Aniline and homologues **CAS:** 62-53-3
CODE: H.S. 1025

COMMENTS (continued):
IARC reviewed aniline in 1982 [IARC 1982a; IARC 1982b] and cited several studies. A National Cancer Institute (NCI) study of 1978 found negative results in $B6C3F_1$ mice and positive results in Fischer 344 rats [NCI 1978]. Fibrosarcomas or sarcomas were seen in dose-related trend in the spleen and abdominal cavity in males and females. Hemangiosarcomas were seen in dose-related trend in spleen and body cavities of male rats. In a Japanese study [Hagiwara et al. 1980], an increase in papillomas of the forestomach was observed. A study in Osborne-Mendel rats indicated appearance of liver and splenic tumors in rats treated with aniline hydrochloride [White et al. 1948]. Based on these studies, IARC concluded that "there is limited evidence for the carcinogenicity of aniline hydrochloride in experimental animals." The available epidemiological data are insufficient to allow a conclusion as to the carcinogenicity of aniline in humans.

A histopathologic review of F344 rat spleens from the NCI study [1978] was conducted to assess splenotoxic changes associated with splenic sarcoma induced by these aromatic amines [Weinberger et al. 1985]. Fatty metamorphosis, splenic fibrosis, capsule hyperplasia and hemorrhage were markedly increased in incidence and severity in treated animals, correlated with tumor incidence. Treatment-related splenic lesions appear to be precursors of the induced splenic sarcomas.

A study in rats and mice [Parodi et al. 1982] indicated that, contrary to previously reported lack of mutagenicity, aniline caused DNA damage in vivo in the liver and kidney of rats and induced sister chromatid exchanges in Swiss mice bone marrow cells.

EPA [1985] classified aniline as group C, possible human carcinogen.

These data indicate that aniline meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 2002) for aniline is 0.9 ppm (30 L).

REFERENCES:
ACGIH [1986]. Aniline and homologues. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 30.

Ekman B, Strombeck JP [1949]. The effect of feeding aniline on the urinary bladder in rats. Acta Pathol Microbiol Immunol Scand 26:472-477.

EPA [1985]. Research and development: Health and environmental effects profile for aniline. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. Final draft report ECAO-CIN-P136.

Hagiwara et al. [1980]. Chronic effects of noharman in rats treated with aniline. Toxicol Ltr 6, pp. 71-75.

NAME: Aniline and homologues **CAS:** 62-53-3
CODE: H.S. 1025

REFERENCES (continued):

IARC [1982a]. Aniline (Group 3). IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 4. Lyon, France: World Health Organization. International Agency for Research on Cancer.

IARC [1982b]. Aniline and its hydrochloride. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 27. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NCI [1978]. Bioassay of aniline hydrochloride for possible carcinogenicity. Tech Rep Ser No. 130: Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-1385.

Parodi S, Pala M, Russo P, Zunino A, Balbi C, Albini A, Valerio F, Cimberle MR, Santi L [1982]. DNA damage in liver, kidney, bone marrow, and spleen of rats and mice treated with commercial and purified aniline as determined by alkaline elution assay and sister chromatide exchange induction. Cancer Res 42:2277-2283.

Weinberger MA, Albert RH, Montogomery SB [1985]. Splenotoxicity associated with splenic sarcomas in rats fed high doses of D & C red no. 9 or aniline hydrochloride. J Nat Cancer Inst 75(4):681-690.

White et al. [1948]. Oral administration of p-aminodimethylaniline, aniline and p-aminoazobenzene and the development of tumors in rats. Unio int contra cancrun Acta 6, 75-78.

NAME: Captafol (Difolatan)

CAS: 2425-06-1
CODE: H.S. 1066

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
ppm (skin) 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 3,700 (1974) **VOLUME:** 1.7 million (1975) POUNDS

TOXICITY:
Human Skin & respiratory irritation & sensitization **Animal** Kidney & bladder toxicity; cancer (mice)

MUTAGENICITY:
Human -- **Animal** POS (technical grade)

TERATOGENICITY:
Human -- **Animal** POS/NEG (fetotoxicity)

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA wants to adopt as the PEL the value of 0.1 mg/m^3 with a "skin" notation proposed by ACGIH in 1986. OSHA discusses the carcinogenicity issue based on a study by Reinhardt and Britelli [1981], which found no evidence of carcinogenicity of captafol. However, newer studies indicate that captafol is a broad spectrum carcinogen in mice and rats [Ito et al. 1984; EPA 1984, 1985, 1987].

EPA cancelled the registration of captafol in 1987 "based on data showing that captafol causes oncogenic effects in laboratory animals and is very toxic to fish." Captafol is classified by EPA as Group C. "a possible human carcinogen."

NAME: Captafol (Difolatan)

CAS: 2425-06-1
CODE: H.S. 1066

COMMENTS (continued):
These data indicate that captafol meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for captafol because there is no NIOSH analytical method.

REFERENCES:
EPA [1984]. Research and development: Health and environmental effects profile for captafol. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. Final draft report ECAO-CIN-P091.

EPA [1985]. Captafol; Special review of certain pesticide products. Washington, DC: U.S. Environmental Protection Agency. Federal Register 50(6):1103-1107.

EPA [1987]. Captafol: Decision to terminate a special review for pesticide products containing captafol. Washington, DC: U.S. Environmental Protection Agency. Federal Register 52(140):27576-27578.

Ito N, Ogiso T, Fukushima S, Shibata M, and Hagiwara A [1984]. Carcinogenicity of captafol in B6C3F$_1$ mice. Gann 75(10):853-865.

NAME: Captan **CAS:** 133-06-2
CODE: H.S. 1067

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 46,300 (1972 NOHS)

VOLUME: 13,000,000 (1978 - U.S. Domestic); POUNDS
130,000 (1980 - U.S. Imports) POUNDS

TOXICITY:
Human Irritant and low incidence sensitizer (IARC 1983)
Animal Irritant; reproductive and carcinogenic effects

MUTAGENICITY:
Human --
Other POS (Salmonella; cytogenetics [NTP]); sufficient evidence in cellular systems but insufficient evidence in mammals (IARC 1983)

TERATOGENICITY:
Human --
Animal Little, if any, potential (IARC 1983)

CARCINOGENICITY:
IARC : Human -- **Animal** Limited evidence
NTP : Human -- **Animal** POS (male and female mice); NEG (male and female rats)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Captan was tested for carcinogenicity in mice and rats by administration in the diet. It was carcinogenic to one strain of mice, inducing duodenal tumours (adenocarcinoma and adenomatous polyp). No evidence of carcinogenicity was found in rats [IARC 1983; NCI 1977].

NAME: Captan **CAS:** 133-06-2
CODE: H.S. 1067

COMMENTS (continued):
Captan has shown little, if any, embryotoxic or teratogenic potential in mice or rats at maternally tolerated doses. Results obtained in tests with rabbits and hamsters were considered inconclusive [IARC 1983].

Captan was mutagenic to bacteria and yeast. Both positive and negative results were obtained in the host-mediated assay in mice. Weak or negative effects were observed in Drosophila melanogaster. Captan induced chromosomal aberrations, sister chromatid exchange and mutations at several loci, but not unscheduled DNA synthesis, in cultured mammalian cells. No increase in micronucleated erythrocytes or chromosomal aberrations was detected in treated mice or rats; positive results obtained in dominant lethal tests in mice and rats were not confirmed by other studies. Thus, there is sufficient evidence to establish the mutagenicity of captan in cellular systems, but the data were insufficient to establish its mutagenicity in mammals [IARC 1983].

Results of the experiments in mice provide limited evidence [IARC 1983] that captan is carcinogenic to experimental animals. No data on humans were available. The available data are insufficient to evaluate the carcinogenicity of captan to humans. Captan should be considered as a potential occupational carcinogen as defined by OSHA [29 CFR 1990].

NIOSH does not have an LOQ for captan because there is no NIOSH analytical method.

REFERENCES:
IARC [1983]. Miscellaneous pesticides. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 30. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NCI [1977]. Bioassay of captan for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, Technical Report Series No. 15.

NAME: Carbon Tetrachloride **CAS:** 56-23-5
CODE: H.S. 1073

PEL CURRENT:
10 ppm 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(Ceiling - 25 ppm for 8 hours; 200 ppm peak for no more than 5 minutes, every 4 hours)

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) 2 ppm 12.6 mg/m^3 (ceiling - 60 min)

TLV:
(A2) 5 ppm (A2) 30 (skin) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) 2 ppm 12.6 mg/m^3 (ceiling - 60 min)

PRODUCTION WORKERS: 77,300 (1982) **VOLUME:** 707 million POUNDS

TOXICITY:
Human Cancer (liver), liver, kidney, CNS depressant **Animal** Liver, kidney toxicity, cancer (liver)

MUTAGENICITY:
Human -- **Animal** --

TERATOGENICITY:
Human -- **Animal** Increased fetal mortality

CARCINOGENICITY:
IARC : **Human** NEG (inadequate evidence) **Animal** POS (sufficient evidence)
NTP : **Human** -- **Animal** --
NIOSH: Potential occupational carcinogen
ACGIH: Suspected human carcinogen

NIOSH DATE: Criteria Document (1975); Revised Criteria Document (1976)

COMMENTS:
In the revised criteria document on carbon tetrachloride, NIOSH recommends that carbon tetrachloride be handled as a potential occupational carcinogen, and states:

> "Carbon tetrachloride shall be controlled in the workplace so that the concentration of carbon tetrachloride is not greater than 2 ppm (12.6 mg/m^3) of breathing zone air in a 45-liter air sample taken over a period not to exceed 1 hour in duration." [NIOSH 1976]

NAME: Carbon Tetrachloride **CAS:** 56-23-5
CODE: H.S. 1073

COMMENTS (continued):
ACGIH, in their documentation of the TLV refers to carbon tetrachloride as a "suspected human carcinogen." In the IARC Monograph, vol. 20, the World Health Organization states:

> "There is sufficient evidence that carbon tetrachloride is carcinogenic in experimental animals. There are suggestive case reports of liver cancer in humans. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard carbon tetrachloride as if it presented a carcinogenic risk to humans." [IARC 1979]

These data indicate that carbon tetrachloride meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

REFERENCES:
IARC [1979]. Some halogenated hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1976]. Revised recommended carbon tetrachloride standard. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-133.

NAME: Chloroform **CAS:** 67-66-3
CODE: H.S. 1086

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) 50 ppm 250 mg/m^3 (ceiling)

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) 2 ppm 9.78 mg/m^3 (STEL - 15 min.)

TLV (suspected human carcinogen):
(A2) 10 ppm (A2) 50 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) 2 ppm 9.78 mg/m^3 (ceiling)

PRODUCTION WORKERS: 95,330 (1982) **VOLUME:** 400,000,000 (1982) POUNDS

TOXICITY:
Human -- **Animal** Kidney; thyroid

MUTAGENICITY:
Human Kidney; liver; CNS **Other** NEG (Salmonella)

TERATOGENICITY:
Human -- **Animal** NEG

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Sufficient evidence
NTP : **Human** -- **Animal** Sufficient evidence
NIOSH: Ca (liver and kidney tumors)
ACGIH: A2 (suspected human carcinogen)

NIOSH DATE: Criteria Document (1974); Revised Criteria Document (1976); Current Intelligence Bulletin #9 (1976); Criteria Document (Waste Anesthetic Gases) (1977)

COMMENTS:
The current OSHA PEL for chloroform is 50 ppm ceiling. The ACGIH TLV [1986] is 10 ppm TWA with an A2 designation as a "suspected human carcinogen." The NIOSH REL [1976] is stated as a concentration not greater than 2 ppm in a 45-liter air sample taken over a period not to exceed 1 hour in duration. In the proposed, OSHA is proposing a 2 ppm short-term limit (15 min) as the PEL. Chloroform has been tested in 3 experiments in mice and in 1 in rats by oral administration [IARC 1979]. It produced liver cancers in mice, malignant kidney tumors in male rats and tumors of the thyroid in female rats. IARC judged this chemical to have "sufficient evidence" in animals and inadequate evidence in humans for carcinogenicity.

NAME: Chloroform

CAS: 67-66-3
CODE: H.S. 1086

COMMENTS (continued):
These data indicate that chloroform meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The 2 ppm NIOSH REL and proposed OSHA PEL are based on the lowest level that can be reliably measured. The NIOSH LOQ (Method #1003) for chloroform is 0.8 ppm (50 L).

REFERENCES:
ACGIH [1986]. Chloroform. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 130-131.

IARC [1979]. Some halogenated hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 401-427.

NIOSH [1974]. Criteria for a recommended standard....occupational exposure to chloroform. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-114.

NIOSH [1976]. Current intelligence bulletin #9: Chloroform. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-127.

NIOSH [1976]. Revised recommended chloroform standard. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NIOSH [1977]. A recommended standard for occupational exposure to....waste anesthetic gases and vapors. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-140.

NAME: Di-sec-octyl-phthalate **CAS:** 117-81-7
CODE: H.S. 1116

PEL CURRENT:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 5 mg/m^3 (TWA) -- ppm 10 mg/m^3 ( )

TLV:
-- ppm 5 mg/m^3 (TWA) -- ppm 10 mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 147,800 (1982) **VOLUME:** 251 million (1982) POUNDS

TOXICITY:
Human -- **Animal** Cancer (liver) rat and mouse

MUTAGENICITY:
Human -- **Other** Dominant lethal mutations and Salmonella

TERATOGENICITY:
Human -- **Animal** Skeletal effects

CARCINOGENICITY:
IARC : **Human** No adequate data **Animal** Sufficient evidence
NTP : **Human** Not classified **Animal** POS
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Synonym: di-2-ethylhexyl phthalate (DEHP). In the proposed rule, OSHA did not consider the results of the NTP bioassay [NTP 1982]. In an NTP bioassay [NTP 1982], DEHP elicited treatment-related increases in the incidence of liver carcinomas in male and female rats and mice. Fischer 344 rats (50 male and 50 female) and B6C3F$_1$ mice (50 of each sex) were fed diets containing DEHP at 6,000 ppm, 3,000 ppm or 0 ppm for 103 weeks. When compared with the controls, a statistically significant increase in the incidence of hepatocellular carcinomas resulted in both sexes of both species. Based on the results of the NTP bioassay, NIOSH [1983] recommended substitutes for DEHP in respirator quantitative fit testing. IARC [1982] reviewed the NTP [1982] feeding studies and determined that DEHP has "sufficient evidence" for carcinogenicity in mice

NAME: Di-sec-octyl-phthalate **CAS:** 117-81-7
CODE: H.S. 1116

COMMENTS (continued):
and rats. The U.S. Consumer Product Safety Commission (CPSC) [1985] reviewed the same data and concluded that "DEHP is carcinogenic in mice and rats, causing cancer of the liver." The CPSC [1985] considers DEHP "potentially carcinogenic to humans."

These data indicate that di-sec-octyl-phthalate meets the OSHA definition of a potential occupational carcinogenc as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 5120) for di-sec-octyl-phthalate is 0.015 mg/m^3 (200 L).

REFERENCES:
CPSC [1985]. Report to the U.S. Consumer Product Safety Commission by the Chronic Hazard Advisory Panel on di(2-ethylhexyl)phthalate (DEHP). Washington, DC: U.S. Consumer Product Safety Commission, Directorate for Health Sciences.

IARC [1982]. Some industrial chemicals and dyestuffs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 29. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1983]. Special occupational hazard review with control recommendations--alternatives to di-2-ethylhexyl phthalate ("DOP") respirator quantitative fit testing. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 83-109.

NTP [1982]. Carcinogenesis bioassay of di(2-ethylhexyl)phthalate (CAS No. 117-81-7) in F344 rats and B6C3F$_1$ mice (feed study). Research Triangle Park, NC; Bethesda, MD: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NIH Publication 82-1773 (NTP-80-37) (NTP TR 217)

NAME: Dichloroacetylene **CAS:** 7572-29-4
CODE: H.S. 1123

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) 0.1 ppm 0.4 mg/m^3 (ceiling)

TLV:
-- ppm -- mg/m^3 (TWA) 0.1 ppm 0.4 mg/m^3 (ceiling)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 61 (1982) **VOLUME:** -- POUNDS

TOXICITY:
Human Trace produced nausea; neurotoxic **Animal** Respiratory distress

MUTAGENICITY:
Human -- **Animal** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** Limited evidence
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
An inhalation carcinogenicity study [Reichert et al. 1984] with dichloroacetylene produced a statistically significant number of renal cystic adenocarcinomas in male mice and a significant number of other tumors in both sexes of mice and rats. IARC [1986] reviewed the Reichert inhalation studies and classified dichloroacetylene as having "limited evidence" for carcinogenicity to animals. On the basis of carcinogenic and tumorigenic responses in rats and mice, and in accordance with the Cancer Policy of the Occupational Safety and Health Administration (OSHA) ("Identification Classification and Regulation of Potential Occupational Carcinogens," 29 CFR 1990), dichloroacetylene may be classified as a potential occupational carcinogen. Since there is no safe level of exposure to a carcinogenic substance but lower exposure reduces the probability of cancer development, workers should be aware of the possible carcinogenic effects of dichloroacetylene.

NAME: Dichloroacetylene **CAS:** 7572-29-4
CODE: H.S. 1123

COMMENTS (continued):
Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 1003 - no NIOSH validation) for dichloroacetylene is 9 ppm (3 L).

REFERENCES:
IARC [1986]. Some chemicals used in plastics and elastomers. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Reichert D, Spengler U, Romen W, Henschler D [1984]. Carcinogenicity of dichloroacetylene: An inhalation study. Carcinogenesis 5:1411-1420.

NAME: Dichloroethyl Ether (Bis [2-Chloroethyl] Ether) **CAS:** 111-44-4
CODE: H.S. 1127

PEL CURRENT:
15 ppm 90 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
5 ppm 30 mg/m^3 (TWA) 10 ppm 60 mg/m^3 (STEL)

TLV:
5 ppm 30 mg/m^3 (TWA) 10 ppm 60 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 660,000 (1974) **VOLUME:** 13,300,000 (1977) POUNDS

TOXICITY:
Human Eye, upper respiratory, and lung 35 ppm not irritating **Animal** Irritation (eye and respiratory)

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** -- **Animal** Limited evidence (liver cancer - mice)
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The ACGIH, in 1971 [ACGIH 1986], revised the TLV for dichloroethyl ether to 5 TWA and 10 ppm STEL based on preventing eye and upper respiratory irritation, as well as lung injury. IARC, in 1975 [IARC 1975], reviewed dichloroethyl ether and found an increased incidence of liver-cell tumors in male mice of two species following oral administration. Subcutaneous route in mice produced low incidence of sarcomas at the injection site. IARC classified this chemical as having limited evidence of carcinogenicity. Subsequently, Weisburger et al. [1981] reported a negative carcinogenic finding in rats. Austria, Germany, and Japan have added carcinogen notation to this compound. A further evaluation of the carcinogenic data would seem to be in order since it has not been reviewed by ACGIH in the establishment of the TLV.

NAME: Dichloroethyl Ether (Bis [2-Chloroethyl] Ether) **CAS:** 111-44-4
CODE: H.S. 1127

COMMENTS (continued):
These data indicate that dichloroethyl ether meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. S-357) for dichloroethyl ether is 1.7 mg/m^3 (15-L).

REFERENCES:
ACGIH [1986]. Dichloroethyl ether. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 186.

IARC [1975]. Some aziridines, N-, S- & O-mustards and selenium. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 9. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Weisburger EK, Ulland BM, Nam J, Gart JJ, Weisburger JH [1981]. Carcinogenicity tests of certain environmental and industrial chemicals. JNCI 67:75-88.

NAME: 1,3-Dichloropropene **CAS:** 542-75-6
CODE: H.S. 1129

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 1 ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 1 ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,779 (1981) **VOLUME:** 35,500,000 (1977) POUNDS

TOXICITY:
Human Irritation; respiratory; liver; CNS/respiratory **Animal** Nasal, eye and skin irritation; cancer (rats and mice); kidney and liver toxicity

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** POS in several Salmonella studies, but there is evidence that polar impurities may be the cause

CARCINOGENICITY:
IARC : **Human** Inadequate evidence/(overall 2B: possibly carcinogenic to humans") **Animal** POS (sufficient evidence)
NTP : **Human** -- **Animal** Clear evidence for male F344/N rats; clear evidence for female B6C3F$_1$ mice
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Telone II® (89% 1,3-dichloropropene/2.5% of 1,2-dichloropropene/1.5% trichloropropene isomer/1% epichlorohydrin [also an animal carcinogen]) was tested by NTP [1985]. NTP TR 269 arrived at the following conclusions:

NAME: 1,3-Dichloropropene **CAS:** 542-75-6
CODE: H.S. 1129

COMMENTS (continued):

"Under the conditions of these gavage studies, there was clear evidence of carcinogenicity for male F344/N rats, as indicated by Telone II®-related increased incidences of squamous cell papillomas and carcinomas of the forestomach as well as an increased incidence of neoplastic nodules of the liver. In female F344/N rats, there was some evidence of carcinogenicity because Telone II® caused an increased incidence of squamous cell papillomas of the forestomach. The experiment in male $B6C3F_1$ mice was considered to be an inadequate study of carcinogenicity because of reduced survival in the vehicle control group. However, there was some indication in the male mice of Telone II®-related increases of transitional cell carcinomas of the urinary bladder, squamous cell papillomas of the forestomach, and alveolar/bronchiolar adenomas and carcinomas of the lung. There was clear evidence of carcinogenicity for female $B6C3F_1$ mice, since Telone II® caused increased incidences of transitional cell carcinomas of the urinary bladder; Telone II® also increased the incidences of alveolar/bronchiolar adenomas of the lung and squamous cell papillomas of carcinomas of the forestomach in the female mice. Telone II®-related nonneoplastic lesions included basal cell or epithelial cell hyperplasia in the forestomach of male and female rats and male and female mice, and epithelial hyperplasia of the urinary bladder in male and female mice."

IARC [1986] evaluated the evidence regarding 1,3-dichloropropene, including the NTP [1985] study. IARC [1986] considered the evidence for carcinogenicity to be "sufficient" for animals and "inadequate" for humans.

These data indicate that 1,3-dichloropropene meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 1003 - no NIOSH validation) for 1,3-dichloropropene is 1.3 ppm (15 L).

REFERENCES:

IARC [1986]. Some halogenated hydrocarbons and pesticide exposures. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 41. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NTP [1985]. Toxicology and carcinogenesis studies of Telone II (technical-grade 1,3-dichloropropene [CAS No. 542-75-6] containing 1.0% epichlorohydrin as a stabilizer) in F344/N rats and $B6C3F_1$ mice (gavage studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NIH Publication 85-2525 (NTP-83-22) (NTP TR 269).

NAME: Diglycidyl Ether

CAS: 2238-07-5
CODE: H.S. 1139

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) 0.5 ppm 2.8 mg/m^3 (ceiling)

PEL PROPOSED:
0.1 ppm 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
0.1 ppm 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) 0.2 ppm 1.0 mg/m^3 (ceiling - 15 minutes)

PRODUCTION WORKERS: 108 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human Acute irritant of eyes & respiratory tract; skin burns **Animal** Degeneration of germinal epithelium; mutagenic

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: Skin cancer (mice)
ACGIH: --

NIOSH DATE: Criteria Document (1978); Current Intelligence Bulletin # 29 (1978)

COMMENTS:
NIOSH believes diglycidyl ether to be a potential human carcinogen and recommends a ceiling value, never to be exceeded. Diglycidyl ether has produced skin cancers in mice [Kotin and Falk 1963], and a number of similar compounds have produced skin cancers as well [Weil et al. 1963]. Furthermore, these cancers were produced following topical application which is consistent with workplace exposure. These data indicate that diglycidyl ether meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen. NIOSH further recommends that exposure to diglycidyl ether be controlled to 0.2 ppm as a ceiling for any 15 minute period.

NAME: Diglycidyl ether

CAS: 2238-07-5
CODE: H.S. 1139

COMMENTS: (Continued)
The NIOSH LOQ (Method No. 336) for diglycidyl ether is 0.0014 mg/m^3 (720 L) and 0.033 mg/m^3 (30 L - for a short-term sample).

REFERENCES:
Kotin P, Falk HL [1963]. Organic peroxides, hydrogen peroxide, epoxides, and neoplasia. Radiat Res 3:193-211.

NIOSH [1978a]. Criteria for a recommended standard....occupational exposure to glycidyl ethers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 78-166.

NIOSH [1978b]. Current intelligence bulletin 29 - glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 79-104.

Weil CS, Condra N, Haun C, Striegel JA [1963]. Experimental carcinogenicity and acute toxicity of representative epoxides. Ind Hyg J 24:305-325.

NAME: Dimethyl Sulfate **CAS:** 77-78-1
CODE: H.S. 1142

PEL CURRENT:
1 ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
0.1 ppm 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
0.1 (A2) (skin) ppm 0.5 (A2) (skin) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(Appendix A2 - suspected carcinogen)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 10,500 (1982) **VOLUME:** 60,000,000 (1977) POUNDS

TOXICITY:
Human Irritation (respiratory, eyes), dysuria **Animal** Irritation (eye, respiratory), CNS effects, liver

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** inadequate **Animal** sufficient evidence
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: A2 (suspected carcinogen)

NIOSH DATE:

COMMENTS:
Dimethylsulfate has been shown to cause cancer in rats (sarcomas) [Druckrey 1966; Druckrey 1970]. IARC considers the evidence for animal carcinogenicity to be "sufficient," but the evidence for human carcinogenicity is considered "inadequate" [IARC 1973; IARC 1987]. ACGIH classified dimethyl sulfate as a "suspected carcinogen" [ACGIH 1986].

OSHA has concluded, based on the carcinogenicity in rats when administered by multiple routes, that there is sufficient evidence to predict that workers exposed to dimethyl

NAME: Dimethyl Sulfate

CAS: 77-78-1
CODE: H.S. 1142

COMMENTS (continued):
sulfate are at significant risk of developing cancer. OSHA states that reducing the current limit to 0.1 ppm will substantially reduce the risk of cancer in workers. These data indicate that dimethyl sulfate meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 301) for dimethyl sulfate is 0.015 ppm (12-L).

REFERENCES:

ACGIH [1986]. Dimethyl Sulfate. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 212-213.

Druckrey H, Kruse H, et al. [1970]. Cancerogenic alkylating substances - alkyl-halide, sulfate, sulfonate, and ring strained heterocyclic compounds. Z Krebsforsch 74:241-270.

Druckrey H, Preussmann R, Nashed N, Ivankovic S [1966]. Carcinogenic alkylating substances - I. Dimethylsulfate, carcinogenic action in rats and probable cause of occupational cancer. Zeit F Krebsforsch 68:103-111.

IARC [1973]. Some aromatic amines, hydrazine and related substances, N-nitroso compounds and miscellaneous alkylating agents. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Volume 4. Lyon, France: World Health Organization, International Agency for Research on Cancer.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs, volumes 1 to 42. IARC Monographs on the Evaluations of Carcinogenic Risks to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Dioxane

CAS: 123-91-1
CODE: H.S. 1145

PEL CURRENT:
(skin) 100 ppm | 360 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 25 ppm | 90 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(skin) 25 ppm | 90 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | -- mg/m^3 (TWA) | 1 ppm | 3.6 mg/m^3 (ceiling - 30-min)

PRODUCTION WORKERS: 100,000 (1977) **VOLUME:** -- POUNDS

TOXICITY:
Human CNS depression; renal failure; eye, nose, throat irritation **Animal** Liver and nasal tumors (rats); liver and kidney pathology

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** POS
NTP : Human -- **Animal** POS
NIOSH: POS - Animal
ACGIH: NEG

NIOSH DATE: Criteria Document (1977)

COMMENTS:
OSHA's current PEL for dioxane is 100 ppm with a skin notation. The proposed PEL reduction is to 25 ppm with a skin notation. Based on the data in the NIOSH Criteria Document [NIOSH 1977], these data indicate that dioxane meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen. NIOSH recommends a 30-minute ceiling value of 1 ppm (3.6 mg/m^3) for dioxane and a carcinogenic notation.

The recommended standard for occupational exposure to dioxane [NIOSH 1977] is devised to protect workers for 10-hour days, 40-hour weeks, over a working lifetime.

NAME: Dioxane

CAS: 123-91-1
CODE: H.S. 1145

REFERENCES:

NIOSH [1977]. A recommended standard for occupational exposure to....Dioxane. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-226.

NAME: Hexachlorobutadiene **CAS:** 87-68-3
CODE: H.S. 1195

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 0.02 ppm 0.24 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(A2) 0.02 ppm 0.24 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(skin)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,010 (1982) **VOLUME:** > 5,000 (1982) POUNDS

TOXICITY:
Human -- **Animal** Eye & nose irritation; kidney effects

MUTAGENICITY:
Human -- **Other** POS (AMES)

TERATOGENICITY:
Human -- **Animal** NEG (reproductive study in rats)

CARCINOGENICITY:
IARC : **Human** Inadequate **Animal** Limited evidence (1979)
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: Classified A2 (suspected human carcinogen)

NIOSH DATE: --

COMMENTS:
OSHA cited the lifetime dietary studies in which renal neoplasms were produced in rats fed 20 mg/kg/day [IARC 1979; Kociba et al. 1977a; Kociba et al. 1977b]. These data indicate that hexachlorobutadiene meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 307) for hexachlorobutadiene is 0.00002 ppm (100 L).

NAME: Hexachlorobutadiene **CAS:** 87-68-3
CODE: H.S. 1195

REFERENCES:

IARC [1979]. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans--Some Halogenated Hydrocarbons. Volume 20. Lyon, France: World, Health Organization, International Agency for Research on Cancer.

Kociba RJ, Keyes DG, Jersey GC, Ballard JJ, Dittenber DA, Quast JF, Wade CE, Humiston CG, and Schwetz BA [1977a]. Results of a two year chronic toxicity study with hexachlorobutadiene in rats. Amer Indus Hyg Assoc J 38:589-602.

Kociba RJ, Schwetz BA, Keyes DG, Jersey GC, Ballard JJ, Dittenber DA, Quast JF, Wade CE, and Humiston CG [1977b]. Chronic toxicity and reproduction studies of hexachlorobutadiene in rats. Environ Health Persp 21:49-53.

NAME: Hexachloroethane **CAS:** 67-72-1
CODE: H.S. 1197

PEL CURRENT:
(skin) 1 ppm (skin) 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 1 ppm (skin) 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
10 ppm 100 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(On TLV notice of intended changes at 1 ppm; 10 mg/m^3)

REL (lowest feasible level):
_____ ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 8,335 (1982) **VOLUME:** (approximately 3.2 x 10^6) POUNDS
(Not produced in U.S. but is imported)

TOXICITY:
Human Irritation (eye, mucous membrane) **Animal** Liver cancer; Toxicity (eye, membrane); CNS

MUTAGENICITY:
Human -- **Other** Kidney damage

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** POS (limited evidence)
NTP : Human -- **Animal** POS (hepatocellular carcinomas - mice)
NIOSH: POS (Current Intelligence Bulletin #27 [1978])
ACGIH: Cites National Cancer Institute data

NIOSH DATE: Current Intelligence Bulletin #27 (1978)

COMMENTS:
NIOSH supports OSHA's proposal not to raise the PEL on hexachloroethane. The study reported in the American Industrial Hygiene Journal [Weeks et al. 1979], is described by the author as "rangefinding" and "a baseline for supportive toxicological evidence of hexachloroethane action relevant to the OSHA standard." The subchronic inhalation studies were for 6 weeks, 6 hours a day, 5 days a week. Dogs exposed to 260 ppm showed severe symptoms (CNS) and death (1/4), without any evident clinically significant changes. Rats exposed to 260 ppm began to die at 4 weeks with "No exposure-related gross changes" evident at necropsy (4% mortality).

NAME: Hexachloroethane

CAS: 67-72-1
CODE: H.S. 1197

COMMENTS (continued):
The data cited in the Weeks report [Weeks et al. 1979] and by IARC on the metabolism of hexachloroethane indicate that rabbits dosed with C-14 labeled compound excreted only 5% of 0.5g dose in their urine and exhaled 14% to 24% in their breath after 3 days and the rest was found in the carcass at sacrifice. NIOSH would suggest that the slow metabolic clearance of this compound indicates that the exposure times and durations reported by Weeks are inadequate to justify an increase in the PEL. Based on the reported neurotoxic effects [Weeks et al. 1979], the positive carcinogenic data in mice (hepatocellular carcinomas) [NCI 1978], and the review of toxicity of the chloroethanes [NIOSH 1978], NIOSH concurs with OSHA in not raising the PEL to the current TLV of 10 ppm. As stated in CIB #27, NIOSH recommends that hexachloroethane be labeled as a potential occupational carcinogen and exposures should be limited to as few employees as possible, while minimizing workplace exposure levels with engineering and work practice controls.

These data indicate that hexachloroethane meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990.

The NIOSH LOQ (Method No. 1003) for hexachloroethane is 0.03 ppm (70 L).

REFERENCES:
NIOSH [1978]. Current intelligence bulletin #27: Chloroethanes: Review of toxicity. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-181.

NCI [1978]. Bioassay of hexachloroethane for possible carcinogenicity. CAS No. 67-72-1, National Cancer Institute, Carcinogenesis, Technical Report Series No. 68, U.S. Department of Health, Education and Welfare, National Institutes of Health.

Weeks MH, Angerhofer RA, Bishop R, Thomasino J, Pope CR [1979]. The toxicity of hexachloroethane in laboratory animals. Am Ind Hyg Assoc J 40:187-199.

NAME: Methyl Iodide **CAS:** 74-88-4
CODE: H.S. 1259

PEL CURRENT:
(skin) 5 ppm | 28 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 2 ppm | 10 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(A2) 2 ppm (skin) | (A2) 10 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL (Reduce exposures to the fullest extent feasible):
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 2,833 (OSHA 1988) **VOLUME:** 103,000 (USITC 1983) POUNDS

TOXICITY:
Human Skin irritation; gastrointestinal distress; neurotoxicity (CNS) **Animal** Hepatotoxin; cancer (rat, mouse); irritation (skin, eye, pulmonary)

MUTAGENICITY:
Human -- **Other** POS (Salmonella and mouse lymphoma)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** No adequate data **Animal** POS (limited evidence)
NTP : **Human** -- **Animal** --
NIOSH: Potential occupational cancer
ACGIH: POS; A2--suspected human carcinogen

NIOSH DATE: Current Intelligence Bulletin (1984)

COMMENTS:
The proposed PEL and NIOSH REL are based on the same animal studies. NIOSH's Current Intelligence Bulletin #43 [1984], recommends that methyl iodide be considered a "potential occupational carcinogen" and as such that exposures should be reduced to the "fullest extent feasible." NIOSH based its recommendation on the fact that methyl iodide produced cancer in mice [Poirier et al. 1975] and rats [Druckrey et al. 1970], and that it is a direct acting mutagen in mouse lymphoma assay [Clive et al. 1979]. IARC [1986] reviewed the same animal studies and concluded that there is "limited evidence for carcinogenicity of methyl iodide in experimental animals". These data indicate that methyl iodide meets the OSHA definition of a potential occupational

NAME: Methyl Iodide **CAS:** 74-88-4
CODE: H.S. 1259

COMMENTS (continued):
carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 1014) for methyl iodide is 1.7 ppm (50 L).

REFERENCES:
Clive D, Johnson KO, Spector JFS, Batson AG, Brown MMM [1979]. Validation and characterization of the L5178Y/TK+/-mouse lymphoma mutagen assay system. Mutat Res 59:61-108.

Druckrey H, Kruse H, Preussman R, Ivankovic S, Landschutz C [1970]. Cancerogenic alkylating substances-alkyl-halide, sulfate, sulfonate, and ring strained heterocyclic compounds. Z Krebsforsch 74:241-70 (Ger.).

IARC [1986]. Some halogenated hydrocarbons and pesticide exposures. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 41. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1984]. Current intelligence bulletin #43: Monohalomethanes. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-117.

Poirier LA, Stoner GD, Shimkin MB [1975]. Bioassay of alkyl halides and nucleotide base analogs by pulmonary tumor response in strain A mice. Cancer Res 35:1411-1415.

NAME: Nickel Carbonyl

CAS: 13463-39-3
CODE: H.S. 1284

PEL CURRENT:
0.001 ppm 0.007 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
0.001 ppm 0.007 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
0.05 ppm as Ni 0.35 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
0.001 ppm 0.007 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 500 (1977) VOLUME: -- POUNDS

TOXICITY:
Human Pulmonary effects; headache; dizziness Animal Edema of lung and brain

MUTAGENICITY:
Human -- Other

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal POS IARC 11,75,76 (suspected 2,126,73)
NTP : Human 4th Ann. Report Animal --
NIOSH: Special Hazard Review (1977); cancer
ACGIH: --

NIOSH DATE:

COMMENTS:
NIOSH agrees with OSHA that a very high standard of proof should be required for any relaxation of existing exposure limits. OSHA has properly determined that there is not sufficient evidence to warrant any increase in the existing PEL for nickel carbonyl. The scientific evidence concerning potential carcinogenicity of nickel carbonyl has been reviewed by NIOSH (1977), the NTP (1985), and IARC (1973, 1976, 1987). NIOSH (1977) considered nickel carbonyl carcinogenic. The NTP listed nickel carbonyl in the Fourth Annual Report on Carcinogens among the chemicals that "may reasonably be anticipated to be carcinogens." IARC (1987) classified the evidence of carcinogenicity in animals as

NAME: Nickel Carbonyl **CAS:** 13463-39-3
CODE: H.S. 1284

COMMENTS: (Continued)
"sufficient." These data indicate that nickel carbonyl meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 6007) for Nickel Carbonyl is 0.09 ppb (80 L).

REFERENCES:
IARC (1976). Cadmium, nickel, some epoxides, miscellaneous industrial chemicals and general considerations on volatile anesthetics. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Volume 11. Lyon, France: IARC Working Groups on the Evaluation of the Carcinogenic Risk of Chemicals to Man.

IARC [1973]. Some inorganic and organometallic compounds. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 2. Lyon, France: IARC Working Groups on the Evaluation of the Carcinogenic Risk of Chemicals to Man.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs Volumes 1 to 42. Supplement 7. Lyon, France: IARC Working Groups on the Evaluation of the Carcinogenic Risk of Chemicals to Man.

NTP (1985). Fourth Annual Report on Carcinogens. National Toxicology Program. NTP 85-001.

NAME: Silica, Crystalline-Cristobalite (respirable)

CAS: 14464-46-1
CODE: H.S. 1354

PEL CURRENT:
-- ppm | $\frac{5\ mg/m^3}{\%\ SiO_2 + 2}$ (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
-- ppm | 0.05 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
-- ppm | 0.05 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | 50 ug/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Silicosis, fibrosis Animal Silicosis, fibrosis, cancer

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1974)

COMMENTS:
In the Criteria Document on crystalline silica, NIOSH defines free silica as silicon dioxide (SiO_2) and states, "Other forms of free silica which, upon analysis, are found to have a crystalline structure as part of their composition are also subject to the recommended standard [NIOSH 1975]." Therefore, silica HS 1354, HS 1355, HS 1356, HS 1357, and HS 1358 are covered by the NIOSH REL of 50 ug/m^3.

We believe that the OSHA statement under HS 1355 silica, crystalline - quartz, "NIOSH admits to significant error in the exposure estimates used to establish its 0.05 ug/m^3 REL..." is an overstatement of the qualifying statements cited in the criteria document on crystalline silica. The ACGIH documentation of the TLV for silica, crystalline - quartz states, "Since the margin of safety of the quartz TLV is not known, it is

NAME: Silica, Crystalline-Cristobalite (respirable) **CAS:** 14464-46-1
CODE: H.S. 1354

COMMENTS (continued):
recommended that quartz concentrations be maintained as far below the TLV as current practices will permit" [ACGIH 1986].

In its 1987 Monograph on silica and some silicates, IARC [IARC 1987] reviews the experimental animal and epidemiological data on a variety of crystalline forms of silica, including those considered by OSHA for revision of PELs. IARC's evaluations are that there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans.

Because of the ubiquitous nature of exposure to crystalline silica and often frequent concomitant occupational exposure (or through tobacco smoking) to one or more carcinogenic chemicals, it is recommended that the greatest degree of protection [Lemen et al. 1986] could be gained by adherence to the NIOSH REL of 50 ug/m^3 (for all forms of crystalline SiO_2) which approaches the present lowest quantifiable limit of detection (NIOSH Analytical Method No. 7500 or Method No. 7602. This rationale would apply to protection against silicosis as well as the reported potential carcinogenicity from exposure to certain crystalline silicas.

These data indicate that silica, crystalline - cristobalite meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 7500) for silica, crystalline - cristobalite is 0.04 mg/m^3 (1000 L).

REFERENCES:
ACGIH [1986]. Silica, Crystalline - Cristobalite. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 523-524.

IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lemen RA, Dunnon DD, Wagner WD, Mazzuckelli LF [1986]. Recommended standards for occupational exposure to silica. In: Silica, silicosis, and cancer--controversy in occupational medicine. New York, NY: Praeger Publishers.

NIOSH [1974]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.

NIOSH - JULY 1988

NAME: Silica, Crystalline-Tridymite (respirable)

CAS: 15468-32-3
CODE: H.S. 1356

PEL CURRENT:					
-- ppm	5 mg/m^3 / % SiO_2 + 2 (TWA)	-- ppm	-- mg/m^3	( )	
PEL PROPOSED:					
-- ppm	0.05 mg/m^3 (TWA)	-- ppm	-- mg/m^3	( )	
TLV:					
-- ppm	0.05 mg/m^3 (TWA)	-- ppm	-- mg/m^3	( )	
REL:					
-- ppm	50 þg/m^3 (TWA)	-- ppm	-- mg/m^3	( )	

PRODUCTION WORKERS: --

VOLUME: -- POUNDS

TOXICITY:
Human Silicosis, fibrosis Animal Silicosis, fibrosis, cancer

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1974)

COMMENTS:
In the Criteria Document on crystalline silica, NIOSH defines free silica as silicon dioxide (SiO_2) and states, "Other forms of free silica which, upon analysis, are found to have a crystalline structure as part of their composition are also subject to the recommended standard [NIOSH 1975]." Therefore, silica HS 1354, HS 1355, HS 1356, HS 1357, and HS 1358 are covered by the NIOSH REL of 50 þg/m^3.

We believe that the OSHA statement under HS 1355 silica, crystalline - quartz, "NIOSH admits to significant error in the exposure estimates used to establish its 0.05 þg/m^3 REL..." is an overstatement of the qualifying statements cited in the criteria document on crystalline silica. The ACGIH documentation of the TLV for silica, crystalline - quartz states, "Since the margin of safety of the quartz TLV is not known, it is recommended that quartz concentrations be maintained as far below the TLV as current practices will permit" [ACGIH 1986].

In its 1987 Monograph on silica and some silicates, IARC [IARC 1987] reviews the experimental animal and epidemiological data on a variety of crystalline forms of silica, including those considered by OSHA for revision of PELs. IARC's evaluations are that there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans.

Because of the ubiquitous nature of exposure to crystalline silica and often frequent concomitant occupational exposure (or through tobacco smoking) to one or more NAME:

Silica, Crystalline-Tridymite (respirable) CAS: 15468-32-3
CODE: H.S. 1356

COMMENTS (continued):

carcinogenic chemicals, it is recommended that the greatest degree of protection [Lemen et al. 1986] could be gained by adherence to the NIOSH REL of 50 $\mu g/m^3$ (for all forms of crystalline SiO_2) which approaches the present lowest quantifiable limit of detection (NIOSH Analytical Method No. 7500 or Method No. 7602. This rationale would apply to protection against silicosis as well as the reported potential carcinogenicity from exposure to certain crystalline silicas.

These data indicate that silica, crystalline - tridymite meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 7500) for silica, crystalline - tridymite is 0.04 mg/m^3 (1000 L).

REFERENCES:

ACGIH [1986]. Silica, Crystalline - Tridymite. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 523-524.

IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lemen RA, Dunnon DD, Wagner WD, Mazzuckelli LF [1986]. NIOSH standards. In: Silica, silicosis, and cancer--controversy in occupational medicine. New York, NY: Praeger Publishers.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.

NAME: 1,1,2,2-Tetrachloroethane **CAS:** 79-34-5
CODE: H.S. 1385

PEL CURRENT:
(skin) 5 ppm | 35 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 1 ppm | 7 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(skin) 1 ppm | 7 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL (Lowest feasible limit):
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 11,100 (1978) **VOLUME:** -- POUNDS

TOXICITY:
Human CNS; liver **Animal** CNS; liver

MUTAGENICITY:
Human NEG **Other** POS in strain TA1530 and TA1535 Salmonella; NEG in TA1538 strains of Salmonella

TERATOGENICITY:
Human -- **Animal** Possible - low incidence

CARCINOGENICITY:
IARC : **Human** Inadequate **Animal** POS (limited)
NTP : **Human** -- **Animal** POS
NIOSH: POS
ACGIH: --

NIOSH DATE: Criteria Document (1977); Current Intelligence Bulletin #27 (1978)

COMMENTS:
NIOSH's recommendation concerning the proposed PEL change for 1,1,2,2-tetrachloroethane is the inclusion of a carcinogenic notation. NIOSH's CIB #27 [1978] estimates that approximately 11,100 workers are exposed to 1,1,2,2-tetrachloroethane and it is strongly recommended that workers handle it as a carcinogen. The National Cancer Institute (NCI), in 1978, administered 1,1,2,2-tetrachloroethane in high- and low-dosage amounts to separate groups of 50 mice ($B_6C_3F_1$) and rats (Osborne-Mendel), each containing equal amounts of females and males. Liver cancer resulted in both sexes among mice and rats. The data obtained from NCI exemplifies a statistically significant incidence of cancer concerning 1,1,2,2-tetrachloroethane.

NAME: 1,1,2,2-Tetrachloroethane **CAS:** 79-34-5
CODE: H.S. 1385

COMMENTS (continued):
OSHA's proposed PEL reduction for 1,1,2,2-tetrachloroethane to a TWA of 1 ppm does not alert workers of the possibility of carcinogenic effects. Based on the evidence, NIOSH recommends the addition of a carcinogen notation to the reduced PEL proposed by OSHA. Carcinogenic effects have been recorded exclusively in lab animals but there is a potential risk to man. NIOSH's CIB #27 [1978] clearly states that there is no safe level of exposure to a carcinogenic substance but lower exposure reduces the probability of cancer development, and that workers should be aware of the possible carcinogenic effects. These data indicate that 1,1,2,2-tetrachloroethane meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen. Exposures should be reduced to the lowest feasible limit. The NIOSH LOQ (Method #1019) for 1,1,2,2-tetrachloroethane is 0.7 ppm (10 L).

REFERENCES:
NIOSH [1978]. Current intelligence bulletin #27: Chloroethanes: Review of toxicity. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-181.

NIOSH - JULY 1988

NAME: o-Toluidine **CAS:** 95-53-4
CODE: H.S. 1399

PEL CURRENT:
5 ppm 22 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
2 ppm 9 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(A2) 2 ppm (A2) 9 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(Skin)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 13,100 (1972) **VOLUME:** 5,500,000 (1977) POUNDS

TOXICITY:
Human Bladder tumors Animal Cancer (bladder, skin, liver)

MUTAGENICITY:
Human -- Other POS (Sister chromatid exchange)
POS (Unscheduled DNA synthesis)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human Inadequate evidence Animal Sufficient evidence
NTP : Human -- Animal POS
NIOSH: --
ACGIH: POS (A2)

NIOSH DATE: /

COMMENTS:
Ortho-toluidine is an aromatic amine which has been shown to cause cancer in 56% of rats when fed at a concentration of 3,000 ppm in the diet [Weisburger et al. 1978]. The existing TLV [ACGIH 1986] and OSHA's proposed TLV is 2 ppm. Based on OSHA's risk assessment, reduction of the PEL to 2 ppm will reduce the risk of developing cancer to 0.055 - 0.64 per 1,000 workers. It is not clear whether OSHA has factored skin absorption of o-toluidine into the risk assessments. Since a major route of exposure to other carcinogenic aromatic amines has been shown to be through the skin [Meigs et al. 1954], it is quite likely that this is also the case for o-toluidine. Failure to address the importance of preventing skin absorption of o-toluidine will result in a non-protective standard. This substance meets the definition in the OSHA carcinogen policy (29 CFR 1990) and should be labeled as a carcinogen.

NAME: o-Toluidine **CAS:** 95-53-4
CODE: H.S. 1399

COMMENTS (continued):
The NIOSH LOQ (Method No. 2002) for o-Toluidine is 0.15 ppm (150 L).

REFERENCES:
ACGIH [1986]. o-Toluidine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 586-588.

Meigs JW, Sciarini LJ, Van Sandt WA [1954]. Skin penetration by diamines of the benzidine group. Arch Ind Hyg 9:122-132.

Weisburger EK, Russfield AB, Homburger F, Boger E, Van Dongen CG, Chu KC [1978]. Testing of twenty-one environmental aromatic amines or derivatives for long-term toxicity or carcinogenicity. J Environ Pathol Toxicol 2:325-356.

NAME: Trichloroethylene **CAS:** 79-01-6
CODE: H.S. 1406

PEL CURRENT:

100	ppm	540	mg/m^3 (TWA)	200	ppm	1080	mg/m^3 (ceiling)
				300	ppm	1620	mg/m^3 (peak)

PEL PROPOSED:

25	ppm	135	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

TLV:

50	ppm	270	mg/m^3 (TWA)	200	ppm	1080	mg/m^3 (STEL)

REL:

25	ppm	135	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PRODUCTION WORKERS: 2,780,000 (1972) **VOLUME:** 377,000,000 (1981) POUNDS

TOXICITY:
Human CNS depression; skin irritation; liver & kidney toxicity; cardiac arrhythmias **Animal** Eye & skin irritation; CNS depression; liver & kidney toxicity; liver cancer

MUTAGENICITY:
Human -- **Other** POS (mouse lymphoma); NEG (Salmonella); EQUIV (Drosophila, cytogenetics)

TERATOGENICITY:
Human -- **Animal** NEG (inconclusive)

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Limited evidence (1979, 1987)
NTP : **Human** -- **Animal** POS (mice, 1976); inadequate studies (rats, 1988)
NIOSH: Potential human carcinogen (1978)
ACGIH: --

NIOSH DATE: Current Intelligence Bulletin #2, Criteria Document (1977), Special Occupational Hazard Review (1978)

COMMENTS:
OSHA proposes to adopt the NIOSH REL of 25 ppm [NIOSH 1978]. NIOSH recommends that OSHA also label this substance as a potential occupational carcinogen. OSHA reviewed all the known animal and human carcinogenicity studies for this rulemaking. Although there were

NAME: Trichloroethylene **CAS:** 79-01-6
CODE: H.S. 1406

COMMENTS:
several equivocal and negative animal and human carcinogenicity studies [IARC 1979; NTP 1988], trichlorethylene produced hepatocellular carcinomas in both male and female mice [NCI 1976]. IARC [1979, 1987] reviewed all of the studies available to OSHA and determined that there is "limited evidence for carcinogenicity" of trichloroethylene in animals. NIOSH [1975, 1978] based its conclusion that trichloroethylene has "a carcinogenic potential in the workplace" on the NCI [1976] study. NIOSH [1977] also recommended that where halogenated anesthetic gases, including trichlorethylene, are used alone, "exposure should be limited to the lowest level detectable by monitoring methods used in the workplace." These data indicate that trichloroethylene meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 1022) for trichloroethylene is 3 ppm for a 3-L air sample (a STEL).

REFERENCES:
IARC [1979]. Some halogenated hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 545-574.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 364-366.

NCI [1976]. Carcinogenesis bioassay of trichloroethylene (CAS no. 79-01-6). Technical Report Series No. 2. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Cancer Institute. DHEW (NIH) Publication No. 76-802.

NIOSH [1975]. Current intelligence bulletin #2: Trichloroethylene (TCE). Current intelligence bulletin reprints - bulletins 1-18. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-127.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to waste anesthetic gases and vapors. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-140.

NIOSH [1978]. Special occupational hazard review of trichloroethylene. Rockville, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NAME: Trichloroethylene

CAS: 79-01-6
CODE: H.S. 1406

REFERENCES:

NTP [1988]. NTP technical report on the toxicology and carcinogenesis studies of trichlorethylene (CAS No. 79-01-6) in four strains of rats (ACI, August, Marshall, Osborne-Mendel (Gavage studies), NTP TR 273. Research Triangle Park, NC: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Toxicology Program. NIH Publication No. 88-2529.

NAME: Toluene-2,4-Diisocyanate **CAS:** 584-84-9
CODE: H.S. 1398

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) 0.02 ppm 0.15 mg/m^3 (ceiling)

PEL PROPOSED:
0.005 ppm 0.04 mg/m^3 (TWA) 0.02 ppm 0.15 mg/m^3 (STEL)

TLV:
0.005 ppm 0.04 mg/m^3 (TWA) 0.02 ppm 0.15 mg/m^3 (STEL)

REL:
0.005 ppm 0.04 mg/m^3 (TWA) 0.02 ppm 0.15 mg/m^3 (ceiling - 10 min)

PRODUCTION WORKERS: 29,000 (1972) **VOLUME:** 650,000,000 (1987) POUNDS

TOXICITY:
Human Sensitization (respiratory); chemical bronchitis; asthma; CNS effects at high doses **Animal** Respiratory tract irritation; bronchitis; pneumonia; cancer (multiple sites)

MUTAGENICITY:
Human -- **Other** 2,4-TDI: NEG (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human Inadequate evidence **Animal** Sufficient evidence
NTP : Human -- **Animal** Sufficient evidence (80:20 mix of 2,4 and 2,6-TDI)
NIOSH:
ACGIH: --

NIOSH DATE: Criteria Document (1973) (1978); Respiratory and Immunologic Evaluation of Isocyanate Exposure in a New Manufacturing Plant (1981)

COMMENTS:
The current NIOSH REL for TDI is 0.04 ppm [1973, 1978] (0.035 mg/m^3) as a TWA for up to a 10-hour workday and a 40-hour workweek, with a 10-minute ceiling of 0.02 ppm (0.15 mg/m^3). This REL is based primarily on respiratory effects. NIOSH is in the process of developing a Current Intelligence Bulletin (CIB) entitled "Toluene Diisocyanate (TDI) and Toluene Diamine (TDA): Evidence of Carcinogenicity." This CIB is based on a recent study [NTP 1986] of chronic effects in animals that has produced

NAME: Toluene-2,4-Diisocyanate

CAS: 584-84-9
CODE: H.S. 1398

COMMENTS (continued):
evidence that cancer is associated with exposure to commercial grade TDI (an 80:20 mixture of 2,4- and 2,6-TDI), and to a TDI hydrolysis product, 2,4-TDA. In the NTP study, treatment of rats and mice of both sexes by gavage to commercial grade TDI resulted in tumor induction, primarily in the pancreas and liver in male and female rats and in female mice. The systemic nature of TDI carcinogenicity was demonstrated by the appearance of tumors at multiple sites (skin, mammary glands and circulatory system). Although not statistically significant, uncommon brain tumors were found in the treated male rats (two gliomas and one pinealoma). In addition, an experimental animal study has indicated that 2,4-TDA, a hydrolysis product of 2,4-TDI, is also a carcinogen [NCI 1979]. Oral exposure of rats and mice of both sexes resulted in tumor induction in the liver in male and female rats and in female mice; tumors were also observed in the skin and mammary glands.

The tumorigenic responses observed in both rats and mice treated with TDI meet the criteria of the OSHA cancer policy [29 CFR 1990] for classifying a substance as a potential occupational carcinogen. Although the carcinogenic potential of the other TDI isomers has not been adequately determined, reducing exposure to them would reduce the risk of cancer. NIOSH recommends that all the isomers of TDI be regarded as potential human carcinogens, and that occupational exposures to them be limited to the lowest feasible concentration.

IARC has recently [1986] evaluated the data that have become available on TDI. The IARC working group concluded that there was sufficient evidence for the carcinogenicity of TDI in experimental animals. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method #2535) is 1.7 ug/m^3.

REFERENCES:
IARC [1986]. Some chemicals used in plastics and elastomers. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NCI [1979]. Bioassay of 2,4-diaminotoluene for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, DHEW Publication No. (NIH) 79-1718.

NTP [1986]. NTP technical report on the toxicology and carcinogenesis studies of commercial grade 2,4 (80%)- and 2,6 (20%)-toluene diisocyanate (CAS No. 26471-62-5) in F344/N rats and B6C3F$_1$ mice (gavage studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program, NTP TR 251, NIH Publication No. 86-2507.

NAME: 1,2,3-Trichloropropane

CAS: 96-18-4
CODE: H.S. 1407

PEL CURRENT:
50 ppm 300 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 10 ppm (skin) 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 10 ppm (skin) 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 492 (1982) **VOLUME:** 65,500,500 (1977) POUNDS

TOXICITY:
Human Irritant (skin, eye, respiratory) narcosis; liver toxicity Animal Irritant (skin, eye); CNS; liver and kidney toxicity

MUTAGENICITY:
Human -- Other POS (Salmonella; mouse lymphoma; cytogenetics)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal On test
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The NTP report on 1,2,3-trichloropropane is in the final stage of preparation. All animal exposures and tissue preparations have been completed. Preliminary histopathological reports indicate that trichloropropane is capable of producing multiple type tumors at low levels of exposure (gavage) in both sexes of rats and mice. For current information on the status of the bioassay, the NTP chemical manager (Tom Burka, FTS 629-4667) for 1,2,3-trichloropropane should be contacted. If 1,2,3-trichloropropane proves to be carcinogenic, NIOSH would recommend that OSHA put a cancer designation with the PEL.

The NIOSH LOQ (Method No. 1003) for 1,2,3-trichloropropane is 0.3 ppm (60-L air).

NAME: Uranium, insoluble **CAS:** 1440-61-1
CODE: H.S. 1418

PEL CURRENT:
-- ppm 0.25 as U mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.2 as U mg/m^3 (TWA) -- ppm 0.6 as U mg/m^3 (STEL - 15-min)

TLV:
-- ppm 0.2 as U mg/m^3 (TWA) -- ppm 0.6 as U mg/m^3 (STEL - 15-min)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 13,500 (OSHA 1988) **VOLUME:** Classified POUNDS

TOXICITY:
Human Low oral toxicity **Animal** 50 mg/kg rat

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** Rat; mouse

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --
OTHER: IARP - Uranium is an alpha particle emitter and a radon source.

NIOSH DATE:

COMMENTS:
The OSHA justification of the proposed new limit is extracted from the ACGIH documentation [ACGIH 1986] and the data cited is not supportive of the proposed limit. In the data cited by OSHA, the Mason [1958], Patterson [1958], and McKown [1958] papers, it is clearly stated that during high exposures workers wore respiratory protection. After 1950 the workers were exposed to less than 0.050 mg/m^3, less than one-fourth of the proposed PEL. Insoluble uranium is a potential carcinogen due to its alpha and Radon emitting properties. The guidelines followed in the industry for exposure to insoluble uranium are those of the International Conference on Radiation Protection

NAME: Uranium, insoluble **CAS:** 1440-61-1
CODE: H.S. 1418

COMMENTS (continued):
(ICRP) and the National Conference on Radiation Protection (NCRP). These limits are based on alpha emitting radiation exposure, and the present ICRP limit for natural uranium in insoluble form would correspond to 0.050 mg/m^3.

A significant body of data exists to establish the carcinogenicity of insoluble uranium [NIOSH 1987]. If OSHA chooses to accept the past manufacturing experience as a no-effect level, then the limit in use, 0.050 mg/m^3, should be proposed. Based on the same data that NIOSH used in the soluble uranium comments, a carcinogen label should be attached and the 0.050 mg/m^3 limit from ICRP should be the highest level considered protective.

These data indicate that uranium, insoluble meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for insoluble uranium compounds because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Uranium, insoluble. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 617.

ICRP [1978]. Limits for intake of radionuclides by workers. Oxford, England: International Commission on Radiological Protection. Pergamon Press. ICRP Publication No. 30.

Mason MG [1958]. A summary of fifteen years of experience with dust problems in the refining and fabrication of uranium. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

McKown DA [1958]. Survey of air-borne normal uranium from various operations at Los Alamos Scientific Laboratory. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

NIOSH [1987]. A recommended standard for occupational exposure to...radon progeny in underground mines. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-101.

Patterson GR [1958]. Air sampling for the control of internal exposure from enriched uranium at Y-12. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

NAME: Uranium (Soluble Compounds) **CAS:** 7440-61-1
CODE: H.S. 1419

PEL CURRENT:
-- ppm 0.05 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 0.05 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 0.2 as U mg/m^3 (TWA) -- ppm 0.6 as U mg/m^3 (STEL - 15-min)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: Not available
13,365 to insoluble (OSHA) **VOLUME:** -- POUNDS

TOXICITY:
Human Kidney (0.01 mg/kg) **Animal** Acute nephrotoxin - Uranyl nitrate

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Radon Criteria Document (1987)

COMMENTS:
The ACGIH documentation [1986] considers exposure to two separate types of uranium compounds, soluble and insoluble. The Z-1 Table has a value of 0.25 mg/m^3 for insoluble uranium compounds and a value of 0.05 mg/m^3 for soluble compounds.

ACGIH describes data concerning mill workers prior to 1958 as follows: a) "Prior to 1950, exposures were commonly 4 to 30 times the 0.05 mg limit;" b) "Exposures of the majority of uranium plant workers were to dust of uranium feed materials, to the intermediates, to uranium metal, and included the soluble and most toxic of the industrial uranium compounds, UF6;" c) "During the period of high exposures, well over 1,000 workers were exposed;" d) "In one plant with about 800 workers, 90% were exposed to multiples of the TLV until 1948, and 6% had an average exposure above the TLV between

NAME: Uranium (Soluble Compounds) **CAS:** 7440-61-1
CODE: H.S. 1419

COMMENTS: (Continued)
1948 and 1956;" e) "In a report of the health in one plant after 15 years (1958) in which exposure was to natural uranium and its compounds but not to UF6, no abnormal clinical findings were traced to uranium as a cause."

The Mason paper [1958] is the only citation for these premises although Breslin [1958], McKown [1958], and Patterson [1958] are separate papers at the same conference. The Mason paper notes the extensive use of respirators to control individual exposures to uranium dust. Mason also notes that "Its ultimate goal for health protection is to limit exposures to no greater than 10% of the permissible levels." The permissible level referred to was 70 alpha disintegrations per minute per cubic meter, equivalent to approximately .050 mg/m^3.

Extensive data exists to indicate that uranium workers are at elevated levels of risk for specific cancers [Archer 1973; Dupree 1987; Waxweiler 1983]. We would note that the data offered by the ACGIH does not offer a health effect analysis for specific exposure to soluble uranium compounds.

No citations are provided by the ACGIH dealing with uranium processing plants from 1958 through 1967 to support the statements: "In the period from 1958 to 1967, no further evidence of uranium effects in these workers has come to light," and "the incidence of all diseases, whether or not they have been linked to radiation exposure, has been no higher than in the general working population." However, Archer [1973] reported the cancer mortality of 662 uranium workers who had been followed through December 31, 1967. This study noted a statistically significant increase for deaths due to malignant diseases of the lymphatic and hematopoetic tissue other than leukemia. This paper notes a number of air measurements made in the 1951 to 1953 period indicating that 59 measurements were made with a low of 0.008 mg/m^3, a high of 5.3 mg/m^3, a median of 0.110 mg/m^3, and an average of 1.351 mg/m^3.

Waxweiler [1983] reported on a survey of 2,002 uranium mill workers employed in the period 1940 through 1971. Of 533 deaths observed, there was a statistically significant mortality due to nonmalignant respiratory disease. Nonsignificant excesses were also observed for lymphatic malignancies and chronic renal disease. There have also been reports of excess brain tumor deaths at nuclear facilities at statistically significant levels but without a clear occupational etiology [JOM 26, p. 29; SMR 589, $p<0.05$, SIR 2.67, at 5% confidence limit].

The data used by ACGIH concerning accidental exposures to soluble uranium compounds is incorrectly cited as a 1963 paper in the TLV documentation. The ACGIH concludes that: a) Seven brief exposures at two to five times the former TLV occurred to UF6 and UO2F2; b) No physiological changes occurred as exhibited in "well documented" urinary and clinical tests; c) The author suggested that the limits be reexamined.

An abstract of this paper is printed in Health Physics, Vol. 11, p. 806 [Wing 1965] indicating that the exposures involved were for from approximately 30 seconds to "probably not over 7 minutes." The exposure was estimated, not measured, and the limits referred to are the ICRP limits of 2.5 mg total inhalation in one day. The author

NAME: Uranium (Soluble Compounds) **CAS:** 7440-61-1
CODE: H.S. 1419

COMMENTS: (Continued)
refers to the limited data used by the ICRP and cites a book review in support of this. The actual IRCP analysis referred to by this author appears in Science, Volume 139, pages 565 through 571, with 23 citations [Morgan 1963].

Conclusion

NIOSH believes there is extensive evidence indicating worker risk at the present exposure levels. There is no scientifically significant evidence presented in support of the contention that exposure of workers to concentrations of soluble uranium at 8-hour time weighted averages in excess of 0.05 mg/m^3 has had no health effect. All of the data on worker exposures that NIOSH has obtained indicate that workers in the last 20 years have been exposed to atmospheric concentrations considerably below the present PEL for soluble uranium.

A careful analysis of the ACGIH documentation reveals that there is no significant scientific data for raising the PEL. The industry standards used prior to the Z-1 Table were not the ACGIH values, but the ICRP recommendations. It is not possible to analyze the statements, pertaining to uranium worker good health, that are not cited, but there is a substantial body of reported data that indicates there is an increased level of risk of specific cancers in uranium workers.

The Wing study cannot be interpreted as a controlled epidemiological study. The exposures are reported as exceeding the ICRP limits. The duration of the exposures were extremely short and the only medical follow up is urine albluminuria analysis. The exposure dosages are described as "estimated."

Significant data exists [NIOSH 1987] indicating exposure to radon and its progeny emanating from uranium compounds is a human carcinogen. Uranium compounds are also alpha emitters. The present PEL should be maintained and a carcinogen designation added.

These data indicate that uranium (soluble compounds) meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for uranium (soluble compounds) because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Uranium. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 617.

Archer VE, Wagoner JK, Lundin FE [1973]. Cancer mortality among uranium mill workers. J Occup Med 15(1):11-14.

NAME: Uranium (Soluble Compounds) **CAS:** 7440-61-1
CODE: H.S. 1419

REFERENCES: (Continued)

Breslin AJ [1958]. Occupational exposures to uranium contamination in feed materials production facilities, 1948-1956. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

Dupree EA, Cragle DL, McLain RW, Crawford-Brown DJ, Teta MJ [1987]. Mortality among workers at a uranium processing facility, the Linde Air Products Company Ceramic Plant, 1943-1949. Scand J Work Environ Health 13:100-107.

Mason MG [1958]. A summary of fifteen years of experience with dust problems in the refining and fabrication of uranium. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

McKown DA [1958]. Survey of air-borne normal uranium from various operations at Los Alamos Scientific Laboratory. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

Morgan KZ [1963]. Permissible exposure to ionizing radiation. Science 139(3555): 565-570.

NIOSH [1987]. A recommended standard for occupational exposure to...radon progeny in underground mines. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 88-101.

Patterson GR [1958]. Air sampling for the control of internal exposure from enriched uranium at Y-12. HASL-58, Symposium on Occupational Health Experiences and Practices in the Uranium Industry. New York, NY: October 1958.

Waxweiler RJ, Archer VE, Roscoe RJ, Watanabe A, Thun MJ [1983]. Mortality patterns among a retrospective cohort of uranium mill workers. Proceedings of the Sixteenth Midyear Topical Meeting of the Health Physics Society. Albuquerque, NM: January 9-13, 1983.

Wing JF, Heatherton RC, Quigley JA [1964]. Accidental acute inhalation exposure of humans to soluble uranium. Health Phys 10(842):806.

NAME: Vinyl Cyclohexene Dioxide

CAS: 106-87-6
CODE: H.S. 1426

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
10 ppm 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV (suspected human carcinogen):
(A2) 10 ppm (A2) 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 38,700 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human Skin, eye, respiratory irritant **Animal** Skin, eye, respiratory irritant

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human No data **Animal** POS (limited evidence)
NTP : Human -- **Animal** Two year study on test October 1987
NIOSH: --
ACGIH: A2, suspected human carcinogen

NIOSH DATE:

COMMENTS:
Vinyl cyclohexene dioxide (VCD) is recognized as a suspected human carcinogen and as a demonstrated animal carcinogen by the ACGIH [ACGIH 1986]. In addition, "OSHA preliminarily concludes that exposed employees are at significant risk of cancer potentially associated with exposure to VCD . . ." (OSHA pp. 21208-21209 of the Federal Register notice). These data indicate that vinyl cyclohexene dioxide meets the OSHA definition of a potential carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen. A NIOSH sampling and analytical method [Gagnon et al. 1981] sets the LOQ for VCD at approximately 10 mg/m^3 (<2 ppm) requiring a 12-liter air sample.

NAME: Vinyl Cyclohexene Dioxide

CAS: 106-87-6
CODE: H.S. 1426

REFERENCES:

ACGIH [1986]. Vinyl Cyclohexene Dioxide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 627.

Gagnon YT, Lunsford RA [1981]. Research on an air sampling and analytical method for 4-vinylcyclohexene dioxide. NIOSH sampling and analytical method. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Physical Sciences and Engineering.

NAME: Wood Dust - Hard Wood

CAS: None
CODE: H.S. 1430A

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: Unknown **VOLUME:** -- POUNDS

TOXICITY:
Human Dermatitis; respiratory effects; nasal cancer **Animal** POS (very limited data)

MUTAGENICITY:
Human -- **Other** POS/NEG (wood extracts)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** Nasal cancer in furniture workers **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: No REL or CD; 1987 white paper to OSHA
ACGIH: Not classified as a carcinogen although TLV is based on potential carcinogenicity

NIOSH DATE: White Paper (1987)

COMMENTS:
The TLV of 1 mg/m^3 for hardwood is based primarily on mucostasis and its potential role in the development of adenocarcinoma in furniture workers because of prolonged retention of wood dust in the nasal cavity [ACGIH 1986]. The references cited in the TLV documentation are primarily limited to the original English studies; although single studies from Belgium, France, and Denmark are also cited. None of the published U.S. studies are discussed. It should also be noted that although exposure to hardwoods has been most often implicated in nasal adenocarcinoma, there is at least one study implicating softwoods as well. A comprehensive summary of the health effects (including carcinogenicity) caused by exposure to wood dust is contained in the NIOSH white paper

NAME: Wood Dust - Hard Wood

CAS: None
CODE: H.S. 1430A

COMMENTS: (Continued)
submitted to OSHA in 1987 [NIOSH 1987] (Since this document was written, additional wood dust studies have appeared in the literature. A list of these new references is attached). These data indicate that wood dust--hard wood meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 500) for wood dust is 0.04 mg/m^3 (1000 L).

REFERENCES:
ACGIH [1986]. Wood dust. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 635-636.

NIOSH [1987]. Health effects of exposure to wood dust: A summary of the literature (white paper). Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (unpublished).

NAME: Anisidine p- and o-

CAS: 29191-52-4
CODE: H.S. None

PEL CURRENT:
(skin) 0.1 ppm | 0.5 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
(skin) 0.1 ppm | (skin) 0.5 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 1,800 (1974)

VOLUME: 3,200,000 (1979) (Imported) POUNDS

TOXICITY:
Human CNS; blood; urogenitial; liver; skin
Animal Hemolytic; anemia; cancer (o-anisidine)

MUTAGENICITY:
Human --
Other Ortho-anisidine: POS (Salmonella)/NEG (2 tests); Para-anisidine: EQUIV

TERATOGENICITY:
Human --
Animal --

CARCINOGENICITY:
IARC : **Human** o-anisidine hydrochloride: category 2B (possibly carcinogenic)
Animal o-anisidine hydrochloride: sufficient evidence
NTP : **Human** --
Animal o-anisidine hydrochloride: sufficient evidence
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The current OSHA PEL and TLV [ACGIH 1986] are both 0.1 ppm, TWA; therefore, anisidine was not considered in the proposed rule. o-Anisidine hydrochloride, given in the diet, was carcinogenic in rats and mice, including cancer or neoplasms of the bladder in animals of both sexes and cancer of the pelvis and the kidneys, and tumors of the

NAME: Anisidine p- and o-

CAS: 29191-52-4
CODE: H.S. None

COMMENTS (continued):
thyroids in male rats [NCI 1978a]. p-Anisidine hydrochloride did not produce carcinogenic effects in mice and the data on rats were inadequate for evaluation [NCI 1978b]. These carcinogen studies were not considered in the setting of the TLV. Based on the NCI study, IARC [1982; 1987] judged o-anisidine to have sufficient evidence for carcinogenicity in animals and to be regarded as a carcinogenic risk to humans. NTP [1985] concurred in the findings of "sufficient evidence" of carcinogenicity of o-anisidine in animals.

These data indicate that o-anisidine meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method #2514) p- and o-anisidine is 8 ug/m^3 (320 L).

REFERENCES:
ACGIH [1986]. Anisidine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 31.

IARC [1982]. Some aromatic amines, anthraquinones and nitroso compounds, and inorganic fluorides used in drinking-water and dental preparations. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 27. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 63-80.

IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 1-42, Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer, p. 57.

NCI [1978a]. Bioassay of o-anisidine hydrochloride for possible carcinogenicity. Carcinogenesis technical report series #89. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, Publication No. (NIH) 78-1339.

NCI [1978b]. Bioassay of p-anisidine hydrochloride for possible carcinogenicity. Carcinogenesis technical report series #116. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, Publication No. (NIH) 78-1371.

NTP [1985]. Fourth annual report on carcinogens. U.S. Department of Health and Human Services, Public Health Service, NTP 85-001, pp. 45-47.

NAME: Chlordane **CAS:** 57-74-9
CODE: H.S. None

PEL CURRENT:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm 2 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Gastritis; CNS; fatty liver degeneration **Animal** CNS; damage to liver; gastrointestinal, liver, and endocrine tumors

MUTAGENICITY:
Human POS (unscheduled DNA synthesis) **Other** NEG (Salmonella); POS (mouse lymphoma); EQUIV (cytogenetics)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Limited evidence
NTP : **Human** -- **Animal** POS - liver (mice); thyroid (rat)
NIOSH: Suspected carcinogen
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
Chlordane was tested in the NCI Carcinogenesis Program [NCI 1977] and was found to be a liver carcinogen in male and female mice, and cause thyroid tumors in rats.

IARC [1979] finds sufficient evidence for cancer in animals and classified chlordane in group 3.

These data indicate that chlordane meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NAME: Chlordane **CAS:** 57-74-9
CODE: H.S. None

COMMENTS (continued):
The NIOSH LOQ (Method #S278) is 0.15 mg/m^3 (120 L).

Chlordane has been evaluated for toxic effects and carcinogenicity by EPA [1987a, 1987b, 1988] and is listed as B2 "probable human carcinogen," based on sufficient evidence in animals and inadequate evidence in humans.

REFERENCES:
EPA [1987a]. Health effects assessment for chlordane. Cincinnati, OH: Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Report #EPA 540/1-86/023.

EPA [1987b]. Reportable quantity document for chlordane. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

EPA [1988]. Integrated risk information system (IRIS): Risk estimate for carcinogenicity for chlordane. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

IARC [1979]. Chlordane. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NCI [1977]. Bioassay of chlordane for possible carcinogenicity (CAS No. 97-74-9). Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute, Technical Report Series No. 8, DHEW Publication No. (NIH) 77-808.

NIOSH [1978].

NAME: Heptachlor **CAS:** 76-44-8
CODE: H.S. None

PEL CURRENT:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 567,000 (NOHS) **VOLUME:** 100,000 (SRI 1981) POUNDS

TOXICITY:
Human CNS; skin irritation; liver damage **Animal** CNS; liver cancer

MUTAGENICITY:
Human POS (human fibroblast) **Other** NEG (Salmonella); POS (mouse lymphoma, cytogenetics)

TERATOGENICITY:
Human -- **Animal** EQUIV

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Sufficient evidence (rats and mice)
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Heptachlor is a pesticide causing liver tumors in mice and rats [IARC 1979]. IARC [1982] classified heptachlor in Group 3 carcinogen. EPA had cancelled the registration of heptachlor, except of its use through subsurface ground insertion for termite control [ACGIH 1986].

NCI [1977] conducted a bioassay of technical grade heptachlor for possible carcinogenicity in B6C3F$_1$ mice and Osborne-Mendel rats. In mice, hepatocellular

NAME: Heptachlor

CAS: 76-44-8
CODE: H.S. None

COMMENTS (continued):
carcinoma showed a highly significant dose-related trend in both males and females. In rats, there were no hepatic tumors, but there was evidence for the induction of proliferative lesions of follicular cells of the thyroid in treated females. It is concluded that under the conditions of this bioassay, heptachlor is carcinogenic for the liver in mice.

Heptachlor has been evaluated for toxic effects and carcinogenicity by EPA [1987a, 1987b, 1988] and is listed as B2 "probable human carcinogen," based on sufficient evidence in animals and inadequate evidence in humans.

These data indicate that heptachlor meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method #S287) for heptachlor is 0.5 ppb (60 L).

REFERENCES:
ACGIH [1986]. Heptachlor. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 296.

EPA [1987a]. Health effects assessment for heptachlor. Cincinnati, OH: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Report #EPA 600/8-88/042 (final draft).

EPA [1987b]. Reportable quantity document for heptachlor. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

EPA [1988]. Integrated risk information system (IRIS): Risk estimate for carcinogenicity for heptachlor. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

IARC [1979]. Heptachlor and heptachlor epoxide. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer.

IARC [1982]. Chlordane/Heptachlor. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 4. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 80-82.

NCI [1977]. Bioassay of heptachlor for possible carcinogenicity. Bethesda MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, Technical Report Series No. 9, DHEW Publication No. (NIH) 77-809, pp. iii-111

NAME: Hexamethyl Phosphoramide **CAS:** 680-31-9
CODE: H.S. None

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV (suspected human carcinogen):
A2 (skin) ppm A2 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 700 (1982) **VOLUME:** Probably >5,000 (1976, SRI) POUNDS

TOXICITY:
Human -- Animal Cancer (nasal); respiratory toxicity; renal toxicity; testicular atrophy

MUTAGENICITY:
Human NEG (human leukocytes) Other POS (Drosophilia, mouse lymphoma)
NEG (Salmonella)

TERATOGENICITY:
Human -- Animal NEG (rats)

CARCINOGENICITY:
IARC : Human -- Animal Sufficient evidence
NTP : Human -- Animal --
NIOSH: Carcinogen (Current Intelligence Bulletin #6)
ACGIH: A2 (Suspected carcinogen)

NIOSH DATE: Current Intelligence Bulletin #6 (1975)

COMMENTS:
The first report of the potential carcinogenicity (by inhalation) of hexamethyl phosphoramide (HMPA) was by Zapp [1975]. He exposed four groups of rats to 0, 50, 400, and 4000 ppb of HMPA for six hours daily, five days per week. After eight months, there was a dose-related increased incidence of nasal tumors in the groups exposed to 400 and 4000 ppb of HMPA. The author urged everyone using HMPA to handle it with the "...precautions appropriate to a potential carcinogen." This information was disseminated by NIOSH in its Current Intelligence Bulletin #6 [1975] and in a summary report in the American Industrial Hygiene Association Journal [Lloyd 1975].

NAME: Hexamethyl Phosphoramide

CAS: 680-31-9
CODE: H.S. None

COMMENTS: (Continued)
This study [Zapp 1975] was also prominent in the review of HMPA by IARC [1977], when it concluded that "Hexamethylphosphoramide is carcinogenic in rats, the only species tested, following its administration by inhalation. In this study, which was reported as a preliminary note, HMPA produced squamous-cell carcinomas of the nasal cavity. It has also been inadequately tested in rats by oral administration."

Lee and Trochimowicz [1982; 1984] induced nasal tumors (well-differentiated epidermoid carcinomas) in rats by inhalation of 50, 100, 400, and 4000 ppb of HMPA for 6 to 24 months. No pathological lesions attributable to HMPA were found in rats exposed to 10 ppb for 24 months.

The ACGIH TLV Committee [1986] concurred with IARC's assessment and classified HMPA as an "...A2 industrial substance suspect of carcinogenic potential for man because of its demonstrated carcinogenesis in rats by inhalation." No TLV was recommended pending determination of a no-observed effect level, but the committee felt that it should be in the low ppb range at best.

These data indicate that hexamethyl phosphoramide meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for hexamethyl phosphoramide because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Hexamethyl phosphoramide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 304.

IARC [1977]. Some fumigants, the herbicides 2,4-D and 2,4,5-T chlorinated dibenzodioxins and miscellaneous industrial chemicals. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 15. Lyon, France: World Health Organization, International Agency for Research on Cancer, pp. 211-222.

Lee KP, Trochimowicz HJ [1982]. Pulmonary response to inhaled hexmethylphosphoramide in rats. Toxicol Appl Pharmocol 62:90-103.

Lee KP, Trochimowicz HJ [1984]. Morphogenesis of nasal tumors in rats exposed to hexamethylphosphoramide by inhalation. Environ Res 33:106-118.

Lloyd JW [1975]. Hexamethylphosphoric triamide (HMPA). Am Indus Hyg Assoc J 36:917-919

NIOSH [1975]. Current intelligence bulletin #6: Hexamethylphosphoric triamide (HMPA). Current intelligence bulletin reprints - bulletins 1-18. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-127.

NAME: Hexamethyl Phosphoramide

CAS: 680-31-9
CODE: H.S. None

REFERENCES: (Continued)

Zapp JA [1975]. Inhalation toxicity of hexamethylphosphoramide. Am Indus Hyg Assoc J 36:916.

NAME: Propylene Imine **CAS:** 75-55-8
CODE: H.S. None

PEL CURRENT:
2 ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(A2) 2 (skin) ppm (A2) 5 (skin) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 20 (1972) **VOLUME:** 500,000 (1979) POUNDS

TOXICITY:
Human Nose, throat, skin irritant **Animal** Respiratory; skin, and eye irritant; kidney toxicity

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** POS

CARCINOGENICITY:
IARC : **Human** No adequate data **Animal** Sufficient evidence (rats, a variety of malignant tumors)
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: A2 (1986)

NIOSH DATE:

COMMENTS:
NIOSH strongly recommends the addition of a carcinogenic notation to the OSHA PEL of 2 ppm (5 mg/m^3) for propylene imine. There is significant evidence of the carcinogenic effects of propylene imine to various systems in laboratory animals. ACGIH [1986] cites a study by Weisburger et al. [1971] in which 52 rats were given 10 mg/kg of propylene imine twice a week for 60 weeks. The study used 26 female and 26 male six-week-old Charles River CD rats. Forty-five tumors resulted at a dosage of 10 mg/kg body weight. The 45 tumors that resulted were: 4 gliomas, 3 ear duct squamous cell carcinomas, 2 intestinal adenocarcinomas, 4 leukemias, and 4 miscellaneous tumors in

NAME: Propylene Imine

CAS: 75-55-8
CODE: H.S. None

COMMENTS (continued):
males, and 20 mammary adenocarcinomas, 2 gliomas, 3 ear duct squamous cell carcinomas, and 3 miscellaneous tumors in female rats [IARC 1975]. Weisburger et al. [1971] also administered propylene imine, 20 mg/kg body weight, to rats under identical conditions which resulted in 28 tumors in 22 out of 52 rats. The 28 tumors were: 3 gliomas, 3 ear duct squamous cell carcinomas, 2 intestinal adenocarcinomas, and 6 leukemias in males, and 10 mammary adenocarcinomas, 1 glioma, and 3 miscellaneous tumors in females [IARC 1975].

The OSHA PEL does not alert workers to the possible carcinogenic effects of propylene imine. Based on the evidence, propylene imine is a carcinogen of various body systems in laboratory animals and workers should handle it as a potential human carcinogen.

These data indicate that propylene imine meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for propylene imine because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Propylene imine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 504.

IARC [1975]. 2-Methylaziridine. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. Volume 9. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Weisburger EK, Rice JM, Weisburger JH, Ulland B, Finkelstein M [April 1971]. Carcinogenicity of industrial chemicals propylene imine and propane sultone. Nature 230:460-461.

NIOSH - JULY 1988

NAME: Acetaldehyde **CAS:** 75-07-0
CODE: H.S. 1001

PEL CURRENT:
200 ppm 360 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
100 ppm 180 mg/m^3 (TWA) 150 ppm 270 mg/m^3 (STEL - 15 min)

TLV:
100 ppm 180 mg/m^3 (TWA) 150 ppm 270 mg/m^3 (STEL - 15 min)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 14,000 (1982) **VOLUME:** 6,300 million (1985) POUNDS
1,490 million (1977)

TOXICITY:
Human Eye, skin, respiratory irritant Animal Respiratory-tract tumors; eye, skin, respiratory-tract irritant

MUTAGENICITY:
Human POS Other POS

TERATOGENICITY:
Human -- Animal POS (embryotoxic, skeletal malformation)

CARCINOGENICITY:
IARC : Human Inadequate evidence Animal POS (sufficient evidence)
NTP : Human -- Animal Deferred
NIOSH: Review in progress for CIB
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA's recommendation is to lower the PEL from 200 ppm to 100 ppm with a STEL of 150 ppm. These numbers are adopted TLVs from ACGIH [ACGIH 1986]. The rationale given by OSHA is "re-examination of data by Silverman et al., 1946."

NAME: Acetaldehyde

CAS: 75-07-0
CODE: H.S. 1001

COMMENTS (continued):
Careful examination of the original data by Silverman et al. [1946] shows that:

1. Exposures in his human experiment were only 15 minutes, and thus inadequate to establish the health consequences of 8-hour exposures and, even less, the consequences of repeated occupational exposures.
2. Even after 15 minutes of exposures, a "majority of the subjects experienced some degree of eye irritation at 50 ppm, and several subjects objected to this material strenuously even at 25 ppm."

Interestingly, Silverman et al. [1946] note that "A majority of subjects were willing to work an 8 hour day in 200 ppm."

It appears that ACGIH's TLV [ACGIH 1986] and OSHA's proposed PEL of 100 ppm for an 8-hour day are not sufficiently protective, since lower levels (25 ppm) cause eye irritation even after only 15 minutes of exposures.

The occupational exposure limit in Sweden is 25 ppm (TWA) and 50 ppm (STEL), in Germany and Finland, 50 ppm (TWA), and in USSR, 5 mg/m^3 corresponding to 2.8 ppm.

IARC [1985] concluded that "there is sufficient evidence for the carcinogenicity of acetaldehyde to experimental animals" and "inadequate evidence for the carcinogenicity of acetaldehyde in humans." "In the absence of adequate data on humans, it is reasonable, for practical purposes, to regard chemicals for which there is sufficient evidence of carcinogenicity in animals as if they presented a carcinogenic risk to humans."

EPA has produced several criteria documents [EPA 1987a; EPA 1987b; EPA 1988]. In the Health Assessment Document for Acetaldehyde [EPA 1987a] EPA concluded: "Based on positive carcinogenic responses in rats and hamsters and inadequate epidemiologic evidence, acetaldehyde is considered to be a probable human carcinogen. Using EPA's Guidelines for Carcinogen Risk Assessment [EPA 1988], acetaldehyde is classified in Group B2 (probable human carcinogen)."

NIOSH is currently considering development of a criteria document for acetaldehyde. The ACGIH TLV Committee is currently reviewing data on acetaldehyde and its potential as an occupational carcinogen.

These data indicate that acetaldehyde meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 3507) for acetaldehyde is 18 ppm (60 L).

REFERENCES:
ACGIH [1986]. Acetaldehyde. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 3.

NAME: Acetaldehyde

CAS: 75-07-0
CODE: H.S. 1001

REFERENCES (continued):
EPA [1987a]. Health assessment document for acetaldehyde. Research Triangle Park, NC: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. External review draft report EPA-600/8-86-015A.

EPA [1987b]. Reportable quantity document for acetaldehyde. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office. Final draft report ECAO-CIN-R364.

EPA [1988]. Integrated risk information system (IRIS): Risk estimate for carcinogenicity for acetaldehyde. Cincinnati, OH: U.S. Environmental Protection Agency, Environmental Criteria and Assessment Office.

IARC [1985]. Allyl compounds, aldehydes, epoxides and peroxides. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 36. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Silverman L, Schulte HF, First MW [1946]. Further studies on sensory response to certain industrial solvent vapors. Ind Hyg Tox 28:262-266.

NAME: Asphalt Fumes (Petroleum)

CAS: 8052-42-4
CODE: H.S. 1028

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm 5 mg/m^3 (ceiling - 15 min measured as total particulate)

PRODUCTION WORKERS: 204,415 (NOES 1982) **VOLUME:** 54,000,000,000 (BOM 1975) POUNDS

TOXICITY:
Human Irritant (eyes, skin, mucous membranes) **Animal** Cancer (skin, mouse)

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human Inadequate evidence **Animal** Sufficient evidence for extracts of steam; limited evidence for refined and air refined bitumens
NTP : Human -- **Animal** --
NIOSH: -- --
ACGIH: --

NIOSH DATE: Criteria Document (1977)

COMMENTS:
The proposed OSHA PEL for asphalt fumes is 5 mg/m^3. The NIOSH REL of a ceiling of 5 mg/m^3 is based upon literature prior to 1978 and addresses prevention of irritation to the eyes and respiratory tract of workers, and upon a concern that asphalt fumes may contain carcinogenic components. Asphalt is a difficult compound to accurately

NAME: Asphalt Fumes (Petroleum)

CAS: 8052-42-4
CODE: H.S. 1028

COMMENTS (continued):
characterize in that its content of polynuclear aromatic hydrocarbons (including known carcinogens) varies dependent upon the temperature at which it is used or generated. An additional confounding factor is the potential carcinogenicity of the coal tar pitch fumes to which the worker may be simultaneously exposed [Niemeier et al. 1988]. These can be a source of exposure to benzo[a]pyrene, a known ubiquitous carcinogen. Asphalt "fractions" have produced skin tumors in mice [Simmers et al. 1959; Simmers 1965a; Simmers 1965b; Simmers 1966; Hueper et al. 1960; Kireeva 1968; Wallcave et al. 1971]. Subsequent to the 1978 Criteria document, skin tumors were also found in two strains of mice following exposure to actual asphalt fume condensates [Niemeier et al. 1988]. Of concern is the finding that occupational exposures of roofing workers to asphalt and coal tar pitch fumes for more than 20 years were associated with increased mortality from cancer and other pulmonary diseases [Hammond et al. 1976]. Smoking histories were not available for this study. According to Niemeier et al. [1988], asphalt fumes generated during normal roofing operations exhibit about one-fifth the carcinogenic activity as that of coal tar pitch fumes which are considered to be highly carcinogenic.

Asphalt fumes should be considered as a potential occupational carcinogen since it meets the OSHA definition (CFR 29.1990), and exposures should be reduced in accordance with the NIOSH REL of 5 mg/m^3 as a ceiling measured as total particulate for any 15-minute period. NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for asphalt fumes because there is no NIOSH analytical method.

REFERENCES:
Hammond EC, Selikoff IJ, Lawther PL, Seidman H [1976]. Inhalation of benzpyrene and cancer in man. Ann NY Acad Sci, pp. 116-124.

Hueper WC, Payne WW [1960]. Carcinogenic studies on petroleum asphalt, cooling oil, and coal tar. Arch Pathol 70:106-118.

Kireeva IS [1968]. Carcinogenic properties of coal-tar pitch and petroleum asphalts used as binders for coal briquettes. Hygiene and Sanitation 33(5):180-186.

Niemeier RW, Thayer PS, Menzies KT, von Thuna P, Moss CE, Burg J [1988]. A comparison of the skin carcinogenicity of condensed roofing asphalt and coal tar pitch fumes. In: Polynuclear Aromatic Hydrocarbons: A Decade of Progress. Cooke M, Dennis AJ (eds.). Columbus, OH: Battelle Press, pp. 609-647.

Simmers MH, Podolak E, Kinosita R [1959]. Carcinogenic effects of petroleum asphalt. Proceedings of the Society for Experimental Biology and Medicine 101(2):266-268.

Simmers MH [1965a]. Cancers in mice from asphalt fractions. Industrial Medicine and Surgery 34(7):573-577.

NAME: Asphalt Fumes (Petroleum) **CAS:** 8052-42-4
CODE: H.S. 1028

REFERENCES: (Continued)

Simmers MH [1965b]. Cancers from air-refined and steam-refined asphalt. Industrial Medicine and Surgery 34(3):255-261.

Simmers MH [1966]. Tumors from asphalt fractions injected into mice. Industrial Medicine and Surgery, pp. 889-894.

Wallcave L, Garcia H, Feldman R, Lijinsky W, Shubik P [1971]. Skin tumorigenesis in mice by petroleum asphalts and coal-tar pitches of known polynuclear aromatic hydrocarbon content. Toxicol Appl Pharmacol 18:41-52.

NAME: Beryllium & Compounds

CAS: 7440-41-7
CODE: H.S. 1033

PEL CURRENT:
-- ppm 0.002 mg/m^3 (TWA) -- ppm * mg/m^3 (ceiling)
*(Ceiling - 0.005 mg/m^3 acceptable C; and 0.025 mg/m^3 maximum C, 30-minute peak)

PEL PROPOSED:
-- ppm 0.002 mg/m^3 (TWA) -- ppm * mg/m^3 (ceiling)
*(Ceiling - 0.005 mg/m^3 acceptable C; and 0.025 mg/m^3 maximum C, 30-minute peak)

TLV:
-- ppm 0.002 (A2) mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm 0.0005 mg/m^3 (ceiling)

PRODUCTION WORKERS: 12,800 (1982) **VOLUME:** 1,266,000 POUNDS

TOXICITY:
Human Lung disease Animal --

MUTAGENICITY:
Human -- Animal --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human POS (limited evidence) Animal POS
NTP : Human POS (limited evidence) Animal POS
NIOSH: POS --
ACGIH: POS (A2) --

NIOSH DATE: Criteria Document (1972); Revised Criteria Document (1977)

COMMENTS:
In August 1977, NIOSH recommended that worker exposure to beryllium compounds not exceed 0.5 ug Be/m^3 [Baier 1977]. This was based upon evidence that beryllium causes lung cancer in animals and humans.

Schepers et al. [1957] reported that inhalation exposures to 35 ug of Be (0.035 mg)/m^3 of air intermittently for 6 months induced lung neoplasms in 58% of rats. Reeves et al. [1967] reported the induction of lung tumors in 100% of rats exposed to the same concentration of beryllium (35 ug/m^3) for 12 months. In both experiments, beryllium sulfate was the compound tested.

NAME: Beryllium & Compounds

CAS: 7440-41-7
CODE: H.S. 1033

COMMENTS (continued):
Vorwald [1968] also reported the induction of lung cancer in 8/9 rhesus monkeys that had survived 6 or more years of intermittent inhalation exposures to beryllium sulfate. The exposures ranged from 1178 to 4070 hours, to 35 ug Be/m^3 of air. The lung tumors all metastasized to mediastinal lymph nodes and some metastasized to the bone, adrenals, and liver.

Several different beryllium-containing compounds have been shown to be carcinogenic in animals, including beryllium sulfate, beryllium hydroxide, beryllium aluminum alloy, passivated beryllium metal, beryl ore, beryllium rocket exhaust, beryllium oxide (fired at 500, 1100 or 1600°C), beryllium silicate, beryllium phosphate, zinc beryllium silicate, and zinc manganese beryllium silicate [Groth 1980; Groth et al. 1980].

The ACGIH TLV Committee categorizes beryllium and its compounds as "A2," "suspected human carcinogen" based on either 1) limited epidemiologic evidence, or 2) demonstration of carcinogenesis in one or more animal species..." [ACGIH 1986].

Although the incidence of lung cancer in beryllium production workers has been shown to be higher than controls [Wagoner et al. 1980], the increase was probably not as high as one might have anticipated (based on animal studies). One of the reasons for this is that 70% of the worker cohort was employed for less than 1 year and 84.3% for less than 3 years during the period 1940-1949.

Based on the experimental data, beryllium is a carcinogen. It is unlikely that the existing TLV of 0.002 mg/m^3 as a TWA, or the PEL of 0.002 mg/m^3 as a TWA, 0.005 mg/m^3 ceiling, will provide the margin of protection that OSHA recommends, i.e., the prevention of more than 1 cancer in 1,000 workers exposed for a working lifetime. These data indicate that beryllium meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen and that the PEL be reduced to 0.0005 mg/m^3 as a ceiling limit.

The NIOSH LOQ (Method No. 7102) for beryllium is 0.05 ug/m^3 (1000 L).

REFERENCES:
ACGIH [1986]. Beryllium and Compounds. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 56-57.

Baier E [1977]. Statement before the Department of Labor, Occupational Safety and Health Administration, Public Hearing on the Occupational Standard for Beryllium by Baier E, Deputy Director, National Institute for Occupational Safety and Health, Center for Disease Control, Public Health Service, Department of Health, Education and Welfare, August 19, 1977.

Groth DH [1980]. Carcinogenicity of beryllium: Review of the literature. Environ Res 21:56-62.

NAME: Beryllium & Compounds

CAS: 7440-41-7
CODE: H.S. 1033

REFERENCES (continued):

Groth DH, Kommineni C, Mackay GR [1980]. Carcinogenicity of beryllium hydroxide and alloys. Environ Research 21:63-84.

Reeves AL, Deitch D, Vorwald AJ [1967]. Beryllium carcinogeneis. I. Inhalation exposure of rats to beryllium sulfate aerosol. Cancer Res 27:439-445.

Schepers GWH, Durkan TM, Delahant AB, Creedon FT [1957]. The biological action of inhaled beryllium sulfate. AMA Arch Indust Hlth 15:32-58.

Vorwald AJ [1968]. Biologic manifestations of toxic inhalants in monkeys. In: Use of Nonhuman Primates in Drug Evaluation. Vagtborg H (ed.). Austin, TX: University Texas Press, pp. 222-228.

Wagoner JK, Infante PF, Bayliss DL [1980]. Beryllium: An etiologic agent in the induction of lung cancer, nonneoplastic respiratory disease, and heart disease among industrially exposed workers. Environ Res 21:15-34.

NAME: Chlorinated Camphene (Toxaphene) **CAS:** 8001-35-2
CODE: H.S. 1078

PEL CURRENT:
-- ppm 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm (skin) 1 mg/m^3 (STEL)

TLV:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm (skin) 1 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 203 (1972) and a large number of farmers and farm workers **VOLUME:** 40 million (1977) POUNDS

TOXICITY:
Human CNS Animal Liver, cancer (mice and rats)

MUTAGENICITY:
Human Chromosome aberrations Other POS (Salmonella)

TERATOGENICITY:
Human -- Animal NEG

CARCINOGENICITY:
IARC : Human Limited evidence Animal Sufficient evidence
NTP : Human -- Animal POS (rats and mice)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
OSHA's current PEL for chlorinated camphene (toxaphene) is 0.5 mg/cu m without STEL. The proposed PEL is the same, but also a STEL of 1 mg/cu m is suggested. These values are based on ACGIH values for TLVs [ACGIH 1986].

The proposed PEL does not consider the carcinogenicity of toxaphene. IARC's evaluation concluded that "There is sufficient evidence that toxaphene is carcinogenic in mice and rats. In the absence of adequate data in humans, it is reasonable, for practical purposes, to regard toxaphene as if it presented a carcinogenic risk to humans" [IARC 1979].

NAME: Chlorinated Camphene (Toxaphene) **CAS:** 8001-35-2
CODE: H.S. 1078

COMMENTS (continued):
An NCI study of carcinogenicity of toxaphene concluded that "toxaphene was carcinogenic in male and female $B6C3F_1$ mice, causing increased incidences of hepatocellular carcinoma" and "test results also suggest carcinogenicity of toxaphene for the thyroid of male and female Osborne-Mendel rats [NCI 1979].

These data indicate that toxaphene meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. S67) for chlorinated camphene (toxaphene) is 0.01 mg/m^3 (200-L air).

REFERENCES:
ACGIH [1986]. Chlorinated Camphene (60%). In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 115.

IARC [1979]. Some Halogenated Hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: International Agency for Research on Cancer.

NCI [1979]. Bioassay of toxaphene for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, DHEW Publication No. (NIH) 79-837 (NCI TRS 37).

NAME: Chromic Acid, Chromates

CAS: 7738-94-5
CODE: H.S. 1092

PEL CURRENT:

-- ppm	-- mg/m^3 (TWA)	-- ppm	0.1 mg/m^3 (CrO_3) (ceiling)

PEL PROPOSED:

-- ppm	-- mg/m^3 (TWA)	-- ppm	0.1 mg/m^3 (CrO_3) (ceiling)

TLV:

-- ppm	0.05 mg/m^3 (TWA) (Cr VI, water soluble and certain insoluble compounds and insoluble chromates A1)	-- ppm	-- mg/m^3 ( )

REL (noncarcinogenic Cr VI):

-- ppm	0.025 mg/m^3 (TWA)	-- ppm	0.05 mg/m^3 (ceiling - 15 min)

REL (carcinogenic Cr VI):

-- ppm	0.001 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

PRODUCTION WORKERS: --

VOLUME: 100,000,000 POUNDS

TOXICITY:
Human Cancer (lung); nasal ulceration; dermatitis; gastrointestinal effects
Animal Cancer (bronchial carcinomas; injection site sarcomas); kidney damage

MUTAGENICITY:
Human Chromosomal aberrations
Other POS (Drosophila; chromosomal aberrations)

TERATOGENICITY:
Human --
Animal Skeletal anomalies (chromic acid)

CARCINOGENICITY:
IARC : **Human** Sufficient evidence **Animal** Sufficient evidence
NTP : **Human** Positive **Animal** Positive
NIOSH: Positive carcinogenicity
ACGIH: A1 (confirmed human carcinogen)

NIOSH DATE: Criteria Document (1973) (1975)

COMMENTS:
The current PEL for chromic acid and chromates, including zinc chromates, is a 15-minute ceiling of 0.1 mg/m^3, as CrO_3. The ACGIH TLV is an 8-hour TWA of 0.05 mg/m^3, as Cr, for soluble and insoluble forms of Cr (VI), with "certain water insoluble" chromates labeled A1--Confirmed Human Carcinogens. As noted by OSHA, 0.1 mg of CrO_3 is approximately equal to 0.05 mg Cr, but it would be inaccurate to say that the worker

NAME: Chromic Acid

CAS: 7738-94-5
CODE: H.S. 1092

COMMENTS (continued):
protection afforded by an 8-hour TWA of 0.05 mg Cr/m^3 is approximately equal to that offered by a 15-minute ceiling of 0.1 mg CrO_3/m^3. Because the 15-minute ceiling should be more protective, NIOSH agrees that the current OSHA PEL for chromic acid and chromates, including zinc chromates, is preferable to the ACGIH PEL.

Zinc chromates are still designated as an A2 (Suspected Human) carcinogen in the 1987-1988 TLV booklet with a TLV of 0.1 mg/m^3, as Cr, but in the 1986-1987 TLV list, the ACGIH first published a notice of intent to change that TLV to 0.01 mg/m^3 with designation as an A1 (Confirmed Human) carcinogen. The revised TLV should be adopted in the 1988-1989 TLVs. Although it varies according to the specific form of zinc chromate, 0.1 mg as CrO_3 is equivalent to approximately 0.03 mg as Cr. Nevertheless, OSHA's 15-minute ceiling limit probably is more restrictive and NIOSH prefers that PEL to the ACGIH TLV.

NIOSH believes that worker health would be better protected by adoption of the NIOSH RELs. NIOSH has recommended that worker exposure to chromic acid and other soluble forms of Cr (VI) be limited to a TWA of 0.025 mg/m^3, as Cr, with a 15-minute ceiling of 0.05 mg Cr/m^3. For carcinogenic, insoluble forms of Cr (VI), NIOSH recommends a TWA limit of 0.001 mg Cr/m^3. Zinc chromate is covered by this latter REL.

IARC [1980; 1987] considers that there is sufficient evidence that hexavalent chromium compoiunds are carcinogenic in animals and humans. The NTP [1985] stated that "if any chromium compounds are carcinogenic, then all compounds containing chromium are potentially carcinogenic." In a recent quantitative risk assessment [Gibb et al. 1986], it was estimated that lifetime exposure to an ambient concentration of 0.001 mg Cr (VI)/m^3 produces an excess cancer risk of 1 in 100.

NIOSH demonstrated in the 1975 chromium (VI) criteria document [NIOSH 1975] that there was sufficient evidence to confirm that the insoluble Cr (VI) compounds are carcinogenic. Since that time, at least six additional scientific papers have been published on the health risks to workers exposed to soluble hexavalent chromium compounds [Blair and Mason 1980; Franchini et al. 1983; Royle 1975; Silverstein et al. 1981; Sorahan et al. 1987; Waterhouse 1975]. In addition, Glaser et al. [1986] and Steinhoff et al. [1986] have demonstrated that lifespan exposure of rats to soluble chromates can induce statistically significant excess cancer rates. These data would seem to support classification of both soluble and insoluble Cr (VI) compounds as "potential occupational carcinogens" under the OSHA carcinogen policy. Data such as these raise new concerns that the present OSHA PEL and ACGIH TLVs are too high for Cr (VI) compounds. Therefore, NIOSH recommends that OSHA adopt the most protective of the available standards, the NIOSH RELs.

NIOSH also recommends that chromate ore processing and chromate pigment manufacture be included as occupations with exposures recognized to have a significant carcinogenic potential [Machle and Gregorius 1948; Baetjer 1950a; Baetjer 1950b; Langard and Norseth 1975; Davies 1978; Dalager et al. 1980; Sheffet et al. 1982]. Chromate ore processing and chromate pigment manufacture is listed in the 1987-1988 TLV booklet as category A1: Confirmed Human Carcinogen. The ACGIH TLV Documentation [1986] for chromium includes

NAME: Chromic Acid, Chromates

CAS: 7738-94-5
CODE: H.S. 1092

COMMENTS: (Continued)
these processes in an A1a category (Human carcinogens. Substances, or substances associated with industrial processes, recognized to have carcinogenic or cocarcinogenic potential, with an assigned TLV). The TLV Documentation stated that the A1a designation would "draw attention to those processes where increased risk of cancer has been associated with chromium compounds." (The A1a and A1b classifications are not used by ACGIH in the 1987-1988 TLV booklet.)

In addition to adopting the NIOSH RELs for the hexavalent chromium compounds, NIOSH recommends that OSHA place these substances on its regulatory agenda for Section 6(b) rulemaking.

REFERENCES:
ACGIH [1986]. Chromium. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 139-140.

Baetjer AM [1950a]. Pulmonary carcinoma in chromate workers. I. A review of the literature and report of cases in chromate workers. AMA Arch Ind Hyg Occ Med 2(5):487-504.

Baetjer AM [1950b]. Pulmonary carcinoma in chromate workers. II. Incidence on basis of hospital workers. AMA Arch Ind Hyg Occ Med 2(5):505-516.

Blair A and Mason TJ [1980]. Cancer mortality in United States countries with metal electroplating industries. Arch Environ Health 35(2):92-94.

Dalager NA, Mason TJ, Fraumeni JF, Jr., Hoover R, Payne WW [1980]. Cancer mortality among workers exposed to zinc chromate paints. J Occup Med 22(1):25-29.

Davies JM [1978]. Lung-cancer mortality of workers making chrome pigments. Lancet, p. 384.

Franchini I, Magnani F, Mutti A [1983]. Mortality experience among chromeplating workers--initial findings. Scand J Work Environ Health 9(3):247-252.

Gibb HJ, Chen CW, Hiremath CB [1986]. Carcinogen risk assessment of chromium compounds. In: Serrone DM, ed. Proceedings of the Chromium Symposium 1986: An update, Arlington, VA, May 20-21, 1986. Pittsburgh, PA: Industrial Health Foundation, Inc.

Glaser U, Hochrainer D, Klöppel H, Oldiges H [1986]. Carcinogenicity of sodium dichromate and chromium (VI/III) oxide aerosols inhaled by male Wistar rats. Toxicology 42:219-232.

IARC [1980]. Some metals and metallic compounds. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 23. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Chromic Acid **CAS:** 7738-94-5
CODE: H.S. 1092

REFERENCES (continued):
IARC [1987]. Overall evaluations of carcinogenicity: An updating of IARC Monographs. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 1-42, Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Langard S and Norseth T [1975]. A cohort study of bronchial carcinomas in workers producing chromate pigments. Br J Ind Med 32:62-65.

Machle W, Gregorius F [1948]. Cancer of the respiratory system in the United States chromate-producing industry. Public Health Rep 63(34):1114-1127.

NIOSH [1973]. Criteria for a recommended standard....occupational exposure to chromic acid. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. HSM 73-11021.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to chromium (VI). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-129.

NTP [1985]. Chromium and certain chromium compounds. Fourth Annual Report on Carcinogens. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, NTP 85-002.

Royle H [1974]. Toxicity of chromic acid in the chromium plating industry. Environ Res 10:39-53.

Sheffet A, Thind I, Miller AM, Louria DB [1982]. Cancer mortality in a pigment plant utilizing lead and zinc chromates. Arch Environ Health 37(1):44-52.

Silverstein M, Mirer F, Kotelchuck D, Silverstein B, Bennett M [1981]. Mortality among workers in a die-casting and electroplating plant. Scand J Work Environ Health 7(Supplement 4):156-165.

Sorahan T, Burges DCL, Waterhouse JAH [1987]. A mortality study of nickel/chromium platers. Br J Ind Med 44:250-258.

Steinhoff D, Gad SH C, Hatfield K, Mohr U [1986]. Carcinogenicity study with sodium dichromate in rats. Exp Pathol 30:129141.

Waterhouse JAH [1975]. Cancer among chromium platers. Br J Cancer 32:262.

NAME: Chromyl Chloride **CAS:** 14977-61-8
CODE: H.S. 1094

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
0.025 ppm 0.15 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(Corresponds to 0.05 mg/m^3 of Cr)

REL:
-- ppm 0.001 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
as Cr VI

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Corrosive Animal Corrosive

MUTAGENICITY:
Human -- Other POS (Salmonella)

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human Sufficient evidence Animal Sufficient evidence
NTP : Human -- Animal --
NIOSH: POS
ACGIH: NEG

NIOSH DATE: Criteria Document (1975)

COMMENTS:
NIOSH classified chromyl chloride as an insoluble hexavalent chromium compound with carcinogenic potential in their 1975 Chromium (VI) Criteria Document [NIOSH 1975]. ACGIH [1986] has not adopted this NIOSH classification, and has listed chromyl chloride as a soluble rather than an insoluble hexavalent chromium compound. ACGIH neither stated the criterion to be met for classification as a soluble Cr VI compound, nor why chromyl chloride was singled out from all the other potential compounds which could likewise be reclassified from inclusion within the general NIOSH classification for insoluble Cr VI compounds. In addition, the ACGIH TLV of 0.05 mg Cr VI/m^3 is two times higher than the 0.025 mg Cr VI/m^3 proposed by NIOSH for soluble Cr VI compounds. Since ACGIH has neither human nor animal data in their documentation to demonstrate that chromyl chloride is not a carcinogen, NIOSH does not agree that it be singled out for reclassification. NIOSH bases their position upon two scientific papers

NAME: Chromyl Chloride **CAS:** 14977-61-8
CODE: H.S. 1094

COMMENTS: (Continued)
[Glaser et al. 1986; Steinhoff 1986], which demonstrate that a soluble Cr VI chromate (sodium dichromate) can induce excess lung cancers in chronically exposed (inhalation and intratracheal injection, respectively). Gibb et al. [1986] calculated the lifetime cancer risk due to 1 ug/m^3 of hexavalent chromium (NIOSH REL) in the ambient atmosphere to be 1.2 x 10^{-2} on the basis of the epidemiology work done by Mancuso [1975]; however, these workers were exposed to both soluble and insoluble hexavalent chromates. If OSHA adopts the ACGIH classification of chromyl chloride rather than that proposed by NIOSH, then NIOSH recommends it be included with the other similar compounds contained within OSHA H.S. No. 1092 (chromic acid, chromates, zinc chromates) rather than as a separate proposed PEL (H.S. No. 1094). These data indicate that chromyl chloride meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for chromyl chloride because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. Chromyl chloride. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 141.

Gibb HJ, Chen CW, Hiremath CB [1986]. Carcinogen risk assessment of chromium compounds. In: Proceedings of chromium symposium 1986: An update. Arlington, VA: Industrial Health Foundation, Inc., pp. 248-309.

Glaser U, Hochrainer D, Kloppel H, Oldiges H [1986]. Carcinogenicity of sodium dichromate and chromium (VI/III) oxide aerosols inhaled by male Wistar rats. Toxicol 42:219-232.

IARC [1982]. Chromium and chromium compounds. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 4. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NIOSH [1975]. Criteria for a recommended standard...occupational exposure to Chromium VI. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 76-129.

Mancuso TF [1975]. Consideration of chromium as an industrial carcinogen. In: Hutchinson TC (ed.). Proceedings of International Conference on Heavy Metals in the Environment, Institute for Environmental Studies, pp. 343-356.

Steinhoff D, Gad SC, Hatfield GK, Mohr U [1986]. Carcinogenicity study with sodium dichromate in rats. Exp Pathol 30:129-141.

NAME: DDT

CAS: 50-29-3
CODE: H.S. C-18 (skin only)

PEL CURRENT:
-- ppm (skin) 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
-- ppm (skin) 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm (skin) 0.5 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: --

VOLUME: Not produced in U.S. POUNDS (1983)

TOXICITY:
Human CNS; gastrointestinal **Animal** CNS; liver tumors

MUTAGENICITY:
Human Chromatid-type aberrations in peripheral lymphocytes **Other** NEG (Salmonella, mouse lymphoma); POS (DNA damage, inhibitor of DNA synthesis); unscheduled DNA synthesis

TERATOGENICITY:
Human -- **Animal** Preimplantation; fetotoxicity; urogenital effect on fetus

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Sufficient evidence
NTP : **Human** -- **Animal** NEG (mouse and rat)
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1978)

COMMENTS:
DDT has not been produced in the United States since 1983.

A NIOSH Criteria Document [NIOSH 1978] notes the possibility of skin absorption. Therefore, the skin notation should be retained.

There is sufficient evidence that DDT is an animal carcinogen in hamsters, rats, and

NAME: DDT

CAS: 50-29-3
CODE: H.S. C-18 (skin only)

COMMENTS (continued):
mice [IARC 1974]. IARC [IARC 1982] listed DDT under 2B carcinogen.

In an NTP assay [NCI 1978], DDT caused liver and endocrine tumors in mice.

Since there is sufficient evidence that DDT is carcinogenic in animals, NIOSH recommends that the PEL should be reduced to the lowest feasible level. The lowest quantifiable level for DDT measurement in the air by NIOSH Method No. S274 is 0.1 mg/cu m (90 L).

REFERENCES:
IARC [1974].

IARC [1982].

NCI [1978].

NIOSH [1978]. Criteria for a recommended standard....occupational exposure to DDT. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NAME: p-Dichlorobenzene **CAS:** 106-46-7
CODE: H.S. 1125

PEL CURRENT:
75 ppm 450 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
75 ppm 450 mg/m^3 (TWA) 110 ppm 665 mg/m^3 (STEL - 15-min)

TLV:
75 ppm 450 mg/m^3 (TWA) 110 ppm 665 mg/m^3 (STEL - 15-min)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 1,000,000 (1980, EPA) **VOLUME:** 72,700,000 (1982, USITC) POUNDS

TOXICITY:
Human Eye; pulmonary system effects **Animal** Eye and nasal irritant; cancer (liver and kidney)

MUTAGENICITY:
Human -- **Other** Dominant lethal assay in mice

TERATOGENICITY:
Human -- **Animal** Rat inhalation studies

CARCINOGENICITY:
IARC : Human inadequate **Animal** sufficient evidence
NTP : Human -- **Animal** POS (1987)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
Synonym: 1,4-dichlorobenzene. In the NPR OSHA did not consider the carcinogenicity bioassay of the NTP. In January 1987, NTP published the results of chronic gavage studies of 1,4 dichlorobenzene in F344/N rat and B6C3F$_1$ mice [NTP 1987]. Doses of 0, 150, or 300 mg/kg were given to groups of 50 male rats, five days per week for 103 weeks. Groups of 50 female rats and 50 male and female mice were administered 0, 300, or 600 mg/kg on the same schedule. Under the conditions of these 2-year gavage studies, 1,4-dichlorobenzene produced clear evidence of carcinogenicity for male F344/N rats, as shown by an increased incidence of renal tubular cell adenocarcinomas. There was no evidence of carcinogenicity for female F344/N rats receiving doses of 300 or 600 mg/kg.

NAME: p-Dichlorobenzene **CAS:** 106-46-7
CODE: H.S. 1125

COMMENTS (continued):
There was clear evidence of carcinogenicity for both male and female B6C3F$_1$ mice, as shown by increased incidences of hepatocellular carcinomas and hepatocellular adenoma. Marginal increases were observed in the incidences of pheochromocytomas of the adrenal gland in male mice. Nonneoplastic effects in the kidney of male and female rats, in the liver of male and female mice, and in the thyroid gland and adrenal gland of male mice were also associated with the administration of 1,4-dichlorobenzene.

IARC [1987] evaluated the NTP study and classified 1,4 dichlorobenzene as having "sufficient evidence" for carcinogenicity in animals. These data indicate that p-dichlorobenzene meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 1003) for p-dichlorobenzene is 1.7 ppm (10-L).

REFERENCES:
IARC [1987]. Overall evaluations of carcinogenicity: an updating of IARC monographs, volumes 1-42. IARC Monographs on the Evaluations of Carcinogenic Risks to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NTP [1987]. NTP technical report on the toxicology and carcinogenesis studies of 1,4-dichlorobenzene in F344/N rats and B6C3F$_1$ mice (gavage studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, NIH Publication No. 87-2575.

NAME: Epichlorohydrin **CAS:** 106-89-8
CODE: H.S. 1158

PEL CURRENT:
(skin) 5 ppm 25 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
(skin) 2 ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 2 ppm 10 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL (Minimize occupational exposure, carcinogen):
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 85,000 (1972) **VOLUME:** 330,000,000 (1982) POUNDS

TOXICITY:
Human Respiratory paralysis; ocular; respiratory irritation **Animal** Cyanosis; respiratory paralysis

MUTAGENICITY:
Human POS (somatic cells - 500 umol/l) **Other** POS (Drosophila [Salmonella])

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** POS (sufficient evidence) rat and mouse
NTP : **Human** **Animal**
NIOSH: 720 mg/kg/18 wks in TDLO mice
ACGIH: NEG (still under study)

NIOSH DATE: Criteria Document (1976); Current Intelligence Bulletin #30 (1978)

COMMENTS:
NIOSH's recommendation concerning the PEL proposed for epichlorohydrin is the addition of a carcinogenic notation and to minimize exposure. NIOSH's CIB #30 [1978] estimates that 85,000 workers are directly exposed to epichlorohydrin. It is estimated that 900,000 workers have a potential for exposure to epichlorohydrin in the workplace.

A study of 864 workers who were exposed to epichlorohydrin was reported in NIOSH's CIB #30 [1978]. This study, conducted by the Shell Chemical Company, observed increased death rates for all cancers, leukemia, and suicide among the 864 workers.

NAME: Epichlorohydrin

CAS: 106-89-8
CODE: H.S. 1158

COMMENTS (continued):
Wester et al. [1985] administered epichlorohydrin to rats by gastric intubation for 2 years, 5 times a week, at dosages of 0.2, and 10 mg/kg body weight. A high incidence of squamous cell carcinomas of low-grade malignancy occurred in the forestomachs at the rate of 100% in females and 81% in males for the 10 mg/kg group. A lower incidence occurred in the 2 mg/kg group at a rate of 7% in females and 14% in males. Laskin et al. [1980] performed inhalation exposure experiments on male Sprague-Dawley rats. A short-term 30-exposure experiment with 140 rats at a 100 ppm concentration of epichlorohydrin resulted in malignant squamous cell carcinomas of the nasal cavity in 15 rats and respiratory tract papillomas in 3 rats. The American Association for Cancer Research [1980] in a study with Sprague-Dawley rats exposed at 100 ppm of epichlorohydrin for 6 hours a day, 5 days a week for 30 exposures, and lifetime follow-up observations, reported respiratory tract tumors for approximately 35% of the deaths. Stoner et al. [1986] performed tests on A/J mice and concluded epichlorohydrin to be more active when administered IP (intraperitoneal) than PO (per oral) and produced an increase in lung tumor response. In the experiment of 24 weeks, the total dosage was 2400 mg/kg of epichlorohydrin and the total number of survivors with lung tumors was 43% (PO; male), 31% (PO; female), 67% (IP; male), and 44% (IP; female). There is also sufficient evidence of epichlorohydrin's carcinogenic effects in rats and mice [IARC 1987].

These data indicate that epichlorohydrin meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH recommends minimizing exposures to epichlorohydrin. In addition, exposures should be limited to as few employees as possible while workplace exposure should be minimized with engineering and work practice controls. In particular skin exposure should be avoided.

The LOQ (Method #1018) for epichlorohydrin is 2.5 mg/m^3 (30 L).

REFERENCES:
AACR [1980]. Proceedings of AACR (American Association for Cancer Research) and ASCO (American Society of Clinical Oncology). Abstract #426, p. 106.

IARC [1987]. Epichlorohydrin. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Laskin S, Sellakumar AR, Kuschner M, Nelson N, La Mendola S, Rusch GM, Katz GV, Dulak NC, Albert RE [1980]. Inhalation carcinogenicity of epichlorohydrin in noninbred Sprague-Dawley rats. J Nat Cancer Inst 65(4):751-755.

NAME: Epichlorohydrin **CAS:** 106-89-8
CODE: H.S. 1158

REFERENCES (continued):
NIOSH [1978]. Current intelligence bulletin #30: Epichlorohydrin. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 79-105.

Stoner GD, Conran PB, Greisiger EA, Stober J, Morgan M, Pereira MA [1986]. Comparison of two routes of chemical administration on the lung adenoma response in strain A/J mice. Toxicol Appl Pharmacol 82:19-31.

Wester PW, Van Der Heijden CA, Bisschop A, Van Esch GJ [1985]. Carcinogenicity study with epichlorohydrin (CEP) by gavage in rats. Tox 36:325-339.

NIOSH - JULY 1988

NAME: Ethyl Acrylate **CAS:** 140-88-5
CODE: H.S. 1161

PEL CURRENT:
(skin) 25 ppm | 100 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
(skin) 5 ppm | 20 mg/m^3 (TWA) | 15 ppm | 61 mg/m^3 (STEL - 15-min)

TLV:
5 ppm | 20 mg/m^3 (TWA) | 15 ppm | 61 mg/m^3 (STEL - 15-min)

REL:
-- ppm | -- mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: 40,489 (1972) **VOLUME:** 135 million (1977) POUNDS

TOXICITY:
Human Pulmonary, eye, & skin irritant **Animal** Cancer; irritation of skin, eyes, mucous membranes, CNS, GI tract, & respiratory system

MUTAGENICITY:
Human -- **Animal** POS (salmonella), POS (mouse lymphoma)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** POS (sufficient evidence)
NTP : Human -- **Animal** POS (squamous cell carcinomas and rats and mice papillomas)
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
An IARC Monograph states, "There is sufficient evidence for the carcinogenicity of ethyl acrylate in experimental animals. No data on humans were available." [IARC 1985]. These data indicate that ethyl acrylate meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NAME: Ethyl Acrylate

CAS: 140-88-5
CODE: H.S. 1161

COMMENTS (continued):
The NIOSH LOQ (Method No. 1450) for ethyl acrylate is 4 ppm (10 L).

REFERENCES:
IARC [1985]. Some chemicals used in plastics and elastomers. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 39. Lyon, France: World Health Organization, International Agency for Research on Cancer.

NAME: Gasoline **CAS:** 8006-61-9
CODE: H.S. 1185

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
300 ppm 900 mg/m^3 (TWA) 500 ppm 1500 mg/m^3 (STEL)

TLV:
300 ppm 900 mg/m^3 (TWA) 500 ppm 1500 mg/m^3 (STEL)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Skin and eye irritant; CNS; cancer (EPA) **Animal** Gastrointestinal, kidney (cancer)

MUTAGENICITY:
Human -- **Other** POS (EPA)

TERATOGENICITY:
Human -- **Animal** NEG (EPA)

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
There is no current OSHA PEL for gasoline. OSHA proposes a 300 ppm 8-hour TWA and a 500 ppm 15-minute STEL. These values are adopted from ACGIH TLVs. The rationale for their derivation is not quite clear.

Human toxicity data indicate that gasoline is an eye and throat irritant after 8-hour exposure to 140 ppm [Drinker et al. 1943], and produced conjunctival irritation at air concentrations of 160-270 ppm [Davis et al. 1960].

In addition, several studies [EPA 1987] indicate carcinogenic effects in animals and possibly in humans. EPA concluded that gasoline can be classified as B2, a probable

NAME: Gasoline **CAS:** 8006-61-9
CODE: H.S. 1185

COMMENTS: (Continued)
human carcinogen [EPA 1987]. OSHA should consider these findings in their final exposure limit determination.

The NIOSH LOQ (Method No. 1551 - no NIOSH validation) for gasoline is 15 ppm (8 L).

REFERENCES:
ACGIH [1986]. Gasoline. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 283.

Davis A, Schafer LJ, Bell ZG [1960]. The effects on human volunteers of exposure to air containing gasoline vapor. Arch Environ Health 1:548-554.

Drinker P, Yaglou CP, Warren MF [1943]. The threshold of gasoline vapor. J Ind Hyg Tox 25:225-232.

EPA [1987]. Evaluation of the public health of the carcinogenicity of unleaded gasoline, Environmental Protection Agency. EPA/6006-87/001.

NAME: Hydrazine **CAS:** 302-01-2
CODE: H.S. 1205

PEL CURRENT:				
(skin) 1 ppm	1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
PEL PROPOSED:				
0.1 ppm	0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
TLV:				
(A2) 0.1 ppm (skin)	(A2) 0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
REL:				
-- ppm	-- mg/m^3 (TWA)	0.03 ppm	0.04 mg/m^3 (ceiling - 120 min)	

PRODUCTION WORKERS: 48,000 (1982) **VOLUME:** 2,200,000 (est.) POUNDS

TOXICITY:
Human Eye; mucous membranes; respiratory **Animal** POS (hepatotoxicity; Salmonella [5 strains])

MUTAGENICITY:
Human -- **Animal** POS (Drosophila)

TERATOGENICITY:
Human -- **Animal** POS (embryotoxicity; newborn effect)

CARCINOGENICITY:
IARC : **Human** POS (2 reports 1972-1988) **Animal** POS
NTP : **Human** POS **Animal** POS
NIOSH: Potential for cancer in humans
ACGIH: POS

NIOSH DATE: Criteria Document (1978)

COMMENTS:
NIOSH's recommendation for the proposed reduction of the current PEL for hydrazine is to label the proposed PEL with a carcinogen designation based on the carcinogenic effects of hydrazine. A study by Vernot et al. [1985] examined long-term inhalation toxicity of hydrazine in rats, mice, hamsters, and dogs. The experiment consisted of year-long intermittent exposures using concentrations of 0.05, 0.25, 1.0, or 5.0 ppm of hydrazine. In rats, the data revealed a marginal production of nasal tumors at a concentration of 0.05 ppm (females, 2/97 nasal adenomatous polyps and 1/97 nasal

NAME: Hydrazine **CAS:** 302-01-2
CODE: H.S. 1205

COMMENTS (continued):
adenocarcinomas; males, 2/96 nasal adenomatous polyps, 1/96 nasal adenocarcinoma; and 6/96 thyroid carcinomas).

These data indicate that hydrazine meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for hydrazine because there is no NIOSH analytical method.

[The current ACGIH-TLV is 0.1 ppm TWA, identified as an A2 carcinogen (suspect of carcinogenic potential for man), and with a SKIN notation.) The OSHA documentation for its proposed PEL cites the TLV as a 0.1 ppm TWA (SKIN) without the A2 designation].

REFERENCES:
ACGIH [1986]. Hydrazine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 310.

NIOSH [1978]. Criteria for a recommended standard....hydrazines. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-172.

Vernot EH, MacEwen JD, Bruner RH, Haun CC, Kinkead ER, Prentice DE, Hall A, Schmidt RE, Eason RL, Hubbard GB, Young JT [1985]. Long-term inhalation toxicity of hydrazine. Fund Appl Tox 5:1050-1064.

NAME: Methyl Bromide **CAS:** 74-83-9
CODE: H.S. 1253

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) (skin) 20 ppm 80 mg/m^3 (ceiling)

PEL PROPOSED:
(skin) 5 ppm 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
(skin) 5 ppm (skin) 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL (fullest extent feasible - CA):
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 105,000 (1972) **VOLUME:** 30,000,000 (1977) POUNDS

TOXICITY:
Human Neuropathic effects **Animal** Respiratory irritant

MUTAGENICITY:
Human -- **Other** POS (Ames and rat inhalation micronucleus test)

TERATOGENICITY:
Human -- **Animal** NEG (rats and rabbits)

CARCINOGENICITY:
IARC : **Human** Inadequate **Animal** Limited evidence
NTP : **Human** -- **Animal** On test, to be reported 1989
NIOSH: Potential occupational carcinogen
ACGIH: --

NIOSH DATE: CIB (1984)

COMMENTS:
In the proposed rule, OSHA did not consider the NIOSH recommendation [NIOSH 1984] that methyl bromide be considered a potential occupational carcinogen. NIOSH based its recommendation on a 13-week study from the National Institute of Public Health in the Netherlands [Danse et al. 1984] and positive results in an Ames mutagenicity assay. In the 13-week study, 13 of 20 female Wistar rats receiving an oral gavage dose of 50 mg methyl bromide/kg body weight, developed squamous cell carcinomas of the forestomach. All animals of this group showed a marked diffuse hyperplasia of the epithelium of the forestomach [Danse et al. 1984]. A dose-related incidence of hyperplasia was also noted in the rats at all levels except at 0 and 0.4 mg/kg [Danse et al. 1984]. The two-year inhalation carcinogenicity study at NTP in B6C3F1 mice at 0, 10, 33, and 100 ppm levels has been completed. Results are expected in 1989. In a 1987 chronic inhalation study, Wistar rats were exposed at 0, 3, 30 or 90 ppm for 6 hours/day, 5 days/week for

NAME: Methyl Bromide

CAS: 74-83-9
CODE: H.S. 1253

COMMENTS (continued):
29 months. There were no differences in incidence of neoplastic alterations amongst the groups which could be attributed to exposure to methyl bromide [Reuzel PGJ et al. 1987]. It was concluded that under the conditions of this study, methyl bromide did not induce tumors in Wistar rats [Reuzel et al. 1987].

On the basis of the tumorigenic and carcinogenic response in rats, and as stated in Current Intelligence Bulletin #43 (NIOSH 1984), NIOSH recommends that there is sufficient data on methyl bromide to indicate the potential for carcinogenicity, and since the data conform to the classification for a potential occupational carcinogen (29 CFR 1990), OSHA should label methyl bromide as such and reduce exposures to the fullest extent feasible.

The NIOSH LOQ (Method No. 2520) for methyl bromide is 4.7 ppm (11 L).

REFERENCES:
Danse LHJC, van Velsen FL, van der Heijden CA [1984]. Methylbromide: Carcinogenic effects in the rat forestomach. Toxicology and Applied Pharmacology 72:262-271.

NIOSH [1984]. Current intelligence bulletin #43: Monohalomethanes (methyl chloride, methyl bromide, methyl iodide). Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-117.

Reuzel PGJ, Kuper CF, Dreef-van der Meulen HC, Hollanders VMH [1987]. Chronic (29-month) inhalation toxicity and carcinogenicity study of methyl bromide in rats. The Netherlands: CIVO Institutes TNO, Report No. V86.469/221044.

NAME: Methyl Chloride **CAS:** 74-87-3
CODE: H.S. 1254

PEL CURRENT:

100	ppm	210	mg/m^3 (TWA)	200	ppm	410	mg/m^3 (ceiling - 15-min)
100	ppm	210	mg/m^3 (TWA)	300	ppm	615	mg/m^3 (ceiling - 5-min)

PEL PROPOSED:

50	ppm	105	mg/m^3 (TWA)	100	ppm	205	mg/m^3 (STEL - 15-min)

TLV:

50	ppm	105	mg/m^3 (TWA)	100	ppm	205	mg/m^3 (STEL - 15-min)

REL: (lowest feasible limit)

	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PRODUCTION WORKERS: 40,500 (1972) **VOLUME:** 366,000,000 (SRI 1982) POUNDS

TOXICITY:
Human Neurotoxic effects **Animal** Cancer (kidney) in mice; seminiferous tubule atrophy in rats

MUTAGENICITY:
Human Gene mutation in in human lymphocyte **Animal** POS (Salmonella typhimurium)

TERATOGENICITY:
Human -- **Animal** Cardiac malformations in mice

CARCINOGENICITY:
IARC : Human Inadequate **Animal** Inadequate evidence (1986)
NTP : Human -- **Animal** --
NIOSH: Potential occupational carcinogen
ACGIH: --

NIOSH DATE: Current Intelligence Bulletin (1984)

COMMENTS:
In the proposed rule, OSHA stated that NIOSH considers methyl chloride a carcinogen, but did not consider the study cited in the Current Intelligence Bulletin #43 [NIOSH 1984] on methyl chloride. In Current Intelligence Bulletin #43 [NIOSH 1984], NIOSH recommended that methyl chloride be considered a potential occupational carcinogen and

NAME: Methyl Chloride

CAS: 74-87-3
CODE: H.S. 1254

COMMENTS (continued):
controlled to the fullest extent feasible. NIOSH based its recommendation on a 2-year inhalation study [Pavkov 1982] in which male and female mice were exposed at concentrations of 0, 50, 225, or 1,000 ppm for 6 hours/day, 5 days/week. A statistically significant increase in both malignant and nonmalignant renal tumors occurred in male mice exposed at 1000 ppm. Rats exposed under the same conditions did not exhibit induction of cancer or other lesions observed in mice. It was recommended that methyl chloride also be considered a potential occupational teratogen. The teratogenic recommendation was based on an inhalation study [Pavkov 1982] in which a statistically significant number of fetal heart malformations was observed in the offspring exposed in utero at the 500 or 750 ppm concentrations. Degeneration and atrophy of seminiferous tubules in methyl chloride exposed male rats has been reported. Based on the evidence, NIOSH recommends addition of a carcinogenic notation to the reduced PEL.

The NIOSH LOQ (Method No. 1001) for methyl chloride is 16 ppm (3 L).

REFERENCES:
NIOSH [1984]. Current intelligence bulletin #43: Monohalomethanes, methyl chloride (CH_3Cl), methyl bromide (CH_3Br), methyl iodide (CH_3I). Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-117.

Pavkov KL [1982]. Final report on a chronic inhalation toxicology study in rats and mice exposed to methyl chloride. Volumes I-IV. Chemical Industry Institute of Toxicology Battelle Columbus Laboratories. CIIT Docket # 12712.

NAME: 4,4'-Methylene Bis(2-Chloroaniline (MBOCA)

CAS: 101-14-4
CODE: H.S. 1273

PEL CURRENT:

*--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

*OSHA limit suspended by Court Action in 1974.

PEL PROPOSED:

0.02 (skin)	ppm	0.22	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

TLV:

(A2) 0.02 (skin)	ppm	0.22	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

REL:

--	ppm	*0.003	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

*Lowest level at which it can be reliably measured at this time.

PRODUCTION WORKERS: 33,100 (1972) **VOLUME:** -- POUNDS

TOXICITY:
Human Hematuria; cancer, kidney and bladder **Animal** Cancer (liver-rat; bladder-dog); cyanosis; methemoglobinemia

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human Inadequate evidence (but is classified A2) **Animal** Sufficient evidence
NTP : Human -- **Animal** Sufficient evidence (4th Annual Report)
NIOSH: Potential occupational carcinogen
ACGIH: Suspected carcinogen

NIOSH DATE:

COMMENTS:
The proposed OSHA PEL is 0.02 ppm (0.22 mg/m^3) which is the current TLV [1986] but doesn't include the TLV A2-Suspected Carcinogen designation. The NIOSH REL is .003 mg/m^3, which is the lowest level that can be reliably measured [NIOSH 1978] based on carcinogenic effects. The OSHA PEL documentation erroneously reports the NIOSH REL as 3 mg/m^3 rather than the correct value of 0.003 mg/m^3. The TLV is the "level

NAME: 4,4'-Methylene Bis(2-Chloroaniline (MBOCA) CAS: 101-14-4
CODE: H.S. 1273

COMMENTS (continued):
which will prevent systemic poisoning provided skin contact is avoided," although no documentation as to a no effect level was found. NTP [1985] judged "sufficient evidence" for the carcinogenicity of MBOCA in experimental animals. IARC [IARC 1973; IARC 1987] evaluation resulted in categorizing the evidence as "insufficient in humans," "sufficient in animals" and overall rating it in Group 2A which is "agent is probably carcinogenic to humans." MBOCA has been found to be carcinogenic in three animal species and has been reported by three independent groups of investigators to be carcinogenic.

Two epidemiology studies which have reported negative findings [Mastromatteo 1965; Linch et al. 1971] have same shortcomings [NIOSH 1973]. However, NIOSH in a retrospective study [Ward et al. 1988] of 400 MBOCA workers has found three workers with bladder cancer. NIOSH has previously transmitted this information to OSHA. In view of the carcinogenic animal studies and limited human data, it would appear that no safe level has been demonstrated for exposure to MBOCA. It would seem appropriate to recommend at this time that exposure be limited to the lowest level it can be reliably measured (0.003 mg/m^3).

These data indicate that MBOCA meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NIOSH does not have an LOQ for MBOCA because there is no NIOSH analytical method.

REFERENCES:
ACGIH [1986]. 4,4-Methylene Bis (2-Chloroaniline). In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 392.4.

IARC [1973]. Some aromatic amines, hydrazine and related substances, N-nitroso compounds and miscellaneous alkylating agents. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Volume 4. Lyon, France: World Health Organization, International Agency for Research on Cancer.

IARC [1987]. Overall evaluation of carcinogenicity: an update of IARC monographs. . IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Supplement 7. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Linch AL, O'Connor GB, Barnes JR, Killian AS, Neeld WE [1971]. Methylene-bis-Ortho-Chloroaniline (MOCA®): Evaluation of hazards and exposure control. Am Ind Hyg Assoc J 32:802-819.

Mastromatteo E [1965]. Recent occupational health experiences in Ontario. J Occup Med 7(10):502-511.

NAME: 4,4'-Methylene Bis(2-Chloroaniline (MBOCA)

CAS: 101-14-4
CODE: H.S. 1273

REFERENCES: (Continued)

NIOSH [1973]. Hazard review of 4,4'-Methylene-Bis(2-Chloroaniline). Rockville, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

NIOSH [1978]. Special Occupational Hazard Review and Control Recommendation: 4,4'-Methylene Bis(2-Chloroaniline). Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

NTP [1985]. Fourth annual report on carcinogens. Summary 1985. U.S. Department of Health and Human Services, Public Health Service, NTP 85-002.

Ward E, Halperin W, Thun M, Grossman HB, Fink B, Koss L, Osorio AM, Schulte P [1988]. Bladder tumors in two young males occupationally exposed to MBOCA. Am J Indus Med 14:1-6.

NAME: Nickel (Soluble Compounds) **CAS:** 7440-02-0
CODE: H.S. 1283

PEL CURRENT:

-- ppm	1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

PEL PROPOSED:

-- ppm	0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

TLV:

-- ppm	0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

REL:

-- ppm	0.015 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

PRODUCTION WORKERS: 250,000 (1982) **VOLUME:** 293,000,000 POUNDS

TOXICITY:
Human Cancer Animal Cancer

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human POS (Sufficient evidence) Animal POS (Sufficient evidence)
NTP : Human POS Animal POS
NIOSH: POS
ACGIH: NEG (Nickel sulfide roasting)

NIOSH DATE: Criteria Document (1977)

COMMENTS:
NIOSH recommended in 1977 [NIOSH 1977] that in the absence of adequate information on the amount of inorganic nickel that can be inhaled over a working lifetime without an excess risk of cancer, that employee exposures be kept below the lowest TWA concentration reliably detectable over a single work shift, namely 15 ug Ni/m^3 (0.015 mg/m^3). Since 1977 there have been several epidemiological studies which have confirmed the carcinogenicity of inhaled insoluble, semi-soluble, and soluble nickel dusts [Chovil et al. 1981]. In some cohorts over 40% of the workers developed lung cancer. Inhalation studies have shown that exposures to less than 1 mg of Ni/m^3 of air (as Ni_2S_3) can produce lung tumors in 15-19% of rats [Ottolenghi et al. 1974]. The current PEL of 1 mg Ni/m^3 of air for nickel sulfide is clearly non-protective. Extremely high incidences of lung cancer have occurred in workers exposed to the insoluble as well as the soluble nickel dusts. For this reason, NIOSH recommends that

NAME: Nickel (Soluble Compounds) **CAS:** 7440-02-0
CODE: H.S. 1283

COMMENTS (continued):
OSHA consider lowering the PEL for Ni as it occurs in either the soluble or insoluble form. Furthermore, it is unclear how OSHA derived a risk of 1.4 deaths from lung cancer per 1,000 workers exposed for a working lifetime to 0.1 mg soluble Ni/m^3. The exposure data in the reference that OSHA cites [Magnus et al. 1982] is inadequate for risk assessment. These data indicate that soluble nickel compounds meet the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ for nickel (soluble compounds) is 0.0025 mg/m^3 (1000 L).

REFERENCES:
Chovil A, Sutherland RB, Halliday M [1981]. Respiratory cancer in a cohort of nickel sinter plant workers. Brit J Ind Med 38:327-333.

Magnus K, Andersen A, Hogetveit AC [1982]. Cancer of respiratory organs among workers at a nickel refinery in Norway. Int J Cancer 30:681-685.

NIOSH [1977]. Criteria for a recommended standard....occupational exposure to inorganic nickel. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 77-164.

Ottolenghi AD, Haseman JK, Payne WW, Falk HL, MacFarland HN [1974]. Inhalation studies of nickel sulfide in pulmonary carcinogenesis of rats. J Nat Can Inst 54:1165-1172.

NAME: p-Nitrochlorobenzene

CAS: 100-00-5
CODE: H.S. 1288

PEL CURRENT:
0.17 ppm (skin) 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
0.17 ppm (skin) 1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:*
0.5 ppm (skin) 3 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
*On notice of intended change to 0.1 ppm (0.6 mg/m^3)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** 50-100 million (1977) POUNDS

TOXICITY:
Human Cyanosis; jaundice; methemoglobinemia **Animal** Liver; kidney; methemoglobinemia; cancer (?)

MUTAGENICITY:
Human -- **Animal** POS (Salmonella); NEG (Drosophila); POS (Cytogenetics)

TERATOGENICITY:
Human -- **Animal** POS (rat - embryotoxicity, fetal skeletal malformations)

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** Inhalation study in progress
NIOSH: --
ACGIH: Equivocal [Weisburger 1978]

NIOSH DATE:

COMMENTS:
The ACGIH [1986] TLV is presently 3 mg/m^3 TWA, but is on the "Intended Change" list to lower it to 0.6 mg/m^3 TWA. The TLV is being lowered based on methemoglobin formation in rats and humans. The OSHA PEL for p-nitrochlorobenzene is currently 1 mg/m^3 and it is proposed to retain this value with the skin designation.

Weisburger et al. [1978] reported in a dietary study no that tumors were observed in male rats, but there was an increase in vascular and liver tumors in male and female mice. DuPont [1983] in a critique of this study reported by NTP [NTP 1985] indicated that the evidence was equivocal based on the lower number of animals tested and evaluated histologically, the high incidence of spontaneous tumors, and the inadequate description and definition of tissue.

NAME: p-Nitrochlorobenzene

CAS: 100-00-5
CODE: H.S. 1288

COMMENTS (continued):
NTP presently has an ongoing chronic inhalation study on this chemical. The TLV committee indicated in the documentation [ACGIH 1986] that they considered Weisburger results to be equivocal.

It is recommended that this chemical be controlled to the lowest feasible limit. NTP reported environmental sampling at two plants which use p-nitrochlorobenzene as a chemical intermediate level well below the proposed OSHA PEL. The LOQ is 0.25 mg/m^3 for p-nitrochlorobenzene.

REFERENCES:
ACGIH [1986]. p-Nitrochlorobenzene. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 432.1-432.2.

NTP[1985]. 4-Chloronitrobenzene (working draft). U.S. Public Health Service, National Institute of Health, National Toxicology Program.

Weisburger EK, Russfield AB, Homburger F, Weisburger JH, Boger E, Van Dongen CG, Chu KC [1978]. Testing of twenty-one environmental aromatic amines or derivatives for long-term toxicity or carcinogenicity. J Env Pathol Toxicol 2:325-356.

NAME: 2-Nitropropane **CAS:** 79-46-9
CODE: H.S. 1291

PEL CURRENT:
25 ppm 87 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
10 ppm 35 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV (suspected human carcinogen):
(A2) 10 ppm (A2) 35 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL (lowest feasible level):
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 185,000 (1972) **VOLUME:** 30 x 10^6 (1977) POUNDS

TOXICITY:
Human Liver toxicity; nausea, headache **Animal** Liver

MUTAGENICITY:
Human -- **Other** POS (Salmonella; Drosophila)

TERATOGENICITY:
Human -- **Animal** POS (heart development)

CARCINOGENICITY:
IARC : Human -- **Animal** POS (rat, liver - sufficient evidence)
NTP : Human -- **Animal** POS
NIOSH: POS
ACGIH: POS (rat) A2 - suspected human carcinogen

NIOSH DATE: Current Intelligence Bulletin #17 (1977)

COMMENTS:
In a Joint 1980 Health Hazard Alert, OSHA and NIOSH recommended that occupational exposure to 2-nitropropane be reduced to the lowest feasible level [OSHA/NIOSH 1980]. This was based upon several experimental inhalation studies in rats. Lewis et al. [1979] reported that inhalation of 200 ppm 2-nitropropane for 6 months induced liver cancer in 100% of rats by the end of the exposure (6 months). In a contract report, Coulston et al. [1978] reported the induction of liver cancer in 100% of rats after 6-months inhalation exposure to 200 ppm 2-nitropropane. Ninety percent of the rats exhibited pulmonary metastases 6 months post-exposure. In addition, exposures of rats to 100 ppm 2-nitropropane for nine months induced the same histopathological changes seen in livers of rats exposed for 3 months to 200 ppm. These studies were also

NAME: 2-Nitropropane **CAS:** 79-46-9
CODE: H.S. 1291

COMMENTS (continued):
mentioned in scientific articles in the open literature. Griffin et al. [1980] reported that 9/10 rats exposed for 6 months to 200 ppm 2-nitropropane developed liver cancer with metastases 6 months post-exposure. They also stated that in rats exposed to 100 ppm 2-nitropropane for 18 months that "a similar, though not as severe, pathologic picture emerged." Griffin et al. [1982] also reported in their discussion that "at a concentration of 100 ppm, hepatocarcinomas are induced in animals exposed to 2-NP...". Even at exposures to 25 ppm 2-nitropropane for 22 months, an increase in the incidence of hepatocellular nodules were seen [Griffin et al. 1980]. No tests of statistical significance were reported. In addition, the term "hepatocellular nodules" probably refers to neoplastic nodules which are considered to be neoplasms by most experimental pathologists. More recently, liver cancer was induced in 100% of rats when given 2-nitropropane by gavage, 3 times per week for 16 weeks (3.7 months) [Fiala et al. 1987]. The National Research Council [NRC 1981] concluded that "2-nitropropane is a potent carcinogen in rats."

OSHA in their document refers to one high-dose and two low-dose studies reporting negative results for rats. One of the references OSHA cites is an abstract of a presentation at a meeting [Griffin et al. 1978]. That presentation was an interim report of the other studies cited above [Coulston et al. 1978; Griffin et al. 1980; Griffin et al. 1982]. The two low-dose studies OSHA refers to are actually two reports on the same study (exposures to 25 ppm).

OSHA proposes to lower the PEL from 25 ppm to 10 ppm (A2), the existing TLV. Considering the facts that: 1) liver cancer was induced in 100% of rats exposed to 200 ppm 2-nitropropane for 6 months and in a high percentage of rats exposed to 100 ppm for 18 months, 2) liver neoplasms were induced in rats exposed to 25 ppm for 22 months, and 3) 2-nitropropane is a more potent carcinogen than vinyl chloride for which the PEL is 1 ppm, it is clear that the proposed PEL of 10 ppm for 2-nitropropane will not be protective.

These data indicate that 2-nitropropane meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen. It is recommended that the PEL be reduced to the lowest possible limit.

The NIOSH LOQ (Method No. 2528) for 2-nitropropane is 1.4 ppm (2 L).

REFERENCES:
Coulston F, Benitz K [1978]. Chronic inhalation of 200 ppm of 2-nitropropane in rats. Six month report. Albany, NY: Institute of Comparative and Human Toxicology, Albany Medical College.

Fiala ES, Czerniak R, Castonguay A, Conaway CC, Rivenson A [1987]. Assay of 1-nitropropane, 2-nitropropane, 1-azoxypropane and 2-azoxypropane for carcinogenicity by gavage in Sprague-Dawley rats. Short communication. Carcinogenesis 8(12):1947-1949.

NAME: 2-Nitropropane **CAS:** 79-46-9
CODE: H.S. 1291

REFERENCES (continued):
Griffin TB, Benitz K-F, Coulston F, Rosenblum I [1978]. Chronic inhalation toxicity of 2-nitropropane in rats. Pharmocologist 20(3):145.

Griffin TB, Coulston F, Stein AA [1980]. Chronic inhalation exposure of rats to vapors of 2-nitropropane at 25 ppm. Ecotoxicol Environ Safety 4:267-281.

Griffin TB, Stein AA, Coulston F [1982]. Inhalation exposure of rats to vapors of 1-nitropropane at 100 ppm. Ecotoxicol Environ Safety 6:268-282.

Lewis TR, Ulrich CE, Busey WM [1979]. Subchronic inhalation toxicity of nitromethane and 2-nitropropane in rats. J Environ Pathol Toxicol 2:233-249.

NRC [1981]. Selected aliphatic amines and related compounds: An assessment of the biological and environmental effects. Washington, DC: National Research Council, Assembly of Life Sciences, Board on Toxicology and Environmental Health Hazards, Committee on Amines, Contract No. 68-01-4655.

OSHA/NIOSH [1980]. Health hazard alert - 2-Nitropropane (2-NP). Washington, D.C.: U.S. Department of Labor, Occupational Safety and Health Administration. Rockville, MD: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 80-142.

NAME: Perchloroethylene (Tetrachloroethylene) **CAS:** 127-18-4
CODE: H.S. 1308

PEL CURRENT:

100 ppm	670 mg/m^3 (TWA)	200 ppm	1340 mg/m^3	(ceiling - 15 min)
		300 ppm	2010 mg/m^3	(ceiling - 5 min peak in 3 hours)

PEL PROPOSED:

50 ppm	340 mg/m^3 (TWA)	200 ppm	1340 mg/m^3	(ceiling - 15 min)

TLV:

50 ppm	340 mg/m^3 (TWA)	200 ppm	1340 mg/m^3	(STEL - 15 min)

REL (minimize exposure, carcinogen):

-- ppm	-- mg/m^3 (TWA)	-- ppm	-- mg/m^3	( )

PRODUCTION WORKERS: 396,000 (1982) **VOLUME:** 670,000,000 (1985) POUNDS

TOXICITY:
Human Peripheral nervous system; liver injury **Animal** Cancer (liver); neurotoxic; eye and skin irritant

MUTAGENICITY:
Human NEG (assay of human lymphocytes) **Other** NEG (in 8 studies; EQUIV in one study)

TERATOGENICITY:
Human -- **Animal** Inhalation study

CARCINOGENICITY:
IARC : **Human** Inadequate evidence **Animal** Limited evidence
NTP : **Human** -- **Animal** POS (1977; 1986)
NIOSH: Potential occupational carcinogen
ACGIH: --

NIOSH DATE: Current Intelligence Bulletin #20 (1978)

COMMENTS:
In Current Intelligence Bulletin #20 [NIOSH 1978], NIOSH recommended that tetrachloroethylene be considered a potential occupational carcinogen. NIOSH based its recommendation on the NCI Bioassay of Tetrachloroethylene [NCI 1977] in which male and

NAME: Perchloroethylene (Tetrachloroethylene) **CAS:** 127-18-4
CODE: H.S. 1308

COMMENTS: (Continued)
female B6C3F$_1$ mice, given the test substance by gavage in corn oil, had a significantly increased incidence of hepatocellular carcinoma. The results of the bioassay in Osborne-Mendel rats did not allow an evaluation of the carcinogenicity of tetrachloroethylene due to the high rate of early death among the treated and untreated animals. Subsequently, IARC [1979] evaluated the 1977 NCI Bioassay, an abstract of an inconclusive inhalation study in rats, and a limited study in mice via intraperitoneal injection, and determined that there is "limited evidence" for carcinogenicity in animals. IARC [1982] also evaluated two limited epidemiological studies and determined that there is "inadequate evidence" for carcinogenicity in humans. ACGIH [1986] evaluated the two inconclusive epidemiological studies, the 1977 NCI bioassay, a negative lifetime inhalation study in rats, and a negative mouse skin painting study, and concluded that tumors are not expected if liver injury does not occur. ACGIH [1986] based its TLV on prevention of narcotic effects and liver injury.

In August 1986, NTP released the results of an inhalation carcinogenicity study on tetrachloroethylene in F344/N rats and B6C3F$_1$ mice [NTP 1986]. The rats and mice (groups of 50 male and female) were exposed for 6 hrs/day, 5 days/wk for 103 weeks to 0, 200, or 400 ppm for rats and 0, 100, or 200 ppm for mice. Under the conditions of these 2-year inhalation studies, there was clear evidence of carcinogenicity of tetrachloroethylene for male 344/N rats as shown by an increased incidence of mononuclear cell leukemia and uncommon renal tubular cell neoplasms. There was some evidence of carcinogenicity of tetrachloroethylene for female F344/N rats as shown by increased incidences of mononuclear cell leukemia. There was clear evidence of carcinogenicity for B6C3F$_1$ mice as shown by increased incidences of both hepatocellular adenomas and carcinomas in males and of hepatocellular carcinomas in females.

In "commercial" dry cleaning plants utilizing perchloroethylene, 8-hour TWA exposures can be limited to less than 10 ppm if a single machine for washing, extraction, and drying (a "dry-to-dry" unit) is used in conjunction with exhaust ventilation, carbon adsorption systems, and general exhaust ventilation [Ludwig 1981; Ludwig et al. 1983; NIOSH 1980].

On the basis of carcinogenic and tumorigenic response in rats and mice, and in accordance with the cancer policy of OSHA (29 CFR 1990), NIOSH recommends that perchloroethylene (tetrachloroethylene) be labeled as a potential occupational carcinogen. NIOSH further recommends that occupational exposure to perchloroethylene be minimized by limiting exposure to as few employees as possible, while minimizing workplace exposure levels.

The NIOSH LOQ (Method No. 1003) for perchloroethylene is 0.4 ppm (40 L).

REFERENCES:
ACGIH [1986]. Perchloroethylene. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 464-465.

NAME: Perchloroethylene (Tetrachloroethylene) **CAS:** 127-18-4
CODE: H.S. 1308

REFERENCES: (Continued)

IARC [1979]. Some halogenated hydrocarbons. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 20. Lyon, France: World Health Organization, International Agency for Research on Cancer.

IARC [1982]. Chemicals, industrial processes and industries associated with cancer in humans. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volumes 1-29, Supplement 4, pp. 243-245. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Ludwig HR [1981]. Occupational exposure to perchloroethylene in the dry cleaning industry. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, [unpublished].

Ludwig HR, Meister MV, Roberts DR, Cox C [1983]. Worker exposure to perchloroethylene in the commercial dry cleaning industry. Amer Ind Hyg Assoc J 44(8):600-605.

NIOSH [1980]. Engineering control technology assessment of the dry cleaning industry. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 80-136.

NIOSH [1978]. Current intelligence bulletin #20 - tetrachloroethylene (perchloroethylene). Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-112.

NCI [1977]. Bioassay of tetrachloroethylene for possible carcinogenicity. Bethesda, MD: U.S. Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, National Cancer Institute. DHEW (NIH) Publication No. 77-813.

NTP [1986]. Toxicology and carcinogenesis studies of tetrachloroethylene (perchloroethylene) in F344/N rats and B6C3F$_1$ mice (inhalation studies). Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Toxicology Program. NIH Publication No. 86-2567

NAME: Phenyl Glycidyl Ether (PGE) **CAS:** 122-60-1
CODE: H.S. 1315

PEL CURRENT:
10 ppm 60 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
1 ppm 6 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
1 ppm 6 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) 1 ppm 5 mg/m^3 (ceiling - 15 minutes)

PRODUCTION WORKERS: 8,000 (1978, CIB #29) **VOLUME:** 600,000 POUNDS

TOXICITY:
Human Skin irritation & sensitization **Animal** Respiratory & eye irritant; liver toxicity; testicular degeneration

MUTAGENICITY:
Human -- **Animal** POS (salmonella)

TERATOGENICITY:
Human -- **Animal** POS (rat)

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: POS (Lee et al. 1983)
ACGIH: --

NIOSH DATE: Current Intelligence Bulletin #29 (1978)
Criteria Document, June 1978

COMMENTS:
The ACGIH TLV and NIOSH REL are based on the same animal studies. The criteria document on glycidyl ethers states:

> "...and in order to provide an adequate safety margin, NIOSH recommends that the environmental limit for PGE be set at 5 mg/cu m (1 ppm), designated as a ceiling concentration for a 15-minute sampling period." [NIOSH 1978]

However, in consideration of the 1983 report by Lee et al. [1983] reporting epidermoid nasal carcinomas and squamous metaplasia of the nasal epithelium in rats exposed at 1 or

NAME: Phenyl Glycidyl Ether (PGE) **CAS:** 122-60-1
CODE: H.S. 1315

COMMENTS (continued):
12 ppm of phenyl glycidyl ether, it would be prudent for OSHA to label PGE as a potential occupational carcinogen since it meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990 and to limit exposures to a 1 ppm ceiling of 15 minutes.

The NIOSH LOQ (Method No. S74) for phenyl glycidyl ether is 1 ppm (50-L).

REFERENCES:
Lee KP, Schneider PW, Trochimowicz HJ [1983]. Morphologic expression of glandular differentiation in the epidermoid nasal carcinomas induced by phenylglycidyl ether inhalation. Am J Pathol 111(2):140-148.

NIOSH [1978]. Criteria for a recommended standard....occupational exposure to glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-166.

NIOSH [1978b]. Current intelligence bulletin #29: Glycidyl ethers. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 79-104.

NAME: Phenylhydrazine **CAS:** 100-63-0
CODE: H.S. 1317

PEL CURRENT:				
(skin) 5 ppm	(skin) 20 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )	
PEL PROPOSED:				
5 ppm	20 mg/m^3 (TWA)	10 ppm	45 mg/m^3 (STEL)	
TLV:				
(A2) 5 ppm	(A2) 20 mg/m^3 (TWA)	(A2) 10 ppm	(A2) 45 mg/m^3 (STEL)	
REL:				
-- ppm	-- mg/m^3 (TWA)	0.14 ppm	0.6 mg/m^3 (ceiling - 2 hour)	

PRODUCTION WORKERS: 1120 (1972) **VOLUME:** >20,000 (1977) POUNDS

TOXICITY:
Human Skin irritant and sensitizer; CNS; hemolytic anemia **Animal** Hemolytic anemia, liver/kidney lesions; cancer (lung)

MUTAGENICITY:
Human -- **Other** POS (Salmonella; DNA damage, [mouse])

TERATOGENICITY:
Human -- **Animal** Behavioral effect (rat offspring)

CARCINOGENICITY:
IARC : **Human** -- **Animal** --
NTP : **Human** -- **Animal** --
NIOSH: POS (Potential occupational carcinogen)
ACGIH: Suspected human carcinogen

NIOSH DATE: Criteria Document (1978) (Hydrazines)

COMMENTS:
The article [Clayson et al. 1965] that ACGIH [ACGIH 1986] cites as indicating the "weak carcinogenicity" of phenylhydrazine also states that "the pulmonary tumours induced by phenylhydrazine hydrochloride were more malignant (adenomas becoming malignant) than those obtained with the other chemicals (investigated)." Another study [Toth et al. 1976] confirms the tumorigenicity of phenylhydrazine. These data indicate that phenylhydrazine meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen and reduce the proposed PEL to 0.14 ppm as a 2-hour ceiling concentration [NIOSH 1978].

NAME: Phenylhydrazine

CAS: 100-63-0
CODE: H.S. 1317

REFERENCES:

ACGIH [1986]. Phenylhydrazine. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 477.

Clayson DB, Biancifiori C, Giornelli-Santilli A, Giornelli-Santilli FE [1965]. The induction of pulmonary tumours in BALB/c/Cb/Se mice by derivatives of hydrazine. In: Proceedings of the Quadrennial Conference on Cancer, pp. 869-880.

NIOSH [1978]. A recommended standard for occupational exposure to....hydrazines. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-172.

Toth B, Shimizu H [1976]. Tumorigenic effects of chronic administration of benzylhydrazine dihydrochloride and phenylhydrazine hydrochloride in swiss mice. Z Krebsforsch 87:267-273.

NAME: Propylene Dichloride **CAS:** 78-87-5
CODE: H.S. 1341

PEL CURRENT:
75 ppm 350 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
75 ppm 350 mg/m^3 (TWA) 110 ppm 510 mg/m^3 (STEL - 15-min)

TLV:
75 ppm 350 mg/m^3 (TWA) 110 ppm 510 mg/m^3 (STEL - 15-min)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 714,496 (1972) **VOLUME:** 146,000,000 POUNDS
77,000,000 (NCI 1985)

TOXICITY:
Human Eye and skin irritant; CNS depressant **Animal** Hepatotoxic; eye and respiratory irritant; carcinogen

MUTAGENICITY:
Human -- **Other** POS (salmonella; mouse lymphoma; cytogenetics)
NEG (Drosophila)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** POS (limited evidence)
NTP : Human -- **Animal** POS (rat and mouse [NCI 1985]; Female rat equivocal evidence; Male & female mice (some evidence [NTP 1986]
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
A 1977 Russian article stated that, "prolonged inhalatory exposure to DCP (1,2-dichloropropane) in concentrations of 9 mg/m^3 (approximately 2 ppm) caused a reliable change in the functional state of the central nervous system, blood enzyme activity, structural shifts in the liver, lungs, and corpuscle-cell system, and the disruption of bioenergetic processes in the liver, lungs and adrenal glands, as well as

NAME: Propylene Dichloride

CAS: 78-87-5
CODE: H.S. 1341

COMMENTS (continued):
changes in the DNA-synthesizing system of the liver" [Isulaya et al. 1977]. Even if this reference is discounted, important new information has been generated since the ACGIH itself stated that "reconsideration of the TLV-TWA of 75 ppm and the TLV-STEL of 110 ppm would seem to be in order" [ACGIH 1986]. A National Toxicology Program carcinogenesis study completed in 1986 [NTP 1986] reported that 2-year gavage treatment of male and female mice induced hepatocellular adenomas. Female rats developed mammary gland adenocarcinomas. The NTP formally concluded that there was equivocal evidence of carcinogenicity produced in female rats in that there was a marginally increased incidence of adenocarcinomas in the mammary gland; there was some evidence of carcinogenicity for male and female mice as indicated by increased incidences of hepatocellular neoplasms (primarily adenomas); and there was no evidence of carcinogenicity for male rats.

NIOSH urges OSHA to consider these new findings in their final exposure limit determination. NIOSH recommends that OSHA label propylene dichloride a potential occupational carcinogen, in accordance with the OSHA carcinogen policy (29 CFR 1990).

The NIOSH LOQ (Method No. 1013) for propylene dichloride is 0.03 ppm (3.5 L).

REFERENCES:
ACGIH [1986]. Propylene dichloride. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 501.

Isulaya VR, Bonashevskaya TI, Zykova VV, Shaypak VM, Erman FM, Shoricheva VN, Belyayeva NN, Kumpan NN, Tarasova KI, Gushchina LM [1977]. The toxicological characteristics of certain chlorines derived from hydrocarbons. Gigiyena i Sanitariya 8:50-53.

NTP [1986]. Toxicology and carcinogenesis studies of 1,2-dichloropropane (propylene dichloride) in F344/N rats and B6C3F$_1$ mice (gavage studies). Bethesda, MD: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, Technical Report Series No. 263.

NAME: Propylene Oxide **CAS:** 75-56-9
CODE: H.S. 1344

PEL CURRENT:
100 ppm 250 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
20 ppm 50 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
20 ppm 50 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 194,000 (1982) **VOLUME:** 1,236,000,000 (1977) POUNDS

TOXICITY:
Human Primary irritant: eyes, lungs, & skin; CNS **Animal** Irritation to lungs; CNS

MUTAGENICITY:
Human POS (Human lymphocytes) **Other** POS (Many systems)

TERATOGENICITY:
Human -- **Animal** NEG

CARCINOGENICITY:
IARC : **Human** NEG (Inadequate evidence) **Animal** POS (Sufficient evidence)
NTP : **Human** -- **Animal** POS (Some evidence)
NIOSH: (Current Intelligence Bulletin in preparation)
ACGIH: Not labeled carcinogen

NIOSH DATE:

COMMENTS:
OSHA does not mention any data regarding the carcinogenicity of propylene oxide in its determination for lowering the PEL and relies solely on the TLV documentation [ACGIH 1986] which cites the NIOSH Registry of Toxic Effects of Chemical Substances, 1977, as its latest reference. Since that time, numerous reports have appeared in the literature including the following:

The NTP TR 267 [NTP 1985] states: "Under the conditions of these studies, there was some evidence of carcinogenicity* for F344/N rats, as indicated by increased incidences of papillary adenomas of the nasal turbinates in male and female rats exposed to propylene oxide at 400 ppm. For male and female B6C3F$_1$ mice, there was clear evidence of carcinogenicity, as indicated by increased incidences of hemangiomas or

NAME: Propylene Oxide **CAS:** 75-56-9
CODE: H.S. 1344

COMMENTS: (Continued)
hemangiosarcomas of the nasal turbinates at 400 ppm. In the respiratory epithelium of the nasal turbinates, propylene oxide also caused suppurative inflammation, hyperplasia, and squamous metaplasia in rats and inflammation in mice."

The IARC Monograph [IARC 1985] concludes that there is sufficient evidence for the carcinogenicity of propylene oxide in animals and inadequate evidence in humans.

IARC reviewed the following studies (on animal carcinogenicity) prior to making this determination:

(1) NTP study - (TR 267 is attached).
(2) Dunkelberg [1982] - attached.
(3) Lynch et al. [1984] - attached.
(4) Dunkelberg [1981] - not currently available in English.

On the basis of carcinogenic responses in rats and mice, and in accordance with the Cancer Policy of the Occupational Safety and Health Administration (OSHA) ("Identification, Classification, and Regulation of Potential Occupational Carcinogens," 29 CFR 1900), NIOSH recommends that propylene oxide be labelled as a "potential occupational carcinogen."

The NIOSH LOQ (Method No. 1612) for propylene oxide is 8.4 ppm (5 L).

REFERENCES:
ACGIH [1986]. Propylene Oxide. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 504.

Dunkelberg H [1981]. Carcinogenic activity of ethylene oxide and its reaction products 2-chloroethanol, 2-bromoethanol, ethylene oxide and diethylene glycol. (Ger) Zbl Brakt Hyg I Abt Org B 174:383-404

Dunkelberg H [1982]. Carcinogenicity of ethylene oxide and 1,2-propylene oxide upon intragastric administration to rats. Br J Cancer 46:924-933.

IARC [1985]. Allyl compounds, aldehydes, epoxides, and peroxides. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 36. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lynch, DW, Lewis TR, Moorman WJ, Burg JA, Groth DH, Khan A, Ackerman LJ, Cockrell BY [1984]. Carcinogenic and toxicologic effects of inhaled ethylene oxide and propylene oxide in F344 rats. Toxicol Appl Pharmacol 76:69-84.

NIOSH [1985]. Manual of analytical methods, revised 3rd edition. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS Vol 2, Method No. 1612.

NAME: Propylene Oxide

CAS: 75-56-9
CODE: H.S. 1344

REFERENCES: (Continued)

NTP [1985]. Toxicology and carcinogenesis studies of propylene oxide in F344 /N rats and B6C3F1 mice (inhalation studies). Research Triangle Park, NC: National Toxicology Program, Technical Report Series, No. 267, NTP 83-020.

NAME: Rosin Core Solder Pyrolysis Products

CAS: None
CODE: H.S. 1350

PEL CURRENT:

--	ppm	--	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

PEL PROPOSED:

--	ppm	0.1 (as formaldehyde)	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

TLV:

--	ppm	0.1 (as formaldehyde)	mg/m^3 (TWA)	--	ppm	--	mg/m^3 ( )

REL:

--	ppm	--	mg/m^3 (TWA)	--	ppm	0.1	mg/m^3 (ceiling - 15 min) as formaldehyde

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Upper respiratory and eye irritation **Animal** Minimal organ toxicity (organ to body-weight ratios)

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** --
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE:

COMMENTS:
The proposed OSHA PEL is 0.1 mg/m^3 for rosin core solder pyrolysis products (as formaldehyde). In unpublished studies by Melvin et al. [ACGIH 1986], 80 percent of volunteer subjects experienced moderate to severe irritation of the eyes, nose or throat at concentrations above 0.12 mg/m^3, while 30 percent reported irritation of the mucous membranes at a concentration of 0.07 mg/m^3 of aliphatic aldehydes measured as formaldehyde. Burge et al. [1981] showed that 23 percent of workers exposed to an

NAME: Rosin Core Solder Pyrolysis Products

CAS: None
CODE: H.S. 1350

COMMENTS (continued):
average concentration of only 0.02 mg/m^3 flux-cored solder (containing rosin and resin acids) had developed occupational asthma.

In NIOSH's most recent testimony [Millar 1986], formaldehyde is regarded as a potential occupational carcinogen, and therein, NIOSH recommends that exposure to formaldehyde be controlled to 0.1 ppm in air by collection of an air sample for any 15 minute period as described in NIOSH Analytical Method 3500.

The NIOSH LOQ (Method S3500) for Rosin Core Solder Pyrolysis Products (as formaldehyde) is 0.016 ppm (100 L).

Available data relating exposure concentrations to responses of human subjects (volunteers) and industrial exposures indicate that the current TLV and proposed OSHA PEL do not provide a satisfactory limit of exposure/margin of safety for exposure to rosin core solder pyrolysis products measured as formaldehyde from the total of aliphatic aldehydes present in the pyrolysis products.

This is the most sensitive formaldehyde method of the three included in the NIOSH Manual of Analytical Methods "and is able to measure ceiling levels as low as 0.1 ppm (15-liter sample). It is also preferred for the determination of formaldehyde in area samples at all concentrations due to its simplicity."

REFERENCES:
ACGIH [1986]. Rosin Core Solder Pyrolysis Products. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., p. 514.

Burge PS, Edge G, Hawkins R, White V, Taylor AJN [1981]. Occupational asthma in a factory making flux-cored solder containing colophony. Thorax 36:828-834.

Millar JD [1986]. Statement before the Department of Labor, Occupational Safety and Health Administration, Public Hearing on the Occupational Standard for Formaldehyde by Millar JD, Director, National Institute for Occupational Safety and Health, Centers for Disease Control, Public Health Service, Department of Health and Human Services, May 1986.

NAME: Silica, Crystalline Quartz (respirable) **CAS:** 14808-60-7
CODE: H.S. 1355

PEL CURRENT:
-- ppm | $\frac{10\ mg/m^3}{\%\ SiO_2 + 5}$ (TWA) | -- ppm | -- mg/m^3 ( )

PEL PROPOSED:
-- ppm | 0.1 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

TLV:
-- ppm | 0.1 mg/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

REL:
-- ppm | 50 ug/m^3 (TWA) | -- ppm | -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Silicosis, fibrosis **Animal** Silicosis, fibrosis, cancer

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** POS (Limited evidence) **Animal** POS (Sufficient evidence)
NTP : **Human** -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1974)

COMMENTS:
In the Criteria Document on crystalline silica, NIOSH defines free silica as silicon dioxide (SiO_2) and states, "Other forms of free silica which, upon analysis, are found to have a crystalline structure as part of their composition are also subject to the recommended standard [NIOSH 1975]." Therefore, silica HS 1354, HS 1355, HS 1356, HS 1357, and HS 1358 are covered by the NIOSH REL of 50 ug/m^3.

We believe that the OSHA statement under HS 1355 silica, crystalline - quartz, "NIOSH admits to significant error in the exposure estimates used to establish its 0.05 ug/m^3 REL..." is an overstatement of the qualifying statements cited in the criteria document on crystalline silica. The ACGIH documentation of the TLV for silica, crystalline - quartz states, "Since the margin of safety of the quartz TLV is not known, it is

NAME: Silica, Crystalline Quartz (respirable) **CAS:** 14808-60-7
CODE: H.S. 1355

COMMENTS (continued):
recommended that quartz concentrations be maintained as far below the TLV as current practices will permit" [ACGIH 1986].

In its 1987 Monograph on silica and some silicates, IARC [IARC 1987] reviews the experimental animal and epidemiological data on a variety of crystalline forms of silica, including those considered by OSHA for revision of PELs. IARC's evaluations are that there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans.

Because of the ubiquitous nature of exposure to crystalline silica and often frequent concomitant occupational exposure (or through tobacco smoking) to one or more carcinogenic chemicals, it is recommended that the greatest degree of protection [Lemen et al. 1986] could be gained by adherence to the NIOSH REL of 50 ug/m^3 (for all forms of crystalline SiO_2) which approaches the present lowest quantifiable limit of detection (NIOSH Analytical Method No. 7500 or Method No. 7602). This rationale would apply to protection against silicosis as well as the reported potential carcinogenicity from exposure to certain crystalline silicas.

These data indicate that silica, crystalline quartz (respirable) meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 7500) for silica, crystalline quartz (respirable) is 0.04 mg/m^3 (1000 L).

REFERENCES:
ACGIH [1986]. Silica, Crystalline quartz. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 523-524.

IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lemen RA, Dunnon DD, Wagner WD, Mazzuckelli LF [1986]. NIOSH standards. In: Silica, silicosis, and cancer--controversy in occupational medicine. New York, NY: Praeger Publishers.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.

NAME: Silica, Crystalline - Tripoli (as respirable quartz dust)

CAS: 1317-95-9
CODE: H.S. 1357

PEL CURRENT:

-- ppm	10 mg/m^3 / % SiO_2 +2 (TWA)	-- ppm	-- mg/m^3 ( )

PEL PROPOSED:

-- ppm	0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

TLV:

-- ppm	0.1 mg/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

REL:

-- ppm	50 ug/m^3 (TWA)	-- ppm	-- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Silicosis, fibrosis **Animal** Silicosis, fibrosis, cancer

MUTAGENICITY:
Human -- **Other** --

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : Human -- **Animal** POS (Sufficient evidence)
NTP : Human -- **Animal** --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1974)

COMMENTS:
In the Criteria Document on crystalline silica, NIOSH defines free silica as silicon dioxide (SiO_2) and states, "Other forms of free silica which, upon analysis, are found to have a crystalline structure as part of their composition are also subject to the recommended standard [NIOSH 1975]." Therefore, silica HS 1354, HS 1355, HS 1356, HS 1357, and HS 1358 are covered by the NIOSH REL of 50 ug/m^3.

We believe that the OSHA statement under HS 1355 silica, crystalline - quartz, "NIOSH admits to significant error in the exposure estimates used to establish its 0.05 ug/m^3 REL..." is an overstatement of the qualifying statements cited in the criteria document on crystalline silica. The ACGIH documentation of the TLV for silica, crystalline - quartz states, "Since the margin of safety of the quartz TLV is not known, it is

NAME: Silica, Crystalline - Tripoli (as respirable quartz dust) **CAS:** 1317-95-9 **CODE:** H.S. 1357

COMMENTS: (Continued)
recommended that quartz concentrations be maintained as far below the TLV as current practices will permit" [ACGIH 1986].

In its 1987 Monograph on silica and some silicates, IARC [IARC 1987] reviews the experimental animal and epidemiological data on a variety of crystalline forms of silica, including those considered by OSHA for revision of PELs. IARC's evaluations are that there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans.

Because of the ubiquitous nature of exposure to crystalline silica and often frequent concomitant occupational exposure (or through tobacco smoking) to one or more carcinogenic chemicals, it is recommended that the greatest degree of protection [Lemen et al. 1986] could be gained by adherence to the NIOSH REL of 50 ug/m^3 (for all forms of crystalline SiO_2) which approaches the present lowest quantifiable limit of detection (NIOSH Analytical Method No. 7500 or Method No. 7602. This rationale would apply to protection against silicosis as well as the reported potential carcinogenicity from exposure to certain crystalline silicas.

These data indicate that silica, crystalline - tripoli meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 7500) for silica, crystalline - tripoli is 0.04 mg/m^3 (1000 L).

REFERENCES:
ACGIH [1986]. Silica, Crystalline - Tripoli. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 523-524.

IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lemen RA, Dunnon DD, Wagner WD, Mazzuckelli LF [1986]. NIOSH standards. In: Silica, silicosis, and cancer--controversy in occupational medicine. New York, NY: Praeger Publishers.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.

NAME: Silica, Amorphous-Fused (respirable) **CAS:** 60676-86-0
CODE: H.S. 1358

PEL CURRENT:
-- ppm $\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$ (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
_____ ppm 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV:
-- ppm 0.1 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL:
-- ppm -- ug/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: -- **VOLUME:** -- POUNDS

TOXICITY:
Human Silicosis, fibrosis Animal Silicosis, fibrosis, cancer

MUTAGENICITY:
Human -- Other --

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: --

NIOSH DATE: Criteria Document (1974)

COMMENTS:
In the Criteria Document on crystalline silica, NIOSH defines free silica as silicon dioxide (SiO_2) and states, "Other forms of free silica which, upon analysis, are found to have a crystalline structure as part of their composition are also subject to the recommended standard [NIOSH 1975]." Therefore, silica HS 1354, HS 1355, HS 1356, HS 1357, and HS 1358 are covered by the NIOSH REL of 50 ug/m^3.

We believe that the OSHA statement under HS 1355 silica, crystalline - quartz, "NIOSH admits to significant error in the exposure estimates used to establish its 0.05 ug/m^3 REL..." is an overstatement of the qualifying statements cited in the criteria document on crystalline silica. The ACGIH documentation of the TLV for silica, crystalline - quartz states, "Since the margin of safety of the quartz TLV is not known, it is

NAME: Silica, Amorphous-Fused (respirable) **CAS:** 60676-86-0
CODE: H.S. 1358

COMMENTS (continued):
recommended that quartz concentrations be maintained as far below the TLV as current practices will permit" [ACGIH 1986].

In its 1987 Monograph on silica and some silicates, IARC [IARC 1987] reviews the experimental animal and epidemiological data on a variety of crystalline forms of silica, including those considered by OSHA for revision of PELs. IARC's evaluations are that there is sufficient evidence for the carcinogenicity of crystalline silica to experimental animals and limited evidence for the carcinogenicity of crystalline silica to humans.

Because of the ubiquitous nature of exposure to crystalline silica and often frequent concomitant occupational exposure (or through tobacco smoking) to one or more carcinogenic chemicals, it is recommended that the greatest degree of protection [Lemen et al. 1986] could be gained by adherence to the NIOSH REL of 50 ug/m^3 (for all forms of crystalline SiO_2) which approaches the present lowest quantifiable limit of detection (NIOSH Analytical Method No. 7500 or Method No. 7602. This rationale would apply to protection against silicosis as well as the reported potential carcinogenicity from exposure to certain crystalline silicas.

These data indicate that silica, amorphous - fused meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

The NIOSH LOQ (Method No. 7501) for silica, amorphous - fused is 0.05 mg/m^3 (400 L).

REFERENCES:
ACGIH [1986]. Silica, Amorphous - Fused. In: Documentation of the threshold limit values and biological exposure indices. 5th edition. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, Inc., pp. 523-524.

IARC [1987]. Silica and some silicates. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Volume 42. Lyon, France: World Health Organization, International Agency for Research on Cancer.

Lemen RA, Dunnon DD, Wagner WD, Mazzuckelli LF [1986]. NIOSH standards. In: Silica, silicosis, and cancer--controversy in occupational medicine. New York, NY: Praeger Publishers.

NIOSH [1975]. Criteria for a recommended standard....occupational exposure to crystalline silica. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 75-120.

NAME: p-Toluidine

CAS: 106-49-0
CODE: H.S. 1400

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
2 ppm 9 mg/m^3 (TWA) ppm -- mg/m^3 ( )

TLV:
(A2) 2 ppm (A2) 9 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )
(skin)

REL:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 2,000 (1972) VOLUME: -- POUNDS

TOXICITY:
Human -- Animal --

MUTAGENICITY:
Human -- Other POS

TERATOGENICITY:
Human -- Animal --

CARCINOGENICITY:
IARC : Human -- Animal --
NTP : Human -- Animal --
NIOSH: --
ACGIH: POS (A2)

NIOSH DATE:

COMMENTS:
Para-toluidine is an aromatic amine which has been shown to cause cancer in 30% of mice when fed at a monthly average concentration of 1,000 ppm in the diet [Weisburger et al. 1978]. The existing TLV and OSHA's proposed PEL is 2 ppm. OSHA's risk assessment predicts that 1.2-1.9% of workers (maximum likelihood estimate of risk of 12/1,000 workers with an upper bound of 19/1,000 workers) will develop cancer when exposed to that level for a working lifetime. That degree of risk is highly significant, and the proposed PEL is, therefore, considered non-protective. These data indicate that p-toluidine meets the OSHA definition of a potential occupational carcinogen as defined in 29 CFR 1990. Therefore, NIOSH recommends that OSHA label this substance a potential occupational carcinogen.

NAME: p-Toluidine

CAS: 106-49-0
CODE: H.S. 1400

COMMENTS (continued):
The NIOSH LOQ (Method No. 2002 - no NIOSH validation) for p-toluidine is 0.15 ppm (150 L).

REFERENCES:
Weisburger EK, Russfield AB, Homburger F, Boger E, Van Dongen CG, Chu KC [1978]. Testing of twenty-one environmental aromatic amines or derivatives for long-term toxicity or carcinogenicity. J Environ Pathol Toxicol 2:325-356.

NAME: Vinyl Bromide

CAS: 593-60-2
CODE: H.S. 1425

PEL CURRENT:
-- ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PEL PROPOSED:
5 ppm 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

TLV (suspected human carcinogen):
(A2) 5 ppm (A2) 20 mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

REL (Lowest possible level):
_____ ppm -- mg/m^3 (TWA) -- ppm -- mg/m^3 ( )

PRODUCTION WORKERS: 26,000 (1974) **VOLUME:** 5,000,000 (1977) POUNDS

TOXICITY:
Human -- **Animal** Cancer, CNS, eye irritant; liver & kidney toxicity

MUTAGENICITY:
Human -- **Other** POS (Salmonella)

TERATOGENICITY:
Human -- **Animal** --

CARCINOGENICITY:
IARC : **Human** No data **Animal** POS (Sufficient evidence) (Mice and rats)
NTP : **Human** -- **Animal** --
NIOSH: POS
ACGIH: POS (A2) suspected human carcinogen

NIOSH DATE: Criteria Document (1979); Current Intelligence Bulletin #28 (1978)

COMMENTS:
NIOSH and OSHA jointly recommended in 1978 in a Current Intelligence Bulletin that occupational exposure to vinyl bromide be reduced to the lowest possible level. This was based upon experimental evidence which indicated that vinyl bromide caused cancer in animals.

In a recent publication [Benya et al. 1982], vinyl bromide was shown to produce angiosarcomas in about 10% of rats exposed by inhalation to 10 ppm of vinyl bromide. Based upon the comparative animal data, vinyl bromide is a more potent carcinogen than vinyl chloride. The current PEL for vinyl chloride is 1 ppm.