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Introduction

This chapter lists and describes common chemical contaminants that may be found in the mining environment. This is not an all-inclusive list. If other contaminants are identified at a mine site, contact your District Office for guidance.

The contaminants are listed alphabetically. Each contaminant listing contains information regarding chemical description, applicable exposure limits, contaminant code(s), analytical method(s), and sampling method(s). The information for each sampling method specifies the materials needed and their use. Once a method has been chosen, the inspector can refer to other chapters of this Handbook for further instructions. There may be alternate sampling methods other than those listed in this chapter which can be used for a particular contaminant. For assistance, contact the District Office.

The District, prior to any unusual non-routine or rush sampling, should contact the Technical Support Laboratory. The laboratory should be contacted in advance whenever a special analysis or expediting is needed, since the samples may have to be sent to an outside contract laboratory. The lab can provide advice or information and prepare for the samples. In these cases, arrangements may be made for special sampling equipment, media, or vials that can be sent from the laboratory directly to the inspector.

A list of abbreviations used in the descriptions of each contaminant is contained in Appendix A of this chapter. Because an individual chemical may have many different names, an alphabetized list of chemical synonyms with a cross-reference to each listed chemical is given in Appendix B.

SPECIAL NOTES:

Analyses

- Send ALL samples to the MSHA Laboratory in Pittsburgh as soon as possible after collection. If special mailing instructions include **"store and ship refrigerated"** or **"submit samples overnight to the MSHA Laboratory,"** notify the Laboratory that the samples are being sent and need to be processed as soon as they are received.

- **For expedited analysis**, coordinate shipment with the Laboratory so that the samples can be processed as soon as can be arranged. Send the samples via overnight service or express mail.

- **Controls and Blanks** are submitted to the MSHA Laboratory for quality assurance purposes: to determine if the collection media is contaminated from sample handling, storage, and shipping. In general, submit a control or blank for each set of like samples (five per Request for Laboratory Analysis (RLA) form). If multiple sample cassettes are needed for one exposure measurement, count each cassette as a separate sample and be sure there is one control or blank for each five samples. Also, prepare one control or blank for each type of analysis desired. For example, an "elemental" analysis of all 14 metals requires one blank, and a "calcium oxide" analysis would require its own separate blank. Separate controls or blanks must be submitted for each shift sampled. Controls or blanks must come from the same media lot or box used for the exposure sampling period. For example, this means that control sample cassettes must have the same pre-weighing date as the dust sample cassettes.

  Control Filter (submitted for respirable and total dust sampling): At no time may inlet or outlet plugs be removed from the control filter cassette. The respirable/total dust sample cassette may be submitted sealed in its original plastic wrapper.

  Blank (submitted for all other sampling media): For filter cassettes (asbestos, fibers, welding fumes, elemental dust, etc.), remove inlet and outlet plugs and then replace them. For other sampling media, open the sorbent tube, badge, or wipe filter paper and immediately seal it with the caps, cover, or container provided.

- **Bulk samples** taken are shipped separately from airborne contaminants exposure samples.

- **Error factors** will be supplied by the MSHA Laboratory when analyses are performed for compliance determination.

References

The following references were used in the preparation of this manual. These documents are periodically revised and updated, so later editions may be available from the publisher. Consult the current version of each reference.

- **Immediately Dangerous to Life or Health (IDLH)** concentration values are from the *NIOSH Chemical Listing and Documentation of Revised IDLH Values (as of 3/1/95)* [http://www.cdc.gov/niosh/idlh/intridl4.html, accessed from 11/27/2001 to 11/30/2001]. The NIOSH definition for an IDLH exposure condition, as stipulated in the *NIOSH Respirator Decision Logic* [DHHS (NIOSH) Publication No. 87-108, NTIS Publication No. PB-91-151183], is a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment."

- Personal Protective Equipment (**PPE)** recommendations are from the *NIOSH Pocket Guide to Chemical Hazards* [DHHS (NIOSH) Publication No. 97-140, June 1997] and the *Recommendations for Chemical Protective Clothing: A Companion to the NIOSH Pocket Guide to Chemical Hazards* [NTIS No. PB98-137730, February 1998]. Consult these references for more complete information. MSHA standards require that PPE be appropriate to the hazard and exposure level of the affected miner.

  Key to recommended protective clothing barriers:
  (from the *Recommendations for Chemical Protective Clothing*)

  Butyl = Butyl Rubber (Gloves, Suits, Boots)
  Natural = Natural Rubber (Gloves)
  Neoprene = Neoprene Rubber (Gloves, Suits, Boots)
  Nitrile = Nitrile Rubber (Gloves, Suits, Boots)
  PE = Polyethylene (Gloves, Suits, Boots)
  PVA = Polyvinyl Alcohol (Gloves)
  PVC = Polyvinyl Chloride (Gloves, Suits, Boots)
  Teflon = Teflon™ (Gloves, Suits, Boots)
  Viton = Viton™ (Gloves, Suits)
  Saranex = Saranex™ coated suits
  PE/EVAL = 4H™ and Silver Shield™ brand gloves
  Barricade = Barricade™ coated suits
  CPF3 = CPF3™ suits
  Responder = Responder™ suits
  Trellchem = Trellchem HPS™ suits
  Tychem = Tychem 10000™ suits
  8 hr = More than 8 hours of resistance to breakthrough >0.1g/cm^2/min.
  4 hr = At least 4 but less than 8 hours of resistance to breakthrough >0.1g/cm^2/min.

  Brand Names:

  Neoprene is a tradename and Teflon™, Barricade™ and Tychem 10000™ are trademarks of the DuPont Company. Viton™ is a registered trademark of DuPont Dow Elastomers. Saranex is a tradename of the Dow Chemical Company. 4H is a trademark of the Safety 4 Company. Silver Shield is a trademark of the Siebe North Company. CPF3 and Responder are trademarks of the Kappler Company. Trellchem HPS is a trademark of the Trelleborg Company. Tyvek® is a registered trademark of DuPont for its brand of spun-bonded olefin. Recommendations for PPE usage are NOT valid for very thin natural rubber, Neoprene, nitrile, and PVC gloves (0.3 mm or less).

- Information on Dräger diffusion tubes and detector tubes comes from the "Dräger-VOICE 4.0 Hazardous substances database" http://voice.draeger.com/voice/owa/vn.com. Consult Dräger Safety's "Dräger-VOICE 4.0" online for Instructions for Use [to include: application; requirements; principle of reaction; ambient conditions (e.g., temperature, humidity, atmospheric pressure); prerequisites; duration and range of measurement; standard deviation; exposure limits; cross sensitivities / specificity; shelf life; disposal]. This information can be accessed by entering the name of the hazardous substance.

  NIOSH Manual of Analytical Methods (NMAM), 4th ed., DHHS (NIOSH) Publication 94-113 (August, 1994), Cassinelli, M.E. & O'Connor, P.F., Eds.

  (www.cdc.gov/niosh/nmampub.html **):** The NMAM is the result of part of the research activities of NIOSH relating to the determination of workplace contaminants. The NMAM is a collection of methods for sampling and analysis of contaminants in workplace air, and in the blood and urine of workers who are occupationally exposed. These methods have been developed specifically to have adequate sensitivity to detect the lowest concentrations as regulated by OSHA and recommended by NIOSH and sufficient range to measure concentrations exceeding safe levels of exposure.

  The methods have been developed or adapted by NIOSH or its contractors and have been evaluated according to established experimental protocol and evaluation criteria. The NMAM also includes chapters on quality assurance, strategies of sampling airborne substances, method development and discussions of some portable direct-reading instrumentation.

- The www.OSHA.gov web site site has an index of sampling and analytical methods. Chemicals that have either a validated or partially validated OSHA method are listed in alphabetical order. Some chemicals are listed by their common synonym. The index includes the method number, validation status, Chemical Abtract Series (CAS) number, analytical instrument and sampling device. There is information on protocols for methods evaluation, what is new in methods development at the OSHA Salt Lake Technical Center, and a listing of current projects. There are links to other OSHA information on chemical sampling information, hazardous and toxic substances, OSHA analytical studies and sampling and analysis.

Short Term Exposure Limits (STELs)

- The *TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1973* did not list Short Term Exposure Limits (STELs) for substances. It did, however, provide in Appendix D, Permissible Excursions for Time-Weighted Average (TWA) Limits, pgs. 51-52, the instruction to consult the Pennsylvania Rules and Regulations, Chapter 4, Article 432, and "Acceptable Concentrations," ANSI, to find the appropriate excursions for 142 substances. [Note: The American National Standards Institute (ANSI) coordinated available information on various contaminants and

established acceptable concentrations that were published as individual consensus standards.] MSHA enforces those excursions as 15-minute STELs. MSHA also enforces a STEL for asbestos given in 30 CFR §§56/57.5001(b).

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Acetic Acid - CH_3COOH
50 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
433	10 ppm	40 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: acetic acid (aqueous), ethanoic acid, glacial acetic acid (pure compound), methane carboxylic acid

Sources: used in mine laboratories

Description: colorless liquid or crystals, with sour, vinegar-like odor

Incompatibilities: strong oxidizers (especially chromic acid, sodium peroxide, nitric acid), strong caustics

Exposure: inhalation, skin and/or eye contact

Health Effects: irritation eyes, skin, nose, throat; eye, skin burns; skin sensitization; dental erosion; black skin, hyperkeratosis; conjunctivitis, lacrimation (discharge of tears); pharyngeal edema, chronic bronchitis

PPE:

Respirator: Up to 50 ppm - any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) (APF = 50)

Skin: Prevent skin contact (conc. >10% in water);
8 hr: Butyl, Teflon, Viton, PE/EVAL, Responder, Tychem
4 hr: Neoprene, Barricade

Eyes: Prevent eye contact

Special Precautions: if 10-80% acid in water, Class II combustible liquid, vapor may explode if ignited in an enclosed area

LABORATORY INFORMATION

CAS Number: 64-19-7
Analytical Technique: detector/diffusion tube
Analytical Reference Method: NA

SAMPLING INFORMATION

<u>Full Shift Sampling</u>:
Sampling Strategy: see Chapter 11
Collection Media: Dräger diffusion tube #8101071
Note: up to 8 hours per tube (EF = 1.41).

<u>Grab Sampling</u>:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #6722101, range 5 - 80 ppm (EF = 1.25).

Acetone - CH_3COCH_3

2,500 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 2.5%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
243	1000 ppm	1250 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: dimethyl ketone, ketone propane, 2-propanone, pyroacetic ether
Sources: solvent; used for paint and varnish removal
Description: colorless liquid, with fragrant mint-like odor
Incompatibilities: oxidizers, acids
Exposure: inhalation, skin or eye contact, ingestion
Health Effects: respiratory system, eyes, skin, central nervous system
PPE: **Respirator:** Recommendations - NIOSH: Up to 2500 ppm**:** (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s**)**
Skin: Prevent skin contact;
8 hr: Butyl, PE/EVAL, Barricade, CPF3, Responder, Trellchem, Tychem
Eyes: Prevent eye contact

Special Precautions: Class IB combustible liquid, vapors may explode if ignited in an enclosed area

LABORATORY INFORMATION

CAS Number: 67-64-1
Analytical Technique: detector tube
Analytical Reference Method: NA

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger diffusion tube #6728731
Note: up to 8 hours per tube. (EF = 1.33).

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #22901, range 100 - 12000 ppm (EF = 1.33).

Alcohols (Screen)

Note: Profile sample when contaminants listed below are suspected. Analyses will quantify individual components. The results can be used for compliance with respective TLVs.

Organics Analyzed:

Group 1 Profile: Ethyl Alcohol (Ethanol), Isopropyl Alcohol (Isopropanol), tert-Butyl Alcohol.

Group 2 Profile: n-Butyl Alcohol, sec-Butyl Alcohol, n-Propyl Alcohol

SPECIAL INSTRUCTIONS

Specify group of three contaminants desired.

CONTAMINANT INFORMATION, Contaminant Codes, TLVs: see individual contaminants

LABORATORY INFORMATION

Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1400/1401

SAMPLING INFORMATION

Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: for a 100/50 mg tube, 0.01 - 0.05 Lpm. Must use a pump adaptor or arrange for low flow pumps.

Aluminum - Al
as Aluminum Oxide (Al_2O_3)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
151 (aluminum oxide dust, as Al_2O_3)	10.0 mg/m^3	20.0 mg/m^3 - 15 min.
703 (aluminum oxide fume, as Al_2O_3)	10.0 mg/m^3	20.0 mg/m^3 - 15 min.
123 (nuisance dust)	10.0 mg/m^3	20.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: alundum, alumina, aluminum trioxide, corundum
Sources: *dust* - corundum
fume - welding, torch cutting, smelting
Description: white odorless crystalline powder
Incompatibilities: chlorine trifluoride, hot chlorinated rubber, acids, oxidizers
Exposure: inhalation, ingestion, skin and/or eye contact
Health Effects: skin and eye irritation, respiratory system (possible lung fibrosis)
PPE: Respirator: None specified
Skin: None specified
Eyes: None specified
Special Precautions: Combustible solid, finely divided dust is easily ignited and may cause explosions

LABORATORY INFORMATION

Metal Dust and Fume
CAS Numbers: 1344-28-1 (Al_2O_3)
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Ammonia - NH_3
300 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
401	25 ppm	100 ppm - 30 min.

CONTAMINANT INFORMATION

Synonyms: ammonia gas, anhydrous ammonia, aqua ammonia, aqueous ammonia, liquid ammonia

Sources: fertilizers, nitric acid, explosives, plastics, gas/coke refinery, chemical reagents

Description: colorless gas or liquid, pungent odor (note: odor threshold is 47 ppm), corrosive, alkaline

Incompatibilities: strong oxidizers, acids, halogens, salts of silver & zinc, amides, isocyanates, aldehydes, nitro-compounds

Exposure: inhalation, ingestion, skin and/or eye contact

Health Effects: eye and skin irritation, respiratory inflammation, pulmonary edema, caustic burn (freeze burn by evaporation)

PPE: Respirator; Recommendations: NIOSH, Up to 250 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern

Skin: Prevent contact; 8 hr: Butyl, Teflon™, Viton™, Responder, Trellchem, Tychem; 4 hr: Nitrile

Eyes: Prevent contact

Special Precautions: Severe eye and skin irritant; should be treated as a flammable gas. Vapor may explode if ignited in an enclosed area

LABORATORY INFORMATION

CAS Number: 7664-41-7
Analytical Technique: diffusion tube/detector tube
Analytical Reference Method: NA

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger diffusion tube #8101301 -
Note: up to 8 hours per tube. (EF = 1.41).

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #CH20501, range 5 to 700 ppm. (EF = 1.25).

Amorphous Silica - SiO_2

(Diatomaceous Earth)
3,000 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
519 (enforcement)	20 mppcf (1.5 mg/m^3)	40 mppcf (3.0 mg/m^3) - 15 min.
519 (PEDS "screening")	6.7 mg/m^3	13.3 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: diatomaceous silica, diatomite, fused silica, infusorial earth, infusorial silica, kieselguhr, opaline silica, precipitated amorphous silica, silica gel, silicon dioxide (amorphous), tripolite
Sources: mining of diatomaceous earth
Description: particulates
Exposure: Inhalation, eyes
Incompatibilities: NA
Health Effects: eyes, respiratory system
PPE: Respirator: Recommendations - NIOSH: Up to 30 mg/m^3, (APF = 5), any dust and mist respirator
Skin: None specified
Eyes: None specified
Special Precautions: none reported

LABORATORY INFORMATION

CAS Number: 7631-86-9, 68855-54-9
Analytical Technique: x-ray diffraction
Analytical Reference Method: MSHA P-2/impinger method

SAMPLING INFORMATION

Screening, Full Shift Sampling: - Note: cannot be used for enforcement
Sampling Strategy: see Chapter 6
Collection Media: cyclone and filter [10 mm nylon cyclone and 37-mm diameter, 5-µm poly vinyl chloride (PVC) filter]
Sample Flow Rate: 1.7 Lpm

Enforcement, Full Shift - Partial Period Sampling: - Note: for compliance with TLV
Sampling Strategy: see Chapter 6
Collection Media: impinger
Sample Flow Rate: 2.8 Lpm

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will usually conduct impinger sampling with inspector escort.

Antimony & Compounds (as Sb)

50 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
611 (dust)	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1500 µg/m^3) - 15 min.
705 (fume)	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1500 µg/m^3) - 15 min.
	(PEDS units of measure in parentheses)	

Antimony Hydride

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
311 stibine, SbH_3	0.1 ppm (100 ppb)	0.3 ppm (300 ppb) - 15 min.
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: elemental**:** stibium
*compounds***:** antimonic..., antimonial..., antimonious..., antimonyl..., stibic..., stibo-, ...antimonate, powder of Algaroth, mercurious vitae.
*stibine***:** antimony hydride, antimony trihydride, hydrogen antimonide

Sources: coating metals, mining of ores of lead, stibnite, kermesite, cervantite, exitelite, senarmontite, valentinite, weisspiessglanz.

Description: *elemental:* silver-white, lustrous, hard, brittle metal or dark-gray lustrous powder (when tarnished by moist air)
compounds: vary

Incompatibilities: Hydrogen gas or acids (forms extremely toxic stibine), ammonium nitrate, halogens, potassium nitrate, potassium permanganate, potassium oxide, sodium nitrate, and oxidants

Exposure: inhalation, ingestion, skin or eyes

Health Effects: dermatitis, eye inflammation, cardiovascular system, nausea/diarrhea, and ulcers of the nose by contact (fumes or dust), systemic poisoning

PPE: Respirator: Recommendation: NIOSH, Up to 5 mg/m^3 (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators

Skin: Prevent skin contact with a barrier that will prevent contamination from the dry chemical

Eyes: Prevent eye contact

Special Precautions: Can present a fire and explosion hazard when in the form of dust and vapors and exposed to flame or heat

LABORATORY INFORMATION
CAS Number: 7440-36-0 *(elemental)*
Analytical Technique: Inductively Coupled Plasma (ICP) or Graphite Furnace Atomic Absorption (GFAA)
Analytical Reference Method: OSHA 125

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 30 min.
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: 1.7 Lpm

Special Instructions: submit samples to MSHA Laboratory (contract laboratory analysis).

Arsenic and Compounds
5 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
613 (dust)	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1500 µg/m^3) - 15 min.
707 (fume)	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1500 µg/m^3) - 15 min.
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: *arsenic*: arsenia, arsenic salt, gray arsenic, metallic arsenic
arsenic acid: orthoarsenic acid, arsenic pentoxide
arsenic disulfide: realgar, red arsenic glass, red arsenic sulfide
arsenic trichloride: fuming liquid arsenic, arsenic (III) trichloride, arsenic chloride, arsenous chloride, caustic arsenic chloride
arsenic trioxide: arsenous acid, arsenous acid anhydride, arsenous oxide
arsenic trisulfide: arsenic yellow, king's gold, king's yellow, orpiment, yellow arsenic sulfide

Sources: used for hardening copper, lead, alloys; insecticides; by product in the smelting of copper, lead, cobalt, and gold ores

Description: *inorganic* - silver-gray or tin-white, brittle, odorless solid, may be yellow as condensed vapor
organic - varies by compounds

Incompatibilities: strong oxidizers, bromine azide, hydrogen gas

Exposure: inhalation, skin and/or eye contact, ingestion

Health Effects: liver, kidneys, bladder, skin, lungs, lymphatic system; cancer of these systems, inorganic forms more dangerous than organic.

PPE: Respirator: At concentrations above the NIOSH REL, 0.002 mg/m^3 [15-minute]: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

Skin: Prevent skin contact; contact the manufacturer for recommendations For organic compounds, recommendations regarding personal protective clothing vary depending upon the specific compound**.**

Eyes: Prevent eye contact

Special Precautions: Suspected carcinogen (National Toxicology Program); slight explosion hazard in the form of dust, when exposed to flame

LABORATORY INFORMATION
CAS Number: 7440-38-2
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Arsine - AsH_3
3 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
313	0.05 ppm (50 ppb)	0.15 ppm (150 ppb) - 15 min.
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: arsenic hydride, arsenic trihydride, arseniuretted hydrogen, arsenoushydride; hydrogen arsenide

Sources: water on metallic arsenide

Description: colorless gas; garlic-like odor

Incompatibilities: strong oxidizers, chlorine, nitric acid

Exposure: inhalation, skin and/or eye contact

Health Effects: blood, kidneys, liver

PPE: Respirator: At concentrations above the NIOSH REL, 0.002 mg/m^3 [15-minute]: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

Skin: Frostbite; Prevent skin contact; Prevent possible skin freezing from direct liquid contact.

Eyes: Frostbite; Prevent contact. Use appropriate protection to prevent eye contact with the liquid.

Special Precautions: lung and lymphatic cancer; flammable gas

LABORATORY INFORMATION

CAS Number: 7784-42-1

Analytical Technique: detector tube

Analytical Reference Method: NA

SAMPLING INFORMATION

Grab Sampling:

Sampling Strategy: see Chapter 11

Collection Media: Dräger detector tube #CH25001, range 0.05 to 3.0 ppm (EF = 1.33).

Asbestos
(Fibers)

Contaminant Codes:	30 CFR §§56/57.5001(b) MSHA TLV:	30 CFR §§56/57.5001(b) MSHA STEL/Ceiling (C):
501	2.0 fibers/mL	10.0 fibers/mL - 15 min.

CONTAMINANT INFORMATION

Synonyms: actinolite, anthophyllite asbestos, chrysotile, crocidolite (riebeckite), amosite (cummingtonite-grunerite), and tremolite asbestos.

Sources: fireproofing, insulation, cement, commercial products, natural occurring mineral contaminant (can be found in serpentine, taconite wollastonite, vermiculite, some stone sand and gravels), depending on geology.

Description: fibrous; white or greenish (chrysotile), blue (crocidolite) or gray-green (amosite), odorless solid hydrated mineral silicates.

Incompatibilities: none reported

Exposure: inhalation, ingestion, clothing contamination

Health Effects: respiratory system; asbestosis, mesothelioma, lung cancer

PPE: Respirator: Recommendations: NIOSH, at concentrations above the NIOSH REL, which is 0.1 fiber per cubic centimeter of air (0.1 fiber/cc): (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Prevent skin contact, with a barrier that will prevent contamination from fibers.

Eyes: Prevent eye contact

Special Precautions: recognized human carcinogen

LABORATORY INFORMATION

CAS Numbers: Asbestos - 1332-21-4, Amosite - 12172-73-5, Chrysotile - 12001-29-5, Anthophyllite - 77536-67-5, Tremolite - 77536-68-6, Actinolite - 77536-66-4

Analytical Technique: Microscopy - Phase Contrast Microscope (PCM) for fibers unidentified, Transmission Electron Microscope (TEM) to confirm asbestos fiber minerology

Analytical Reference Method: Personal - NIOSH 7400 (PCM) & NIOSH 7402 (TEM)
Bulk Sample - OSHA 191, EPA 600/R93/116, EPA 600/M4-82-0

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 8
Collection Media: 0.8 µm mixed cellulose ester (MCE) filter in 25 mm black cassette
Sample Flow Rate: 1.7 Lpm recommended
Air Collection Volume: Minimum - Maximum (L): 300 - 2400. [at least 200 recommended per consecutive sampling cassette.]

Short Term Sampling:
Sampling Strategy: see Chapter 8
Sample Duration: 15 - 30 minutes
Collection Media: 0.8 µm mixed cellulose ester (MCE) filter, 25 mm black cassette
Sample Flow Rate: 1.7 Lpm - 2.5 Lpm - up to maximum stable personal sampling pump capacity. [use lower range flow rates only in expected high fiber environments]

Grab Sampling:
Sampling Strategy: see Chapter 8
Collection Media: Bulk material or Core Sampler/Container, at least 1 to 10 grams.

Special Instructions: Ship in rigid container to MSHA Laboratory. Do not ship bulk and air samples together (contract laboratory analysis).

Use contaminant code 505 (no TLV) for unidentified fibers by PCM analysis only.
Use contaminant code 501 for asbestos identified fibers by TEM analysis.

Notes: For optimal filter loading without overloading, the initial flow rate setting or the sampling times may need to be adjusted. (See Chapter 8, V. Section F. 3., and 4.) Do not change pump flow rate after starting sampling sequence.

Barium (Soluble Compounds)
50 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
641	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1500 µg/m^3) - 15 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: *soluble compounds* - barium carbonate, barium chlorate, barium cyanide, barium hydroxide, barium nitrate, barium oxide, barium perchlorate, barium permanganate, barium peroxide, barium sulfide

Sources: electroplating, catalyst for organic reactions, barite and weathered ores, aluminum refining

Description: appearance and odor varies by compound - soluble salts are white, green, or yellow powders, mostly alkaline

Incompatibilities: varies by compound

Exposure: inhalation, ingestion, skin and/or eye contact (caustic burns)

Health Effects: eye and skin irritant, respiratory system, spasms, violent diarrhea/ vomiting, cardiac arrest

PPE: Respirator: Varies by compound. e.g., respirator recommendations for barium nitrate: NIOSH/OSHA, Up to 5 mg/m^3, (APF=10) any dust and mist respirator except single-use and quarter-mask respirators

Skin: Prevent skin contact; contact the manufacturer for recommendations.

Eyes: Prevent eye contact.

Special Precautions: Compounds may cause fire on contact with combustibles, containers may explode in fire

LABORATORY INFORMATION

CAS Numbers: Barium Nitrate - 10022-31-8

Analytical Technique: Inductively Coupled Plasma (ICP) 10022-31-8

Analytical Reference Method: OSHA ID 121

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 7

Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter

Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Benzene - C_6H_6
500 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Ceiling (C**):**
603	25 ppm (Skin)	25 ppm (C)

CONTAMINANT INFORMATION

Synonyms: benzol, benzole, cyclohexatriene, phenyl hydride
Sources: solvents, paint removers, gasoline
Description: colorless liquid solvent; characteristic aromatic gasoline-like odor
Incompatibilities: strong oxidizers, fluorides, perchlorates, nitric acid
Exposure: inhalation, ingestion; 1973 TLV "Skin" notation - cutaneous, mucous membrane and eye absorption by direct contact.
Health Effects: eye and skin irritant, respiratory system, blood, bone marrow, central nervous system, leukemia, carcinogen
PPE: Respirator: Recommendations: NIOSH, at concentrations above the NIOSH REL, 0.1 ppm for 15 minutes: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Skin: Prevent skin contact; 8 hr: PVA, PE/EVAL, Barricade, CPF3, Responder, Tychem; 4 hr: Teflon, Viton
Eyes: Prevent contact: goggles, safety glasses, face shield.
Special Precautions Flammable liquid: vapor may explode if ignited; carcinogen

LABORATORY INFORMATION

CAS Number: 71-43-2
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1501/3M

SAMPLING INFORMATION

Full Shift Sampling
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Short Term Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #6728561, range 0.5 -10 ppm (E.F. = 1.49)

Beryllium - Be

4 mg/m^3 (as Be) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
541 (dust)	0.002 mg/m^3 (2 µg/m^3)	0.025 mg/m^3 (25 µg/m^3) - 5 min.
709 (fumes)	0.002 mg/m^3 (2 µg/m^3)	0.025 mg/m^3 (25 µg/m^3) - 5 min.
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: *beryllium*: beryllium metal, beryllium salts, glucinium
compounds: beryllium chloride, beryllium fluoride, beryllium nitrate, beryllium oxide, beryllium sulfate

Sources: hardening agent in alloys; ores of beryl, phenacite, chrysoberyl

Description: hard, brittle, gray-white metal

Incompatibilities: acids, caustics, chlorinated hydrocarbons, oxidizers, molten lithium

Exposure: inhalation, and/or eye contact, skin (depending on form)

Health Effects: eye and skin irritant, respiratory system, central nervous system, berylliosis.

PPE: Respirator: Recommendations: NIOSH, at concentrations above 0.0005 mg/m^3: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent contact; contact the manufacturer for recommendations

Eyes: Prevent contact

Special Precautions: Suspected carcinogen (National Toxicology Program); dust may explode if ignited in an enclosed area, poisonous gases released in fire

LABORATORY INFORMATION

CAS Number: 7440-41-7
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sample Duration: 30 min.
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water
Special Instructions: Seal wipe sample in plastic bag, jar, or vial.

Boron Oxide
2,000 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
161	10.0 mg/m^3	20.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: boracic acid anyhydride, boric anhydride, boric oxide, boron sesquioxide, boron trioxide, fused boric acid, orthoboric acid anhydride, sassolite
Sources: product of borax mines
Description: lumps of whitish, odorless crystals
Incompatabilities: water (reacts to form boric acid), hydroxide and carbonate solutions
Exposure: inhalation, ingestion, or eyes
Health Effects: irritates eyes, skin and respiratory system; circulatory collapse and heart fibrillation; affects central nervous system leading to convulsions and coma
PPE: Respirator: Recommendations: NIOSH, Up to 50 mg/m^3: (APF = 5) any dust and mist respirator
Skin: Prevent contact; contact the manufacturer for recommendations
Eyes: Prevent contact
Special Precautions: NA

LABORATORY INFORMATION

CAS Number: 1303-86-2
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: NIOSH 7300

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 30 min.
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm

Special Instructions: Submit samples to MSHA Laboratory (contract laboratory analysis).

Bromoform - $CHBr_3$

850 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	0.5 ppm (Skin)	1.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Methenyl tribromide, methyl tribromide, tribromomethane
Sources: Separating minerals mixtures (process chemical)
Description: Colorless to yellow liquid with chloroform-like odor
Incompatibilities: Lithium, sodium, potassium, calcium, aluminum, zinc, magnesium, caustics
Exposure: Inhalation, ingestion; 1973 TLV "Skin" notation - cutaneous, mucous membrane and eye absorption by direct contact.
Health Effects: Central nervous system, respiratory system, liver, kidneys.
PPE: Respirator: Recommendations: NIOSH/OSHA, Up to 12.5 ppm, (APF=25) Any supplied-air respirator operated in a continuous-flow mode/(APF=25) Any powered, air-purifying respirator with organic vapor cartridge(s)
Skin: Prevent contact; 8 hr: PVA, Viton
Eyes: Prevent contact
Special Precautions: Store in the dark, decomposes when exposured to air and light producing **toxic and corrosive fumes including hydrogen bromide and bromine.**

LABORATORY INFORMATION

CAS Number: 75-25-2
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1003/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

BTEX (Profile)

Note: Profile sample when contaminants listed below are suspected. Analyses will quantify individual components. The results can be used for compliance with respective TLVs.

Organics Analyzed: Benzene, Toluene, Ethyl Benzene, Xylene

CONTAMINANT INFORMATION

See individual contaminants

LABORATORY INFORMATION

Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1501/3M

SAMPLING INFORMATION

Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 0.01 - 0.2 Lpm, must use a pump adaptor or arrange for low flow pumps.

n-Butyl Acetate - $CH_3COO(CH_2)_3CH_3$

1,700 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.7%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	150 ppm	187.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Butyl acetate, butyl ethanoate, n-butyl ester of acetic acid
Sources: Resins, lacquers, plastics
Description: Colorless liquid, fruity odor
Incompatibilities: Nitrates, strong oxidizers, alkalis (bases)
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Eye and skin irritant, respiratory system, central nervous system
PPE: Respirator; Recommendations: NIOSH/OSHA, Up to 1500 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s)
Skin: Prevent contact; 8 hr: PE/EVAL, 4 hr: PVA, Teflon
Eyes: Prevent contact
Special Precautions: Vapor may explode if ignited in an enclosed area.

LABORATORY INFORMATION

CAS Number: 123-86- 4
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1450/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series -
Note: maximum 8-hour sample per badge.
2. Collection Media: 100/50 mg or 400/200 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm; 400/200 mg: 0.05 - 0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps.

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sample Duration: 30 min.
Collection Media: 100/50 mg or 400/200 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm; 400/200 mg: 0.05 - 0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps.
Special Instructions: Coordinate with Laboratory - Store and ship refrigerated.

n-Butyl Alcohol - $CH_3CH_2CH_2CH_2OH$

1,400 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.4%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
245	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: 1-butanol, butanol, butyl alcohol, butyric alcohol, butyl hydroxide, 1-hydroxybutane, NBA, n-butanol, n-propylcarbinol, propylcarbinol
Sources: solvents
Description: colorless liquid; strong, mildly, oily/alcoholic odor
Incompatibilities: strong oxidizers, mineral acids, alkali metals, halogens
Exposure: inhalation, absorption
Health Effects: respiratory system, central nervous system; eye and skin irritant (1999 TLV "Skin" notation - cutaneous, mucous membrane and eye absorption by direct contact).
PPE: Respirator: Recommendations: NIOSH, Up to 1400 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
Skin: Prevent contact**;** 8 hr: Butyl, Teflon, Viton, PE/EVAL, Barricade, CPF3, Responder4 hr: Neoprene
Eyes: Prevent contact
Special Precautions: Protect eyes; Class IC flammable liquid, vapor may explode if ignited in an enclosed area.

LABORATORY INFORMATION

CAS Numbers: 71-36-3
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1401/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg or 400/200 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, 400/200 mg: 0.05 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sample Duration: 30 min.
Collection Media: 100/50 mg or 400/200 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm; 400/200 mg: 0.05 - 0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps.

Special Instructions: Coordinate with Laboratory - Store in freezer and ship on ice.

sec-Butyl Alcohol - $CH_3CH(OH)CH_2CH_3$
2,000 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	150 ppm	187.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: 2-butanol, butylene hydrate, ethylmethyl carbinol, 2-hydroxybutane, methyl ethyl carbinol
Sources: Cleaning materials, paint removers, lacquer solvent
Description: Colorless liquid; strong, pleasant odor
Incompatibilities: Strong oxidizers, organic peroxides, perchloric & permonosulfuric acids
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Eye and skin irritant, respiratory system, central nervous system
PPE: Respirator: Recommendations: NIOSH/OSHA, Up to 1000 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s)
Skin: Prevent contact; 8 hr: PE/EVAL, 4 hr: Butyl, Nitrile
Eyes: Prevent contact
Special Precautions: flammable, vapor may explode if ignited in an enclosed area

LABORATORY INFORMATION

CAS Number: 78-92-2
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1401/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg or 400/200 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm; 400/200 mg: 0.05 - 0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps.

Special Instructions: Coordinate with Laboratory - Store in freezer and ship on ice.

tert-Butyl Alcohol - $(CH_3)_3COH$
1,600 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: 2-methyl-2-propanol, TBA, t-butinol, trimethyl carbinol
Sources: Lacquers, chemical intermediates, paint remover, gasoline octane booster
Description: Colorless crystal or liquid; strong, pleasant odor (camphor-like)
Incompatibilities: Strong oxidizers, organic peroxides, perchloric & permonosulfuric acids
Exposure: Inhalation, absorption, ingestion, skin and/or eye contact
Health Effects: Eye and skin irritant, respiratory system, central nervous system (narcosis)
PPE: Respirator: Recommendations: NIOSH/OSHA, Up to 1600 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s)
Skin: Prevent contact; 8 hr: Butyl, PE/EVAL, Responder
Eyes: Prevent contact
Special Precautions: Flammable, vapor may explode if ignited in an enclosed area

LABORATORY INFORMATION

CAS Number: 75-65-0
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1400

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sample Duration: 30 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Special Instructions: Coordinate with Laboratory - Store in freezer and ship on ice.

Cadmium - Cd (metal dust and soluble salts)

9 mg/m^3 (as Cd) dust, IDLH (NIOSH, 1995)

Cadmium Oxide fume, as Cd

9 mg/m^3 (as Cd) fume, IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	ANSI Z37.5-1970 STEL/Ceiling (C):
623 (metal dust)	0.2 mg/m^3 (200 µg/m^3)	0.6 mg/m^3 (600 µg/m^3) - (C)
	(PEDS units of measure in parentheses)	

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Ceiling (C):
711 (oxide fume, as Cd)	0.1 mg/m^3 (100 µg/m^3)	0.1 mg/m^3 (100 µg/m^3) - (C)
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: *Cadmium compounds*: cadmium acetate, cadmium bromide, cadmium chloride, cadmium cyanide, cadmium fluoroborate, cadmium nitrate, cadmium sulfate

Sources: Electroplating, solder for aluminum, deoxidizer in nickel plating, pigments in enamels, welding rods/electrodes, ores of zinc, greenockite (CdS), otavite ($CdCO_3$)

Description: Appearance and odor varies by elemental sulfur, selenium, & tellurium

Incompatibilities: Strong oxidizers; elemental sulfur, selenium & tellurium

Exposure: Inhalation (as fume or dust), ingestion

Health Effects: Respiratory system, kidneys, prostate, blood

PPE: Respirator: Recommendations: NIOSH, At concentrations above 9 mg/m^3 (as Cd): (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: None specified

Eyes: None specified

Special Precautions: Carcinogen (National Toxicology Program); poisonous gases may be produced in fire

LABORATORY INFORMATION

CAS Numbers: 7440-43-9 (Cd), 1306-19-0 (CdO), 10325-94-7 (CdN_2O_6), 10108-64-2 ($CdCl_2$)

Analytical Technique: Inductively Coupled Plasma (ICP)

Analytical Reference Method: OSHA 121/125

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sample Duration: 15 min.
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water
Special Instructions: Seal wipe sample in plastic bag, jar, or vial.

Calcium Arsenate
5 mg/m^3 (as As) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995 $Ca_3(AsO_4)_2$	1 mg/m^3	N/A

CONTAMINANT INFORMATION

Synonyms: *Calcium arsenate* [$Ca_3(AsO_4)_2$]: Pencal, cucumber dust, Tricalcium arsenate, Tricalcium ortho-arsenate
Sources: Insecticides, herbicides
Description: Colorless to white, odorless powder
Incompatibilities: None reported [Note: Produces toxic fumes of arsenic when heated to decomposition]
Exposure: inhalation, ingestion, skin and/or eye contact
Health Effects: Eye irritant, respiratory system, liver, skin, central nervous system, lymphatic system, lymphatic and lung cancer
PPE: Respirator: Recommendations: NIOSH, At concentrations above 0.002 mg/m^3 [15-minute]: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Skin: Prevent contact; contact the manufacturer for recommendations.
Eyes: Prevent contact
Special Precautions: Potential occupational carcinogen

LABORATORY INFORMATION

CAS Numbers: 7778-44-1
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: OSHA 121/125

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water
Special Instructions: Seal wipe sample in plastic bag, jar, or vial.

Calcium Carbonate - $CaCO_3$

Contaminant Codes:	**1973 ACGIH TLV:**	**STEL/Ceiling (C):**
121, 123 ($CaCO_3$)	10.0 mg/m^3	N/A
523 ($CaCO_3$)	10 mg/m^3	N/A
if respirable fraction >1% quartz	% SiO_2 + 2	

Calcium Oxide - CaO

25 mg/m^3 (CaO) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
451 (CaO)	5.0 mg/m^3	10.0 mg/m^3 - 30 min.

CONTAMINANT INFORMATION

Synonyms: *calcium oxide* [CaO]: - lime, burnt lime, calx, quick lime. [Note: Cement kiln dust (CKD) is predominantly CaO.]
calcium carbonate [$CaCO_3$]: - limestone, chalk, marble, dolomite, aragonite, calcite, calcidia, calcium salt, carbonic acid, citrical, Paris white

Sources: Manufacture of mortar, lubricants, drilling fluids, manufacture of steel, aluminum and magnesium; calcium carbonate-occurs naturally as limestone, chalk, marble, dolomite, aragonite, calcite, and oyster shells

Description: Appearance and odor varies by compound (crystalline gray solid; white microcrystalline powder; crystals, white or grayish white lumps; granular powder

Incompatibilities: *$CaCO_3$* - Acids, alum, ammonium salts, mercury & hydrogen, fluorine, magnesium
CaO - Water (liberates heat), fluorine, ethanol. [Note: Reacts with water to form calcium hydroxide.]

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: *CaO* - Eye and skin corrosive; respiratory system irritant

PPE: Respirator: *$CaCO_3$* - suitable for nuisance dusts if <1% quartz, suitable for silica if respirable fraction >1% quartz;
CaO- Respirator Recommendations: NIOSH, Up to 10 mg/m^3: (APF = 5) any dust and mist respirator; up to 20 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators

Skin: *CaO* - Prevent contact. Use any barrier, including clothing, that will prevent contact with the chemical, especially on wet or moist skin; practice good personal hygiene by washing after exposure.
$CaCO_3$ - to be determined, based on working conditions

Eyes: *CaO* - Prevent contact by wearing safety glasses or goggles. Promptly remove foreign material from the eyes and follow up with a medical check.

Special Precautions: Calcium oxide is a noncombustible solid that will support combustion by the liberation of oxygen.

LABORATORY INFORMATION

CAS Numbers: 1305-78-8 (CaO), 1317-65-3 ($CaCO_3$)
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: $CaCO_3$: use a pre-weighed, 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter;
CaO: Prefer to a use 37-mm diameter .8 micron methyl cellulose ester (MCE) filter to sample for CaO (as Ca). [Note: a 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter can be used if an MCE filter is not available.]
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sample Duration: 30 min.
Collection Media: $CaCO_3$: use a pre-weighed, 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter;
CaO: Prefer to use a 37-mm diameter .8 micron methyl cellulose ester (MCE) filter to sample for CaO (as Ca). [Note: a 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter can be used if an MCE filter is not available.]
Sample Flow Rate: usual sampling is 1.7 Lpm

Special Instructions: It is not necessary to take bulk samples.

Carbon Dioxide - CO_2
40,000 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
105	0.5 % (5000 ppm)	1.5 % - 15 min.

CONTAMINANT INFORMATION

Synonyms: Carbonic acid gas, carbonic anhydride, carbonic gas, dry ice
Sources: Lime kiln operations, propellant in aerosols, confined spaces, coke burning
Description: Colorless, odorless gas, faint acid taste
Incompatibilities: Strong oxidizers, acids, halogens, salts of silver & zinc
Exposure: Inhalation, skin and/or eye contact (freeze burns from dry ice or compressed gas)
Health Effects: Respiratory system, cardiovascular system
PPE: Respirator: Recommendations: NIOSH/OSHA, Up to 40,000 ppm: (APF = 10) any supplied-air respirator/(APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent contact. Frostbite is possible from contact with liquid.
Eyes: Prevent contact. Freezing is possible from contact with liquid.
Special Precautions: Simple asphyxiant; containers may explode in fire; dusts of various metals, such as magnesium, zirconium, titanium, aluminum, chromium & manganese are ignitable and explosive when suspended in carbon dioxide

LABORATORY INFORMATION

CAS Number: 124-38-9
Analytical Technique: diffusion tube/detector tube/Gas Chromatograph (GC)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger diffusion tube #8101381
Note: up to 8 hours per tube. (EF = 1.41).

Grab Sampling:
1. Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #CH23501, range 0.1% to 6% (EF = 1.17).
2. Sampling Strategy: see Chapter 12
Collection Media: Evacuated 50 mL gas-sampling bottle or 10 mL vacutainer (EF = 1.11).
Various electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Special Instructions: 14 day holding time for vacuum samples and 7 day hold time for vacutainers. Submit sample as soon as possible to MSHA Laboratory.

Carbon Disulfide - CS_2
500 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
631	20 ppm (Skin)	100 ppm - 30 min.

CONTAMINANT INFORMATION

Synonyms: Carbon bisulfide, carbon disulphide

Sources: Solvent for industrial hygiene samples in laboratories; solvent for resins, rubber, oils; insecticides

Description: Colorless to faint yellow liquid, sweet ether-like odor

Incompatibilities: Strong oxidizers; chemically active metals (sodium, potassium, zinc); azides; rust; halogens; amines

Exposure: Inhalation, ingestion, 1973 TLV "Skin" notation - cutaneous, mucous membrane and eye absorption by direct contact.

Health Effects: Respiratory system, skin, eyes, kidneys, liver, central nervous system, peripheral nervous system, reproductive system

PPE:
- **Respirator:** Recommendations: NIOSH -Up to 10 ppm**:** (APF = 10) Any chemical cartridge respirator with organic vapor cartridge(s)
- **Skin:** Prevent contact; 8 hr: PVA, Viton, PE/EVAL, Barricade, Responder, Trellchem, Tychem; 4 hr: Teflon
- **Eyes:** Prevent contact

Special Precautions: Class IB flammable liquid, vapors can be easily ignited, for example, by ordinary light bulb

LABORATORY INFORMATION

CAS Number: 75-15-0

Analytical Technique: Detector tube

Analytical Reference Method: NA

SAMPLING INFORMATION

<u>Grab Sampling</u>:

Sampling Strategy: see Chapter 11

Collection Media: Dräger detector tube #6728351, range 5 - 60 ppm (EF = 1.25).

Carbon Monoxide - CO
1,200 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
111	50 ppm	400 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Carbon oxide, exhaust gas, flue gas, monoxide
Sources: Incomplete combustion of organic fuels, vehicle exhaust
Description: Colorless, odorless gas
Incompatibilities: Strong oxidizers, bromine trifluoride, chlorine trifluoride, lithium
Exposure: Inhalation, skin and/or eye contact, freeze burns from compressed gas
Health Effects: Cardiovascular system, lungs, blood, central nervous system
PPE: Respirator: Recommendations: NIOSH - Up to 1200 ppm: (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front or back-mounted canister providing protection against the compound of concern
Skin: Prevent contact.
Eyes: Prevent contact.
Special Precautions: Poisonous gas; flammable gas, containers may explode in fire

LABORATORY INFORMATION

CAS Number: 630-08-0
Analytical Technique: Diffusion tube/detector tube/Gas Chromatograph (GC)/DRI

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger diffusion tube #6733191; range 50-600 ppm (1 hour), 25-300 ppm (2 hours), 10-120 ppm (5 hours), 6-75 ppm (8 hours); **Note:** up to 8 hours per tube. (EF = 1.41).

Grab Sampling:
1. Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #CH25601, range 5 - 700 ppm (EF = 1.25).
2. Sampling Strategy: see Chapter 12
Collection Media: Evacuated 50 mL gas-sampling vacuum bottle (EF = 1.11).
3. Sampling Strategy: see Chapter 13
Collection Media: Electronic Direct Reading Instrument - TMX410 or TMX412 (EF = 1.25).

Various other electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Special Instructions: 14 day holding time for vacuum samples. Submit sample as soon as possible to MSHA Laboratory.

Carbon Tetrachloride* - CCl_4

*** Restricted use chemical as per 30 CFR §§ 56/57.5006**
200 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
601	10 ppm (Skin)	20 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Carbon chloride, carbon tet, Freon® 10, Halon® 104
Sources: Solvents for oils, lacquers, resins, degreasing and cleaning agents
Description: Clear, colorless liquid; sweetish odor
Incompatibilities: Chemically active metals (sodium, potassium, fluorine, Al, Mg)
Exposure: Inhalation, ingestion; 1973 TLV "Skin" notation - cutaneous, mucous membrane and eye absorption by direct contact.
Health Effects: Central nervous system, eyes, lungs, liver, kidneys, skin
PPE: Respirator: Recommendations: NIOSH - At concentrations above 2 ppm [60 min.]: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Skin: Prevent contact. 8 hr: PVA, Viton, PE/EVAL, Barricade, Responder
4 hr: Teflon
Eyes: Prevent contact
Special Precautions: Carcinogen (National Toxicology Program); avoid skin contact; poisonous vapors

LABORATORY INFORMATION

CAS Number: 56-23-5
Analytical Technique: Gas Chromatograph (GC)/Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 7/NIOSH 1003/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series-
Note: 8-hour max sample/badge
2. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps .

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 30 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Chlorine - Cl_2
10 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH	1968 PA Rules
	TLV:	STEL/Ceiling (C):
485	1 ppm	3 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Molecular chlorine

Sources: Metal fluxing, bleaching agent, detinning and dezincing iron

Description: Amber liquid or greenish-yellow gas; characteristic irritating (suffocating) odor

Incompatibilities: Reacts explosively or forms explosive compounds with many common substances such as acetylene, ether, turpentine, ammonia, fuel gas, hydrogen and finely divided metals**,** combustible substances, finely divided metals, oxides

Exposure: Inhalation, skin and/or eye contact

Health Effects: Burns to eyes, skin, respiratory system (including pulmonary edema)

PPE: Respirator: Recommendations: NIOSH, Up to 5 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern

Skin: Prevent contact. Frostbite-possible skin/tissue freezing from direct liquid contact

Eyes: Prevent contact.

Special Precautions: Poisonous vapors; strong irritant; may cause fire on contact with combustibles

LABORATORY INFORMATION

CAS Number: 7782-50-5

Analytical Technique: detector tube

Analytical Reference Method: NA

SAMPLING INFORMATION

<u>Full Shift Sampling</u>:

Sampling Strategy: see Chapter 11

Collection Media: Drager diffusion tube #6728421, range 0.13 to 2.5 - Note: Up to 8 hrs per tube. **(EF=1.25)**.

<u>Grab Sampling</u>:

Sampling Strategy: see Chapter 11

Collection Media: Dräger detector tube CH24301, range 0.2 - 3 ppm (EF = 1.25).

Chlorine Dioxide - ClO_2
5 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	0.1 ppm	0.3 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Chlorine oxide, chlorine peroxide
Sources: Bactericide, bleaching agent, deodorizer
Description: Yellow to red gas or a red-brown liquid, unpleasant chlorine odor
Incompatibilities: Organic materials, heat, phosphorus, potassium hydroxide, sulfur, mercury, carbon monoxide
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Eye, skin, respiratory system (including pulmonary edema)
PPE: Respirator: Recommendations: NIOSH/OSHA, Up to 5 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern
Skin: Prevent contact (liquid); contact the manufacturer for recommendations
Eyes: Prevent contact (liquid).
Special Precautions: Flammable gas/combustible liquid, unstable in light, powerful oxidizer.

LABORATORY INFORMATION

CAS Number: 10049-04-4
Analytical Technique: Dräger: detector tube
Analytical Reference Method: Dräger

SAMPLING INFORMATION

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube CH24301, range 0.1 - 1.5 ppm (EF = 1.25).
***Note:** Chlorine dioxide is indicated with approximately twice the sensitivity as chlorine, therefore divide the reading for chlorine by 2 to get the ClO_2 reading.

Chloroform - $CHCl_3$
500 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
661	50 ppm	75 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Methane trichloride, trichloromethane
Sources: Refrigerants, aerosol propellants, solvents, resins
Description: Colorless liquid; pleasant, sweet odor
Incompatibilities: Caustics, chemically active metals (aluminum, magnesium, sodium, potassium)
Exposure: Inhalation, absorption, ingestion, skin and/or eye contact
Health Effects: Liver, kidneys, heart, eyes, skin, central nervous system
PPE: Respirator: Recommendations: NIOSH, At concentrations above 2 ppm [60-minute]: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
Skin: Prevent contact; 8 hr: PVA, Viton, PE/EVAL, Barricade, Responder, Trellchem, Tychem; 4 hr: Teflon
Eyes: Prevent contact
Special Precautions: Suspected carcinogen (National Toxicology Program); strong irritant; when heated to decomposition, forms phosgene gas.

LABORATORY INFORMATION

CAS Number: 67-66-3
Analytical Technique: Gas Chromatograph (GC) / Flame Ionization Detector (FID)
Analytical Reference Method: OSHA 5/NIOSH 1003/3M

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge
2. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 30 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: 100/50 mg: 0.01 - 0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Chromic Acid and Chromates as CrO_3
15 mg/m^3 as Chromium(VI) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
543 (chromic acid and chromate dusts as CrO_3)	0.1 mg/m^3 (100 µg/m^3)	0.3 mg/m^3 (300 µg/m^3) - 15 min.
713 (fumes, chromate)	0.1 mg/m^3 (100 µg/m^3) (PEDS units of measure in parentheses)	0.3 mg/m^3 (300 µg/m^3) - 15 min.

CONTAMINANT INFORMATION

Synonyms: Buttercup yellow, chromic acid salts, chromic anhydride, chromium trioxide, dichromates, polychromates, zinc yellow

Sources: Pigments/paints, corrosion inhibitors, stainless steel welding; ores of chromates (lead chromate, crocoite)

Description: CrO_3: Dark-red, odorless flakes or powder**,** appearance and odor varies by compound

Incompatibilities: Combustible, organic or other readily-oxidized material, e.g. paper, wood

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Blood, respiratory system, liver, kidneys, eyes, skin

PPE: Respirator: Recommendations: NIOSH, At concentrations above 0.001 mg/m^3 TWA: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent contact; As Chromic Acid - 8 hr: PE, PVC, Saranex; 4 hr: Butyl, Viton

Eyes: Prevent contact

Special Precautions: Carcinogen (National Toxicology Program); avoid skin contact

LABORATORY INFORMATION

CAS Number: 1333-82-0 (CrO_3)

Analytical Technique: Colorimetric

Analytical Reference Method: NIOSH 7600

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 7

Collection Media: 5 µm poly vinyl chloride (PVC) filter, 37 mm

Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Special Instructions: Place filter into a glass vial after sampling (stable for only two weeks). Submit sample as soon as possible to MSHA Laboratory.

Chromium, Soluble Chromic, Chromous Salts as Cr

250 mg/m^3 [as Cr(II)] IDLH (NIOSH, 1995)
25 mg/m^3 [as Cr(III)] IDLH (NIOSH, 1995)

Chromium, Metal and Insoluble Salts

250 mg/m^3 (as Cr) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
545 (chromium, soluble chromic, chromous salts as Cr)		
	0.5 mg/m^3 (500 µg/m^3)	1.5 mg/m^3 (1,500 µg/m^3) - 15 min.
	(PEDS units of measure in parentheses)	
547 (Cr, metal and insoluble salts)		
	1.0 mg/m^3	3.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Chromic acetate hexahydrate, chromic anhydride, chromic nitrate, chromic oxide, chromic sulfate, chromium trioxide

Sources: Stainless and alloy steels, electroplating, corrosion inhibitors, green paints, ores of crocoite (lead chromate), chromite

Description: Appearance and odor varies by compound (bright blue or green crystals)

Incompatibilities: Chromium: Strong oxidizers (such as hydrogen peroxide), alkalis (varies according to compound)

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Blood, respiratory system, liver, kidneys, eyes, skin

PPE: Respirator: Recommendations: NIOSH, up to 2.5 mg/m^3: (APF = 5) Any dust and mist respirator;

Skin: For metal, determine based on working conditions; all others - prevent contact**;** contact the manufacturer for recommendations for the specific compound

Eyes: For metal, determine based on working conditions; all others - prevent contact

Special Precautions: Hexavalent chromium is a carcinogen (IARC); chromium is a noncombustible solid in bulk form, but finely divided dust burns rapidly if heated in a flame.

LABORATORY INFORMATION
CAS Number: 7440-47-3 (chromium - Cr)
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: usual sampling is 1.7 Lpm for up to 9 hrs.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Sampling Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water

Coal Dust (bituminous)

Contaminant Codes: **1973 ACGIH TLV, see page 34**

MSHA TLV:

531 (respirable dust < 1% quartz) 2.0 mg/m^3

523 (respirable dust > 1% quartz) use Quartz formula

CONTAMINANT INFORMATION

Synonyms: Bituminous coal, cannel coal, coking coal, fat coal, flaming coal, gas coal, parrot coal, soft coal

Sources: Fuel for coal-fired kilns, dryers, boilers, etc., at cement and lime plants or other coal-fired operations

Description: Very fine dark-brown to black solid particles

Incompatibilities: N/A

Exposure: Inhalation

Health Effects: Respiratory system disorders including pneumoconiosis (black lung).

PPE: Respirator: Any that are suitable for nuisance dusts if <1% quartz or suitable for silica if respirable fraction >1% quartz;

Skin: Determine based on working conditions

Eyes: Determine based on working conditions

Special Precautions: Combustible; fire or explosion hazard in the presence of open flame

***LABORATORY INFORMATION*:**

See DUST, RESPIRABLE

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 5

Collection Media: cyclone and filter [10mm nylon cyclone and 37-mm diameter 5 µm poly vinyl chloride (PVC) filter]

Sample Flow Rate: 1.7 Lpm.

Coal Tar Pitch Volatiles (benzene soluble fraction)

Anthracene, BaP, Phenanthrene, Acridine, Chrysene, Pyrene

80 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	0.2 mg/m^3 (200 µg/m^3)	0.6 mg/m^3 (600 µg/m^3)
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: Anthracin, coal tar creosote (vapors), creosote volatiles, green oil,

Sources: Sealing of tanks, fabrication of charcoal briquets; distillation residues of coal, petroleum (less asphalt), and other organic matter

Description: Acrid, smoky-tasting vapors from translucent brown to black, oily liquid (creosote), composed mainly of aromatic (benzene-related) hydrocarbons

Incompatibilities: Strong oxidizers

Exposure: Inhalation, ingestion, skin and eye absorption

Health Effects: Central nervous system, respiratory difficulty, hypothermia; skin or eye irritation, bladder, kidneys, skin cancer

PPE: Respirator: Recommendations: NIOSH, At concentrations above TWA 0.1 mg/m^3 for the cyclohexane-extractable fraction or at any detectable concentration: (APF = 10,000); any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent contact; contact the manufacturer for recommendations

Eyes: Prevent contact

Special Precautions: Flammable; confirmed carcinogen (BaP and chrysene fractions); nitric oxide byproduct when acridine is heated

LABORATORY INFORMATION

CAS Number: 65996-93-2

Analytical Technique: Gravimetric

Analytical Reference Method: OSHA 58

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 7

Collection Media: Glass fiber filter

Sample Flow Rate: Usual sampling is 1.7 Lpm for up to 9 hrs.

Special Instructions: Place filter into glass vial and wrap with aluminum foil to protect from light. Submit samples to MSHA Laboratory (contract laboratory analysis).

Cobalt

20 mg/m^3 (as Co) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
649 (dust)	0.1 mg/m^3 (100 µg/m^3)	0.5 mg/m^3 (500 µg/m^3) - 30 min.
715 (metal fume)	0.1 mg/m^3 (100 µg/m^3)	0.5 mg/m^3 (500 µg/m^3) – 30 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Cobalt metal dust, cobalt metal fumes
Sources: Alloys, carbides, paint, electroplating; ores of cobaltite, linnaeite, smaltite, erythrite
Description: Fume or dust; odorless, silver-gray to black solid
Incompatibilities: Strong oxidizers, ammonium nitrate
Exposure: Inhalation, ingestion, skin or eye contact
Health Effects: Skin, respiratory system
PPE: Respirator: Recommendations: NIOSH, up to 0.25 mg/m^3: (APF = 5) any dust and mist respirator; up to 0.5 mg/m^3: (APF = 10); any dust and mist respirator except single-use and quarter-mask respirators.
Skin: Prevent skin contact
Eyes: Prevent eye contact
Special Precautions: Noncombustible solid in bulk form, but finely divided dust will burn at high temperatures.

LABORATORY INFORMATION

CAS Number: 7440-48-4
Analytical Technique: Inductively Coupled Plasma (ICP)
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: Usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 30 min.
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: Usual sampling is 1.7 Lpm.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water

Copper - Cu

100 mg/m^3 (as Cu) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
171 (dust, mist)	1.0 mg/m^3	3.0 mg/m^3 - 15 min.

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
717 (fume)	0.1 mg/m^3 (100µg/m^3)	0.1 mg/m^3 (100µg/m^3) - 30 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Copper metal dusts, copper metal fumes;
CuO fume: black copper oxide fume, copper monoxide fume, copper(II) oxide fume, cupric oxide fume

Sources: Welding of copper containing metals; ores of copper, lead, zinc, chalcopyrite, chalcocite, bornite, tetrahedrite, enargite,

Description: *Dusts and mists*: reddish, lustrous, malleable**,** odorless solid;
Fumes: finely divided black particulate dispersed in air

Incompatibilities: *Dusts and mists*: oxidizers, alkalis, sodium azide**,** acetylene;
CuO fume: acetylene, zirconium

Exposure: *Dusts and mists*: inhalation, ingestion, skin and/or eye contact;
Fumes: inhalation, skin and/or eye contact

Health Effects: *Dusts and mists*: irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia.
Fumes: irritation eyes, upper respiratory system; metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough, weakness, lassitude (weakness, exhaustion); metallic or sweet taste; discoloration skin, hair

PPE: Respirator: *Dusts and mists*: NIOSH/OSHA: Up to 5 mg/m^3: (APF = 5) any dust and mist respirator; up to 10 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators (if not present as a fume)**;** up to 25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a dust and mist filter; up to 50 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter.
Fumes: NIOSH/OSHA: Up to 1 mg/m^3: (APF = 10) any dust, mist, and fume respirator; up to 2.5 mg/m^3: (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter; up to 5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50**)** any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter

Skin: *Dusts and mists*: Prevent skin contact; contact the manufacturer for recommendations; fumes: no specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment.
Eyes: *Dusts and mists*: Prevent eye contact; fumes: no recommendation is made specifying the need for eye protection
Special Precautions: *Dusts*: noncombustible solid in bulk form, but powdered form may ignite; *CuO fume*: noncombustible solid

LABORATORY INFORMATION
CAS Number: Dusts and mists: 7440-50-8; fumes: 1317-38-0 (CuO), 1317-39-1 (Cu_2O)
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37 mm, 0.8 µm mixed cellulose ester (MCE) filter
Sample Flow Rate: Usual sampling is 1.7 Lpm for up to 9 hrs.

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: Dusts and mists: 15 min.; fumes: 30 min.
Collection Media: 37-mm diameter, 0.8 µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate: Usual sampling is 1.7 Lpm.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water

Cresol (all isomers) - $CH_3C_6H_4OH$
250 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
447	5.0 ppm (Skin)	10 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: O-cresol: ortho-cresol, 2-cresol, o-cresylic acid, 1-hydroxy-2-methylbenzene, 2-hydroxytoluene, 2-methyl phenol; m-cresol: meta-cresol, 3-cresol, m-cresylic acid, 1-hydroxy-3-methylbenzene, 3-hydroxytoluene, 3-methyl phenol p-cresol: para-cresol, 4-cresol, p-cresylic acid, 1-hydroxy-4-methylbenzene, 4-hydroxytoluene, 4-methyl phenol

Sources: Flotation agent, industrial solvents, fumigants

Description: O-cresol: white crystals with a sweet, tarry odor; m-cresol: colorless to yellowish liquid with a sweet, tarry odor; p-cresol: crystalline solid with a sweet, tarry odor

Incompatibilities: Strong oxidizers, acids

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, mucous membrane; central nervous system effects: confusion, depressant/depression, respiratory failure; dyspnea (breathing difficulty), irregular/irregularities rapid respiratory, weakness pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage

PPE:

Respirator: Recommendations: NIOSH - Up to 23 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) in combination with a dust and mist filter**;** up to 57.5 ppm: (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) in combination with a dust and mist filter; up to 115 ppm**:** (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s) in combination with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter

Skin: Prevent skin contact; o-cresol: Contact the manufacturer for recommendations; m-cresol: 4 hr: Neoprene, Teflon; p-cresol: 4 hr: PE/EVAL

Eyes: Prevent eye contact

Special Precautions: O-cresol: combustible solid; Class IIIA combustible liquid
m-cresol: Class IIIA combustible liquid
p-cresol: Combustible solid; Class IIIA combustible liquid

LABORATORY INFORMATION

CAS Number: 1319-77-3 (all isomers), 95-48-7 (o-), 108-39-4 (m-), 106-44-05 (p-)
Analytical Technique: NIOSH 2546 (IV): gas chromatography / flame ionization detection
Analytical Reference Method: NIOSH 2546 (IV)

SAMPLING INFORMATION

Special Instructions: XAD-7 tube required for contract lab analysis; flow rate and volume dependent upon method used. Call MSHA Laboratory for sampling parameters.

Grab Sampling:

Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube #8101641, Phenol 1/b, range 1 - 20 ppm (EF = 1.25).
Note: Temperature range must be 10°- 30° C (50°- 86° F). Detector tube is responsive to both phenol (which has the same TLV) and cresols. To determine m-cresol, multiply the indication by 0.8. Benzene, toluene, and other aromatics without the hydroxyl group are not indicated. Aliphatic hydrocarbons are not indicated.

Cristobalite - SiO_2 (Respirable)
25 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
525	5 mg/m^3 % SiO_2 + 2	N/A

CONTAMINANT INFORMATION

Synonyms: Silica, volcanic sand, calcined diatomite

Sources: Kilns, clay fire brick, volcanic rock containing silica (especially lavas of Colorado)

Description: Colorless, odorless solid

Incompatibilities: Powerful oxidizers (e.g., fluorine, chlorine, trifluoride, manganese trioxide, oxygen difluoride, hydrogen peroxide); acetylene; ammonia

Exposure: Inhalation, skin and/or eye contact

Health Effects: Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [potential occupational carcinogen]

PPE: Respirator: Recommendations: NIOSH - Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; Up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; Up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 14464-46-1**;** 14808_60_7

Analytical Technique: X-ray diffraction

Analytical Reference Method: MSHA P-2

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 5

Collection Media: MSHA P-2

Sample Flow Rate: Minimum - Maximum (Lpm): 1.7

Cyanide - CN
25 mg/m^3 (as CN) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH	1968 PA Rules
	TLV:	STEL/Ceiling (C):
419	5.0 mg/m^3 (Skin)	5.0 mg/m^3 - 30 min.

CONTAMINANT INFORMATION

Synonyms: Hydrogen cyanide (HCN): formonitrile, hydrocyanic acid, prussic acid; potassium cyanide (KCN): potassium salt of hydrocyanic acid
sodium cyanide (NaCN): sodium salt of hydrocyanic acid

Sources: Extraction of gold and silver, electroplating, coppering, bronzing, hardening of metals, pest fumigation

Description: HCN: colorless or pale-blue liquid or gas (above 78°F) with a bitter, almond-like odor
KCN: white, granular or crystalline solid with a faint, almond-like odor
NaCN: white, granular or crystalline solid with a faint, almond-like odor

Incompatibilities: HCN: amines, oxidizers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, water, caustics, ammonia; [note: can polymerize at 122-140°F.]
KCN: strong oxidizers (e.g., acids, acid salts, chlorates, nitrates)
NaCN: strong oxidizers (e.g., acids, acid salts, chlorates, nitrates)

Exposure: HCN: inhalation, skin absorption, ingestion, skin and/or eye contact
KCN: inhalation, skin absorption, ingestion, skin and/or eye contact
NaCN: inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: HCN: asphyxia; weakness, headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes
KCN: irritation eyes, skin, upper respiratory system; asphyxia; weakness, headache, confusion; nausea, vomiting; increased respiratory rate, slow gasping respiratory; thyroid, blood changes
NaCN: irritation eyes, skin; asphyxia; weakness, headache, confusion; nausea, vomiting; increased respiratory rate; slow gasping respiration; thyroid, blood changes

PPE: Respirator: HCN: NIOSH - Up to 47 ppm (51.7 mg/m^3): (APF = 10) any supplied-air respirator
KCN: NIOSH/OSHA - Up to 25 mg/m^3: (APF = 10) any supplied-air respirator; (APF = 50) any self-contained breathing apparatus with a full facepiece

NaCN: NIOSH/OSHA - Up to 25 mg/m^3: (APF = 10) any supplied-air respirator; (APF = 50) Any self-contained breathing apparatus with a full facepiece

Skin: HCN: Prevent skin contact; 8 hr: Teflon; 4 hr: PE/EVAL, Responder, Tychem
KCN: Prevent skin contact; (solution <30% only) 8 hr: PE
NaCN: Prevent skin contact; (solution >70% only) 8 hr: Saranex, Barricade

Eyes: HCN: Prevent eye contact
KCN: Prevent eye contact
NaCN: Prevent eye contact

Special Precautions: HCN: Class IA flammable liquid; flammable gas
KCN: noncombustible solid; contact with acids releases highly flammable hydrogen cyanide
NaCN: noncombustible solid; contact with acids releases highly flammable hydrogen cyanide

LABORATORY INFORMATION

CAS Numbers: 57-12-5 (CN); 74-90-8 (HCN); 151-50-8 (KCN); 143-33-9 (NaCN)
Analytical Technique: HCN, KCN, NaCN: NIOSH 7904 (IV) - Ion-Specific Electrode (ISE)
Analytical Reference Method: NIOSH 7904 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapters 6 & 7
Collection Media: 37-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter, followed by glass midget bubbler containing 15 mL 0.1 N KOH
Sample Flow Rate: Minimum - Maximum (Lpm): 0.5-1.0
Air Collection Volume: Minimum - Maximum (L): 10-180

Short Term Sampling:
Sampling Strategy: see Chapters 6 & 7
Sampling Duration: 30 min.
Collection Media: 37-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter, followed by glass midget bubbler containing 15 mL 0.1 N KOH
Sample Flow Rate: Minimum - Maximum (Lpm): 0.5-1.0
Air Collection Volume: Minimum - Maximum (L): 10-180

Special Instructions: Quantitatively transfer the contents of the bubbler to a 20-mL vial. Close cap tightly and wrap with plastic tape to avoid sample loss during transit. Overnight samples to MSHA Laboratory for analysis. Analyze within 5 days. Particulate on filter may liberate HCN gas.

Cyclohexanone - $C_6H_{10}O$
700 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
265	50 ppm	75 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Anone, cyclohexyl ketone, pimelic ketone

Sources: Metal degreaser

Description: Water-white to pale-yellow liquid with a peppermint- or acetone-like odor

Incompatibilities: Oxidizers, nitric acid

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, mucous membrane; headache; narcosis, coma; dermatitis; in animals: liver, kidney damage

PPE: Respirator: Recommendations - NIOSH: Up to 625 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance causes eye irritation or damage; eye protection needed); (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance causes eye irritation or damage; eye protection needed); Up to 700 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Butyl, PE/EVAL; 4 hr: PVA

Eyes: Prevent eye contact

Special Precautions: Class IIIA combustible liquid

LABORATORY INFORMATION

CAS Number: 108-94-1

Analytical Technique: 3M: Passive monitor; NIOSH 1300 (IV): gas chromatography (GC) / flame ionization detection (FID); OSHA 1: gas chromatography (GC) / flame ionization detection (FID)

Analytical Reference Method: 3M; NIOSH 1300 (IV); OSHA 1

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

2. Collection Media: NIOSH 1300 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

3. Collection Media: OSHA 1: Chromosorb 106

Sample Flow Rate: Minimum - Maximum (Lpm): 0.05-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. Collection Media: NIOSH 1300 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

2. Collection Media: OSHA 1: Chromosorb 106

Sample Flow Rate: Minimum - Maximum (Lpm): 0.05-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

1,2-Dichloroethane - $ClCH_2CH_2Cl$ (Ethylene Dichloride)

50 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
263	50 ppm	75 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Glycol dichloride; ethylene dichloride

Sources: Degreaser compounds

Description: Colorless liquid with a pleasant, chloroform-like odor; [note: decomposes slowly, becomes acidic & darkens in color.]

Incompatibilities: Strong oxidizers & caustics; chemically-active metals (e.g., magnesium or aluminum powder, sodium, potassium; liquid ammonia; [note: decomposes to vinyl chloride & HCl above 1112°F.]

Exposure: Inhalation, ingestion, skin absorption, skin and/or eye contact

Health Effects: Irritation eyes, corneal opacity; central nervous system depressant / depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]

PPE: Respirator: Recommendations: NIOSH - At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Prevent skin contact; 8 hr: Teflon, Viton, PE/EVAL, Barricade, CPF3, Responder, Tychem; 4 hr: PVA

Eyes: Prevent eye contact

Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 107-06-2

Analytical Technique: NIOSH 1003 (IV): gas chromatography (GC) / flame ionization detection (FID); **OSHA** 3: gas chromatography (GC) / electron capture detection (ECD); 3M: passive monitor

Analytical Reference Method: NIOSH 1003 (IV); OSHA 3; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: NIOSH 1003 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-50

2. Collection Media: OSHA 3: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

3. Collection Media: 3M: Passive monitor, 3M, 3500 series

Note: Maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. Collection Media: NIOSH 1003 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-50

2. Collection Media: OSHA 3: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

Dust (Mineral), Respirable

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
523 (quartz dust, respirable fraction, > 1% quartz)	$\frac{10}{\%\ \text{resp quartz} + 2}$ mg/m^3	N/A
521 (quartz not analyzed)	N/A	N/A
131 (unlisted particulate, respirable fraction, < 1% quartz)	N/A	N/A
121 (listed nuisance dust, respirable fraction, < 1% quartz)	10 mg/m^3	N/A

CONTAMINANT INFORMATION

Description: Dust particulate less than 10 microns

Sources: Mining and mineral processing at operations producing materials containing silica

Exposure: Inhalation, skin and/or eye contact

Health Effects: Crystalline silica: cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH:
crystalline silica: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; up to 25 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION
CAS Number: 14808-60-7 (quartz, crystalline silica)
Analytical Technique: X-ray diffraction spectrometry
Analytical Reference Method: MSHA P-2

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 5
Collection Media: Cyclone and filter [10-mm nylon cyclone and pre-weighed 37-mm diameter, 5 µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7

Dust, Total*

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
123 (listed nuisance dust, total particulate, < 1% quartz)	10 mg/m^3	N/A
133 (unlisted particulate, total particulate, < 1% quartz)	N/A	N/A

***Note: No quartz analysis performed.**

CONTAMINANT INFORMATION

Synonyms: Nuisance dust; alundum (Al_2O_3), calcium carbonate, cellulose (paper fiber), portland cement, corundum (Al_2O_3); emery, glass [fibrous (<5-7 µm in diameter) or dust], glycerin mist, graphite (synthetic), gypsum, vegetable oil mists (except castor, cashew nut, or similar irritant oils), kaolin, limestone, magnesite, marble, pentaerythritol, plaster of Paris, rouge, silicon carbide, starch, sucrose, tin oxide, titanium dioxide

Sources: Mining and mineral processing at operations producing materials contained in Appendix E of the ***TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by the ACGIH for 1973***

Description: When toxic impurities are not present (e.g. quartz < 1%), Appendix E listed contaminants include**:** alundum (Al_2O_3); calcium carbonate; cellulose (paper fiber); portland cement; corundum (Al_2O_3); emery; glass [fibrous (<5-7 µm in diameter) or dust]; glycerin mist; graphite (synthetic); gypsum; vegetable oil mists (except castor, cashew nut, or similar irritant oils); kaolin; limestone; magnesite; marble; pentaerythritol; plaster of Paris rouge; silicon carbide; starch; sucrose; tin oxide; and titanium dioxide

Incompatibilities: N/A

Exposure: Inhalation, skin and/or eye contact

Health Effects: These dusts can cause significant toxic effects when inhaled in large quantities

PPE: Respirator: Recommendations - Minimum N-95 if no oil particles are present in work environment minimum R-95 if oil particles are present

Skin: Portland cement: prevent contact. Use any barrier, including clothing, that will prevent contact with the chemical, especially on wet or moist skin; practice good personal hygiene by washing after exposure. For other substances, no specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment.

Eyes: Portland cement: wear safety glasses or goggles; remove foreign material promptly and follow up with medical check. For other substances, no specific recommendation is made regarding eye protection

Special Precautions: See above

LABORATORY INFORMATION

CAS Number: Varies according to contaminant
Analytical Technique: NIOSH 0500 (IV) [particulates not otherwise regulated, total]: gravimetric (filter weight)
Analytical Reference Method: MSHA P-19

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 5
Collection Media: Filter [pre-weighed 37-mm diameter, 5 µm pore size polyvinyl chloride (PVC) filter, no cyclone]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Dependent on dust levels and shift length see chapter 5.

Special Instructions: Under special circumstances and with laboratory permission, dust samples collected on the total dust PVC filters can be analyzed for metal elements.

Elemental Profile
(Metal Dusts and Fumes)

Metals Analyzed: Aluminum, arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, platinum, selenium, silver, sodium, tellurium, thallium, titanium, vanadium, yttrium, zinc, zirconium

***CONTAMINANT INFORMATION*:** Varies by element

LABORATORY INFORMATION
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES); NIOSH 7300 (IV).
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): varies by element

Special Instructions: Under special circumstances, the 37-mm diameter polyvinyl chloride (PVC) filter pre-weighed dust cassettes can be used. Contact Lab for permission. **Note**: There are 16 individual elements that can be selectively analyzed, however the standard profile is a 14-metal elemental profile that does not include aluminum and titanium.

Ethyl Acetate - $CH_3COOCH_2H_5$

2,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 2.0%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	400 ppm	500 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Acetic ester, acetic ether, ethyl ester of acetic acid, ethyl ethanoate
Sources: Solvents
Description: Colorless liquid with an ether-like, fruity odor
Incompatibilities: Nitrates, strong oxidizers, alkalis & acids
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, skin, nose, throat; narcosis; dermatitis
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 2000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance causes eye irritation or damage, eye protection needed); (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance causes eye irritation or damage, eye protection needed); (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: Prevent skin contact; 8 hr: PE/EVAL, Barricade, CPF3, Responder, Trellchem, Tychem; 4 hr: PVA, Teflon
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 141-78-6
Analytical Technique: NIOSH 1457 (IV): gas chromatography (GC) / flame ionization detector (FID); **OSHA** 7: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1457 (IV); OSHA 7; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: NIOSH 1457 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.1-10

2. Collection Media: OSHA 7: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 6

3. Collection Media: 3M: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. Collection Media: NIOSH 1457 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.1-10

2. Collection Media: OSHA 7: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 6

Special Instructions: Coordinate with Laboratory - Ship on ice; sample stable six days refrigerated. Overnight sample to MSHA laboratory.

Ethyl Alcohol - CH_3CH_2OH

3,300 ppm IDLH **(NIOSH**, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 3.3%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
247	1000 ppm	1250 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Alcohol, cologne spirit, ethanol, EtOH, grain alcohol
Sources: Solvents
Description: Clear, colorless liquid with a weak, ethereal, vinous odor
Incompatibilities: Strong oxidizers, potassium dioxide, bromine pentafluoride, acetyl bromide, acetyl chloride, platinum, sodium
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, skin, nose; headache, drowsiness, fatigue, narcosis; cough; liver damage; anemia; reproductive, teratogenic effects
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 3,300 ppm: (APF = 10) any supplied-air respirator; (APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent skin contact; 8 hr: Butyl, Viton, PE/EVAL; 4 hr: Neoprene, Teflon
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 64-17-5
Analytical Technique: NIOSH 1400 (IV): gas chromatography (GC) / flame ionization detector (FID); **OSHA** 100: gas chromatography (GC) / flame ionization detector (FID)
Reference Method: NIOSH 1400 (IV); OSHA 100

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. Collection Media: NIOSH 1400 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 0.1-1

2. Collection Media: OSHA 100: 400/200 mg Anasorb 747
Sample Flow Rate (Lpm): 0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 12

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
1. Collection Media: NIOSH 1400 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 0.1-1
2. Collection Media: OSHA 100: 400/200 mg Anasorb 747
Sample Flow Rate (Lpm): 0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 0.75

Special Instructions: Coordinate with MSHA Laboratory. Store in freezer and ship on ice.

Ethyl Benzene - $CH_3CH_2C_6H_5$

800 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 0.8%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
267	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Ethylbenzol, phenylethane
Sources: Solvents
Description: Colorless liquid with an aromatic odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 800 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage, may require eye protection); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent skin contact; 8 hr: Viton, Barricade, Responder, Tychem; 4 hr: Teflon
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 100-41-4
Analytical Technique: NIOSH 1501 (IV): gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1501 (IV); 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: NIOSH 1501 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-24

2. Collection Media: 3M: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

Collection Media: NIOSH 1501 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-24

Fluorine - F_2
25 ppm IDLH (NIOSH, 1995)

Fluorides (as F)
250 ppm (as F) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
487 (F_2, fluorine gas)	1.0 ppm	0.5 ppm - 5 min.
719 (fluoride fume)	2.5 mg/m^3	10.0 mg/m^3 - 30 min.
417 (fluoride dust, as F)	2.5 mg/m^3	10.0 mg/m^3 - 30 min.

CONTAMINANT INFORMATION

Synonyms: Fluorine gas (F_2): fluorine-19

Sources: Fluoride dust: metallic ores & mining of fluorspar, florspar, apatite
fluoride fume: welding fumes (flux emissions)

Description: Fluorine gas: pale-yellow to greenish gas with a pungent, irritating odor

Incompatibilities: Fluorine gas: water, nitric acid, oxidizers, organic compounds; [note: reacts violently with all combustible materials, except the metal containers in which it is shipped; reacts with H_2O to form hydrofluoric acid.]

Exposure: Fluorine gas: inhalation, skin and/or eye contact

Health Effects: Fluorine gas: irritation eyes, nose, respiratory system; laryngeal spasm, bronchitis spasm; pulmonary edema; eye, skin burns; in animals: liver, kidney damage

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 1 ppm: (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 2.5 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); up to 5 ppm: (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 25 ppm: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Fluorine: Prevent skin contact (liquid); 8 hr: Barricade, Responder

Eyes: Fluorine: Prevent eye contact (liquid)

Special Precautions: Fluorine gas: nonflammable gas, but an extremely strong oxidizer

LABORATORY INFORMATION
CAS Number: 7782-41-4 (fluorine gas as F_2); 7664-39-3 (fluoride as HF)
Analytical Technique: NIOSH 7902 (IV) [fluorides, aerosol and gas]: ion-specific electrode (ISE); Dräger: detector tube
Analytical Reference Method: NIOSH 7902 (IV) [fluorides as F, aerosol and gas]; Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: Fluorides, aerosol and gas: filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 12-800

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: F_2, fluorine gas: 15 min.; fluoride fume, fluoride dust: 30 min.
Collection Media: Fluorides, aerosol and gas: filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 12-800

Special Instructions: For total and gaseous forms, a treated filter is required. Contact MSHA Laboratory for media and sampling instructions.

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: fluorine: Dräger detector tube, #8101491, range 0.05-40 ppm (EF = 1.33)

Formaldehyde - HCHO
20 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (**C):**
441	2.0 ppm	2.0 ppm (C)

CONTAMINANT INFORMATION

Synonyms: Methanal, methyl aldehyde, methylene oxide, formalin (aqueous 30-60% w/v formaldehyde), formic aldehyde

Sources: Adhesives, disinfectants, carpet off-gassing, rosin-core soldering

Description: Nearly colorless gas with a pungent, suffocating odor

Incompatibilities: Strong oxidizers, alkalis & acids; phenols; urea; [note: pure formaldehyde has a tendency to polymerize; reacts with HCl to form bis-Chloromethyl ether.]

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation eyes, nose, throat, respiratory system; lacrimation (discharge of tears); cough; bronchitis spasm; [potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Formaldehyde: Prevent skin contact; contact the manufacturer for recommendations.
Formalin: Prevent skin contact; 8 hr: Butyl, Nitrile, Viton, Saranex, Barricade, CPF3; 4 hr: Teflon, PE/EVAL, Responder

Eyes: Prevent eye contact

Special Precautions: Flammable gas

LABORATORY INFORMATION
CAS Number: 50-00-0
Analytical Technique: NIOSH 2016 (IV): high-pressure liquid chromatography (HPLC) / ultraviolet detection (UVD); NIOSH 2541 (IV): gas chromatography (GC) / flame ionization detection (FID); NIOSH 3500 (IV): visible absorption spectrometry; 3M: passive monitor / OSHA ID-205: visible absorption spectrometry (UV spectrophotometer at 580 nm); Dräger: detector tube
Analytical Reference Method: NIOSH 2016 (IV); NIOSH 2541 (IV); NIOSH 3500 (IV); 3M / OSHA ID-205; Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media:
1. NIOSH 2016 (IV): 2,4-dinitrophenylhydrazine (DNPH)-coated silica gel tube [i.e., plastic holder containing 0.35 g of 500-1000 µm silica gel coated with 0.9 mg DNPH];
2. NIOSH 2541 (IV): Solid sorbent tube [i.e., 120/60 mg 10% 2-(hydroxymethyl) piperidine-coated XAD-2]
3. NIOSH 3500 (IV): Filter + impingers [i.e., 37-mm diameter, 1-3-µm pore size polytetrafluoroethylene (PTFE) filter, followed by 2 midget impingers (each containing 20 mL 1% sodium bisulfite solution)]
4. 3M / OSHA ID-205: Passive monitor, 3M, 3721 [bisulfite impregnated paper]
Note: monitor has 18-month shelf life when stored at room temperature and in an environment free of formaldehyde; maximum 8-hour sample per badge
Sample Flow Rate: Minimum - Maximum (Lpm):
1. NIOSH 2016 (IV): 0.1-1.5
2. NIOSH 2541 (IV): 0.01-0.10; Must use a pump adaptor or arrange for low flow pumps.
3. NIOSH 3500 (IV): 0.2-1
Air Collection Volume: Minimum - Maximum (L):
1. NIOSH 2016 (IV): 1-15
2. NIOSH 2541 (IV): 1-36
3. NIOSH 3500 (IV): 1-100

Short Term Sampling:
Sampling Strategy: see Chapter 9.
Sampling Duration: 15 min.
Collection Media:
1. NIOSH 2016 (IV): 2,4-dinitrophenylhydrazine (DNPH)-coated silica gel tube [i.e., plastic holder containing 0.35 g of 500-1000 µm silica gel coated with 0.9 mg DNPH];
2. NIOSH 2541 (IV): solid sorbent tube [i.e., 120/60 mg 10% 2-(hydroxymethyl) piperidine-coated XAD-2]

3. NIOSH 3500 (IV): Filter + impingers [i.e., 37-mm diameter, 1-3-µm pore size polytetrafluoroethylene (PTFE) filter, followed by 2 midget impingers (each containing 20 mL 1% sodium bisulfite solution)]
Sample Flow Rate: Minimum - Maximum (Lpm):
1. NIOSH 2016 (IV): 0.1-1.5
2. NIOSH 2541 (IV): 0.01-0.10 Lpm, Must use a pump adaptor or arrange for low flow pumps.
3. NIOSH 3500 (IV): 0.2-1
Air Collection Volume: Minimum - Maximum (L):
1. NIOSH 2016 (IV): 1-15
2. NIOSH 2541 (IV): 1-36
3. NIOSH 3500 (IV): 1-100

Special Instructions:
1. NIOSH 2016 (IV): Coordinate with MSHA laboratory. Ship on ice via overnight express carrier. Samples are stable for 14 days at 4^{o}C.
2. NIOSH 2541 (IV): N/A
3. NIOSH 3500 (IV): Coordinate with MSHA laboratory. Transfer samples to low-density polyethylene bottles before shipping.

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #6733081, range 0.04-25 ppm (EF = 1.49).

Gas (Profile)

Gases Analyzed: Carbon Monoxide*, Carbon Dioxide**,** Oxygen, Methane and Nitrogen Dioxide

CONTAMINANT INFORMATION
see individual contaminants

LABORATORY INFORMATION
CAS Number: see individual contaminants
Analytical Technique: Gas Chromatography (GC)/DRI
Analytical Reference Method: Gas Chromatography

SAMPLING INFORMATION
Grab Sampling:
Sampling Strategy: See chapter 12
Collection Media: 50 mL vacuum bottle or 10 mL vacutainer (EF = 1.11).
* **Note:** for inclusion of carbon monoxide, use 50 mL vacuum bottle
Sample Flow Rate: Minimum - Maximum (Lpm): N/A
Air Collection Volume: Minimum - Maximum (L): 10 mL - 50 mL

Grab Sampling:
Sampling Strategy: see Chapter 13
Collection Media: Direct Reading Instrument TMX412 (EF = 1.25): for carbon monoxide (CO), oxygen (O_2), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), methane (CH_4/combustibles - LEL%).
Various other electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Special Instructions:
There is a 14-day holding time for vacuum samples and a 7-day hold time for vacutainers. Submit sample as soon as possible to MSHA laboratory.

Gasoline

Contaminant Codes: TLVs: STEL/Ceiling (C):

**** NOTE:** Lab must perform qualitative analysis first to determine the applicable TLV according to analytically determined composition.

CONTAMINANT INFORMATION

Synonyms: Motor fuel, motor spirits, natural gasoline, petrol
Sources: Fuel, diluent, solvent
Description: Clear liquid with a characteristic odor
Incompatibilities: Strong oxidizers (e.g., peroxides, nitric acid, perchlorates)
Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, skin, mucous membrane; dermatitis; headache, fatigue, blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonia (aspiration of liquid); possible liver, kidney damage; [potential occupational carcinogen]
PPE: Respirator: Recommendations - NIOSH: At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Skin: Prevent skin contact; 8 hr: Nitrile, Viton, Barricade; 4 hr: PVA, PE/EVAL, Responder
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 8006-61-9
Analytical Technique: NIOSH 1550 (IV): gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1550 (IV); 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1.3-20

2. Collection Media: Passive monitor, 3M, 3500 series

Note: Maximum 8-hour sample per badge.

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 30 min.

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1.3-20

Special Instructions: Samples are stable for only one week at room temperature. Ship samples to MSHA laboratory via overnight carrier.

Graphite (natural) - C

1,250 mg/m^3 (as C) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
517 (< 1 % quartz)	15 mppcf (1.9 mg/m^3)	30 mppcf (3.8 mg/m^3) - 15 min.

(PEDS "screening" units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Black lead, mineral carbon, plumbago, silver graphite, stove black

Sources: Graphite mines or processing plants, lubricants, polishing compounds, electroplating

Description: Steel gray to black, greasy feeling, odorless solid

Incompatibilities: Very strong oxidizers (*e.g.,* fluorine, chlorine trifluoride, potassium peroxide)

Exposure: Inhalation, skin and/or eye contact

Health Effects: cough, dyspnea (breathing difficulty), black sputum, decreased pulmonary function, lung fibrosis

PPE: Respirator: Recommendations - NIOSH: Up to 12.5 mg/m^3: (APF = 5) any dust respirator; up to 25 mg/m^3: (APF = 10) any dust respirator except single-use and quarter-mask respirators/(APF = 10) any supplied-air respirator; up to 62.5 mg/m^3: (APF = 25) any powered, air-purifying respirator with a dust filter; (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 125 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 1250 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Combustible solid

LABORATORY INFORMATION

CAS number: 7782-42-5

Analytical Technique:
1. X-ray diffraction
2**.** Mineral Dust: impinger method
Analytical Reference Method: MSHA p-2; impinger method

SAMPLING INFORMATION
Full Shift Sampling: Screening - **Note:** cannot be used for enforcement
Sampling Strategy: See chapter 6
MSHA P-2
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7

Full Shift - Partial Period Sampling: Enforcement - **Note:** for compliance with TLV
Sampling Strategy: see Chapter 6
Collection Media: Impinger
Sample Flow Rate (Lpm): 2.8
Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will conduct impinger sampling with inspector escort.

n-Heptane -$CH_3[CH_2]_5CH_3$
750 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	500 ppm	625 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Eptane, normal-heptane
Sources: Solvent, testing gasoline engines (knocking)
Description: Colorless liquid with a gasoline-like odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Lightheadedness, giddiness, stupor, vertigo (an illusion of movement), loss of coordination, loss of appetite, nausea, dermatitis, chemical pneumonia (aspiration of liquid), unconsciousness
PPE: Respirator: Recommendations - NIOSH: up to 750 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s); (APF = 10) any supplied-air respirator; (APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent skin contact; 8 hr: Nitrile, Viton, PE/EVAL
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 142-82-5
Analytical Technique: NIOSH 1500 (IV): gas chromatography (GC) / flame ionization detector (FID); **OSHA** 7: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1500 (IV); OSHA 7; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Special Instructions: N/A

n-Hexane - $CH_3(CH_2)_4CH_3$

1,100 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.1%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
659	500 ppm	625 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Hexane, hexyl hydride, normal-hexane
Sources: Solvents, glues, mineral analytical laboratories, ligroine (VM&P naphtha)
Description: Colorless liquid with a gasoline-like odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, nose; lightheadedness; nausea, headache; peripheral neuropathy: numbness in extremities, muscle weakness; dermatitis; giddiness; chemical pneumonia (aspiration of liquid)
PPE: Respirator: Recommendations - NIOSH: Up to 500 ppm: (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 1100 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: Prevent skin contact; 8 hr: Nitrile, PVA, Teflon, Viton, PE/EVAL, CPF3, Responder, Trellchem, Tychem; 4 hr: Barricade
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 110-54-3
Analytical Technique: NIOSH 1500 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 7: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1500 (IV); OSHA 7; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Special Instructions: N/A

Hexone (Methyl Isobutyl Ketone) - $CH_3COCH_2CH(CH_3)_2$
500 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
249	100 ppm	125 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Isobutyl methyl ketone, methyl isobutyl ketone, 4-methyl 2-pentanone, MIBK

Sources: Paints, glues, solvents, forgum, resins

Description: Colorless liquid with a pleasant odor

Incompatibilities: Strong oxidizers, potassium tert-butoxide

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, mucous membrane; headache, narcosis, coma, Dermatitis, in animals: liver, kidney damage

PPE: Respirator: Recommendations - NIOSH: Up to 500 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact; contact the manufacturer for recommendations

Eyes: Prevent eye contact

Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 108-10-1

Analytical Technique: NIOSH 1300 (IV): gas chromatography (GC) / flame ionization detection (FID); **OSHA** 1004: gas chromatography (GC) / flame ionization detection (FID); 3M: passive monitor

Analytical Reference Method: NIOSH 1300 (IV); OSHA 1004; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: Maximum 8-hour sample per badge

2. NIOSH 1300 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

3. OSHA 1004:

Collection Media: 150/75 mg Anasorb carbon molecular sieve (CMS) sampling tubes

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 12

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1300 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

2. OSHA 1004:

Collection Media: 150/75 mg Anasorb carbon molecular sieve (CMS) sampling tubes

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 0.75

Special Instructions: NIOSH 1300 (IV): Coordinate with MSHA Laboratory. Samples must be refrigerated. Ship on ice via overnight express carrier.

Hydrocarbons, Total (Screen)
[as n-Hexane - $CH_3(CH_2)_4CH_3$]
1,100 ppm (as n-Hexane) IDLH (NIOSH, 1995), based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.1%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
659	500 ppm	625 ppm - 15 min.

Note: "Screening" sample for field application when contaminants listed below are suspected. Analyses will quantify as n-Hexane. The results can be used for compliance with n-Hexane TLV.

Organics Analyzed: Fuels, including**:** gasoline, kerosene, diesel fuel, fuel oil

LABORATORY INFORMATION
CAS Number: 110-54-3 (n-hexane)
Analytical Technique: NIOSH 1500 (IV): gas chromatography (GC) / flame ionization detector (FID)
Analytical Reference Method: NIOSH 1500 (IV)

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 100/50 mg: 0.01-0.2; must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 4

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: **1**5 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 100/50 mg: 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 3

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tubes:
A. Hexane: #6728391, range 50-3,000 ppm (EF = 1.33).
B. Hydrocarbons: #CH26101, range 0.1-0.8 vol. (% butane) and 0.5-1.3 vol. (% propane) (EF = 1.66).
C. Hydrocarbons: #CH25401, range 2-23 mg/L (EF = 1.66).
D. Petroleum hydrocarbons: #8101691, range 10-300 ppm (n-octane) (EF = 1.41).
E. Petroleum hydrocarbons: #6730201, range 100-2,500 ppm (n-octane) (EF = 1.25).

Hydrogen Chloride - HCl
50 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
413	5.0 ppm	5.0 ppm - (C)

CONTAMINANT INFORMATION

Synonyms: Anhydrous hydrogen chloride, aqueous hydrogen chloride, hydrochloric acid, muriatic acid

Sources: Used in mine laboratories; ore processing of manganese, radium, vanadium, tantalum, tin, and tungsten; formed during fires involving polyvinyl chloride (PVC)

Description: Colorless to slightly yellow gas with a pungent, irritating odor

Incompatibilities: Hydroxides, amines, alkalis, copper, brass, zinc; [note: hydrochloric acid is highly corrosive to most metals.]

Exposure: Inhalation, ingestion (solution), skin and/or eye contact

Health Effects: Irritation nose, throat, larynx; cough, choking; pulmonary edema; contact dermatitis, eye, skin; acid burns

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 50 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact with concentrate or solution; 8 hr: Butyl, Teflon, Saranex, Barricade, Responder, Trellchem, Tychem; 4 hr: Neoprene, PVC; wear appropriate personal protective clothing to prevent skin contact with the liquid or from contact with vessels containing the liquid.

Eyes: Prevent eye contact.

Special Precautions: Nonflammable gas

LABORATORY INFORMATION
CAS Number: 7647-01-0
Analytical Technique: NIOSH 7903 (IV): ion chromatography; Dräger: detector tube
Analytical Reference Method: NIOSH 7903 (IV); Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #CH29501, range 1-10 ppm (EF = 1.25); Dräger detector tube, #6728181, range 50-5,000 ppm (EF = 1.25).

Hydrogen Cyanide - HCN
50 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
309	10 ppm (Skin)	20 ppm - 30 min.

CONTAMINANT INFORMATION

Synonyms: Formonitrile, hydrocyanic acid, prussic acid

Sources: Nitrates; processing of gold, silver, and copper ores from decomposing metal cyanides with hydrochloric acid

Description: Colorless or pale-blue liquid or gas (above 78°F) with a bitter, almond-like odor

Incompatibilities: Amines, oxidizers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, water, caustics, ammonia; [note: can polymerize at 122-140°F.]

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Asphyxia; weakness, headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes

PPE:

Respirator: Recommendations - NIOSH: Up to 47 ppm: (APF = 10) any supplied-air respirator; up to 50 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Teflon; 4 hr: PE/EVAL, Responder, Tychem

Eyes: Prevent eye contact

Special Precautions: Class IA flammable liquid; flammable gas

LABORATORY INFORMATION

CAS Number: 74-90-8

Analytical Technique: NIOSH 6010 (IV): spectrophotometry, visible absorption; NIOSH 7904 (IV): ion-specific electrode (ISE); Dräger: diffusion tube; Dräger: detector tube

Analytical Reference Method: NIOSH 6010 (IV); NIOSH 7904 (IV); Dräger: Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapters 9 & 11

Collection Media:

1. NIOSH 6010 (IV): 600/200 mg: solid sorbent tube (soda lime)

2. NIOSH 7904 (IV): 37-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter, followed by glass midget bubbler containing 15 mL 0.1 N KOH

3. Dräger diffusion tube, #6733221; 20-200 ppm (1 hour), 10-100 ppm (2 hours), 5-50 ppm (4 hours), 2.5-25 ppm (8 hours); (EF = 1.25); **Note:** up to 8 hours per tube.

Sample Flow Rate: Minimum - Maximum (Lpm):

1. NIOSH 6010 (IV): 0.05-0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps .

2. NIOSH 7904 (IV): 0.5-1.0

Air Collection Volume: Minimum - Maximum (L):

1. NIOSH 6010 (IV): 2-90

2. NIOSH 7904 (IV): 10-180

Short Term Sampling:

Sampling Strategy: see Chapters 9 & 11

Sampling Duration: 30 min.

Collection Media:

1. NIOSH 6010 (IV): 600/200 mg: solid sorbent tube (soda lime)

2. NIOSH 7904 (IV): 37-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter, followed by glass midget bubbler containing 15 mL 0.1 N potassium hydroxide (KOH)

Sample Flow Rate: Minimum - Maximum (Lpm):

1. NIOSH 6010 (IV): 0.05-0.2 Lpm. Must use a pump adaptor or arrange for low flow pumps.

2. NIOSH 7904 (IV): 0.5-1.0

Air Collection Volume: Minimum - Maximum (L):

1. NIOSH 6010 (IV): 2-90

2. NIOSH 7904 (IV): 10-180

Special Instructions: NIOSH 7904 (IV): Quantitatively transfer the contents of the bubbler to a 20-mL vial. Close cap tightly and wrap with plastic tape to avoid sample loss during transit. Overnight sample to MSHA laboratory for analysis. Analyze within 5 days. Particulate on filter may liberate HCN gas.

Grab Sampling:

Sampling Strategy: see Chapter 11

Collection Media: Dräger detector tube, #CH25701, range 1-150 ppm (EF = 1.25**)**.

Hydrogen Fluoride - HF
30 ppm (as F) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
415	3.0 ppm	3.0 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Anhydrous hydrogen fluoride; aqueous hydrogen fluoride (i.e., hydrofluoric acid); HF-A

Sources: High octane gasolines, removal of sand from metal casings, removing oxides from metals, processing graphite ore, dissolving ores

Description: Colorless gas or fuming liquid (below 67°F) with a strong, irritating odor

Incompatibilities: Metals, water, or steam; [note: corrosive to metals; will attack glass and concrete]

Exposure: Inhalation, skin absorption (liquid), ingestion (solution), skin and/or eye contact

Health Effects: Irritation eyes, skin, nose, throat; pulmonary edema; eye, skin burns; rhinitis; bronchitis; bone changes

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 30 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact (liquid); 8 hr: Tychem; 4 hr: Teflon

Eyes: Prevent eye contact (liquid)

Special Precautions: nonflammable gas

LABORATORY INFORMATION
CAS Number: 7664-39-3
Analytical Technique: NIOSH 7903 (IV) [acids, inorganic]: ion chromatography; NIOSH 7902 (IV) [fluorides, aerosol and gas]: ion-specific electrode (ISE); NIOSH 7906 (IV) [fluorides, aerosol and gas]: ion chromatography / conductivity; Dräger: detector tube
Analytical Reference Method: NIOSH 7903 (IV) [acids, inorganic]; NIOSH 7902 (IV) [fluorides as F, aerosol and gas]; NIOSH 7906 (IV) [fluorides, aerosol and gas]; Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media:
1. NIOSH 7903 (IV): 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
2. NIOSH 7902 (IV): filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]
3. NIOSH 7906 (IV): filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]
Sample Flow Rate: Minimum - Maximum (Lpm):
1. NIOSH 7903 (IV): 0.2-0.5
2. NIOSH 7902 (IV): 1.7
3. NIOSH 7906 (IV): 1.7
Air Collection Volume: Minimum - Maximum (L):
1. NIOSH 7903 (IV): 3-100
2. NIOSH 7902 (IV): 12-800
3. NIOSH 7906 (IV): 1-800

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
Collection Media:
1. NIOSH 7903 (IV): 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
2. NIOSH 7902 (IV): filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]
3. NIOSH 7906 (IV): filter and treated pad [37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter with Na_2CO_3-treated cellulose pad]

Sample Flow Rate: Minimum - Maximum (Lpm):
1. NIOSH 7903 (IV): 0.2-0.5
2. NIOSH 7902 (IV): 1.7
3. NIOSH 7906 (IV): 1.7
Air Collection Volume: Minimum - Maximum (L):
1. NIOSH 7903 (IV): 3-100
2. NIOSH 7902 (IV): 12-800
3. NIOSH 7906 (IV): 1-800

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media:
a. Hydrogen fluoride: Dräger detector tube, #8103251, range 0.5-90 ppm (EF = ?); or Dräger detector tube, #CH30301, range 1.5-15 ppm (EF = 1.33)
b. Fluorine: Dräger detector tube, #8101491, range 0.05-40 ppm (EF = 1.33)

Hydrogen Peroxide - H_2O_2
75 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	1.0 ppm	3.0 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: High-strength hydrogen peroxide; hydrogen dioxide; hydrogen peroxide (aqueous); hydroperoxide; peroxide

Sources: Oxidizing agent, bleaching agent, metal cleaning (when combined with sodium hydroxide)

Description: Colorless liquid with a slightly sharp odor

Incompatibilities: Oxidizable materials, iron, copper, brass, bronze, chromium, zinc, lead, silver, manganese; [**Note:** contact with combustible material may result in **SPONTANEOUS combustion**]

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, nose, throat; corneal ulcer; erythema (skin redness), vesiculation skin; bleaching hair

PPE: Respirator: Recommendations - NIOSH/OSHA**:** Up to 10 ppm: (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 25 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); up to 50 ppm: (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 75 ppm: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact (solution 30%-70%); 8 hr: Butyl, Natural, Nitrile, PE, Viton, CPF3, Responder, Tychem; 4 hr: PVC, PE/EVAL

Eyes: Prevent eye contact

Special Precautions: Noncombustible liquid; powerful oxidizer

LABORATORY INFORMATION

CAS Number: 7722-84-1

Analytical Technique: Dräger detector tube

Analytical Reference Method: Dräger

Special Instructions: N/A

SAMPLING INFORMATION

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #8101041, range 0.1-3 ppm (EF = 1.25).

Hydrogen Sulfide - H_2S
100 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
305	10 ppm	20 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Sewer gas, hydrosulfuric acid, sulfuretted hydrogen; hepatic gas; stink damp

Sources: By-product of petroleum products; naturally occurs in coal, volcanic gases and sulfur springs. Evolves from bacterial or anerobic decomposition of organic substances and from a variety of industrial operations. Can accumulate in confined spaces and man holes.

Description: Colorless gas with a strong odor of rotten eggs; [note: an insidious poison because the sense of smell becomes rapidly fatigued & can NOT be relied upon to warn of the continued presence of H_2S]

Incompatibilities: Strong oxidizers, strong nitric acid, metals

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, fatigue, irritability, insomnia; gastrointestinal disturbance; liquids: skin irritation, erythema, frostbite

PPE: Respirator: Recommendations - NIOSH: Up to 100 ppm: (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact / frostbite possible; 8 hr: Tychem; 4 hr: Teflon; wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the evaporating liquid or from contact with vessels containing the liquid.

Eyes: Prevent eye contact; wear appropriate eye protection to prevent direct eye contact.

Special Precautions: Flammable gas

LABORATORY INFORMATION

CAS Number: 7783-06-4
Analytical Technique: Dräger: diffusion tube; NIOSH 6013 (IV): ion chromatography / conductivity detector; Dräger: detector tube
Analytical Reference Method: Dräger; NIOSH 6013 (IV); Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapters 9 and 11
1. Dräger
Collection Media: Dräger diffusion tube, #6733091; range 10-300 ppm (1 hour), 5-150 ppm (2 hours), 2.5-75 ppm (4 hours), 1.3-40 ppm (8 hours); **Note:** Up to 8 hours per tube. (EF = 1.41).
2. NIOSH 6013 (IV):
Collection Media: filter [25-mm diameter, 0.45-µm pore size Zefluor polytetrafluoroethylene (PTFE) prefilter] + solid sorbent tube (400/200 mg coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.1-0.2 (Must use a pump adaptor or arrange for low flow pumps.); 0.2-1.5
Air Collection Volume: Minimum - Maximum (L): 1.2-40

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
NIOSH 6013 (IV):
Collection Media: filter [25-mm diameter, 0.45-µm pore size Zefluor polytetrafluoroethylene (PTFE) prefilter] + solid sorbent tube (400/200 mg coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.1-0.2 (Must use a pump adaptor or arrange for low flow pumps.); 0.2-1.5
Air Collection Volume: Minimum - Maximum (L): 1.2-40

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #6728041, range 0.05-150 ppm (EF = 1.49); Dräger detector tube, #8101991, range 0.2-6 ppm (EF = 1.33); Dräger detector tube, #8101461, range 0.2-50 ppm (EF = 1.17); Dräger detector tube, #8101961, range 1-60 ppm (EF = 1.17); Dräger detector tube, #6719001, range 1-200 ppm (EF = 1.17); Dräger detector tube, #8101831, range 1-200 ppm (EF = 1.25); Dräger detector tube, #6728821, range 2-200 ppm (EF = 1.17); Dräger detector tube, #CH29801, range 5-600 ppm (EF = 1.17); Dräger detector tube, #CH29101, range 10-2,000 ppm (EF = 1.17); Dräger detector tube, #CH28101, range 0.02-7 vol. % (EF = 1.17); Dräger detector tube, #8101211, range 0.2-40 vol. % (EF = 1.17).

Iron Oxide (dusts & fumes) - Fe_2O_3
2,500 mg/m^3 (as Fe) IDLH (NIOSH, 1995)

Iron Salts (Soluble) as Fe

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
175 (dust - Soluble salts as Fe)	1.0 mg/m^3	3.0 mg/m^3 - 15 min.
721 (fume - Fe_2O_3)	10.0 mg/m^3	20.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: *Iron oxide*: ferric oxide, iron(III) oxide
iron(II) sulfate [$FeSO_4$]: ferrous sulfate
iron(II) chloride [$FeCl_2$]: ferrous chloride
iron(III) nitrate [$Fe(NO_3)_3$]: ferric nitrate
iron(III) sulfate [$Fe_2(SO_4)_2$]: ferric sulfate
iron(III) chloride [$FeCl_3$]: ferric chloride

Sources: *Iron oxide*: result of welding and silver finishing; ores of hematite and magnetite
iron(II) sulfate: preparation of iron compounds, electroplating, reducing agent in chemical processes; ores of melanterite, siderotil, terisite
iron(II) chloride: reducing agent in metallurgy
iron(III) nitrate: corrosion inhibitor; ores of hematite, maghemite
iron(III) sulfate: preparation of iron compounds, etching aluminum
iron(III) chloride: processing silver and copper ores, catalyst in organic reactives

Description: *Iron oxide*: reddish-brown solid
iron salts: appearance and odor vary depending upon the specific soluble iron salt

Incompatibilities: *Iron oxide*: calcium hypochlorite
iron salts: vary depending upon the specific soluble iron salt

Exposure: *Iron oxide*: inhalation
iron salts: inhalation, ingestion, skin and/or eye contact

Health Effects: *Iron oxide*: benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)
iron salts: irritation eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting; possible liver damage

PPE: **Respirator:** *Iron oxide***:** NIOSH: Up to 50 mg/m^3: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 125 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter; up to 250 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 2,500 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
iron salts: N/A

Skin: *Iron oxide*: no specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment
*iron salts***:** Prevent skin contact; contact the manufacturer for recommendations for the specific compound

Eyes: *Iron oxide*: no recommendation is made specifying the need for eye protection
iron salts: Prevent eye contact

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Numbers: 1309-37-1 [FeO_2], 7439-89-6 [Fe], 7720-78-7 [$FeSO_4$], 7758-94-3 [$FeCl_2$], 10421-48-4 [$Fe(NO_3)_3$], 10028-22-5 [$Fe_2(SO_4)_2$], 7705-08-0 [$FeCl_3$]
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Isopropyl Alcohol - $(CH_3)_2CHOH$

2,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 2.0%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	400 ppm	500 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Rubbing alcohol, dimethyl carbinol, IPA, isopropanol, 2-propanol, sec-propyl alcohol,

Sources: Solvents

Description: Colorless liquid with the odor of rubbing alcohol

Incompatibilities: Strong oxidizers, acetaldehyde, chlorine, ethylene oxide, acids, isocyanates **Exposure:** Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, nose, throat; drowsiness; dizziness; headache; dry cracking skin

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 2000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Butyl, Nitrile, Viton, PE/EVAL, CPF3, Responder; 4 hr: Neoprene, Teflon

Eyes: Prevent eye contact

Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 67-63-0

Analytical Technique: NIOSH 1400 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 109: gas chromatography (GC) / flame ionization detector (FID)

Reference Method: NIOSH 1400 (IV); OSHA 109

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: NIOSH 1400 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.3-3

2. Collection Media: OSHA 109: 400/200 mg Anasorb 747

Sample Flow Rate (Lpm): 0.05-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 18

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. Collection Media: NIOSH 1400 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.05 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.3-3

2. Collection Media: OSHA 109: 400/200 mg Anasorb 747

Sample Flow Rate (Lpm): 0.05-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 18

Special Instructions: NIOSH 1400 (IV): Coordinate with MSHA Laboratory. Store samples in freezer and ship on ice.

Kerosene

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):

**** NOTE:** Lab must perform qualitative analysis first to determine the applicable TLV according to analytically determined composition.

CONTAMINANT INFORMATION

Synonyms: Fuel oil no. 1, range oil [note: a refined petroleum solvent, which typically is 25% normal paraffins, 11% branched paraffins, 30% monocycloparaffins, 12% dicycloparaffins, 1% tricycloparaffins, 16% mononuclear aromatics & 5% dinuclear aromatics]

Sources: Degreaser/cleaner; portable heater fuel

Description: Colorless to yellowish, oily liquid with a strong, characteristic odor

Incompatibilities: Strong oxidizers

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin, nose, throat; burning sensation in chest; headache, nausea, weakness, restlessness, incoordination, confusion, drowsiness; vomiting, diarrhea; dermatitis; chemical pneumonia – if liquid aspiration

PPE: Respirator: Recommendations - NIOSH: Up to 1000 mg/m^3: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s); (APF = 10) any supplied-air respirator; Up to 2500 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s); up to 5000 mg/m^3: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Nitrile, PE, Viton; 4 hr: Neoprene, PVA, PVC, Barricade, Responder

Eyes: Prevent eye contact

Special Precautions: Class II combustible liquid

LABORATORY INFORMATION
CAS Number: 8008-20-6
Analytical Technique: NIOSH 1550 (IV): gas chromatography (GC) / flame ionization detector (FID)
Analytical Reference Method: NIOSH 1550 (IV)

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Special Instructions: Stable at least one week at room temperature. Submit a 5-10 mL bulk sample separately. Submit samples via overnight carrier to MSHA laboratory.

Lead - Pb
(Inorganic fumes and dusts)
100 mg/m^3 (as Pb) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
635 (dust)	0.15 mg/m^3 (150 µg/m^3)	0.45 mg/m^3 (450 µg/m^3) - 15 min.
723 (fume)	0.15 mg/m^3 (150 µg/m^3)	0.45 mg/m^3(450 µg/m^3) - 15 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Lead metal, plumbum

Sources: Welding fume, paint, metallurgy; ores of galena (PbS), anglesite ($PbSO_4$), cerrusite ($PbCO_3$), mimetite, pyromorphite, schultanite, cottunite, plattnerite, wulfenite, lanarkite, altaite, mineral red, Paris red

Description: Heavy, ductile, soft, gray solid

Incompatibilities: Strong oxidizers, hydrogen peroxide, acids

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Weakness, lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypotension

PPE: Respirator: Recommendations - OSHA: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 1.25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 50 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode; up to 100 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; use any barrier that will prevent contact contamination from the dust
Eyes: Prevent eye contact
Special Precautions: Noncombustible solid in bulk form

LABORATORY INFORMATION
CAS Number: 7439-92-1
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Magnesium Oxide Fume - MgO
750 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
725 (fume)	10 mg/m^3	20 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Magnesia fume
Sources: Welding fumes, fire brick, magnesia cements
Description: Finely divided white particulate dispersed in air
Incompatibilities: Chlorine trifluoride, phosphorus pentachloride
Exposure: Inhalation, skin and/or eye contact
Health Effects: Irritation: eyes, nose; metal fume fever: cough, chest pain, flu-like fever
PPE: Respirator: Recommendations - OSHA: Up to 150 mg/m^3: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 375 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter; up to 750 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment
Eyes: No recommendation is made specifying the need for eye protection
Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 1309-48-4
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Manganese - Mn
(Compounds and Fume)
500 mg/m^3 (as Mn) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
647 (dust)	5.0 mg/m^3	5.0 mg/m^3 (C)
727 (fume)	5.0 mg/m^3	5.0 mg/m^3 (C)

CONTAMINANT INFORMATION

Synonyms: Manganese metal: colloidal manganese, manganese-55

Sources: Manufacture of alloys, welding rods; mining and processing of manganese ores - pyrolusite, manganese oxide (MnO), braunite, haussmanite, manganite, manganosite, rhodocrosite, manganomanganic oxide

Description: Ustrous, brittle, silvery solid

Incompatibilities: Oxidizers; [note: will react with water or steam to produce hydrogen]

Exposure: Inhalation, ingestion

Health Effects: Parkinson's; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); fatigue; kidney damage

PPE: Respirator: Recommendations - NIOSH: Up to 10 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators (note: if not present as a fume); (APF = 10) any supplied-air respirator; Up to 25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust and mist filter (note: if not present as a fume); up to 50 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 500 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Metal: combustible solid

LABORATORY INFORMATION

CAS Number: 7439-96-5
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-hm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 0.8-hm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Mercury - Hg

10 mg/m^3 [except (organo) alkyls compounds] (as Hg) IDLH (NIOSH, 1995)
2 mg/m^3 [(organo) alkyls compounds] (as Hg) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
625 [dusts & vapors, except (organo) alkyl compounds]	0.05 mg/m^3 (50 µg/m^3)	0.15 mg/m^3 (150 µg/m^3) - 15 min.
729 [fume, except (organo) alkyl compounds]	0.05 mg/m^3 (50 µg/m^3)	0.15 mg/m^3 (150 µg/m^3) - 15 min.
	(PEDS units of measure in parentheses)	
995 [(organo) alkyl compounds]*	0.01 mg/m^3 (Skin)	0.03 mg/m^3 - 15 min.

***Note: If (organo) alkyl compounds of mercury are encountered, use EXTREME CAUTION and contact the District Office for guidance.**

CONTAMINANT INFORMATION

Synonyms: *Metal*: Colloidal mercury, metallic mercury, quicksilver
(organo) alkyl: synonyms vary depending upon the specific compound

Sources: *Metal*: Measurement control systems, amalgams, lab reagent, gold and silver mining; ores of cinnabar, red sulfide, and vermillion
(organo) alkyl: pesticide, antibacterial agent, explosives (mercury fulminate), reagents

Description: *Metal*: Silver-white, heavy, odorless liquid
(organo) alkyl: appearance and odor vary depending upon the specific compound

Incompatibilities: *Metal*: Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper
(organo) alkyl: strong oxidizers (*e.g.*, chlorine)

Exposure: *Metal*: Inhalation, skin absorption, ingestion, skin and/or eye contact
(organo) alkyl: inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: *Metal*: Irritation: eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis pneumonitis; tremor, insomnia, irritability, indecision, headache, fatigue, weakness; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria
(organo) alkyl: paresthesia; ataxia, dysarthria; vision, hearing disturbance; spasticity, jerking limbs; dizziness; salivation; lacrimation (discharge of tears); nausea, vomiting, diarrhea, constipation; skin burns; emotional disturbance; kidney injury; possible teratogenic effects

PPE: Respirator: *Mercury vapor*: Recommendations - NIOSH: Up to 0.5 mg/m^3: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with cartridge(s) [or canister] providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; up to 2.5 mg/m^3: (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) [or canister] providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 10 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
other non (organo) alkyl mercury compounds: Recommendations - NIOSH / OSHA: Up to 1 mg/m^3: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 10) any supplied-air respirator; up to 2.5 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with cartridge(s) [or canister] providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; up to 5 mg/m^3: (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing

protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) [or canister] providing protection against the compound of concern [note: end of service life indicator (ESLI) required]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 10 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode
(organo) alkyl: Recommendations - NIOSH/OSHA: Up to 0.1 mg/m^3: (APF = 10) any supplied-air respirator; up to 0.25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 0.5 mg/m^3: (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 2 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; contact the manufacturer for recommendations for the specific compound

Eyes: *Non (organo) alkyl mercury compounds / particulate*: No recommendation is made specifying the need for eye protection
(organo) alkyl: Prevent eye contact

Special Precautions: *Metal*: Noncombustible liquid
(organo) alkyl: properties vary depending upon the specific compound

LABORATORY INFORMATION

CAS Number: 7439-97-6

Analytical Technique:

mercury vapor: OSHA ID-140: cold vapor - atomic absorption spectrophotometer (CV-AAS); Assay Technology: passive monitor; Dräger: detector tube; directing reading instrument
other non (organo) alkyl mercury compounds / particulate: OSHA ID-145: cold vapor - atomic absorption spectrophotometer (CV-AAS)
(organo) alkyl: none available

Analytical Reference Method: OSHA ID-145; OSHA ID-140; Assay Technology; Dräger; Jerome Mercury Vapor Analyzer

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapters 7 & 9

1. OSHA ID-140: [*mercury vapor*]

Collection Media: 200 mg Hydrar (or hopcalite) sorbent tube
Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 3-100
2. Assay Technology: [*mercury vapor*]
Collection Media: Assay Technology Mercury Vapor Monitor Badge, #X593; **Note:** maximum 8-hour sample per badge
3. OSHA ID-145: [*other non (organo) alkyl mercury compounds / particulate*]
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2.0
Air Collection Volume (L): 10

Short Term Sampling:
Sampling Strategy: see Chapter 7 & 9
Sampling Duration: 15 min.
1. OSHA ID-140: [*mercury vapor*]
Collection Media: 200 mg Hydrar (or hopcalite) sorbent tube
Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 3-100
2. OSHA ID-145: [*other non (organo) alkyl mercury compounds / particulate*]
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2.0
Air Collection Volume (L): 10

Special Instructions: Submit samples to MSHA Laboratory for contract laboratory analysis.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Grab Sampling:
Sampling Strategy: see Chapters 11 & 13
Collection Media:
1. Detector Tube [*mercury vapor*]: Dräger detector tube, #CH23101, range 0.05-2 mg/m^3 (EF = 1.30)
2. Direct Reading Instrument [*mercury vapor*]: Jerome (Model 411) Gold Film Mercury Vapor Analyzer, range 0.003 - 1.999 mg/m^3 (EF = 1.09); Jerome (Model 431X) Gold Film Mercury Vapor Analyzer, range 0.003 - 0.999 mg/m^3 (EF = 1.09).

Mercury, Solids (Bulk)

CONTAMINANT INFORMATION
See "Mercury - Hg" above

LABORATORY INFORMATION
Analytical Technique: EPA 7471A: cold vapor - atomic absorption spectrophotometer (CV-AAS)
Analytical Reference Method: EPA 7471A [for measuring total (organic and inorganic) mercury in soils, sediments, bottom deposits, and sludge-type materials]

SAMPLING INFORMATION
Sampling Strategy: see Chapter 14
Collection: Bulk Material - 10 grams (soils, sediments, bottom deposits, and sludge-type materials)

Special Instructions: Coordinate with MSHA Laboratory. Refrigerate samples. Submit samples via overnight carrier to MSHA Laboratory (for contract laboratory analysis).

Metal Screen, Wipes (Semiquantitative)

Metals Analyzed: Beryllium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Manganese, Molybdenum, Nickel, Vanadium, and Zinc

CONTAMINANT INFORMATION
See individual contaminants

LABORATORY INFORMATION
Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy
Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Metals, Solids*
(Bulk)

Metals Analyzed: Arsenic, Barium, Cadmium, Chromium, Lead, Nickel, Silver**,** Zinc

***Special Note:** **Other metals may be analyzed. Call to determine if other metals may be added.**

CONTAMINANT INFORMATION
See individual contaminants

LABORATORY INFORMATION
Analytical Technique: EPA 200.7: Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES)
Analytical Reference Method: EPA 200.7 (determination of metals and trace elements in water and wastes)

SAMPLING INFORMATION
Sampling Strategy: see Chapter 14
Collection: Bulk Material - 20 grams (in water and wastes)

Special Instructions: Coordinate with MSHA laboratory.

Methyl Alcohol (Methanol) - CH_3OH
6,000 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH	ANSI Z37.14-1971
	TLV:	STEL/Ceiling (C):
231	200 ppm	600 ppm (C)

CONTAMINANT INFORMATION

Synonyms: Carbinol, Columbian spirits, pyroligneous spirit, wood alcohol, wood naphtha, wood spirit

Sources: Paints, varnishes, cements, antifreeze, octane booster for gasoline

Description: Colorless liquid with a characteristic pungent odor

Incompatibilities: Strong oxidizers

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, upper respiratory system; headache, drowsiness, dizziness, vertigo (an illusion of movement), lightheadedness, nausea, vomiting; visual disturbance, optic nerve damage (blindness); dermatitis

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 2000 ppm: (APF = 10) any supplied-air respirator; up to 5000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 6000 ppm: (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Butyl, Teflon, Viton, Saranex, PE/EVAL, Responder, Trellchem, Tychem

Eyes: Prevent eye contact

Special Precautions: Class IB Flammable Liquid

LABORATORY INFORMATION

CAS Number: 67-56-1

Analytical Technique: Gas Chromatography / Flame Ionization Detection (GC-FID)

Analytical Reference Method: NIOSH 2000

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg silica gel tube
Sample Flow Rate: Minimum - Maximum (Lpm): 0.02-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1-5

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
Collection Media: 100/50 mg silica gel tube
Sample Flow Rate: Minimum - Maximum (Lpm): 0.02-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1-5

Special Instructions: Coordinate with MSHA laboratory. A sample will remain stable for 30 days if maintained at 5^{o}C.

Methyl Chloroform - CH_3CCl_3
700 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
205	350 ppm	1,500 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Chlorothene, 1,1,1-trichloroethane

Sources: Solvents, cleaning of cold metals

Description: Colorless liquid with a mild, chloroform-like odor

Incompatibilities: Strong caustics; strong oxidizers; chemically-active metals (e.g., zinc, aluminum, magnesium powders, sodium); water (note: reacts slowly with water to form hydrochloric acid.)

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin; headache, lassitude (weakness, exhaustion), central nervous system depressant/depression, poor equilibrium, dermatitis, cardiac arrhythmias, liver damage

PPE:

Respirator: Recommendations - NIOSH/OSHA: Up to 700 ppm: (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact; 8 hr: PVA, Viton, PE/EVAL, Barricade, CPF3, Responder, Tychem; 4 hr: Teflon

Eyes: Prevent eye contact

Special Precautions: Combustible liquid, but burns with difficulty

LABORATORY INFORMATION

CAS Number: 71-55-6

Analytical Technique: NIOSH 1003 (IV) / OSHA 14: gas chromatography (GC) / flame ionization detection (FID); 3M: passive monitor

Analytical Reference Method: NIOSH 1003 (IV); OSHA 14; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1003 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.1-8

2. OSHA 14:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 5 min.

1. NIOSH 1003 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.1-8

2. OSHA 14:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Methyl Ethyl Ketone (2-Butanone) - $CH_3COCH_2CH_3$
3,000 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH	1968 PA Rules
	TLV:	STEL/Ceiling (C):
251	200 ppm	300 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: MEK, ethyl methyl ketone, methyl acetone

Sources: Solvent, synthetic colorless resins

Description: Colorless liquid with a moderately sharp, fragrant, mint- or acetone-like odor

Incompatibilities: Strong oxidizers, amines, ammonia, inorganic acids, caustics, isocyanates, pyridines

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, nose; headache; dizziness; vomiting; dermatitis

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 3000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance causes eye irritation or damage; eye protection needed); (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Butyl, Teflon, PE/EVAL, Barricade, CPF3, Tychem; 4 hr: Responder

Eyes: Prevent eye contact

Special Precautions: Class IB Flammable Liquid

LABORATORY INFORMATION

CAS Number: 78-93-3

Analytical Technique: Gas chromatography / flame ionization detector (GC-FID); 3M: passive monitor

Reference Method: NIOSH 2500 (IV); 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 2500 (IV):

Collection Media: 160/80 mg: solid sorbent tube (carbon molecular sieve)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.25-12

2. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Special Instructions: Coordinate with MSHA Laboratory when sampling with 3M passive monitor. When sampled in high relative humidity this contaminant may show a decreased recovery during the laboratory analysis. Refrigerate the sample and expedite the analysis to ensure accurate results.

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 5 min.

NIOSH 2500 (IV):

Collection Media: 160/80 mg: solid sorbent tube (carbon molecular sieve)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.25-12

Methyl Isoamyl Ketone - $CH_3COCH_2CH_2CH(CH_3)_2$

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: MIAK, isoamyl methyl ketone, isopentyl methyl ketone, 2-methyl-5-hexanone, 5-methyl-2-hexanone

Sources: Solvents, cellulose acetate, butyrate

Description: Colorless, clear liquid with a pleasant, fruity odor

Incompatibilities: Oxidizers

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, mucous membrane; headache, narcosis, coma; dermatitis

PPE: Respirator: Recommendations - NIOSH: Up to 500 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 1250 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); up to 2500 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 5000 ppm: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; contact the manufacturer for recommendations
Eyes: Prevent eye contact
Special Precautions: Class IC Flammable Liquid

LABORATORY INFORMATION
CAS Number: 110-12-3
Analytical Technique: None available
Analytical Reference Method: None available

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: N/A
Collection Media: N/A
Sample Flow Rate: Minimum - Maximum (Lpm): N/A
Air Collection Volume: Minimum - Maximum (L): N/A

Short Term Sampling:
Sampling Strategy: N/A
Sampling Duration: 15 min.
Collection Media: N/A
Sample Flow Rate: Minimum - Maximum (Lpm): N/A
Air Collection Volume: Minimum - Maximum (L): N/A

Special Instructions: N/A

Methyl Isobutyl Carbinol - $(CH_3)_2CHCH_2CH(OH)CH_3$
400 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
233	25 ppm - (Skin)	37.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: MIBC, isobutylmethylcarbinol, methyl amyl alcohol, 4-methyl-2-pentanol

Sources: Solvent, brake fluid

Description: Colorless liquid with a mild odor

Incompatibilities: Strong oxidizers

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin; headache, drowsiness, dermatitis

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 250 ppm: (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 400 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; contact the manufacturer for recommendations

Eyes: Prevent eye contact

Special Precautions: Class II combustible liquid

LABORATORY INFORMATION

CAS Number: 108-11-2

Analytical Technique: NIOSH 1402 (IV) / OSHA 7: gas chromatography / flame ionization detection (GC-FID)

Reference Method: NIOSH 1402 (IV); OSHA 7

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1402 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1402 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

Special Instructions: NIOSH 1402 (IV): Coordinate with MSHA Laboratory. Stability of sample is unknown. Store samples in freezer and ship on ice.

Mica (< 1% quartz)

1,500 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
513	20 mppcf (3.0 mg/m^3)	40 mppcf (6.0 mg/m^3) - 15 min.

(PEDS "screening" units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Biotite, lepidolite, margarite, muscovite, phlogopite, roscoelite, zimmwaldite

Sources: Silicate ores with same names as above

Description: Colorless, odorless flakes or sheets of hydrous silicates

Incompatibilities: None reported

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation: eyes; pneumoconiosis, cough, dyspnea (breathing difficulty), weakness, weight loss

PPE: Respirator: Recommendations - NIOSH: Up to 15 mg/m^3: (APF = 5) any dust and mist respirator; up to 30 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 75 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust and mist filter; up to 150 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 1500 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; determine based on working conditions

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION
CAS number: 12001-26-2
Analytical Technique:
1. X-ray diffraction
2. Mineral Dust: impinger method
Analytical Reference Method: NIOSH 0600 (IV); impinger method, MSHA P-2

SAMPLING INFORMATION
Full Shift Sampling: Screening - **Note: cannot be used for enforcement**
Sampling Strategy: see Chapter 6
Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7

Full Shift - Partial Period Sampling: Enforcement - **Note: for compliance with TLV**
Sampling Strategy: see Chapter 6
Collection Media: impinger
Sample Flow Rate (Lpm): 2.8
Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will conduct impinger sampling with inspector escort.

Mine Gas (Profile)

Gases Analyzed: Acetylene, Argon, Carbon Monoxide*, Carbon Dioxide**,** Ethane, Ethylene, Hydrogen, Oxygen, Methane, Nitrogen

LABORATORY INFORMATION
Analytical Technique: Gas Chromatograph (GC)/DRI
Analytical Reference Method: Gas Chromatography

SAMPLING INFORMATION
Grab Sampling:
Sampling Strategy: see Chapter 12
Collection Media: 50 mL vacuum bottle or 10 mL vacutainer (EF = 1.11).
***Note:** For inclusion of carbon monoxide (CO) use 50 mL vacuum bottle
Sample Flow Rate: Minimum - Maximum (Lpm): NA
Air Collection Volume: Minimum - Maximum (L): 10 mL - 50 mL

Grab Sampling:
Sampling Strategy: see Chapter 13
Collection Media: Direct Reading Instrument TMX 410 or TMX412 (EF = 1.25): for carbon monoxide (CO), oxygen (O_2), methane (CH_4/combustibles - LEL%).
Various other electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Special Instructions: Gases normally sampled and tested for are methane, oxygen, carbon monoxide and carbon dioxide. Contact the MSHA laboratory for information if other gases are to be analyzed. There is a 14-day hold time for vacuum samples and a 7-day hold time for vacutainers. Submit the sample as soon as possible to MSHA laboratory.

Molybdenum - Mo

5,000 mg/m^3 (insoluble compounds, as Mo) IDLH (NIOSH, 1995)
1,000 mg/m^3 (soluble compounds, as Mo) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
163 (insoluble dust)	10 mg/m^3	20 mg/m^3 - 15 min.
731 (fume)	10 mg/m^3	20 mg/m^3 - 15 min.
645 (soluble compounds)	5 mg/m^3	10 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Molybdenum metal

Sources: Lubricants, detection of inorganics, corrosion inhibitor

Description: *Metal*: dark gray or black powder with metallic luster
soluble compounds: appearance and odor varies by compound

Incompatibilities: *Metal*: strong oxidizers
soluble compounds: vary depending upon the specific soluble molybdenum compound

Exposure: *Metal*: inhalation, ingestion, skin and/or eye contact

Health Effects: *Metal*: respiratory system and central nervous system effects
Soluble compounds: irritation of respiratory system. Confirmed animal carcinogen with unknown relevance to humans.

PPE: Respirator: *Metal*: –OSHA Recommendation: Up to 75 mg/m^3: (APF = 5) any dust and mist respirator (if not present as a fume); up to 150 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators (note: if substance not present as a fume); (APF = 10) any supplied-air respirator; up to 375 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust and mist filter (note: if substance not present as a fume); up to 750 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 5000 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

*soluble compounds***:** Recommendations - OSHA: Up to 25 mg/m^3: (APF = 5) any dust and mist respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 50 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 10) any supplied-air respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 125 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 25) any powered, air-purifying respirator with a dust and mist filter (note: substance reported to cause eye irritation or damage; may require eye protection); up to 250 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter (note: substance reported to cause eye irritation or damage; may require eye protection); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 1000 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: *Metal*: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment;
soluble compounds: Prevent skin contact; contact the manufacturer for recommendations for specific compounds

Eyes: *Metal*: Determine based on working conditions;
soluble compounds: Prevent eye contact

Special Precautions: *Metal*: combustible solid in form of dust or powder
soluble compounds: vary depending upon the specific soluble molybdenum compound

LABORATORY INFORMATION

CAS Number: 7439-98-7 *(metal)*

Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES); NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy

Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 7

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Short Term Sampling:

Sampling Strategy: see Chapter 7

Sampling Duration: 15 min.

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Wipe Sampling:

Sampling Strategy: see Chapter 14

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Naphtha (Coal Tar)

1,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limits of the various constituents of coal tar naphtha which range from 1.0 to 1.3%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
253	100 ppm	125 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Crude solvent coal tar naphtha, high solvent naphtha, naphtha
Sources: Diluent for paints, coatings, and cements; solvents
Description: Reddish-brown, mobile liquid with an aromatic odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation eyes, skin, nose; lightheadedness, drowsiness; dermatitis
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 1000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) (note: substance causes eye irritation or damage; eye protection needed); (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: Prevent skin contact; 8 hr: Viton; 4 hr: Nitrile, PVA
Eyes: Prevent eye contact
Special Precautions: Class II combustible liquid

LABORATORY INFORMATION

CAS Number: 8030-30-6
Analytical Technique: NIOSH 1550 (IV): gas chromatography / flame ionization detection (GC-FID)
Analytical Reference Method: NIOSH 1550 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Short Term Sampling:

Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Special Instructions: Samples of this contaminant will remain stable at least one week at room temperature. Submit samples via overnight carrier to MSHA laboratory. Submit a 5-10 mL bulk sample separately.

Nickel - Ni

10 mg/m^3 (as Ni) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
621 (metal & soluble compounds)	1.0 mg/m^3	3.0 mg/m^3 - 15 min.
733 (fume)	1.0 mg/m^3	3.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Elemental nickel metal, nickel catalyst
[**Note:** The IDLH, TLV, & STEL do not apply to nickel carbonyl.]

Sources: Corrosion-resistant alloys, electroplating, nickel sulfide (Ni_3S_2) in smelting and refining of some nickel ores

Description: Lustrous, silvery, odorless solid

Incompatibilities: Strong acids, sulfur, selenium, wood & other combustibles, nickel nitrate

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Sensitization; dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen - NIOSH]

PPE: Respirator: Recommendations - NIOSH: At concentrations above the NIOSH REL (i.e., 0.015 mg/m^3): (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Prevent skin contact; contact the manufacturer for recommendations for specific compounds

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Combustible solid; nickel sponge catalyst may ignite spontaneously in air

LABORATORY INFORMATION

CAS Number: 7440-02-0

Analytical Technique: Inductively coupled argon plasma, atomic emission spectroscopy

Analytical Reference Method: MSHA P-3

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Short Term Sampling:
Sampling Strategy: see Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Nitric Acid - HNO_3
25 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
491	2.0 ppm	15 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Aqua fortis, engravers acid, hydrogen nitrate, red fuming nitric acid (RFNA), white fuming nitric acid (WFNA)

Sources: Explosives

Description: Colorless, yellow, or red, fuming liquid with an acrid, suffocating odor; [Note: Often used in an aqueous solution. Fuming nitric acid is concentrated nitric acid that contains dissolved nitrogen dioxide.]

Incompatibilities: Combustible materials, metallic powders, hydrogen sulfide, carbides, alcohols; [Note: Reacts with water to produce heat. Corrosive to metals.]

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, mucous membrane; delayed pulmonary edema, pneumonitis, bronchitis; dental erosion

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 25 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; (<70% only) --- 8 hr: Butyl, Viton, Saranex, Barricade, CPF3, Trellchem, Tychem; 4 hr: Neoprene, PE, PE/EVAL, Responder

Eyes: Prevent eye contact

Special Precautions: Noncombustible liquid, but increases the flammability of combustible materials

LABORATORY INFORMATION
CAS Number: 7697-37-2
Analytical Technique: NIOSH 7903 (IV): ion chromatography; Dräger: detector tube
Analytical Reference Method: NIOSH 7903 (IV); Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 5 min.
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #6728311, range 1-50 ppm (EF = 1.25).

Nitric Oxide - NO
100 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
301	25 ppm	37.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Mononitrogen monoxide, nitrogen monoxide

Sources: Blasting, diesel exhaust

Description: Colorless gas

Incompatibilities: Fluorine, combustible materials, ozone, NH_3, chlorinated hydrocarbons, metals, carbon disulfide; [Note: reacts with water to form nitric acid; rapidly converts in air to nitrogen dioxide.]

Exposure: Inhalation

Health Effects: Irritation: eyes, wet skin, nose, throat; drowsiness; unconsciousness; methemoglobinemia

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 100 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern [note: substance reported to cause eye irritation or damage; may require eye protection; only nonoxidizable sorbents allowed (not charcoal)]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: No recommendation is made specifying the need for personal protective equipment for the body; determine based on working conditions

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Nonflammable gas, but will accelerate the burning of combustible materials

LABORATORY INFORMATION

CAS Number: 10102-43-9
Analytical Technique: NIOSH 6014 (IV): visible absorption spectrophotometry; OSHA ID-190: ion chromatography (IC)
Analytical Reference Method: NIOSH 6014 (IV); OSHA ID-190

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
1. NIOSH 6014 (IV):
Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS) [type 13x, 30-40 mesh]; Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.
Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.5-6
2. OSHA ID-190:
Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS); Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A. {Principle: The sampling device consists of three glass tubes connected in series. The front and back tubes contain TEA-IMS, the middle or oxidizer tube contains an inert carrier impregnated with a chromate salt. The first TEA-IMS tube does not capture NO; this tube is only used to capture and convert NO_2 to NO_2^-. The middle tube oxidizes the sampled NO to NO_2. The back TEA-IMS tube then captures and converts this NO_2 to NO_2^-. Both TEA-IMS samples are desorbed using an aqueous TEA solution and analyzed as NO_2^- by IC. The front tube analytical results are reported as NO_2 and the back tube as NO.}
Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Maximum (L): $\leq$ 6

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
1. NIOSH 6014 (IV):
Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS) [type 13x, 30-40 mesh]; Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.
Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.5-6
2. OSHA ID-190:

Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS); Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A. {Principle: The sampling device consists of three glass tubes connected in series. The front and back tubes contain TEA-IMS, the middle or oxidizer tube contains an inert carrier impregnated with a chromate salt. The first TEA-IMS tube does not capture NO; this tube is only used to capture and convert NO_2 to NO_2^-. The middle tube oxidizes the sampled NO to NO_2. The back TEA-IMS tube then captures and converts this NO_2 to NO_2^-. Both TEA-IMS samples are desorbed using an aqueous TEA solution and analyzed as NO_2^- by IC. The front tube analytical results are reported as NO_2 and the back tube as NO.}
Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Maximum (L): ≤ 6

Grab Sampling:

Collection Media: Various electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Special Instructions: NIOSH 6014 (IV): Coordinate with the MSHA Laboratory. Samples are stable at least 7 days at 25°C. Submit 3 to 6 field blanks and 10 media blanks per set.

Nitrogen Dioxide - NO_2
20 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
493	5.0 ppm	5.0 ppm (C)

CONTAMINANT INFORMATION

Synonyms: Dinitrogen tetroxide (N_2O_4)**,** nitrogen peroxide, nitrogen tetroxide

Sources: Explosives, diesel-powered equipment exhaust

Description: Yellowish-brown liquid or reddish-brown gas (above 70°F) with acrid, pungent odor; [Note: in solid form (below 15°F) it is found structurally as N_2O_4]

Incompatibilities: Combustible material, water, chlorinated hydrocarbons, carbon disulfide, ammonia; [note: reacts with water to form nitric acid.]

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, nose, throat; cough, mucoid frothy sputum, decreased pulmonary function, chronic bronchitis, dyspnea (breathing difficulty); chest pain; pulmonary edema, cyanosis, tachypnea, tachycardia

PPE: Respirator: Recommendations - NIOSH: Up to 20 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance causes eye irritation or damage; eye protection needed];
(APF = 50) any self-contained breathing apparatus with a full facepiece;
(APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Saranex

Eyes: Prevent eye contact

Special Precautions: Noncombustible liquid/gas, but will accelerate the burning of combustible materials

LABORATORY INFORMATION

CAS Number: 10102-44-0

Analytical Technique: Dräger: diffusion tube; NIOSH 6014 (IV): visible absorption spectrophotometry; OSHA ID-182: ion chromatography (IC); Dräger: detector tube; Industrial Scientific: electronic direct reading instrument (DRI) [with catalytic and electrochemical sensors]

Analytical Reference Method: Dräger; NIOSH 6014 (IV); OSHA ID-182; Dräger; Industrial Scientific

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapters 9 and 11

1. Dräger

Collection Media: Dräger diffusion tube, #8101111; range 10-200 ppm (1 hour), 5-100 ppm (2 hours), 2.5-50 ppm (4 hours), 1.3-25 ppm (8 hours); **Note:** up to 8 hours per tube. (EF = 1.41).

2. NIOSH 6014 (IV):

Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS) [type 13x, 30-40 mesh]; Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.

Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1.5-6

3. OSHA ID-182:

Collection Media: **(A):** solid sorbent tube, 400/200 mg triethanolamine-impregnated molecular sieve (TEA-IMS); or
(B): 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS); Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.

Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

2. NIOSH 6014 (IV):

Collection Media: 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS) [type 13x, 30-40 mesh]; Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.

Sample Flow Rate (Lpm): 0.025; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1.5-6

3. OSHA ID-182:

Collection Media: **(A):** solid sorbent tube, 400/200 mg triethanolamine-impregnated molecular sieve (TEA-IMS); or
(B): 3 sorbent tubes in series (i.e., 3-tube sampling device): Tube A = 400 mg triethanolamine-impregnated molecular sieve (TEA-IMS); Tube B = 800 mg oxidizer (chromate) to convert NO to nitrite ion (NO_2^-); and Tube C (positioned closest to the pump inlet): same as Tube A.

Sample Flow Rate (Lpm): 0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Special Instructions: NIOSH 6014 (IV): Coordinate with the MSHA Laboratory. Samples are stable at least 7 days at 25°C. Submit 3 to 6 field blanks and 10 media blanks per set.

Grab Sampling:

Sampling Strategy: see Chapters 11 and 13

1. Collection Media: Dräger detector tube, #CH30001, range 0.5-25 ppm (EF = 1.25).

2. Collection Media: Industrial Scientific electronic direct reading instrument, TMX410 or TMX412 (EF = 1.25).

Various other electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Octane - $CH_3(CH_2)_6CH_3$

1,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit of 1.0%)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
271	400 ppm	500 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: N-octane, normal-octane
Sources: Motor fuels, industrial solvent
Description: Colorless liquid with gasoline-like odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation: eyes, nose; drowsiness; dermatitis; chemical pneumonia (aspiration liquid)
PPE: Respirator: Recommendations - NIOSH: Up to 750 ppm: (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 1000 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: Prevent skin contact; 8 hr: Responder, Tychem; 4 hr: Nitrile, Viton
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 111-65-9
Analytical Technique: NIOSH 1500 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 7: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1500 (IV); OSHA 7; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm**):** 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 4

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1500 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

2. OSHA 7:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Special Instructions: N/A

Oil Mist (Mineral Oil)
2,500 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
535 (total particulate)	5.0 mg/m^3	10 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Heavy mineral oil mist, paraffin oil mist, white mineral oil mist; airborne mist of the following water-insoluble petroleum-based cutting oils: cable oil, cutting oil, drawing oil, engine oil, heat-treating oils, hydraulic oils, machine oil, transformer oil

Sources: Lubricating machinery

Description: Colorless, oily liquid aerosol dispersed in air; [note: has an odor like burned lubricating oil]

Incompatibilities: None reported

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation eyes, skin, respiratory system

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 50 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 125 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; up to 250 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 2500 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; contact the manufacturer for recommendations

Eyes: No recommendation is made specifying the need for eye prevention

Special Precautions: Class IIIB combustible liquid

LABORATORY INFORMATION

CAS Number: 8012-95-1

Analytical Technique: NIOSH 5026 (IV): infrared spectrophotometry, visible absorption

Analytical Reference Method: NIOSH 5026 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9
Collection Media: 37-mm diameter, 0.8-µm or 5-µm pore size polyvinyl chloride (PVC) or mixed cellulose ester (MCE) filter
Sample Flow Rate: Minimum - Maximum (Lpm): 1-3
Air Collection Volume: Minimum - Maximum (L): 20-500

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 30 min.

Special Instructions: Coordinate with MSHA Laboratory. Collect a bulk sample of 5-10 mL unused, undiluted mineral oil for standard preparation. Submit air and bulk samples via overnight carrier to MSHA Laboratory.

Interferences: Any aerosol (*e.g.,* tobacco smoke) which absorbs infrared radiation near 2950 cm^{-1} interferes.

Organic Solvents (Screen)*

Note: "Screening" sample for field application when contaminants listed below are suspected. Analyses will quantify individual components. The results can be used for compliance with respective TLV's.

Organics Analyzed: Chloroform, n-Hexane, Octane, Perchloroethylene (Tetrachloroethylene), Trichloroethylene, 1,1,1-Trichloroethane, 1,2-Dichloroethane

***Special Note: Other components may be determined. Call the Laboratory to determine if other solvents may be added to the screen.**

CONTAMINANT INFORMATION

See individual contaminants

LABORATORY INFORMATION

Analytical Technique: NIOSH 1500: gas chromatography flam ionization detector (FID)
Analytical Reference Method: NIOSH 1500: NIOSH 2549 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
Air Collection Volume (L): 1-6
1. OSHA 7: [n-Hexane, Octane]
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 2-30
2. NIOSH 2549 (IV):
Collection Media: thermal desorption tube (i.e., multi-bed sorbent tubes containing graphitized carbons and carbon molecular sieve sorbents)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.05; Must use a pump adaptor or arrange for low flow pumps.
Collection Media: Passive monitor, 3M, 3500 series
Note: maximum 8-hour sample per badge

Short Term Sampling: N/A

Special Instructions: NIOSH 2549 (IV): Coordinate with MSHA Laboratory. Replace caps immediately after sampling. Keep field blanks capped at all times. Tubes can act as diffusive samplers if left uncapped in a contaminated environment. Store samples at -10^{o}C. Ship in sample storage containers at ambient temperature. Submit samples via overnight carrier to MSHA Laboratory.

Ozone - O_3
5.0 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
481	0.1 ppm (100 ppb)	1.0 ppm (1000 ppb) - 30 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Triatomic oxygen

Sources: Welding, electrostatic precipitators, ionizing air filters, disinfectants

Description: Colorless to blue gas with a very pungent, bleach-like odor

Incompatibilities: All oxidizable materials (both organic & inorganic)

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation: eyes, mucous membranes; pulmonary edema; chronic respiratory disease

PPE:

Respirator: Recommendations - NIOSH/OSHA: Up to 1 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 10) any supplied-air respirator; up to 2.5 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; up to 5 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern [note: only nonoxidizable sorbents allowed (not charcoal)]; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Nonflammable gas, but a powerful oxidizer

LABORATORY INFORMATION

CAS Number: 10028-15-6
Analytical Technique: OSHA ID-214: ion chromatography as nitrate using ultraviolet-visible (UV-VIS) detector (at 200 nm wavelength) or conductivity detector; Dräger: detector tube
Analytical Reference Method: OSHA ID-214; Dräger

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 37-mm diameter, nitrite-impregnated glass fiber filters (IGFFs)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.25-0.5
Air Collection Volume: Minimum - Maximum (L): 90-120

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 30 min.
Collection Media: 37-mm diameter, nitrite-impregnated glass fiber filters (IGFFs)
Sample Flow Rate (Lpm): 0.75
Air Collection Volume (L): 22.5

Special Instructions: Coordinate with MSHA Laboratory. Use a preconditioned oxidizer tube only if SO_2 is suspected of being present in the sampled air.

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #6733181, range 0.005-1.4 ppm (EF = 1.15); Dräger detector tube, #CH21001, range 10-300 ppm (EF = 1.15).
Various electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Perchloroethylene - $(CCl_2)_2$
150 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
218	100 ppm	200 ppm - 30 min.

CONTAMINANT INFORMATION

Synonyms: Perchlorethylene, perk, tetrachlorethylene, tetrachloroethylene; ethylene tetrachloride; Nema; Tetracap; Tetropil; Perclene; Ankilostin; Didakene

Sources: Metal degreaser, solvent, insulating/cooling gas in electrical transformers

Description: Colorless liquid with a mild, chloroform-like odor

Incompatibilities: Strong oxidizers; chemically-active metals (e.g., lithium, beryllium, barium); caustic soda; sodium hydroxide; potash

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; vertigo (an illusion of movement), dizziness, incoordination; headache, somnolence (sleepiness, unnatural drowsiness); skin erythema (skin redness); liver damage; [note: potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Prevent skin contact; 8 hr: PVA, Teflon, Viton, PE/EVAL, Barricade, CPF3, Responder, Trellchem, Tychem

Eyes: Prevent eye contact

Special Precautions: Noncombustible liquid, but decomposes in a fire to hydrogen chloride and phosgene

LABORATORY INFORMATION

CAS Number: 127-18-4

Analytical Technique: NIOSH 1003 (IV): gas chromatography (GC) / flame ionization detection (FID); OSHA 1001: gas chromatography (GC) / flame ionization detection (FID); 3M: passive monitor; Dräger: detector tube

Analytical Reference Method: NIOSH 1003 (IV); OSHA 1001; 3M; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. NIOSH 1003 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.2-40

2. OSHA 1001:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Maximum (L): 12

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 30 min.

1. NIOSH 1003 (IV):

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 0.2-40

2. OSHA 1001:

Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum (L): 0.25

Special Instructions: N/A

Grab Sampling:

Sampling Strategy: See Chapter 11

Collection Media: Dräger detector tube, #8101551, range 0.1-4 ppm (EF = 1.25); Dräger detector tube, #8101501, range 2-300 ppm (EF = 1.20); Dräger detector tube, #CH30701, range 10-500 ppm (EF = 1.20); Dräger detector tube, #8101851, range 50-10,000 ppm (EF = 1.25).

Perlite

Contaminant Codes:	**1973 ACGIH TLV:**	**1973 ACGIH Excursion STEL/Ceiling (C):**
515	30 mppcf (8.6 mg/m^3)	60 mppcf (17.2 mg/m^3) - 15 min.

CONTAMINANT INFORMATION

Synonyms: Expanded perlite [note: an amorphous material consisting of fused sodium potassium aluminum silicate]
Sources: Perlite mining
Description: Odorless, light-gray to glassy-black solid; [note: expanded perlite is a fluffy, white particulate]
Incompatibilities: None reported
Exposure: Inhalation, skin and/or eye contact
Health Effects: Irritation: eyes, skin, throat, upper respiratory system
PPE: Respirator: Recommendations: N/A
Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment
Eyes: No recommendation is made specifying the need for eye protection
Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS number: 93763-70-3
Analytical Technique:
1. NIOSH 0500 (IV) [particulates not otherwise regulated, total]: gravimetric (filter weight)
2. NIOSH 0600 (IV) [particulates not otherwise regulated, respirable]: gravimetric (filter weight)
3. Mineral Dust: impinger method
Analytical Reference Method: NIOSH 0500 (IV); NIOSH 0600 (IV); impinger method

SAMPLING INFORMATION

Full Shift Sampling: Screening - **Note: cannot be used for enforcement**
Sampling Strategy: see Chapter 5
1. NIOSH 0500 (IV)**:**
Collection Media: Filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 7-133
2. NIOSH 0600 (IV):
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 20-400

Short Term Sampling:
Sampling Strategy: see Chapter 5
Sampling Duration: 15 min.
1. NIOSH 0500 (IV)**:**
Collection Media: Filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 7-133
2. NIOSH 0600 (IV):
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 20-400

Full Shift - Partial Period Sampling: Enforcement - **Note: for compliance with TLV**
Sampling Strategy: see Chapter 6
Collection Media: impinger
Sample Flow Rate (Lpm): 2.8
Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will conduct impinger sampling with inspector escort.

Petroleum Distillates (Screen)* (semiquantitative - as Napthas)

Note: "Screening" sample for field application when contaminants listed below are suspected. The results can be used for compliance with applicable TLV's.

Organics Analyzed: Gasoline, Kerosene, Mineral Spirits, Stoddard Solvent, Turpentine, VM&P Naphtha

***Special Note:** **Semiquantitative data requires each sample or set of samples be accompanied by a bulk sample or "reference material." This material is the raw material or product that contains the specific petroleum distillate.**

CONTAMINANT INFORMATION

See individual contaminants (organics analyzed)

LABORATORY INFORMATION

Analytical Technique: NIOSH 1550 (IV): gas chromatography / flame ionization detection (GC-FID)
Analytical Reference Method: NIOSH 1550 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Short Term Sampling:
Sampling Strategy: see Chapter 9
Sampling Duration: 15 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Special Instructions: Stable at least one week at room temperature. Submit a 5-10 mL bulk sample separately. Submit samples via overnight carrier to MSHA Laboratory.

Phosgene - $COCl_2$
2.0 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
495	0.1 ppm (100 ppb)	1.0 ppm (1000 ppb) - 5 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Carbon oxychloride, carbonyl chloride, carbonyl dichloride, chloroformyl chloride

Sources: Gases from welding or torch cutting metals cleaned with chlorinated hydrocarbons; byproduct of some chemical processes

Description: Colorless gas with a suffocating odor like musty hay; [note: a fuming liquid below 47°F; shipped as a liquefied compressed gas]

Incompatibilities: Moisture, alkalis, ammonia, alcohols, copper; [note: reacts slowly in water to form hydrochloric acid and carbon dioxide]

Exposure: Inhalation, skin and/or eye contact (liquid)

Health Effects: Irritation eyes; dry burning throat; vomiting; cough, foamy sputum, dyspnea (breathing difficulty), pulmonary edema; chest pain, cyanosis; liquid: frostbite

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 1 ppm: (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 2 ppm: (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact (liquid); 8 hr: Responder, Tychem; 4 hr: Teflon

Eyes: Prevent eye contact (liquid)

Special Precautions: Nonflammable gas

LABORATORY INFORMATION

CAS Number: 75-44-5

Analytical Technique: OSHA 61: gas chromatography (GC) / nitrogen selective detector; Dräger: detector tube

Analytical Reference Method: OSHA 61; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

Collection Media: Solid sorbent tube [i.e., silane-treated glass tubes packed with 150/75 mg pretreated XAD-2 adsorbent coated with 2-(hydroxymethyl) piperidine (2-HMP)]

Sample Flow Rate (Lpm): 1

Air Collection Volume (L): 240

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

Collection Media: Solid sorbent tube [i.e., silane-treated glass tubes packed with 150/75 mg pretreated XAD-2 adsorbent coated with 2-(hydroxymethyl) piperidine (2-HMP)]

Sample Flow Rate (Lpm): 1

Air Collection Volume (L): 15

Special Instructions: N/A

Grab Sampling:

Sampling Strategy: see Chapter 11

Collection Media: Dräger detector tube, #8101521, range 0.02-1 ppm (EF=1.15); Dräger detector tube, #CH28301, range 0.25-25 ppm (EF=1.25).

Phosphine - PH_3
50 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
315	0.3 ppm (300 ppb)	1.0 ppm (1000 ppb) - 30 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Hydrogen phosphide, phosphorated hydrogen, phosphorus hydride, phosphorus trihydride

Sources: Gases from welding or torch cutting steel coated with phosphate-based rustproofing

Description: Colorless gas with fish- or garlic-like odor; [pesticide]; [note: shipped as a liquefied compressed gas; pure compound is odorless]

Incompatibilities: Air, oxidizers, chlorine, acids, moisture, halogenated hydrocarbons, copper; [note: may ignite spontaneously on contact with air]

Exposure: Inhalation, skin and/or eye contact (liquid)

Health Effects: Nausea, vomiting, abdominal pain, diarrhea; thirst; chest tightness, dyspnea (breathing difficulty); muscle pain, chills; stupor or syncope; pulmonary edema; liquid: frostbite

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 3 ppm: (APF = 10) any supplied-air respirator; up to 7.5 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 15 ppm: (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 50 ppm: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact / frostbite; 8 hr: Responder; prevent possible skin freezing from direct liquid contact

Eyes: Prevent eye contact / frostbite

Special Precautions: Flammable gas

LABORATORY INFORMATION

CAS Number: 7803-51-2

Analytical Technique: OSHA ID-180: ion chromatography (IC) / conductivity detector; OSHA 1003: inductively coupled plasma - atomic emission spectrometry (ICP-AES); NIOSH 6002 (IV): ultraviolet-visible (UV-VIS) spectrometer (at 625 nm wavelength); Dräger: detector tube

Analytical Reference Method: OSHA ID-180; OSHA 1003; NIOSH 6002 (IV); Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. OSHA ID-180:

Collection Media: Solid sorbent tube [i.e., 1.5 g beaded carbon impregnated with potassium hydroxide]

Sample Flow Rate: Minimum - Maximum (Lpm): 0.05 to 0.15 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Maximum (L): 36

2. OSHA 1003: 37-mm diameter, glass fiber filter (GFF) followed by a polyester filter coated with mercuric chloride

Sample Flow Rate (Lpm): 1.0

Air Collection Volume (L): 240

3. NIOSH 6002 (IV):

Collection Media: 300/150 mg mercuric cyanide-treated silica gel tube

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01 to 0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-16

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. OSHA ID-180:

Collection Media: Solid sorbent tube [i.e., 1.5 g beaded carbon impregnated with potassium hydroxide]

Sample Flow Rate (Lpm): 0.3

Air Collection Volume (L): 4.5

2. OSHA 1003: 37-mm diameter, glass fiber filter (GFF) followed by a polyester filter coated with mercuric chloride

Sample Flow Rate (Lpm): 2.0

Air Collection Volume (L): 30

3. NIOSH 6002 (IV):

Collection Media: 300/150 mg mercuric cyanide-treated silica gel tube

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01 to 0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-3

Special Instructions:
1. OSHA ID-180: Analyze samples within 12 days after collection. Samples should be refrigerated to increase stability.
2. OSHA 1003: N/A
3. NIOSH 6002 (IV): Coordinate with MSHA Laboratory. Analyze samples within 7 days after collection.

Grab Sampling:
Sampling Strategy: see Chapter 11
Collection Media: Dräger detector tube, #8101611, range 0.01-3 ppm (EF=1.15); Dräger detector tube, #CH31101, range 0.01-40 ppm (EF=1.20); Dräger detector tube, #8101801, range 1-200 ppm (EF=1.20); Dräger detector tube, #8101621, range 25-10,000 ppm (EF=1.15); Dräger detector tube, #CH21201, range 50-3,000 ppm (EF=1.15)

n-Propyl Alcohol - $CH_3CH_2CH_2OH$
800 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
255	200 ppm	250 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Ethyl carbinol, 1-propanol, n-propanol, propyl alcohol
Sources: Solvents
Description: Colorless liquid with mild, alcohol-like odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact
Health Effects: Irritation: eyes, nose, throat; dry cracking skin; drowsiness, headache; ataxia, gastrointestinal pain; abdominal cramps, nausea, vomiting, diarrhea
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 800 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent skin contact; 8 hr: Butyl, Nitrile, Viton; 4 hr: Neoprene, PVA
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 71-23-8
Analytical Technique: NIOSH 1401 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 7: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor
Analytical Reference Method: NIOSH 1401 (IV); OSHA 7; 3M

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: see Chapter 9

1. Collection Media: NIOSH 1401 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-10

2. Collection Media: OSHA 7: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 10

3. Collection Media: 3M: Passive monitor, 3M, 3500 series

Note: Maximum 6-hour sample per badge

Short Term Sampling:

Sampling Strategy: see Chapter 9

Sampling Duration: 15 min.

1. Collection Media: NIOSH 1401 (IV): 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum - Maximum (L): 1-3

2. Collection Media: OSHA 7: 100/50 mg: solid sorbent tube (coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Special Instructions: NIOSH 1401 (IV): Coordinate with MSHA Laboratory. Store samples in freezer. Ship on ice. Overnight samples to MSHA Laboratory.

Quartz (Crystalline Silica) - SiO_2 (Respirable)

50 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
523 (dust, respirable fraction, > 1% quartz)	$\frac{10}{\%\ \text{resp}\ SiO_2 + 2}$ mg/m^3	N/A

CONTAMINANT INFORMATION

Synonyms: Silicon dioxide

Sources: Sandblasting, metal casting, granite cutting; mining and milling of sandstone, crushed stone, sand and gravel, tripoli, diatomaceous earth

Description: Colorless, odorless solid; [note: a component of many mineral dusts]

Incompatibilities: Powerful oxidizers (e.g., fluorine, chlorine trifluoride, manganese trioxide, oxygen difluoride, hydrogen peroxide); acetylene; ammonia

Exposure: Inhalation, skin and/or eye contact

Health Effects: Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [note: potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; up to 25 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode; unknown concentrations or IDLH conditions: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 14808-60-7
Analytical Technique: NIOSH 7500 (IV): x-ray diffraction spectrometry; OSHA ID-142: x-ray diffraction spectrometry
Analytical Reference Method: NIOSH 7500 (IV); OSHA ID-142

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: see Chapter 5
1. NIOSH 7500 (IV):
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 400-1000
2. OSHA ID-142:
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 408-816

Note: Do not invert cyclone. Anything other than a horizontal orientation may deposit oversized particles on the filter from the cyclone body.

Selenium Compounds (as Se) (except Selenium Hexafluoride)

1 mg/m^3 (as Se) IDLH **(NIOSH**, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
627	0.2 mg/m^3 (200 µg/m^3)	0.3 mg/m^3 (300 µg/m^3) - 30 min.

(PEDS units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Elemental selenium, selenium alloy

Sources: Copper and heavy metal ore dust and refining (including silver and gold), ores of pyrite, clausthalite, naumannite, tiemannite and selenosulfur.

Description: *Elemental:* amorphous or crystalline, red to gray solid; [note: occurs as an impurity in most sulfide ores]
compounds: vary

Incompatibilities: Acids, strong oxidizers, chromium trioxide, potassium bromate, cadmium

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breathing, gastrointestinal disturbance; dermatitis; eye, skin burns

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 1 mg/m^3: (APF = 5) any dust and mist respirator [note: if not present as a fume; substance reported to cause eye irritation or damage; may require eye protection]; (APF = 10) any dust, mist, and fume respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 25) any powered, air-purifying respirator with a dust and mist filter [note: if not present as a fume; substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter [note: substance reported to cause eye irritation or damage ; may require eye protection]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact; contact the manufacturer for recommendations

Eyes: No recommendation is made for specific eye protection

Special Precautions: Combustible solid

LABORATORY INFORMATION

CAS Number: 7782-49-2 (*elemental*)
Analytical Technique: OSHA ID-121: atomic absorption spectroscopy (AAS) or atomic emission spectroscopy (AES); NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)
Analytical Reference Method: OSHA ID-121; NIOSH 7300 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: See Chapter 7
1. OSHA ID-121:
Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume: Minimum - Maximum (L): 480-960
2. NIOSH 7300 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 13-2000

Short Term Sampling:
Sampling Strategy: See Chapter 7
Sampling Duration: 15 min.
1. OSHA ID-121:
Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 30
2. NIOSH 7300 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 13-2000

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Silica, Crystalline (Quartz) - SiO_2 (Respirable)

50 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
523 (dust, respirable fraction, > 1% quartz)	$\frac{10}{\%\ \text{resp}\ SiO_2 + 2}$ mg/m^3	N/A

CONTAMINANT INFORMATION

Synonyms: Silicon dioxide

Sources: Sandblasting, metal casting, granite cutting; mining and milling of sandstone, crushed stone, sand and gravel, tripoli, diatomaceous earth

Description: Colorless, odorless solid; [note: a component of many mineral dusts]

Incompatibilities: Powerful oxidizers (e.g., fluorine, chlorine trifluoride, manganese trioxide, oxygen difluoride, hydrogen peroxide); acetylene; ammonia

Exposure: Inhalation, skin and/or eye contact

Health Effects: Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation eyes; [note: potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; up to 25 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode; unknown concentrations or IDLH conditions: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 14808-60-7
Analytical Technique: NIOSH 7500 (IV): x-ray diffraction spectrometry; OSHA ID-142: x-ray diffraction spectrometry
Analytical Reference Method: NIOSH 7500 (IV); OSHA ID-142

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: See Chapter 5
1. NIOSH 7500 (IV):
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 400-1000
2. OSHA ID-142:
Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 408-816

Bulk Sampling:
Sampling Strategy: See Chapters 5 & 14
1. NIOSH 7500 (IV): [high-volume air]
Collection Media: 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter
Sample Flow Rate (Lpm): 3
Air Collection Volume: Minimum - Maximum (L): 400-1000
2a. OSHA ID-142: [high-volume filter sample - respirable]
Quantity: > 1.0 grams
2b. OSHA ID-142: [high-volume filter sample - nonrespirable]
Quantity: > 1.0 grams
2c. OSHA ID-142: [representative settled dust (*i.e.*, rafter sample)]
Quantity: > 1.0 grams
2d. OSHA ID-142: [representative workplace material]
Quantity: 10-20 grams

Special Instructions: Coordinate with MSHA laboratory. Collect a bulk sample (*e.g.*, high-volume air; settled dust; workplace material) to identify interferences. Submit air and bulk samples via overnight carrier to MSHA laboratory.

Silver - Ag
(Metal and Soluble Compounds)
10 mg/m^3 (as Ag) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
653 (dust)	0.01 mg/m^3 (10 µg/m^3)	0.03 mg/m^3 (30 µg/m^3) - 15 min.
735 (fume)	0.01 mg/m^3 (10 µg/m^3)	0.03 mg/m^3 (30 µg/m^3) - 15 min.
	(PEDS units of measure in parentheses)	

CONTAMINANT INFORMATION

Synonyms: *Metal*: argentum
compounds: vary depending upon the specific compound

Sources: Silver plating, explosives; ores of gold, lead, copper, argentite, horn silver, cerargyrite, proustite, pyrargyrite

Description: *Metal*: white, lustrous solid
compounds: varies depending upon the specific compound

Incompatibilities: Acetylene, ammonia, hydrogen peroxide, bromoazide, chlorine trifluoride, ethyleneimine, oxalic acid, tartaric acid

Exposure: Inhalation, skin and/or eye contact, or ingestion

Health Effects: Argyrosis (a slate-gray or bluish discoloration of the skin, cornea of the eye, nasal septum, or throat,; irritation or ulceration of the skin; gastrointestinal disturbance

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 0.25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance causes eye irritation or damage; eye protection needed]; (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter [note: substance causes eye irritation or damage; eye protection needed]; up to 0.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 10 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; contact the manufacturer for recommendations for specific compound

Eyes: Prevent eye contact

Special Precautions: *Metal:* noncombustible solid, but flammable in form of dust or powder

LABORATORY INFORMATION

CAS Number: 7440-22-4 (silver metal)
Analytical Technique: OSHA ID-121: atomic absorption spectroscopy (AAS) or atomic emission spectroscopy (AES); NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)
Analytical Reference Method: OSHA ID-121; NIOSH 7300 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: See Chapter 7
1. OSHA ID-121:
Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume: Minimum - Maximum (L): 480-960
2. NIOSH 7300 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 250-2000

Short Term Sampling:
Sampling Strategy: See Chapter 7
Sampling Duration: 15 min.
1. OSHA ID-121:
Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 30
2. NIOSH 7300 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 250-2000

Special Instructions: Studies demonstrate that some forms of silver are more toxic than others. Contact the lab or District IH for addtional information to distinguish soluble from insoluble silver in workplace air samples.

Wipe Sampling:
Sampling Strategy: see Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Soapstone (< 1% quartz) - $3MgO\text{-}4SiO_2\text{-}H_2O$

3,000 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
511 (talc, nonfibrous, < 1% quartz)	20 mppcf (3.3 mg/m^3)	40 mppcf (6.6 mg/m^3) - 15 min.

(PEDS "screening" units of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Massive talc, soapstone silicate, steatite

Sources: Talc mines, clarifying liquids by filtration

Description: Odorless, white-gray powder

Incompatibilities: None reported

Exposure: Inhalation, skin and/or eye contact

Health Effects: Pneumoconiosis: cough, dyspnea (breathing difficulty); digital clubbing; cyanosis; basal crackles, corpulmonale

PPE: Respirator: Recommendations - NIOSH: Up to 30 mg/m^3: (APF = 5) any dust and mist respirator; up to 60 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 150 mg/m^3: (APF = 25) any powered, air-purifying respirator with a dust and mist filter; up to 300 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 3000 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS number: 14807-96-6 [talc (containing no asbestos and less than 1% quartz)]
Analytical Technique:
1. NIOSH 0500 (IV) [particulates not otherwise regulated, total]: gravimetric (filter weight)
2. NIOSH 0600 (IV) [particulates not otherwise regulated, respirable]: gravimetric (filter weight)
3. Mineral Dust: Impinger method
Analytical Reference Method: NIOSH 0500 (IV); NIOSH 0600 (IV); impinger method

SAMPLING INFORMATION

Full Shift Sampling: Screening - **Note: cannot be used for enforcement**
Sampling Strategy: see Chapter 5
1. NIOSH 0500 (IV)**:**
Collection Media: filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 7-133
2. NIOSH 0600 (IV):
Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 20-400

Short Term Sampling:
Sampling Strategy: see Chapter 5
Sampling Duration: 15 min.
1. NIOSH 0500 (IV)**:**
Collection Media: filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 7-133
2. NIOSH 0600 (IV):
Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 20-400

Full Shift - Partial Period Sampling: Enforcement - **Note: for compliance with TLV**
Sampling Strategy: See Chapter 6
Collection Media: impinger
Sample Flow Rate (Lpm): 2.8
Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will conduct impinger sampling with inspector escort.

Sodium Hydroxide - NaOH
10 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
455	2.0 mg/m^3	2.0 mg/m^3 (C)

CONTAMINANT INFORMATION

Synonyms: Caustic soda, lye, soda lye, sodium hydrate
Sources: Metal cleaning, electrolytic extraction of zinc, neutralizing acids
Description: Colorless to white, odorless solid (flakes, beads, granular form)
Incompatibilities: Water; acids; flammable liquids; organic halogens; metals (e.g., aluminum, tin & zinc; nitromethane; [note: corrosive to metals]
Exposure: Inhalation, ingestion, skin and/or eye contact
Health Effects: Irritation: eyes, skin, mucous membrane; pneumonitis; burns: eye, skin; temporary loss of hair
PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 10 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance causes eye irritation or damage; eye protection needed]; (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 25) any powered, air-purifying respirator with a dust and mist filter [note: substance causes eye irritation or damage; eye protection needed]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece
Skin: Prevent skin contact; (solution >70% only): 8 hr: Neoprene, PVC, Barricade
Eyes: Prevent eye contact
Special Precautions: Noncombustible solid, but when in contact with water may generate sufficient heat to ignite combustible materials

LABORATORY INFORMATION

CAS Number: 1310-73-2
Analytical Technique: NIOSH 7401 (IV): acid-base titration
Analytical Reference Method: NIOSH 7401 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9
Collection Media: 37-mm diameter, 1.0-µm pore size polytetrafluoroethylene (PTFE) membrane filter
Sample Flow Rate: Minimum - Maximum (Lpm): 1-4
Air Collection Volume: Minimum - Maximum (L): 70-1000

Short Term Sampling:

Sampling Strategy: See Chapter 9
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 1.0-µm pore size polytetrafluoroethylene (PTFE) membrane filter
Sample Flow Rate: Minimum - Maximum (Lpm): 1-4
Air Collection Volume: Minimum - Maximum (L): 70-1000

Special Instructions: N/A

Stoddard Solvent
20,000 mg/m^3 (3,390 ppm) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
241	200 ppm	250 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Dry cleaning safety solvent, mineral spirits, petroleum solvent, spotting naphtha

***Note: Stoddard Solvent is a subgroup of the Naphtha family of solvents. There may be several synonyms in this list that also refer to naphtha (coal tar). The CAS number should be used to distinguish between the two contaminants.**

Sources: Parts cleaning solvents, paint thinner, degreasing agents

Description: Colorless liquid with a kerosene-like odor

Incompatibilities: Strong oxidizers

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, nose, throat; dizziness; dermatitis; chemical pneumonia (aspiration liquid)

PPE: Respirator: Recommendations - NIOSH: Up to 3500 mg/m^3 [or 593 ppm]: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 8750 mg/m^3 [or 1483 ppm]: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 17,500 mg/m^3 [or 2966 ppm]: (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 20,000 mg/m^3 [or 3390 ppm]: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: Prevent skin contact; 8 hr: Nitrile, Viton, Saranex, PE/EVAL, Barricade, Responder; 4 hr: PVA
Eye: Prevent eye contact
Special Precautions: Class II combustible liquid

LABORATORY INFORMATION
CAS Number: 8052-41-3 (Stoddard Solvent)
Analytical Technique: NIOSH 1550 (IV): gas chromatography / flame ionization detection (GC-FID)
Analytical Reference Method: NIOSH 1550 (IV)

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: See Chapter 9
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Short Term Sampling:
Sampling Strategy: See Chapter 9
Sampling Duration: 15 min.
Collection Media: 100/50 mg: solid sorbent tube (coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2 Lpm; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum - Maximum (L): 1.3-20

Special Instructions: Stable at least one week at room temperature. Submit a 5-10 mL bulk sample separately. Submit samples via overnight carrier to MSHA Laboratory.

Sulfur Dioxide - SO_2
100 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
421	5.0 ppm	20 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Sulfurous acid anhydride, sulfurous oxide, sulfur oxide

Sources: Blasting, processing and casting of nonferrous metal (zinc, brass, aluminum, copper), exhaust from combustion of materials containing sulfur (high sulfur diesel fuels)

Description: Colorless gas with a characteristic, irritating, pungent odor; [note: shipped as a liquefied compressed gas]

Incompatibilities: Powdered alkali metals (e.g., sodium, potassium); water; ammonia; zinc; aluminum; brass; copper; [note: reacts with water to form sulfurous acid (H_2SO_3)]

Exposure: Inhalation, skin and/or eye contact

Health Effects: Irritation: eyes, nose, throat; rhinorrhea (discharge of thin nasal mucous); choking, cough; reflex broncho-constriction; pulmonary edema; liquid: frostbite

PPE: Respirator: Recommendations - NIOSH: Up to 20 ppm: (APF = 10) any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 50 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 100 ppm: (APF = 50) any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and cartridge(s) providing protection against the compound of concern [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode [note: substance reported to

cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact / frostbite; 8 hr: Saranex, Barricade, Responder 4 hr: Teflon; prevent possible skin freezing from direct liquid contact

Eyes: Prevent eye contact / frostbite

Special Precautions: Nonflammable gas

LABORATORY INFORMATION

CAS Number: 7446-09-5

Analytical Technique: Dräger: diffusion tube; NIOSH 6004 (IV): ion chromatography (IC); OSHA ID-200: ion chromatography (IC); Dräger: detector tube; Industrial Scientific: electronic direct reading instrument (DRI) [with catalytic and electrochemical sensors]

Analytical Reference Method: Dräger; NIOSH 6004 (IV); OSHA ID-200; Dräger; Industrial Scientific

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapters 9 and 11

1. Dräger

Collection Media: Dräger diffusion tube, #8101091; range 5-150 ppm (1 hour), 2.5-75 ppm (2 hours), 1.3-38 ppm (4 hours), 0.7-19 ppm (8 hours); **Note:** up to 8 hours per tube. (EF = 1.25).

2. NIOSH 6004 (IV):

Collection Media: 2 filter cassettes in series (i.e., 2-cassette sampling device): Front cassette = 37-mm diameter, 0.8-µm pore size cellulose ester (CE) membrane filter; Back cassette = 37-mm diameter, cellulose filter (Whatman 40 or equivalent) saturated with Na_2CO_3 fixative solution.

Sample Flow Rate: Minimum - Maximum (Lpm): 0.5-1.5

Air Collection Volume: Minimum - Maximum (L): 4-200

3. OSHA ID-200:

Collection Media: **(A):** Type I: solid sorbent tube, 100/50 mg impregnated activated beaded carbon (IABC); or

(B): Type II: combination sampling device; front part = Teflon filter (to remove particulate and collect H_2SO_4 mist); second part = 100/50 mg IABC (to collect SO_2).

Sample Flow Rate (Lpm): 0.1; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 12

Short Term Sampling:
Sampling Strategy: See Chapter 9
Sampling Duration: 15 min.
1. NIOSH 6004 (IV):
Collection Media: 2 filter cassettes in series (i.e., 2-cassette sampling device): Front cassette = 37-mm diameter, 0.8-µm pore size cellulose ester (CE) membrane filter; Back cassette = 37-mm diameter, cellulose filter (Whatman 40 or equivalent) saturated with Na_2CO_3 fixative solution.
Sample Flow Rate: Minimum - Maximum (Lpm): 0.5-1.5
Air Collection Volume: Minimum - Maximum (L): 4-200
2. OSHA ID-200:
Collection Media: **(A):** Type I: solid sorbent tube, 100/50 mg impregnated activated beaded carbon (IABC); or
(B): Type II: combination sampling device; front part = Teflon filter (to remove particulate and collect H_2SO_4 mist); second part = 100/50 mg IABC (to collect SO_2).
Sample Flow Rate (Lpm): 0.1; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 1.5

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: See Chapters 11 and 13
1. Collection Media: Dräger detector tube, #6727101, range 0.1-3 ppm (EF = 1.15); Dräger detector tube, #6728491, range 0.5-25 ppm (EF = 1.15); Dräger detector tube, #CH31701, range 1-25 ppm (EF = 1.15); Dräger detector tube, #CH24201, range 10-2,000 ppm (EF = 1.20); Dräger detector tube, #8101531, range 50-8,000 ppm (EF = 1.15).
2. Collection Media: Industrial Scientific electronic direct reading instrument, TMX410 or TMX412 (EF = 1.25).
Various other electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Sulfuric Acid - H_2SO_4
15 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
423	1.0 mg/m^3	3.0 mg/m^3 - 5 min.

CONTAMINANT INFORMATION

Synonyms: Battery acid, hydrogen sulfate, oil of vitriol, sulfuric acid (aqueous)

Sources: Metal cleaning, explosives, processing bauxite, metallurgy, electrowinning

(Note: For copper electrowinning operations contact lab for special sampling procedures).

Description: Colorless to dark-brown, oily, odorless liquid

Incompatibilities: Organic materials, chlorates, carbides, fulminates, water, powdered metals; [note: reacts violently with water with evolution of heat; corrosive to metals]

Exposure: Inhalation, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin, nose, throat; pulmonary edema, bronchitis; emphysema; conjunctivitis; stomatis; dental erosion; tracheobronchitis; burns: eye, skin; dermatitis

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 15 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance causes eye irritation or damage; eye protection needed]; (APF = 25) any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter [note: substance causes eye irritation or damage; eye protection needed]; (APF = 50) any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with a high-efficiency particulate filter; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; (solution >70% only): 8 hr: Butyl, PE, Teflon, Saranex, PE/EVAL, Barricade, CPF3, Responder, Trellchem, Tychem; 4 hr: Viton

Eye: Prevent eye contact

Special Precautions: Noncombustible liquid, but capable of igniting finely divided combustible materials

LABORATORY INFORMATION
CAS Number: 7664-93-9
Analytical Technique: NIOSH 7903 (IV): ion chromatography (IC); Dräger: detector tube
Analytical Reference Method: NIOSH 7903 (IV); Dräger

SAMPLING INFORMATION
Full Shift Sampling:
Sampling Strategy: See Chapter 9
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Short Term Sampling:
Sampling Strategy: See Chapter 9
Sampling Duration: 5 min.
Collection Media: 400/200 mg: solid sorbent tube (washed silica gel, with glass fiber filter plug)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.2-0.5
Air Collection Volume: Minimum - Maximum (L): 3-100

Special Instructions: N/A

Talc - $Mg_3Si_4O_{10}(OH)_2$

1,000 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	30 CFR §§56/57.5001(b) MSHA TLV:	30 CFR §§56/57.5001(b) MSHA STEL/Ceiling (C):
503 (talc, fibrous, <1% quartz)	2.0 fibers/mL	10.0 fibers/mL - 15 min.
Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
511 (talc, nonfibrous, <1% quartz)	20 mppcf (3.3 mg/m^3)	40 mppcf (6.6 mg/m^3) - 15 min.

CONTAMINANT INFORMATION

Synonyms: Hydrous magnesium silicate, steatite talc

Sources: Talc mines

Description: Odorless, white powder

Incompatibilities: None reported

Exposure: Inhalation, skin and/or eye contact

Health Effects: Fibrotic pneumoconiosis, irritation eyes

PPE: Respirator: Recommendations - NIOSH: Up to 10 mg/m^3: (APF = 5) any dust and mist respirator; up to 20 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 50 mg/m^3: (APF = 25) any powered, air-purifying respirator with a dust and mist filter; (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 100 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 1,000 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION - for nonfibrous (i.e., non-asbestiform) Talc

CAS number: 14807-96-6

Analytical Technique:

1. NIOSH 0500 (IV) [particulates not otherwise regulated, total]: gravimetric (filter weight)

2. NIOSH 0600 (IV) [particulates not otherwise regulated, respirable]: gravimetric (filter weight)

3. Mineral Dust: impinger method

Analytical Reference Method: NIOSH 0500 (IV); NIOSH 0600 (IV); impinger method

SAMPLING INFORMATION

Full Shift Sampling: Screening - **Note: cannot be used for enforcement**

Sampling Strategy: See Chapter 5

1. NIOSH 0500 (IV)**:**

Collection Media: filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 7-133

2. NIOSH 0600 (IV):

Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Short Term Sampling:

Sampling Strategy: See Chapter 5

Sampling Duration: 15 min.

1. NIOSH 0500 (IV)**:**

Collection Media: filter [37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 7-133

2. NIOSH 0600 (IV):

Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Full Shift - Partial Period Sampling: Enforcement - **Note: for compliance with TLV**

Sampling Strategy: see Chapter 6

Collection Media: impinger

Sample Flow Rate (Lpm): 2.8

Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support. Dust Division personnel will conduct impinger sampling with inspector escort.

LABORATORY INFORMATION for fibrous (i.e. asbestiform)Talc

CAS Number: 14807-96-6

Analytical Technique:

1. Personal: **(A):** NIOSH 7400 (IV): phase contrast microscopy (PCM)
(B): OSHA ID-160: PCM [at 400x]
(C): NIOSH 7402 (IV): transmission electron microscopy (TEM)

2. Bulk: **(A):** OSHA ID-191: polarized light microscopy (PLM)
(B): EPA 600/R93/116: qualitative identification by polarized light microscopy (PLM) and analytical transmission electron microscopy (TEM)
(D): NIOSH 9002 (IV): stereo (10-45x) and polarized light microscopy (PLM)

Analytical Reference Method:

1. Personal: **(A):** NIOSH 7400 (IV)
(B): OSHA ID-160
(C): NIOSH 7402 (IV)

2. Bulk: **(A):** OSHA ID-191
(B): EPA 600/R93/116
(C): NIOSH 9002 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 8 – Asbestos Fibers [note: for optimal filter loading without overloading, sampling times or flow rate may need to be adjusted;
see Chapter 8, V. Section F. 4.]

1. Personal:

Collection Media: 25-mm diameter, 0.8-µm pore size cellulose ester (CE) membrane filter; 50-mm electrically conductive extension cowl

Sample Flow Rate: Minimum - Maximum (Lpm): 0.5-5.0; [note 1: commonly, 1.7 Lpm] [note 2: always choose a flow rate that will not produce overloaded filters]

Air Collection Volume: Minimum - Maximum (L): 25-2,400

Short Term Sampling:

Sampling Strategy: see Chapter 8 – Asbestos Fibers

Sample Duration: 15-30 minutes

Collection Media: 25-mm diameter, 0.8-µm pore size cellulose ester (CE) membrane filter; 50-mm electrically conductive extension cowl;

Sample Flow Rate: Minimum - Maximum (Lpm): 1.7 – maximum stable pump capacity

Air Collection Volume: Minimum - Maximum (L): use larger sample volumes to acieve quantitfiable loadings, however, do not overload the filter with background dust.

Bulk Sampling:
Sampling Strategy: see Chapter 8 – Asbestos Fibers
Collection Media: Bulk material or cork-borer type sampler
Collect approximately 1 to 10 grams of material and place into screw-cap plastic vials of 10- to 50-mL capacity

Special Instructions:

1. Send the samples to the laboratory with paperwork requesting asbestos analysis. List any known fibrous interferences present during sampling on the paperwork. Also, note the workplace operation(s) sampled.
2. Secure and handle the samples so that they will not rattle during shipment nor be exposed to static electricity. Do not ship samples in expanded polystyrene peanuts, vermiculite, paper shreds, or excelsior. Tape sample cassettes to sheet bubbles and place in a container that will cushion the samples without rattling.
3. To avoid the possibility of sample contamination, always ship bulk samples in separate mailing containers.
4. Ship samples in a rigid container (with sufficient packing material to prevent damage) to MSHA Laboratory (for contract laboratory analysis).

Titanium Dioxide - TiO_2
5,000 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
153 (dust)	10 mg/m^3	20 mg/m^3 - 15 min.
739 (fume)	10 mg/m^3	20 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: Rutile, ilmenite, leucoxene, titanium oxide, titanium peroxide

Sources: Welding rod coatings, some enamels; titanium ores and sands: rutile, ilmenite, leucoxene, perovskite, anatase, octahedrite, brookite, sphene, titanite, benitoite

Description: White, odorless sand or powder

Incompatibilities: None reported

Exposure: Inhalation

Health Effects: Lung fibrosis; [potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: Up to 5,000 mg/m^3: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 13463-67-7

Analytical Technique: Atomic absorption spectroscopy (AAS) or atomic emission spectroscopy (AES); inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)

Analytical Reference Method: MSHA P-14

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 7

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume: Minimum - Maximum (L): 480-960

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-100

Short Term Sampling:

Sampling Strategy: See Chapter 7

Sampling Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume (L): 30

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-100

Special Instructions: N/A

Wipe Sampling:

Sampling Strategy: See Chapter 14

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Toluene - $C_6 H_5CH_3$
500 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	ANSI Z37.12-1974 STEL/Ceiling (C):
221	100 ppm	200 ppm (C)

CONTAMINANT INFORMATION

Synonyms: Methyl benzene, methyl benzol, phenyl methane, toluol
Sources: Solvents, gasoline, off-gassing of new building materials
Description: Colorless liquid with a sweet, pungent, benzene-like odor
Incompatibilities: Strong oxidizers
Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact
Health Effects: Irritation: eyes, nose; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); nervousness, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage
PPE: Respirator: Recommendations - NIOSH: Up to 500 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece
Skin: Prevent skin contact; 8 hr: PVA, Teflon, Viton, PE/EVAL, Barricade, CPF3, Responder, Trellchem, Tychem
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

LABORATORY INFORMATION

CAS Number: 108-88-3
Analytical Technique: NIOSH 1500 (IV): gas chromatography (GC) / flame ionization detector (FID); NIOSH 1501 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 111: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor; Dräger: diffusion tube; Dräger: detector tube
Analytical Reference Method: NIOSH 1500 (IV); NIOSH 1501 (IV); OSHA 111; 3M; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9

1. NIOSH 1500 (IV):

Collection Media: solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 2-8

2. NIOSH 1501 (IV):

Collection Media: solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 1-8

3. OSHA 111:

Collection Media: Solid sorbent tube [100/50 mg coconut shell charcoal; or 140/70 mg Anasorb® 747 (beaded activated carbon)]

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): $\leq$12

4. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

5. Dräger:

Collection Media: Dräger diffusion tube, #8101421; range 100-3,000 ppm (1 hour), 50-1,500 ppm (2 hours), 25-750 ppm (4 hours), 13-380 ppm (8 hours); **Note:** up to 8 hours per tube. (EF = 1.25).

Short Term Sampling:

Sampling Strategy: See Chapter 9

Sampling Duration: 10 min.

1. NIOSH 1500 (IV):

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 2

2. NIOSH 1501 (IV):

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 1-8

3. OSHA 111:
Collection Media: Solid sorbent tube [100/50 mg coconut shell charcoal; or 140/70 mg Anasorb® 747 (beaded activated carbon)]
Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): >0.5

Special Instructions: N/A

Grab Sampling:
Sampling Strategy: See Chapter 11
Collection Media: Dräger detector tube, #8101661, range 5-600 ppm (EF = 1.15); Dräger detector tube, #8101701, range 50-400 ppm (EF = 1.20); Dräger detector tube, #CH23001, range 50-400 ppm (EF = 1.15); Dräger detector tube, #8101731, range 100-1,800 ppm (EF = 1.20).

Trichloroethylene - $ClCH=CCl_2$
1,000 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
211	100 ppm	200 ppm - 30 min.

CONTAMINANT INFORMATION

Synonyms: Ethylene trichloride, TCE, trichloroethene, trilene
Sources: Degreasing and paint solvents
Description: Colorless liquid (unless dyed blue) with a chloroform-like odor
Incompatibilities: Strong caustics & alkalis; chemically-active metals (e.g., barium, lithium, sodium, magnesium, titanium, beryllium)
Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact
Health Effects: Irritation: eyes, skin; headache, vertigo (an illusion of movement); visual disturbance, fatigue, giddiness, tremor, somnolence (sleepiness, unnatural drowsiness), nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]
PPE: Respirator: Recommendations - NIOSH: Up to 1,000 ppm: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Skin: Prevent skin contact; 8 hr: PVA, Viton, PE/EVAL, Barricade, Trellchem, Tychem; 4 hr: Teflon, Responder
Eyes: Prevent eye contact
Special Precautions: Combustible liquid (but burns with difficulty)

LABORATORY INFORMATION

CAS Number: 79-01-6
Analytical Technique: NIOSH 1022 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 1001: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor; Dräger: diffusion tube; Dräger: detector tube
Analytical Reference Method: NIOSH 1022 (IV); OSHA 1001; 3M; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9

1. NIOSH 1022 (IV):

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 1-30

2. OSHA 1001:

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): $\leq$12

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: Maximum 8-hour sample per badge

4. Dräger:

Collection Media: Dräger diffusion tube, #8101441; range 200-1,000 ppm (1 hour), 100-500 ppm (2 hours), 50-250 ppm (4 hours), 25-125 ppm (8 hours); Note: up to 8 hours per tube. (EF = 1.25).

Short Term Sampling:

Sampling Strategy: See Chapter 9

Sampling Duration: 5-10 min.

1. NIOSH 1022 (IV):

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 1-30

2. OSHA 1001:

Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): >0.25

Special Instructions: N/A

Grab Sampling:

Sampling Strategy: See Chapter 11

Collection Media: Dräger detector tube, #6728541, range 2-250 ppm (EF = 1.15); Dräger detector tube, #8101881, range 50-2,000 ppm (EF = 1.40).Dräger detector tube, #CH24401, range 50-2,000 ppm (EF = 1.40).

Tridymite - SiO_2 (Respirable)
25 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
527	5 mg/m^3 % SiO_2 + 2	N/A

CONTAMINANT INFORMATION

Synonyms: Crystalline silica

Sources: Volcanic silica-bearing rock

Description: Colorless, odorless solid; [note: silica is a component of many mineral dusts]

Incompatibilities: Powerful oxidizers (*e.g.*, fluorine, chlorine trifluoride, manganese trioxide, oxygen difluoride, hydrogen peroxide); acetylene; ammonia

Exposure: Inhalation, skin and/or eye contact

Health Effects: Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); irritation: eyes; [potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m^3: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 2.5 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; up to 25 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

Eyes: No recommendation is made specifying the need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 14808-60-7

Analytical Technique: NIOSH 7500 (IV): x-ray diffraction spectrometry; OSHA ID-142: x-ray diffraction spectrometry

Analytical Reference Method: NIOSH 7500 (IV); OSHA ID-142

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 5

1. NIOSH 7500 (IV):

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 400-1000

2. OSHA ID-142:

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 408-816

Bulk Sampling:

Sampling Strategy: See Chapters 5 & 14

1. NIOSH 7500 (IV): [high-volume air]

Collection Media: 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter

Sample Flow Rate (Lpm): 3

Air Collection Volume: Minimum - Maximum (L): 400-1000

2a. OSHA ID-142: [high-volume filter sample - respirable]

Quantity: > 1.0 grams

2b. OSHA ID-142: [high-volume filter sample - nonrespirable]

Quantity: > 1.0 grams

2c. OSHA ID-142: [representative settled dust (*i.e.*, rafter sample)]

Quantity: > 1.0 grams

2d. OSHA ID-142: [representative workplace material]

Quantity: 10-20 grams

Special Instructions: Coordinate with MSHA Laboratory. Collect a bulk sample (e.g., high-volume air; settled dust; workplace material) to identify interferences. Submit air and bulk samples via overnight carrier to MSHA Laboratory.

Trimethylbenzene - $C_6H_3(CH_3)_3$

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
269	25 ppm	37.5 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: *1,2,3-trimethylbenzene:* hemellitol; [note: hemimellite is a mixture of the 1,2,3-isomer with up to 10% of related aromatics such as the 1,2,4-isomer]
1,2,4-trimethylbenzene: asymmetrical trimethylbenzene, psi-cumene, pseudocumene; [note: hemimellite is a mixture of the 1,2,3-isomer with up to 10% of related aromatics such as the 1,2,4-isomer]
1,3,5-trimethylbenzene: mesitylene, symmetrical trimethylbenzene, sym-trimethylbenzene

Sources: Raw material in chemical syntheses, solvents, constituent of gasoline, coal tar

Description: *All isomers:* clear, colorless liquid with a distinctive, aromatic odor

Incompatibilities: *All isomers:* oxidizers, nitric acid

Exposure: *All isomers:* inhalation, ingestion, skin and/or eye contact

Health Effects: *All isomers:* irritation: eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, fatigue, dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonia (aspiration of liquid)

PPE: Respirator: Recommendations - NIOSH: Note: NIOSH has not published respirator recommendations for this substance. If sampling is required, seek guidance before exposing oneself. *all isomers:* N/A

Skin: *all isomers:* prevent skin contact
1,2,3-trimethylbenzene: contact the manufacturer for recommendations
1,2,4-trimethylbenzene: 8 hr: PVA, Viton, PE/EVAL, Barricade, CPF3, Tychem; 4 hr: Teflon, Responder
1,3,5-trimethylbenzene: contact the manufacturer for recommendations

Eyes: *all isomers:* prevent eye contact

Special Precautions: *1,2,3-trimethylbenzene:* Flammable liquid
1,2,4-trimethylbenzene: Class II flammable liquid
1,3,5-trimethylbenzene: Class II flammable liquid

LABORATORY INFORMATION

CAS Number: *1,2,3-trimethylbenzene:* 526-73-8
1,2,4-trimethylbenzene: 95-63-6
1,3,5-trimethylbenzene: 108-67-8

Analytical Technique: Dräger: detector tube

Analytical Reference Method: Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: N/A

Collection Media: N/A

Short Term Sampling:

Sampling Strategy: N/A

Sampling Duration: N/A

Special Instructions: N/A

Grab Sampling:

Sampling Strategy: See Chapter 11

Collection Media: *all isomers:* Dräger detector tube, #8101661, range 10-100 ppm (EF = 1.20).

Tungsten and Compounds (as W)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
741 (fumes)	5.0 mg/m^3	10 mg/m^3 - 15 min.
155 (insoluble dusts, as W)	5.0 mg/m^3	10 mg/m^3 - 15 min.
323 (soluble compounds, as W)	1.0 mg/m^3	3.0 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: *Insoluble dusts & fumes:* tungsten metal, wolfram
soluble compounds: (note: synonyms vary depending upon the specific soluble tungsten compound)

Sources: Ores of wolframite and scheelite, welding or torch cutting of tungsten steel
and tungsten alloys

Description: *Insoluble dusts & fumes:* hard, brittle, steel-gray to tin-white solid
soluble compounds: (note: appearance and odor vary depending upon the specific soluble tungsten compound)

Incompatibilities: *Insoluble dusts & fumes:* bromine trifluoride, chlorine trifluoride, fluorine, iodine pentafluoride
soluble compounds: (note: varies)

Exposure: *Insoluble dusts & fumes:* inhalation, ingestion, skin and/or eye contact
soluble compounds: inhalation, ingestion, skin and/or eye contact

Health Effects: *Insoluble dusts & fumes:* irritation: eyes, skin, respiratory system; diffuse pulmonary fibrosis; loss of appetite, nausea, cough; blood changes
soluble compounds: irritation: eyes, skin, respiratory system

PPE: Respirator: Recommendations - NIOSH:
insoluble dusts & fumes: Up to 50 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; (APF = 50) any self-contained breathing apparatus with a full facepiece
soluble compounds: Up to 10 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 50 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: *Insoluble dusts & fumes:* no specific recommendation can be made; actual working conditions will determine the need and type of personal protective equipment

soluble compounds: recommendations regarding personal protective clothing vary depending upon the specific compound; contact the manufacturer for recommendations for the specific compound

Eyes: *Insoluble dusts & fumes:* prevent eye contact
soluble compounds: recommendations regarding eye protection vary depending upon the specific compound

Special Precautions: *Insoluble dusts & fumes:* combustible in the form of finely divided powder; may ignite spontaneously
soluble compounds: (note: varies depending on the compound)

LABORATORY INFORMATION

CAS Number: 7440-33-7 *(insoluble dusts & fumes)*; varies *(soluble compounds)*
Analytical Technique: NIOSH 7074 (IV): flame atomic absorption spectrometry (FAAS); OSHA ID-213: inductively coupled plasma - atomic emission spectrometer (ICP-AES)
Analytical Reference Method: NIOSH 7074 (IV); OSHA ID-213

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: See Chapter 7
1. NIOSH 7074 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size cellulose ester (CE) filter
Sample Flow Rate: Minimum - Maximum (Lpm): 1-4
Air Collection Volume: Minimum - Maximum (L): 200-1000
2. OSHA ID-213:
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 480

Short Term Sampling:
Sampling Strategy: See Chapter 7
Sampling Duration: 15 min.
1. NIOSH 7074 (IV):
Collection Media: 37-mm diameter, 0.8-µm pore size cellulose ester (CE) filter
Sample Flow Rate: Minimum - Maximum (Lpm): 1-4
Air Collection Volume: Minimum - Maximum (L): 200-1000
2. OSHA ID-213:
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 30

Special Instructions: N/A

Bulk Sampling:
Sampling Strategy: See Chapter 8
OSHA ID-213:
Special Instructions: Place bulk samples in 20-mL scintillation vials. Fill 20-mL scintillation vials at least half full of material sampled. Large pieces that do not fit inside 20-mL scintillation vials may be shipped in larger containers.

Wipe Sampling:
Sampling Strategy: See Chapter 14
OSHA ID-213:
Collection Media: Whatman Filter (No. 41 or 42) or smear tabs, moistened with distilled water
Special Instructions: Seal wipe sample in vial.

Turpentine - C_{10} H_{16} (approx)
800 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
995	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

Synonyms: Gumspirits, gum turpentine, spirits of turpentine, steam distilled turpentine, sulfate wood turpentine, turps, wood turpentine

Sources: Solvents, insecticides

Description: Colorless liquid with a characteristic odor

Incompatibilities: Strong oxidizers, chlorine, chromic anhydride, stannic chloride, chromyl chloride

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation: eyes, skin, nose, throat; headache, vertigo (an illusion of movement), convulsions; skin sensitization; hematuria (blood in the urine), albuminuria; kidney damage; abdominal pain, nausea, vomiting, diarrhea; chemical pneumonia (aspiration of liquid)

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 800 ppm: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance causes eye irritation or damage; eye protection needed]; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) [note: substance causes eye irritation or damage; eye protection needed]; (APF = 50) any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s); (APF = 50) any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece

Skin: Prevent skin contact; 8 hr: Viton, PE/EVAL, Responder; 4 hr: Nitrile, PVA, Teflon

Eyes: Prevent eye contact

Special Precautions: Class IC flammable liquid

LABORATORY INFORMATION

CAS Number: 8006-64-2

Analytical Technique: NIOSH 1551 (IV): gas chromatography (GC) / flame ionization detector (FID)

Analytical Reference Method: NIOSH 1551 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9
Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum – Maximum (L): 1-10

Short Term Sampling:

Sampling Strategy: See Chapter 9
Sampling Duration: 15 min.
Collection Media: Solid sorbent tube (100/50 mg coconut shell charcoal)
Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume: Minimum – Maximum (L): 1-10

Special Instructions: Stable for only one week at room temperature; bulk sample (1 to 10 mL) required, to be shipped in separate container. Submit samples overnight to MSHA Laboratory.

Vanadium - V
Vanadium Oxide - V_2O_5
35 mg/m^3 (as V) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
471 (vanadium dust)	0.5 mg/m^3 (500 µg/m^3)	0.5 mg/m^3 (500µg/m^3) - 30 min.

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
743 (V_2O_5 fume, as V)	0.05 mg/m^3 (50 µg/m^3)	0.05 mg/m^3 (50 µg/m^3) - (C)

(PEDS unit of measure in parentheses)

CONTAMINANT INFORMATION

Synonyms: Divanadium pentoxide, vanadic anhydride, vanadium pentoxide

Sources: *Dust*: ores of patronite (polysulfide - VS_4), vanadinite, volborthite, aegirite
fume: welding, additive to specialty steels, oxidation of sulfur dioxide, some fuel oils

Description: *Dust*: yellow-orange powder or dark gray, odorless flakes dispersed in air
fume: bright white, soft metal, corrosion resistant

Incompatibilities: *Dust and fume*: lithium, chlorine trifluoride

Exposure: *Dust*: inhalation, ingestion, skin and/or eye contact
fume: inhalation, skin and/or eye contact

Health Effects: *Dust*: irritation: eyes, skin, throat; green tongue, metallic taste, eczema; cough; fine rales, wheezing, bronchitis, dyspnea (breathing difficulty)
fume: irritation: eyes, throat; green tongue, metallic taste; cough, fine rales, wheezing, bronchitis, dyspnea (breathing difficulty); eczema

PPE: Respirator: Recommendations - NIOSH: (as V)
dust and fume: Up to 0.5 mg/m^3: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 1.25 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter [note: substance reported to cause eye irritation or damage; may require eye protection]; up to 2.5 mg/m^3:

(APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 35 mg/m^3: (APF = 2000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode

Skin: *Dust*: prevent skin contact; any barrier that will prevent contamination from the dust
fume: no specific recommendation can be made; actual working onditions will determine the need and type of personal protective equipment

Eyes: *Dust*: prevent eye contact
fume: no recommendation is made for specific eye protection

Special Precautions: *Dust*: noncombustible solid, but may increase intensity of fire when in contact with combustible materials
fume: noncombustible solid

LABORATORY INFORMATION

CAS Number: 1314-62-1
Analytical Technique: NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)
Analytical Reference Method: NIOSH 7300 (IV)

SAMPLING INFORMATION

Full Shift Sampling:
Sampling Strategy: See Chapter 7
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 5-2000

Short Term Sampling:
Sampling Strategy: See Chapter 7
Sampling Duration: 15 min.
Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter
Sample Flow Rate (Lpm): 1.7
Air Collection Volume: Minimum - Maximum (L): 5-2000

Special Instructions: N/A

Wipe Sampling:
Sampling Strategy: See Chapter 14
Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water
Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Vinyl Chloride - CH_2=CHCl

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
995	200 ppm	500 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Chloroethene, chloroethylene, ethylene monochloride, monochlorethene, monochlorethylene, VC, vinyl chloride monomer (VCM)

Sources: Refrigerant

Description: Colorless gas or liquid (below 7°F) with a pleasant odor at high concentrations; [note: shipped as a liquefied compressed gas]

Incompatibilities: Copper, oxidizers, aluminum, peroxides, iron, steel; [note: polymerizes in air, sunlight, or heat unless stabilized by inhibitors such as phenol; attacks iron and steel in presence of moisture]

Exposure: Inhalation, skin, and/or eye contact (liquid)

Health Effects: Weakness; abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; liquid: frostbite; [note: potential occupational carcinogen]

PPE: Respirator: Recommendations - NIOSH: At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: Prevent skin contact; frostbite; 8 hr: Tychem; 4 hr: PVA, Teflon; prevent possible skin freezing from direct liquid contact

Eyes: Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite

Special Precautions: Flammable gas

LABORATORY INFORMATION

CAS Number: 75-01-4

Analytical Technique: NIOSH 1007 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 75: gas chromatography (GC) / flame ionization detector (FID); Dräger: detector tube

Analytical Reference Method: NIOSH 1007 (IV); OSHA 1001; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9

1. NIOSH 1007 (IV):

Collection Media: solid sorbent tubes [i.e., two tandem tubes, each with 150 mg of 20/40 mesh activated (600°F) coconut shell charcoal; (note: a pair of two-section 100/50 mg tubes may be used)]

Sample Flow Rate: Minimum - Maximum (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 0.7-5

2. OSHA 75:

Collection Media: solid sorbent tube [130/65 mg of 60/80 mesh Carbosieve S-III (carbon based molecular sieve) adsorbent tube]

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 3

Short Term Sampling:

Sampling Strategy: See Chapter 9

Sampling Duration: 15 min.

1. NIOSH 1007 (IV):

Collection Media: solid sorbent tubes [i.e., two tandem tubes, each with 150 mg of 20/40 mesh activated (600°F) coconut shell charcoal; (note: a pair of two-section 100/50 mg tubes may be used)]

Sample Flow Rate: Minimum - Maximum (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 0.75

2. OSHA 75:

Collection Media: solid sorbent tube [130/65 mg of 60/80 mesh Carbosieve S-III (carbon based molecular sieve) adsorbent tube]

Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume (L): 0.75

Special Instructions:

1. NIOSH 1007 (IV): Separate primary and backup tubes, and cap each. Sample remains stable for 10 days at room temperature.

2. OSHA 75: Samples are to be stored at reduced temperature after they have been received at the analytical laboratory.

Grab Sampling:
Sampling Strategy: See Chapter 11
Collection Media: Dräger detector tube, #8101721, range 0.125-30 ppm (EF = 1.35); Dräger detector tube, #6728031, range 1-50 ppm (EF = 1.15); Dräger detector tube, #CH19601, range 100-3,000 ppm (EF = 1.30).

Welding Fume Profile
(Metals)

Metal Analyzed: Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Magnesium, Molybdenum, Nickel, Vanadium, Zinc

CONTAMINANT INFORMATION

Synonyms: Vary depending upon the specific component of the welding fumes

Sources: Welding and cutting of metals and alloys; electroplating; nickel sulfide (Ni_3S_2) in smelting and refining of some nickel ores

Description: Properties vary depending upon the specific component of the welding fumes

Incompatibilities: Vary depending upon the specific component of the welding fumes

Exposure: Inhalation, skin and/or eye contact

Health Effects: Symptoms vary depending upon the specific component of the welding fumes; metal fume fever: flu-like symptoms, dyspnea (breathing difficulty), cough, muscle pain, fever, chills; interstitial pneumonia; [note: some welding fumes are potential occupational carcinogens]

PPE: Respirator: Recommendations - NIOSH: At any detectable concentration: (APF = 10,000) any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; (APF = 10,000) any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Skin: No recommendation is made specifying the need for personal protective equipment for the body

Eyes: No specific recommendation is made for type of eye protection

Special Precautions: Vary depending upon the specific component of the welding fumes

LABORATORY INFORMATION

CAS Number: Varies depending upon the specific component of the welding fumes

Analytical Technique: OSHA ID-125G: inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES); NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)

Analytical Reference Method: OSHA ID-125G; NIOSH 7300 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 7

1. OSHA ID-125G:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume (L): 480

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-1000

Short Term Sampling:

Sampling Strategy: See Chapter 7

Sampling Duration: 15 min.

1. OSHA ID-125G:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume (L): 30

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-1000

Special Instructions: N/A

Wipe Sampling:

Sampling Strategy: See Chapter 14

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Xylene (Xylol) - $C_6H_4(CH_3)_2$
900 ppm IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	ANSI Z37.10-1971 STEL/Ceiling (C):
223	100 ppm	200 ppm (C)
225 (m-xylene)	100 ppm	200 ppm (C)
227 (o-xylene)	100 ppm	200 ppm (C)
229 (p-xylene)	100 ppm	200 ppm (C)

CONTAMINANT INFORMATION

Synonyms: *o-xylene:* 1,2-dimethylbenzene, ortho-xylene, o-xylol
m-xylene: 1,3-dimethylbenzene, meta-xylene, m-xylol
p-xylene: 1,4-dimethylbenzene, para-xylene, p-xylol

Sources: Solvents, cleaning agents, fuels

Description: Colorless liquid with an aromatic odor

Incompatibilities: Strong oxidizers, strong acids

Exposure: Inhalation, skin absorption, ingestion, skin and/or eye contact

Health Effects: Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, Loss of coordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

PPE: Respirator: Recommendations - NIOSH/OSHA: up to 900 ppm: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 25) any powered, air-purifying respirator with organic vapor cartridge(s) [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 10) any supplied-air respirator [note: substance reported to cause eye irritation or damage; may require eye protection]; (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Prevent skin contact; contact the manufacturer for recommendations

Eyes: Prevent eye contact

Special Precautions: Class IC flammable liquid

LABORATORY INFORMATION

CAS Numbers: 1330-20-7 (all isomers), 95-47-6 (o-xylene), 108-38-3 (m-xylene), 106-42-3 (p-xylene)

Analytical Technique: NIOSH 1501 (IV): gas chromatography (GC) / flame ionization detector (FID); OSHA 1002: gas chromatography (GC) / flame ionization detector (FID); 3M: passive monitor; Dräger: detector tube

Analytical Reference Method: NIOSH 1501 (IV); OSHA 1002; 3M; Dräger

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 9

1. NIOSH 1501 (IV):

Collection Media: solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 2-23

2. OSHA 1002:

(A) **Collection Media:** Solid sorbent tube (100/50 mg coconut shell charcoal)
Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): 12

(B) **Collection Media:** Passive monitor, SKC, 575-002 (500 mg of Anasorb 747)
Note: maximum 4-hour sample per badge

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Strategy: See Chapter 9

Sampling Duration: 5-15 min.

1. NIOSH 1501 (IV):

Collection Media: solid sorbent tube (100/50 mg coconut shell charcoal)

Sample Flow Rate: Minimum - Maximum (Lpm): 0.01-0.2; Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: Minimum – Maximum (L): 2-23

2. OSHA 1002:

(A) **Collection Media:** solid sorbent tube (100/50 mg coconut shell charcoal)
Sample Flow Rate (Lpm): 0.05; Must use a pump adaptor or arrange for low flow pumps.
Air Collection Volume (L): $\geq$0.25

(B) **Collection Media:** Passive monitor, SKC, 575-002 (500 mg of Anasorb 747)
Note: minimum 5-minute sample per badge

Special Instructions:

1. NIOSH 1501 (IV): Sample stability not determined; a bulk sample (1 to 10 mL) is desirable, to be shipped in a separate container.

2. OSHA 1002:

(A) List any chemicals that could be considered potential interferences, especially solvents that are in use in the sampling area. Submit the samples to the MSHA laboratory for analysis as soon as possible. Store the samples in a refrigerator if delay is unavoidable. Ship any bulk samples separate from air samples.

(B) Record sampling site temperature and atmospheric pressure. List any chemicals that could be considered potential interferences, especially solvents that are in use in the sampling area. Submit the samples to the MSHA laboratory for analysis as soon as possible. Store the samples in a refrigerator if delay is unavoidable. Include the port plugs and PTFE tubes which will be used in the laboratory analysis. Ship any bulk samples separate from air samples.

3. 3M: N/A

Grab Sampling:

Sampling Strategy: See Chapter 11

Collection Media: Dräger detector tube, #6733161, range 10-1,000 ppm (EF = 1.30).

Zinc Oxide - ZnO

500 mg/m^3 IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1968 PA Rules STEL/Ceiling (C):
745 (fume)	5.0 mg/m^3	10 mg/m^3 - 30 min.

CONTAMINANT INFORMATION

Synonyms: Zinc peroxide; china white; zinc white; zincite

Sources: *Oxide*: metallic zinc in galvanizing, electroplating, alloying: zinc oxide in pigments; smelting ores of zincite, smithsonite, willemite, hemimorphite, franlinite, lead, copper.
chloride: soldering flux, iron/copper processing

Description: White, odorless solid

Incompatibilities: Chlorinated rubber (at 419°F); water; [note: slowly decomposed by water]

Exposure: Inhalation

Health Effects: Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; weakness, lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; fatigue; malaise (vague feeling of discomfort); tightness chest; dyspnea (breathing difficulty), rales, decreased pulmonary function

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 50 mg/m^3: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 125 mg/m^3: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter; up to 250 mg/m^3: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 50) any supplied-air respirator that has a tight-fitting facepiece and is operated in a continuous-flow mode; (APF = 50) any powered, air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter; (APF = 50) any self-contained breathing apparatus with a full facepiece; (APF = 50) any supplied-air respirator with a full facepiece; up to 500 mg/m^3: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

Skin: No recommendation is made specifying the need for personal protective equipment for the body

Eyes: No recommendation is made specifying a need for eye protection

Special Precautions: Noncombustible solid

LABORATORY INFORMATION

CAS Number: 1314-13-2
Analytical Technique: NIOSH 7502 (IV): x-ray powder diffraction; OSHA ID-143: x-ray diffraction
Analytical Reference Method: NIOSH 7502 (IV); OSHA ID-143

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 7
1. NIOSH 7502 (IV):
Collection Media: 25-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter in open-face cassette (note: an extension cowl on the filter cassette is desirable to produce a more uniform deposit and to prevent contamination of the open-face filter during sampling)
Sample Flow Rate: Minimum - Maximum (Lpm): 1-3
Air Collection Volume: Minimum - Maximum (L): 10-400
2. OSHA ID-143:
Collection Media: 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 960

Short Term Sampling:

Sampling Strategy: See Chapter 7
Sampling Duration: 30 min.
1. NIOSH 7502 (IV):
Collection Media: 25-mm diameter, 0.8-µm pore size polyvinyl chloride (PVC) filter in open-face cassette; (note: an extension cowl on the filter cassette is desirable to produce a more uniform deposit and to prevent contamination of the open-face filter during sampling)
Sample Flow Rate: Minimum - Maximum (Lpm): 1-3
Air Collection Volume: Minimum - Maximum (L): 10-400
2. OSHA ID-143:
Collection Media: 37-mm diameter, 5-µm pore size polyvinyl chloride (PVC) filter
Sample Flow Rate (Lpm): 2
Air Collection Volume (L): 30

Special Instructions:

1. NIOSH 7502 (IV): Take a required bulk, high-volume (4,000 L) air sample using a clean sampler and high-volume sampling pump in the same area as the personal sample(s) for qualitative identification.
2. OSHA ID-143: N/A

Zirconium Compounds (as Zr)
25 mg/m^3 (as Zr) IDLH (NIOSH, 1995)

Contaminant Codes:	1973 ACGIH TLV:	1973 ACGIH Excursion STEL/Ceiling (C):
643	5.0 mg/m^3	10 mg/m^3 - 15 min.

CONTAMINANT INFORMATION

Synonyms: *Metal:* zirconium metal
compounds: vary depending upon the specific compound

Sources: Zircon ore, monazite, all crystalline rocks (especially granite, sanity, schist, and gneiss), reducing agent in metallurgy

Description: *Metal:* soft, malleable, ductile, solid or gray to gold, amorphous powder
compounds: varies; zircon ore is a sand, sometimes pink in color

Incompatibilities: *Metal:* potassium nitrate, oxidizers; [note: fine powder may be stored completely immersed in water]
compounds: vary

Exposure: Inhalation, skin and/or eye contact

Health Effects: Skin, lung granulomas

PPE: Respirator: Recommendations - NIOSH/OSHA: Up to 25 mg/m^3: (APF = 5) any dust and mist respirator; up to 50 mg/m^3: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 25) any powered, air-purifying respirator with a dust and mist filter; (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; (APF = 50) any self-contained breathing apparatus with a full facepiece

Skin: Recommendations regarding personal protective clothing vary depending upon the specific compound; contact the manufacturer for recommendations for the specific compound

Eyes: Recommendations regarding eye protection vary depending upon the specific compound

Special Precautions: *Metal:* combustible, but solid form is difficult to ignite; however, powder form may ignite SPONTANEOUSLY and can continue burning under water

LABORATORY INFORMATION

CAS Number: 7440-67-7 (*metal*)

Analytical Technique: OSHA ID-121: atomic absorption spectroscopy (AAS) or atomic emission spectroscopy (AES); NIOSH 7300 (IV): inductively coupled argon plasma, atomic emission spectroscopy (ICAP-AES)

Analytical Reference Method: OSHA ID-121; NIOSH 7300 (IV)

SAMPLING INFORMATION

Full Shift Sampling:

Sampling Strategy: See Chapter 7

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume: Minimum - Maximum (L): 480-960

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-200

Short Term Sampling:

Sampling Strategy: See Chapter 7

Sampling Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 2

Air Collection Volume (L): 30

2. NIOSH 7300 (IV):

Collection Media: 37-mm diameter, 0.8-µm pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (Lpm): 1.7

Air Collection Volume: Minimum - Maximum (L): 5-200

Special Instructions: N/A

Wipe Sampling:

Sampling Strategy: See Chapter 14

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

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Chapter 3

APPENDIX A
Abbreviations

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Chapter 3
Appendix A
ABBREVIATIONS

ANSI	American National Standards Institute
C	Ceiling Limit
DRI	Direct Reading Instrument
EPA	Environmental Protection Agency
L	Liter
Lpm	Liter per minute
mL	milliLiters (or cubic centimeters)
N/A	Not Applicable
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PA Rule	Pennsylvania Rule STELs
STEL	Short-Term Exposure Limit
TLV	Threshold Limit Value

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Chapter 3

APPENDIX B
Synonyms

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Chapter 3
Appendix B
Synonyms

Chemical	Cross Reference
1,1,1-trichloroethane	methyl chloroform
1,2,5,6-dibenzonaphthalene	coal tar pitch volatiles
1,4-dimethyl benzene	xylene
1,2-dimethyl benzene	xylene
1,3-dimethyl benzene	xylene
1,1,3-trichloroethylene	trichloroethylene
1,1-dichloro-2-chloroethylene	trichloroethylene
1-butanol	n-butyl alcohol
1-chlor-2,2-dichloroethylene	trichloroethylene
1-hydroxybutane	n-butyl alcohol
1-hydroxy-2-methylbenzene	cresol
1-hydroxy-3-methylbenzene	cresol
1-hydroxy-4-methylbenzene	cresol
1-propanol	n-propyl alcohol
2-butanol	sec-butyl alcohol
2-butanone	methyl ethyl ketone
2-hydroxybutane	sec-butyl alcohol
2-methyl-2-propanol	tert-butyl alcohol
2-methyl-4-pentanone	hexone (methyl isobutyl ketone)
2-methyl-5-hexanone	methyl isoamyl ketone
2-oxobutane	methyl ethyl ketone
2-propanol	isopropyl alcohol
2-propanone	acetone
4-methyl-2-pentanol	methyl isobutyl carbinol
4-methyl-2-pentanone	hexone (methyl isobutyl ketone)
5-methyl-2-hexanone	methyl isoamyl ketone
A-Fil cream	titanium dioxide
aboline	oil mist (mineral oil)
absolute alcohol	ethyl alcohol
acetic acid (aqueous)	acetic acid
acetic ester	ethyl acetate
acetic ether	ethyl acetate
acetidin	ethyl acetate
acetoxuethane	ethyl acetate
acetylene trichloride	trichloroethylene
actinolite	asbestos
actinolite asbestos	asbestos
adepsine oil	oil mist (mineral oil)
aero liquid HCN	hydrogen cyanide

aerothene	methyl chloroform
agate	quartz, crystalline silica
alcohol	ethyl alcohol
algrain	ethyl alcohol
algylen	trichloroethylene
alumina	aluminum
aluminum trioxide	aluminum
alundum	aluminum
alundum	dust, total
amethyst	quartz, crystalline silica
ammonia gas	ammonia
amorphous carbon	graphite (natural)
amosite	asbestos
anhydrol	ethyl alcohol
anhydrous alcohol	ethyl alcohol
anhydrous ammonia	ammonia
anhydrous hydrochloric acid	hydrogen chloride
anhydrous hydrofluoric acid	hydrogen fluoride
ankilostin	perchloroethylene
anone	cyclohexanone
anthophyllite	asbestos
anthophyllite asbestos	asbestos
anthracin	coal tar pitch volatiles
antimonate	antimony
antimonic	antimony
antimonial	antimony
antimonious	antimony
antimony hydride	antimony (stibine)
antimony trihydride	antimony (stibine)
antimonyl	antimony
aqua ammonia	ammonia
aqua fortis	nitric acid
aqueous ammonia	ammonia
aqueous hydrogen chloride	hydrogen chloride
aqueous hydrogen fluoride	hydrogen fluoride
aqueous hydrogen peroxide	hydrogen peroxide
argentic fluoride	silver (soluble compounds)
argentium crede	silver
argentum	silver
arsenia	arsenic
arsenic acid	arsenic
arsenic chloride	arsenic
arsenic disulfide	arsenic
arsenic hydride	arsine
arsenic pentoxide	arsenic
arsenic salt	arsenic

arsenic sesquioxide	arsenic
arsenic trichloride	arsenic
arsenic (III) trichloride	arsenic
arsenic trihydride	arsine
arsenic trioxide	arsenic
arsenic trisulfide	arsenic
arsenic yellow	arsenic
arseniuretted hydrogen	arsine
arsenous acid	arsenic
arsenous acid anhydride	arsenic
arsenous chloride	arsenic
arsenous hydride	arsine
arsenous oxide	arsenic
austiox	titanium dioxide
azotic acid	nitric acid
B(a)P	coal tar pitch volatiles
barium carbonate	barium
barium chlorate	barium
barium chromate	barium
barium cyanide	barium
barium hydroxide	barium
barium nitrate	barium
barium oxide	barium
barium perchlorate	barium
barium permanganate	barium
barium peroxide	barium
barium sulfate	barium
barium sulfide	barium
barium sulfite	barium
battery acid	sulfuric acid
bayeritian	titanium dioxide
benz(a)phenanthrene	coal tar pitch volatiles
benz(a)pyrene	coal tar pitch volatiles
benzin	naphtha (coal tar)
benzine	naphtha (coal tar)
benzinoform	carbon tetrachloride
benzinol	trichloroethylene
benzo(a)phenanthrene	coal tar pitch volatiles
benzo(b)quinoline	coal tar pitch volatiles
benzo(d,e,f)chrysene	coal tar pitch volatiles
benzo(d,e,f)phenanthrene	coal tar pitch volatiles
benzol	benzene
benzole	benzene
benzoline	naphtha (coal tar)
benzophenanthrene	coal tar pitch volatiles
benzopyrene	coal tar pitch volatiles

benzypyrene	coal tar pitch volatiles
beryllium chloride	beryllium
beryllium fluoride	beryllium
beryllium nitrate	beryllium
beryllium oxide	beryllium
beryllium salts	beryllium
beryllium sulfide	beryllium
biotite	mica
bisulfite	sulfur dioxide
bituminous coal	coal dust
black lead	graphite (natural)
boracic acid anhydride	boron oxide
boric anhydride	boron oxide
boric oxide	boron oxide
boron sesquioxide	boron oxide
boron trioxide	boron oxide
BOV	sulfuric acid
brocide	1,2-dichloroethane
BTEX	benzene, toluene, ethylbenzene, xylene
burnt lime	calcium oxide
buttercup yellow	chromic acid
butanol	n-butyl alcohol
butyl acetate	n-butyl acetate
butyl alcohol	n-butyl alcohol
butyl ethanoate	n-butyl acetate
butyl hydroxide	n-butyl alcohol
butylene hydrate	sec-butyl alcohol
butyric alcohol	n-butyl alcohol
cable oil	oil mist (mineral oil)
cadmium acetate	cadmium
cadmium bromide	cadmium
cadmium chloride	cadmium
cadmium cyanide	cadmium
cadmium fluoroborate	cadmium
cadmium nitrate	cadmium
cadmium oxide	cadmium
cadmium sulfate	cadmium
calcichew	calcium oxide (calcium compounds)
calcidia	calcium oxide (calcium compounds)
calcined diatomite	cristobalite
calcined diatomite	tridymite
calcined silica	tridymite
calcit	calcium oxide (calcium compounds)
calcium carbonate	dust, total
calcium hydrate	calcium oxide

calcium hydroxide	calcium oxide
calcium salt	calcium oxide (calcium compounds)
calx	calcium oxide
canadol	naphtha (coal tar)
cannel coal	coal dust
carbinol	methyl alcohol
carbon bichloride	perchloroethylene
carbon bisulfide	carbon disulfide
carbon chloride	carbon tetrachloride
carbon dichloride	perchloroethylene
carbon disulphide	carbon disulfide
carbon nitride	cyanide
carbon oxide	carbon monoxide
carbon oxychloride	phosgene
carbon Tet	carbon tetrachloride
carbonic acid	calcium oxide (calcium compounds)
carbonic acid gas	carbon dioxide
carbonic anhydride	carbon dioxide
carbonic gas	carbon dioxide
carbonyl chloride	phosgene
carbonyl dichloride	phosgene
caustic	sodium hydroxide
caustic arsenic chloride	arsenic
caustic flake	sodium hydroxide
caustic soda	sodium hydroxide
cellulose (paper fiber)	dust, total
cement	dust, total
cement clinker	dust, total
cement kiln dust	calcium oxide
cement kiln feed	dust, total
cement raw meal	dust, total
chalcedony	quartz, crystalline silica
chalk	calcium oxide (calcium compounds)
China white	zinc oxide
chlorine oxide	chlorine dioxide
chlorine peroxide	chlorine dioxide
chloroetene	methyl chloroform
chloroethene	vinyl chloride
chloroethylene	vinyl chloride
chloroformyl chloride	phosgene
chlorothene	methyl chloroform
chlorten	methyl chloroform
chlorylene	trichloroethylene
chromic acetate hexahydrate	chromous salts
chromic acid salts	chromic acid
chromic anhydride	chromic acid

chromic anhydride	chromous salts
chromic nitrate	chromous salts
chromic oxide	chromous salts
chromic sulfate	chromous salts
chromium trioxide	chromic acid
chromium trioxide	chromous salts
chrysotile	asbestos
citrical	calcium oxide (calcium compounds)
clinker	dust, total
CKD	calcium oxide
coal oil	kerosene
coal tar creosote, vapors	coal tar pitch volatiles
cobalt metal dust	cobalt
cobalt metal fumes	cobalt
coking coal	coal dust
collargol	silver
colloidal manganese	manganese
colloidial silver	silver
cologne spirit	ethyl alcohol
colonial spirit	methyl alcohol
Columbian spirits	methyl alcohol
copperas	iron oxide (iron salts)
copper metal dust	copper
copper metal fumes	copper
copper oxide	copper
corundum	aluminum
corundum	dust, total
creosote volatiles	coal tar pitch volatiles
-cresol	cresol
cresyl alcohol	cresol
-cresylic acid	cresol
cresylol	cresol
crocidolite	asbestos
crude solvent	naphtha (coal tar)
crystalline carbon	graphite (natural)
crystalline silica	quartz
crystosol	oil mist (mineral oil)
cummingtonite	asbestos
cutting oil	oil mist (mineral oil)
cyclohexatriene	benzene
cyclohexyl ketone	cyclohexanone
dehydrated alcohol	ethyl alcohol
denatured alcohol	ethyl alcohol
deobase	kerosene
diatomaceous earth	amorphous silica
diatomaceous silica	amorphous silica

diatomite	amorphous silica
dibenzo(b,e)pyridine	coal tar pitch volatiles
dichloroethane	1,2-dichloroethane
dichromates	chromic acid
didakene	perchloroethylene
diiron trisulfate	iron oxide (iron salts)
dimethyl benzine	xylene
dimethylcarbinol	isopropyl alcohol
dimethyl ketone	acetone
dinitrogen tetroxide	nitrogen dioxide
dipping acid	sulfuric acid
dipropyl methane	n-heptane
distillates	naphtha (coal tar)
divanadium pentoxide	vanadium oxide
drakeol	oil mist (mineral oil)
dried ferrous sulfate	iron oxide (iron salts)
drierite	calcium oxide (calcium compounds)
dry ice	carbon dioxide
dry-cleaners' naphtha	stoddard solvent
dusting powder	talc
Dutch liquid	1,2-dichloroethane
EB	ethylbenzene
EDC	1,2-dichloroethane
elemental mercury	mercury
elemental nickel metal	nickel
emery	dust, total
engravers' acid	nitric acid
ethanoic acid	acetic acid
ethanol	ethyl alcohol
ethinyl	trichloroethylene
ethyl carbinol	n-propyl alcohol
ethyl ester of acetic acid	ethyl acetate
ethyl ethanoate	ethyl acetate
ethyl hydrate	ethyl alcohol
ethyl hydroxide	ethyl alcohol
ethyl methyl ketone	methyl ethyl ketone
ethylbenzol	ethylbenzene
ethylene chloride	1,2-dichloroethane
ethylene dichloride	1,2-dichloroethane
ethylene monochloride	vinyl chloride
ethylene tetrachloride	perchloroethylene
ethylene trichloride	trichloroethylene
ethylmethyl carbinol	sec-butyl alcohol
ETOH	ethyl alcohol
exhaust gas	carbon monoxide
expanded perlite	perlite

fat coal	coal dust
feosfor	iron oxide (iron salts)
feosol	iron oxide (iron salts)
feospan	iron oxide (iron salts)
fermenicide liquid	sulfur dioxide
fermenicide powder	sulfur dioxide
feromax	iron oxide (iron salts)
feroritard	iron oxide (iron salts)
ferric chloride	iron oxide (iron salts)
ferric nitrate	iron oxide (iron salts)
ferric oxide	iron oxide
ferric persulfate	iron oxide (iron salts)
ferric sesquioxide	iron oxide
ferric susquisulfate	iron oxide (iron salts)
ferric sulfate	iron oxide (iron salts)
ferric tersulfate	iron oxide (iron salts)
ferrous chloride	iron oxide (iron salts)
ferrous sulfate	iron oxide (iron salts)
fertilizer acid	sulfuric acid
fespan	iron oxide (iron salts)
fiber glass	dust, total
fibrous glass dust	dust, total
flamenco	titanium dioxide
flaming coal	coal dust
Fleet-X	trimethyl benzene
flint	quartz, crystalline silica
Flores Martis	iron oxide (iron salts)
florspar	fluorine
flowers of zinc	zinc oxide
flue gas	carbon monoxide
fluoride	fluorine
fluorine-19	fluorine
fluorite	fluorine
fluorohydric acid	hydrogen fluoride
fluorspar	fluorine
formalin	formaldehyde
formalith	formaldehyde
formic aldehyde	formaldehyde
formol	formaldehyde
formonitrile	hydrogen cyanide
French chalk	talc
Freon® 10	carbon tetrachloride
fuel oil No. 1	kerosene
fuming liquid arsenic	arsenic
fused boric acid	boron oxide
fused silica	amorphous silica

fused sodium potassium aluminum silicate	perlite
fyde	formaldehyde
gas coal	coal dust
gemalgene	trichloroethylene
glacial acetic acid	acetic acid
glass dust	dust, total
glass - fibrous	dust, total
glass wool	dust, total
glucinium	beryllium
glycerin mist	dust, total
glycol dichloride	1,2-dichloroethane
glynol	oil mist (mineral oil)
grain alcohol	ethyl alcohol
graphite (synthetic)	dust, total
gray arsenic	arsenic
green oil	coal tar pitch volatiles
green vitriol	iron oxide (iron salts)
grunerite	asbestos
gum turpentine	turpentine
gum spirits	turpentine
gypsum	calcium oxide (calcium compounds)
gypsum	dust, total
Halon® 104	carbon tetrachloride
heavy lubricating oil	oil mist (mineral oil)
hemimellitene	trimethyl benzene
hepatic gas	hydrogen sulfide
heptane	n-heptane
heptyl hydride	n-heptane
hexane	n-hexane
hexanon	cyclohexanone
hexyl hydride	n-hexane
hi-flash naphtha	naphtha (coal tar)
high solvent naphtha	naphtha (coal tar)
high-strength hydrogen peroxide	hydrogen peroxide
hombitan	titanium dioxide
hot liquor	sodium hydroxide
hyacinth	zirconium
hydrated calcium oxide	calcium oxide
hydrated mineral silicates	asbestos
hydrocyanic acid	hydrogen cyanide
hydrofluoric acid	hydrogen fluoride
hydrofluoric acid gas	hydrogen fluoride
hydrofluoride	hydrogen fluoride
hydrogen antimonide	antimony
hydrogen arsenide	arsine
hydrogen dioxide	hydrogen peroxide

hydrogen nitrate	nitric acid
hydrogen sulfate	sulfuric acid
hydroperoxide	hydrogen peroxide
hydrosulfuric acid	hydrogen sulfide
hydrotreated naphtha	naphtha (coal tar)
hydrous magnesium silicate	talc
-hydroxy toluene	cresol
hytrol-o	cyclohexanone
illuminating oil	kerosene
ilmenite	titanium dioxide
infusorial earth	amorphous silica
infusorial silica	amorphous silica
inhibisol	methyl chloroform
IPA	isopropyl alcohol
iron dihydrate	iron oxide (iron salts)
iron persulfate	iron oxide (iron salts)
iron sesquisulfate	iron oxide (iron salts)
iron tersulfate	iron oxide (iron salts)
iron tetrahydrate	iron oxide (iron salts)
iron trichloride	iron oxide (iron salts)
iron trinitrite	iron oxide (iron salts)
iron vitriol	iron oxide (iron salts)
ironate	iron oxide (iron salts)
isoamyl methyl ketone	methyl isoamyl ketone
isobutyl methyl carbinol	methyl isobutyl carbinol
isobutyl methyl ketone	hexone (methyl isobutyl ketone)
isopentyl methyl ketone	methyl isoamyl ketone
isopropanol	isopropyl alcohol
isopropyl acetone	hexone (methyl isobutyl ketone)
jet fuel (JT-1)	kerosene
jeweler’s rouge	iron oxide
kaolin	dust, total
kaydol	oil mist (mineral oil)
kerosine	kerosene
ketone propane	acetone
ketohexamethylene	cyclohexanone
kieselguhr	amorphous silica
King’s gold	arsenic
King’s yellow	arsenic
kremol	oil mist (mineral oil)
lead oxide	lead
lepidolite	mica
leucoxene	titanium dioxide
light naphtha	naphtha (coal tar)
ligroin	naphtha (coal tar)
lime	calcium oxide

limestone	dust, total
liquid ammonia	ammonia
liquid caustic	sodium hydroxide
liquid paraffin	oil mist (mineral oil)
liquid petrolatum	oil mist (mineral oil)
lunar caustic	silver (soluble compounds)
lutosol	isopropyl alcohol
lye	sodium hydroxide
m-xylene	xylene
m-xylol	xylene
magnesia fume	magnesium oxide fume
magnesite	dust, total
manganese oxide	manganese
marble	calcium oxide (calcium compounds)
marble	dust, total
margarite	mica
masonry cement	dust, total
massive talc	soapstone
MEK	methyl ethyl ketone
mercurious vitae	antimony
mercury acetate	mercury (alkyl compounds)
mercury liquid	mercury
mercury metal	mercury
mercury oleate	mercury (alkyl compounds)
mercury salts	mercury
mercury vapor	mercury
mesitylene	trimethyl benzene
meta-xylene	xylene
metallic arsenic	arsenic
metallic lead	lead
methacide	toluene
methanal	formaldehyde
methane carboxylic acid	acetic acid
methane tetrachloride	carbon tetrachloride
methane trichloride	chloroform
methanol	methyl alcohol
methenyl tribromide	bromoform
methyl aldehyde	formaldehyde
methylamyl alcohol	methyl isobutyl carbinol
methylbenzene	toluene
methylbenzol	toluene
methylethylcarbinol	sec-butyl alcohol
methyl hydroxide	methyl alcohol
methyl mercury	mercury (alkyl compounds)
methyl phenol	cresol
-methyl phenol	cresol

methyl toluene	xylene
methyl tribromide	bromoform
methyl trichloromethane	methyl chloroform
methylene oxide	formaldehyde
methylol	methyl alcohol
MIAK	methyl isoamyl ketone
MIBC	methyl isobutyl carbinol
MIBK	hexone (methyl isobutyl ketone)
MIK	hexone (methyl isobutyl ketone)
mineral carbon	graphite (natural)
mineral spirits	naphtha (coal tar)
mineral spirits	stoddard solvent
mineral oil mist	oil mist (mineral oil)
molecular chlorine	chlorine
molol	oil mist (mineral oil)
molybdenum metal	molybdenum
monochlorethene	vinyl chloride
monochlorethylene	vinyl chloride
monohydroxy methane	methyl alcohol
mononitrogen monoxide	nitric oxide
monoxide	carbon monoxide
morbicid	formaldehyde
motor fuel	gasoline
motor fuel	n-heptane
motor spirits	gasoline
motor spirits	n-heptane
muriatic acid	hydrogen chloride
muscovite	mica
n-butanol	n-butyl alcohol
n-butyl ester of acetic acid	n-butyl acetate
n-octane	octane
n-propanol	n-propyl alcohol
n-propylcarbinol	n-butyl alcohol
nadone	cyclohexanone
naphtha	naphtha (coal tar)
naphtha safety solvent	stoddard solvent
natural gasoline	Gasoline
NBA	n-butyl alcohol
necatorina	carbon tetrachloride
nema	perchloroethylene
nickel catalyst	nickel
nitric acid iron + 3 salt	iron oxide (iron salts)
nitrogen monoxide	nitric oxide
nitrogen peroxide	nitrogen dioxide
nitrogen tetroxide	nitrogen dioxide
normal-hexane	n-hexane

normal-octane	octane
nuisance dust	dust, total
o-xylene	xylene
o-xylol	xylene
oil of turpentine	turpentine
oil of vitriol	sulfuric acid
oil rectifier	turpentine
opaline silica	amorphous silica
optal 1-hydroxy propane	n-propyl alcohol
organic mercury	mercury (alkyl compounds)
orpiment	arsenic
orthoarsenic acid	arsenic
orthoboric acid anhydride	boron oxide
ortho-xylene	xylene
oxomethane	formaldehyde
oxymethylene	formaldehyde
p-xylene	xylene
p-xylol	xylene
painters' naphtha	naphtha (coal tar)
pantaerythritol	dust, total
paraffin oil mist	oil mist (mineral oil)
para-xylene	xylene
Paris white	calcium oxide (calcium compounds)
parol	oil mist (mineral oil)
paroleine	oil mist (mineral oil)
parrot coal	coal dust
perchlor	perchloroethylene
perchloromethane	carbon tetrachloride
perclene	perchloroethylene
percosolve	perchloroethylene
perk	perchloroethylene
perklone	perchloroethylene
permachlor	trichloroethylene
peroxide	hydrogen peroxide
persec	perchloroethylene
petrohol	isopropyl alcohol
petrol	n-heptane
petrol	gasoline
petroleum	naphtha (coal tar)
petroleum benzin	naphtha (coal tar)
petroleum distillates	naphtha (coal tar)
petroleum ether	naphtha (coal tar)
petroleum naphtha	naphtha (coal tar)
petroleum solvent	stoddard solvent
petroleum spirits	naphtha (coal tar)
petroleum spirits	stoddard solvent

phenantrin	coal tar pitch volatiles
phenylethane	ethylbenzene
phenyl hydride	benzene
phenyl methane	toluene
phlogopite	mica
phosphorated hydrogen	phosphine
phosphorus hydride	phosphine
phosphorus trihydride	phosphine
pigment white	titanium dioxide
pimelic ketone	cyclohexanone
plaster of Paris	calcium oxide (calcium compounds)
plaster of Paris	dust, total
plumbago	graphite (natural)
plumbum	lead
plumbous salts	lead
polychromates	chromic acid
portland cement	dust, total
potassium cyanide	cyanide
powder of Algaroth	antimony
precipitated amorphous silica	amorphous silica
propan-2-ol	isopropyl alcohol
propyl alcohol	n-propyl alcohol
propylcarbinol	n-butyl alcohol
propyl methane	n-heptane
propylic alcohol	n-propyl alcohol
prussic acid	hydrogen cyanide
pseudocumene	trimethyl benzene
pseudocumol	trimethyl benzene
psi-cumene	trimethyl benzene
β-pyrine	coal tar pitch volatiles
pyroacetic ether	acetone
pyroligneous spirit	methyl alcohol
pyroxylic spirit	methyl alcohol
quick lime	calcium oxide
quicksilver	mercury
range oil	kerosene
rayox	titanium dioxide
realgar	arsenic
red arsenic glass	arsenic
red arsenic sulfide	arsenic
red fuming nitric acid	nitric acid
red orpiment	arsenic
refined solvent naphtha	naphtha (coal tar)
RFNA	nitric acid
riebeckite	asbestos
roscoelite	mica

rouge	dust, total
rubbing alcohol	isopropyl alcohol
rubigine	hydrogen fluoride
ruby arsenic	arsenic
rutile	titanium dioxide
Safety-Kleen	stoddard solvent
salt of Saturn	lead
sand	quartz, crystalline silica
sassolite	boron oxide
sec-propyl alcohol	isopropyl alcohol
selenide	selenium
selenious	selenium
selenyl	selenium
selsun	selenium
sewer gas	hydrogen sulfide
sextone	cyclohexanone
silica	tridymite
silica	cristobalite
silica	quartz, crystalline silica
silica gel	amorphous silica
silicic anhydride	quartz, crystalline silica
silicon carbide	dust, total
silicon dioxide	quartz, crystalline silica
silicon dioxide (amorphous)	amorphous silica
silver (II) fluoride	silver (soluble compounds)
silver graphite	graphite (natural)
Skelly Solve - B	n-hexane
Skelly Solve - C	n-heptane
soapstone silicate	soapstone
soda lye	sodium hydroxide
sodium cyanide	cyanide
sodium hydrate	sodium hydroxide
soft coal	coal dust
solvent naphtha	naphtha (coal tar)
spectrar	isopropyl alcohol
spirits of turpentine	turpentine
spotting naphtha	stoddard solvent
spotting naphtha	stoddard solvent
starch	dust, total
steam distilled turpentine	turpentine
steatite	soapstone
steatite talc	talc
stibic	antimony
stibo-	antimony
stove black	graphite (natural)
strobane	methyl chloroform

sucrose	dust, total
sulfate wood turpentine	turpentine
sulferrous	iron oxide (iron salts)
sulfur oxide	sulfur dioxide
sulfuretted hydrogen	hydrogen sulfide
sulfuric acid (aqueous)	sulfuric acid
sulfurous acid anhydride	sulfur dioxide
sulfurous anhydride	sulfur dioxide
sulfurous oxide	sulfur dioxide
sulphuric acid	sulfuric acid
t-butinol	tert-butyl alcohol
talcum	talc
TBA	tert-butyl alcohol
TCE	trichloroethylene
terebenthine	turpentine
tetlen	perchloroethylene
tetracap	perchloroethylene
tetrachloroethene	perchloroethylene
tetrachloroethylene	perchloroethylene
tetrachloromethane	carbon tetrachloride
tetraleno	perchloroethylene
tetralex	perchloroethylene
tetrapil	perchloroethylene
tetravec	perchloroethylene
tetucur	iron oxide (iron salts)
tin oxide	dust, total
tiofine	titanium dioxide
tioxide	titanium dioxide
titanium dioxide	dust, total
TM8	trimethyl benzene
toluol	toluene
tremolite	asbestos
tremolite asbestos	asbestos
trethylene	trichloroethylene
triclene	trichloroethylene
tri-ethane	methyl chloroform
triatomic oxygen	ozone
tribromomethane	bromoform
trichloran	trichloroethylene
trichloren	trichloroethylene
trichloride	trichloroethylene
trichloroethene	trichloroethylene
trichloromethane	chloroform
tridimite	tridymite
trilene	trichloroethylene
trimar	trichloroethylene

trimethyl benzene	trimethyl benzene
trimethyl benzole	trimethyl benzene
trimethylcarbinol	tert-butyl alcohol
trioxide	titanium dioxide
tripolite	amorphous silica
tronox	titanium dioxide
tungsten carbide	tungsten
tungsten trioxide	tungsten
tungstate	tungsten
tungstic	tungsten
tungstic (VI) acid	tungsten
turpentine substitutes	stoddard solvent
turps	turpentine
unitane	titanium dioxide
vanadic anhydride	vanadium oxide
vanadium pentoxide	vanadium oxide
varnish makers' and painters' naphtha	naphtha (coal tar)
varnoline	stoddard solvent
VC	vinyl chloride
vegetable oil mists (except castor, cashew nut, or similar irritant oils)	dust, total
veracur	formaldehyde acetic acid
vinegar	
vinegar naphtha	ethyl acetate
vinyl chloride monomer	vinyl chloride
vitriol broom oil	sulfuric acid
VM&P Naptha	naphtha (coal tar)
volcanic sand	cristobalite
volcanic sand	tridymite
westrosol	trichloroethylene
WFNA	nitric acid
white arsenic	arsenic
white caustic	sodium hydroxide
white fuming nitric acid	nitric acid
white mineral oil mist	oil mist (mineral oil)
white spirits	naphtha (coal tar)
white spirits	stoddard solvent
wolfram	tungsten
wolframite	tungsten
wood alcohol	methyl alcohol
wood naphtha	methyl alcohol
wood spirit	methyl alcohol
wood turpentine	turpentine
xylol	xylene
yellow arsenic sulfide	arsenic
yellow ultramarine	chromic acid

zimmwaldite	mica
zinc butter	zinc oxide
zinc muriate	zinc oxide
zinc peroxide	zinc oxide
zinc white	zinc oxide
zinc yellow	chromic acid
zincite	zinc oxide
zircat	zirconium
zircon	zirconium
zirconic	zirconium
zirconocene	zirconium
zirconyl	zirconium
zirconium silicate	zirconium
zopaque baytitan	titanium dioxide