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Health Inspection
Procedures Handbook

PREFACE

Miners can be exposed to many health hazards in mining. This handbook sets forth general procedures for conducting mine health inspections consistent with Section 103(a) of the Mine Act. This handbook supersedes previously issued instructions included in separate Coal and Metal and Nonmetal (M/NM) handbooks. The guidance will be general, and persons should refer to title 30 of the Code of Federal Regulations (CFR) that govern coal and other mines for specifics. Compliance related instructions in the MSHA Program Policy Manual remain in effect.

The following sets forth guidance for a mine inspector when conducting mine health inspections, and inspection procedures should be consistent with mine conditions and practices. Not all procedures and requirements are applicable for all mine types. Any deviation from the procedures outlined in this handbook should be based on the inspector's sound discretion, and that of the inspector's supervisor.

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CHAPTER 1 - EVALUATING A MINE'S HEALTH PROGRAM

The mine operator is responsible for providing miners with a healthy workplace. Inspectors should determine if the operator has an effective health surveillance program. Area sampling and personal exposure monitoring are key components of an effective program. Monitoring for contaminants should be conducted as often as necessary to ensure miners' health is protected, to determine the adequacy of control measures, and to ensure the operator is complying with applicable regulations.

The inspector should use these guidelines to evaluate the operator's program when conducting inspections:

- A. Review and evaluate the mine's sample history.
- B. Recognize the health hazards and/or contaminants that exist at the mine. Note what control measures are in place and if they are functioning properly. Determine if the personal protective equipment (PPE) provided is adequate and being used, tested and maintained properly.
- C. Determine if the mine operator is evaluating occupational exposures and tasks properly. Select appropriate methods for determining potential exposure such as area samples, personal samples, and appropriate control measures. Review the sample analysis results for accuracy, consistency, and regulatory compliance.
- D. Determine if the mine operator took the appropriate actions based on sample results.
- E. Determine if MSHA sampling/monitoring is needed or if immediate enforcement action is necessary.

The inspector should evaluate all available information and use it to determine the frequency to conduct MSHA sampling at mines. Mines with effective health programs may be properly evaluated using a modified sampling frequency. Mines with ineffective health programs should be evaluated more frequently.

CHAPTER 2 - PARTICULATE SAMPLING METHODS

Mineral Dusts, Diesel Particulate Matter (DPM), Metal Dusts, Fumes, and Mists

A. Introduction

Inspectors should use the gravimetric sampling method to determine miners' exposure to particulates. The samples are taken by drawing the mine atmosphere through a pre-weighed filter media using a sampling pump. The samples are collected in a miner's breathing zone to determine personal exposure.

B. Definitions

Control Filter: A filter or cassette used as a blank to adjust sample post-weights based on environmental conditions.

Cyclone: A device that separates particles by size and is used to ensure the respirable particles are deposited on the filter cassette and larger particles are collected in the grit pot.

Diesel Particulate Matter (DPM): a component of diesel exhaust (DE) that includes soot particles made up primarily of carbon, ash, metallic abrasion particles, sulfates and silicates.

Filter Lot: Filter cassettes with the same pre-weight date.

Metal Dusts: Airborne particles of metal.

Metal Fumes: Airborne particles formed when a metal is melted, vaporizes into the atmosphere, and then condenses to a solid.

Mists: Liquid droplets suspended in air when a liquid is mechanically disrupted by agitation or atomization.

Respirable Dust: Airborne particles less than or equal to 10 microns in diameter.

Total Dust: Airborne particles collected without regard to their size. No cyclone is used.

C. Sampling Strategy

The inspector should determine what sampling method to use based on the contaminant sources and the type of controls in place to protect miners from exposure.

Records Review

MSHA and operator sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports and the mine overview report (electronic mine file) are valuable sources of information.

What to Sample

Particulate sampling requirements are based on mine site contaminants and the health hazards they pose to miners.

- **M/NM mine sampling**
Inspectors should sample for respirable dust in most cases; however, inspectors should sample for total dust when sampling history indicates that the dust contains less than one percent quartz and the material is an ACGIH listed nuisance particulate. Silica analysis is not performed on total dust samples.
- **Diesel Particulate Matter (DPM) sampling** - Inspectors will collect at least 1 area sample in each work area where DPM personal samples are being taken. Collect area sample(s) downwind from personal samples, at least 25 feet away from smokers, and at least 500 feet away from sources of oil mist.
- **Coal Mine Sampling.** Sampling should be evaluated for the following locations/occupations/areas:
 - Mechanized Mining Units (MMUs) which may include
 - Designated Occupations (DO)
 - Other Designated Occupations (ODO)
 - Represented Number of Non-Designated Occupations
 - An intake air dust sample will also be collected for each MMU.
 - Designated Areas (DAs)
 - Part 90 Miners
 - Designated Work Positions (DWPs)
 - Non-Designated Occupations, Areas, and Work Positions including Contractors

The sampling devices must remain with the occupation being sampled rather than with the individual miner even when miners change positions or alternate duties during the shift

Note: Ask the operator to suspend sampling for the shift if the mine operator is conducting sampling upon arrival at the mine. Inspectors may sample other occupations and monitor the operator's sampling if the operator cannot suspend sampling.

Sample Duration

The sampling duration options are outlined below for the various types of sampling required.

Respirable Dust, Total Dust, and Diesel Particulate Matter (except as noted).

- **Full-Shift Personal Samples:** The inspector will collect samples during the miner's entire work shift to determine compliance when it appears feasible engineering and administrative controls are not in place.
- **Screening Samples:** The inspector may perform partial-shift personal sampling to verify controls are adequate when the inspector believes feasible engineering and administrative controls are in place. Sampling should continue for the full shift for compliance determination if conditions, observed during the screening samples, warrant.

Screening samples will be prepared and conducted the same as full-shift samples but the sample duration will be shorter. Screening samples will be collected for a minimum of 4 hours.

Note: Citations/orders cannot be issued on screening samples. Collect full-shift personal samples as soon as practicable if screening samples exceed 90% of the limits allowed by the regulations.

Metal Dust, Fumes, and Mists

- **Full-Shift Samples:** The inspector will collect samples during the miner's entire work shift when miners are exposed to metal dusts or fumes during the majority of their work shift.

- **Short-Term Samples:** The inspector will collect short-term samples independently or in conjunction with full-shift samples to determine if the short-term exposure limits (STEL) or ceiling limits (C) have been exceeded during suspected periods of peak exposure.

Note: Collect short-term **welding fume** samples for no more than 30 minutes so all of the specified time periods for the 14-element profile are included. Some of these elements can be analyzed from the original 14 metals filter – simply by providing a second Filter Blank – and specifying the additional analysis needed in the Request for Laboratory Analysis (RLA) comments. Consult the MSHA Laboratory prior to submitting a second blank and requesting multiple types of analysis for a single sample.

D. Sampling Components

The components used and the steps taken to conduct gravimetric sampling are outlined below.

1. Filter Cassette

Select the proper medium for the contaminant being sampled. **Note: Refer to the contaminant index for specific guidance.** Use pre-numbered media or uniquely identify the media. This will be the number used to identify the sample when it is sent to the lab for analysis.

- **Respirable and Total Dust:** Cassettes are individually identified by a number and sealed in a plastic bag. A cassette should not be removed from the bag until it is time to mount the cassette on the sampling train. Use cassettes from the same manufacturer's lot to conduct a survey.
- **Diesel Particulate Matter:** Diesel particulate samples must be collected using diesel particulate cassettes. Do not use DPM cassettes that have exceeded their expiration date (available on the shipping box label).
- **Metal Dust, Fumes, and Mists:** A mixed cellulose ester (MCE) filter is used in the cassette for most metal dusts and fumes, including welding fumes. The filter is 37 mm in diameter and has a 0.8-micron pore size. A different sample media may be required depending on the contaminant and analysis. Contact your supervisor for further guidance.

Filter Cassette Types

Total and Respirable Dust



Diesel Particulate Matter (DPM)



Metal Dust, Fumes, and Mists



2. Control Filter

One control filter is needed for each type of sample and for each sample period. The control filter(s) must be from the same manufactured lot as the sample filter cassettes. The caps or end plugs should not be removed from the control filter cassette. It should be left in the sealed plastic bag until sampling activities are complete. A seal label (MSHA Form 4000-30) can be dated, signed, and the word "CONTROL" written on it. The label should be placed on the filter cassette over the end caps. The control filter shall be kept in the same environment as the exposure or area sample filters.

3. Sampling Pump

A properly calibrated sampling pump with the applicable flow rate must be used. **Note:** Use MSHA-approved permissible sampling pumps where required.

Sampling Pump Flow Rates

<u>Sample Type</u>	<u>Flowrate</u>	<u>5% Field Tolerance Range</u>
Respirable Dust (Coal mines)	2.0 LPM	1.90 LPM to 2.10 LPM
Respirable Dust (M/NM mines)	1.7 LPM	1.615 LPM to 1.785 LPM
Total Dust		
Diesel Particulate Matter		
Metal Dust, Fumes and Mists	1.7 LPM**	1.615 LPM to 1.785 LPM**

****Other acceptable sampling flow rate ranges are listed in the contaminant index**

4. Sampling Train

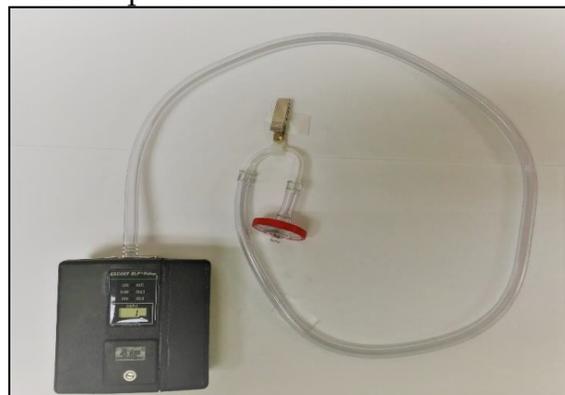
The sampling train components include hose, sample media holder, cyclone assembly, and clips to attach the sample to the miner or area. The end of the sampling hose is connected to a sampling pump inlet to complete the sampling train. There are different arrangements depending on the type of sampling conducted. Assemble the necessary components and attach the filter cassette required for the contaminant being sampled. Make sure the cassette is installed in the correct airflow direction, all fittings are tight, and the filter cassette is secured. Keep the caps/plugs for use after sampling.

Respirable Dust: The sampling train includes all the parts referenced above. It also has a steel lapel holder and a 10-mm cyclone assembly. A zip tie can be used to prevent the cyclone assembly from unintentionally opening if necessary.



Respirable Dust Sampling Train

Total Dust: The sampling train includes all the parts referenced above with the exception of the cyclone assembly and lapel holder. Attach the cassette to the end of the hose or place it in a cassette holder.



Total Dust Sampling Train (with “U” shaped adapter)**Total Dust Sampling Train (without adapter)**

Diesel Particulate Matter (DPM): The sampling train includes all the parts referenced above. It has a steel lapel holder and a 10-mm cyclone assembly. A zip tie can be used to prevent the cyclone assembly from unintentionally opening if necessary.

**DPM Sampling Train**

Metal Dust, Fumes, and Mists: The sampling train includes all the parts above with the exception of the cyclone assembly and lapel holder. Attach the cassette to the end of the hose or place it in a cassette holder.



Metal Dust/Welding Fume Sampling Train



Metal Dust/Welding Fume Sampling Train (with holder)



Welding Fume Sampling Train (with under helmet adapter)

E. Collecting the Sample(s)

1. Instrument Location

- Attach the sampling pump and sampling train to the miner within the miner's breathing zone. Attach the hose to the miner's clothing so it does not interfere with the miner's job performance and does not present a safety hazard.
- Attach the sampling train so that the cyclone's grit pot is on the bottom of the assembly when a cyclone is used and make sure the cyclone inlet is unobstructed and facing away from the miner's body.
- Metal dust, fumes, and mists – attach the sampling train with the filter oriented in the downward position.

Note: Welding fume samples - The miner's breathing zone when wearing a welding hood is considered to be under the hood when the face shield is in the down position.

The sample pump and train may be placed on another miner performing the same occupation/task if a miner objects to wearing it. Document the reason for the objection.

2. Instructions to Miner

- Explain the reason for the sampling, what the sampling device does, and what you are doing.
- Instruct the miner not to remove the sampling pump or sampling train at any time or cover the cassette or cyclone inlet with clothing or other items.
- Instruct the miner not to bump, drop, or tamper with the sampling pump or sampling train.
- Explain the need to keep the cyclone upright to prevent the non-respirable dust from the grit pot from falling back through the cyclone onto the filter and possibly voiding the sample.
- Explain the need to continue to work in a routine manner and report any unusual occurrences during the sampling period to you. The miner needs to notify the inspector if they must leave the mine property during the

shift.

- Inform the miner when and where the sampler will be removed and that you will be checking the equipment throughout the shift.

3. Sample Information

Observe and record the following information (if applicable) in the inspection notes:

- Miner's name, job title/occupation code, and work location(s).
- The typical shift hours per day and days per week worked.
- **(Underground Coal Mines Only):** Review operator records for on- shift respirable dust control parameter checks and any corrective actions for high samples. Determine what a normal production shift is from the 30 most recent production shifts.
- The time the sampling pump was started.

Note: Document the times if the sampling pump needs to be changed out, stopped, or restarted for any reason during sampling.

- Pump and filter cassette identification numbers.

Note: Work environments in Metal Non-Metal mines with a significant amount of dust, fumes, or mists may require changing filter cassettes during sampling to prevent overloading them. Collect samples consecutively using shorter sampling periods. Record the cassette number and the start/stop times for each sample taken.

- Ensure the sampling devices are properly worn and maintained in the environment being sampled.
- Ensure typical mining activities are taking place and the approximate time spent at each activity.
- Potential sources of exposure and provide a general description of what they are. Number of persons affected, and additional control measures that could be recommended.
- Equipment operating in the area.

- Provide a general description of the controls in use and whether or not they seem adequate.

Note: Observe on-shift parameter checks when sampling at underground coal mines.

- Respiratory protection worn (yes/no) (type).
- Does a compliant respiratory protection program exist?
- Changes that occur during the sampling shift which may affect the miner's dust exposure.
- Results of other samples taken, if available (e.g. noise, detector tubes, direct reading instruments).
- Environmental conditions (such as wind, temperature, humidity, elevation, etc.).
- Remove the sampling pump and train from the miner when sampling is complete and note the total sample run time.

F. Sample Analysis Preparation

- Remove the filter cassette from the sampling train and replace the cassette plugs/caps.
- A sample seal (MSHA Form 4000-30) can be dated, signed, and placed over the sample filter cassette end caps.
- Complete the health sample data and upload for each exposed filter cassette. A copy of the forms must be included with the samples when shipped for analysis.
- Package all cassettes from each sampling inspection along with the control filter cassette. All cassettes from the same inspection must be mailed together in one package typically **within 24 hours** to the appropriate MSHA Laboratory for analysis.

Multiple surveys may be packaged in the same mailing container if each survey is placed in a separate sealed plastic bag and the multiple bags are then placed in the mailing container.

G. Special Laboratory Requests and Instructions

1. Crystalline Silica Analysis (M/NM Mines)

Quartz is the most common form of crystalline silica and it is found in almost every type of metal and nonmetal ore.

Cristobolite and *Tridymite* have the same chemical composition as quartz but different crystal structures. Cristobolite and tridymite are the most hazardous forms of crystalline silica. They are found naturally in volcanic rock, fire brick used to insulate cement and lime kilns, bentonite, and calcined diatomaceous earth.

Note: Lab analysis for cristobalite and tridymite samples must be specifically requested.

2. Elemental Analysis for Metals

Elemental Analysis is a profile performed by the MSHA Laboratory to determine the amount of 14 elemental metals and metalloids in fume samples and 8 metals in dust samples. An elemental analysis can be requested for one or any combination of the 14 basic elements. The analysis will include all 14 elements unless otherwise requested:

Arsenic (As)	Lead (Pb)
Beryllium (Be)	Magnesium (Mg)
Cadmium (Cd)	Manganese (Mn)
*Chromium (Cr)	Molybdenum (Mo)
Cobalt (Co)	Nickel (Ni)
Copper (Cu)	Vanadium (V)
Iron (Fe)	Zinc (Zn)

* Chromium results from elemental analysis can only be applied to the TLVs® for contaminant codes 545 (Soluble chromic and chromous salts - chrome, chromium phosphate, chromium carbonate, and chromium acetate and 547 (Chromium metal, Insoluble chromium salts)

Note: Refer to the Contaminant Index for specific sampling instructions.

3. Other Analysis Guidelines

Contact your supervisor for guidance if it is necessary to sample for additional metals or metalloids. The laboratory may need to be notified in advance for special sampling media and handling instructions. Special analysis must be noted on the RLA form.

- Hexavalent Chromium (CrVI) may occur in certain welding operations (*e.g.* on stainless steel) and in some cement plant operations.
- Sample other metals such as silver, barium, calcium, and sodium individually using a separate MCE filter and control.
- Soluble metal salts including Cd, Cr, Fe, Ni, Te, and Mo require a different sample preparation than that for routine welding fume sampling.
- Insoluble metals samples may be taken side-by-side with soluble metal sample(s).

H. Compliance Determination

An analytical report will be provided to the inspector. The inspector will compare the sample results to the appropriate regulations. A citation/order must be issued when samples exceed the citable limit. The citation number is entered in the health sample data and uploaded.

I. Inspection Reports/Documentation

Inspection reports should include the following:

- Laboratory analytical report(s).
- Completed health sample data worksheet(s).
- Issued citation, orders, and/or subsequent actions.
- Requests for Laboratory Analysis.
- Inspection notes and any other supplemental information collected during the inspection.

CHAPTER 3 - NOISE

A. Introduction

This chapter establishes guidelines for conducting noise sampling, evaluating sample results, and verifying a mine's compliance with the noise regulations.

B. Sampling Strategy

Noise sampling is a key component to identify miners with high noise exposures. The high exposures must be reduced to protect miners from the risk of occupational noise-induced hearing loss. Samples should be collected during a miner's typical work shift.

1. Records Review

MSHA sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports, acoustical field investigations, assigned P-codes, and the mine overview report (electronic mine file), are valuable sources of information.

2. What to sample

Miners exposed to sound levels equal to or greater than 80 dBA should be considered for sampling based on the following:

- Prior sampling history at the mine particularly previous personal dosimeter readings at or above 100% dose;
- The mine operator's sampling records;
- Occupations known to be exposed to sound levels of 90 dBA or greater than 85 dBA (if not enrolled in a hearing conservation program); and
- Sound level meter (SLM) reading results.

3. Sample Duration

- **Full Shift:** The inspector will collect samples during the miner's entire work shift to determine compliance when it appears feasible engineering and administrative controls are not in place. Miners should also be sampled during off-shifts and weekends where noise producing activities are occurring.
- **Screening Samples:** The inspector may perform partial-shift personal sampling to verify controls are adequate when the inspector believes

feasible engineering and administrative controls are in place and there is no recent history of overexposure for that occupation at that mine. Sampling should continue for the full shift for compliance determination if results and conditions observed during the screening samples warrant it.

Screening samples will be prepared and conducted the same as full-shift samples, but the sample duration will be shorter. Screening samples will be collected for a minimum of 4 hours.

Note: Full-shift noise sample(s) will normally need to be conducted to terminate MSHA citation(s) for exceeding noise exposure levels. Citations issued for exceeding the action level may not require a full-shift sample for termination.

C. Sampling Components

- The noise sampling equipment inspectors use are personal noise dosimeters and sound level meters. Noise exposure measurements must be made in accordance with the instrument manufacturer's recommendations. A personal noise dosimeter must be used to determine a miner's noise exposure and compliance with MSHA's noise regulations.
- Sound level meters are used to sample real time or short-term noise levels. They may be a separate instrument or a feature of the personal noise dosimeter. Sound level meters can be used to check the sound levels in a work area, evaluate sources of noise, and determine which miners to select for sampling.

The personal noise dosimeters used have built in programming so different compliance levels can be evaluated at the same time.

- Dosimeter I is set to evaluate noise related to the 85-dBA action level (AL). It operates with the A-weighted network, slow response, 80-dBA threshold, 90-dBA criterion level, and a 5-dBA exchange rate.
- Dosimeter II is set to evaluate noise related to the 90-dBA permissible exposure level (PEL). It operates with the A-weighted network, slow response, 90-dBA threshold, 90-dBA criterion level, and a 5-dBA exchange rate.

D. Sampling Preparation

Check the calibration label on the instrument. Do not use the instrument if the date is past one year. Instrument calibration checks must be performed before and after each sample. The dosimeter reading should be within +/- 1.0 dBA of the calibrator level.

E. Collecting the Sample(s)**1. Instrument Location**

- Attach the dosimeter to the miner's clothing with the microphone oriented upward near the ear so that it does not interfere with the miner's job performance and does not present a safety hazard.
- The dosimeter may be placed on another miner performing the same occupation/task if a miner objects to wearing it. Document the reason for the objection.

2. Instructions to Miner

- Explain the reason for the sampling, what the sampling device does, and what you are doing. The dosimeter is not a tape recorder.
- Instruct the miner not to remove the dosimeter at any time or cover the microphone with clothing or other items.
- Instruct the miner not to bump, drop, or tamper with the dosimeter.
- Explain the need to continue to work in a routine manner and report any unusual occurrences during the sampling period to you. The miner needs to notify the inspector if they must leave the mine property during the shift.

Inform the miner when and where the dosimeter will be removed and that you will be checking the equipment throughout the shift.

3. Sample Information

Observe and record the following information (if applicable) in the inspection notes:

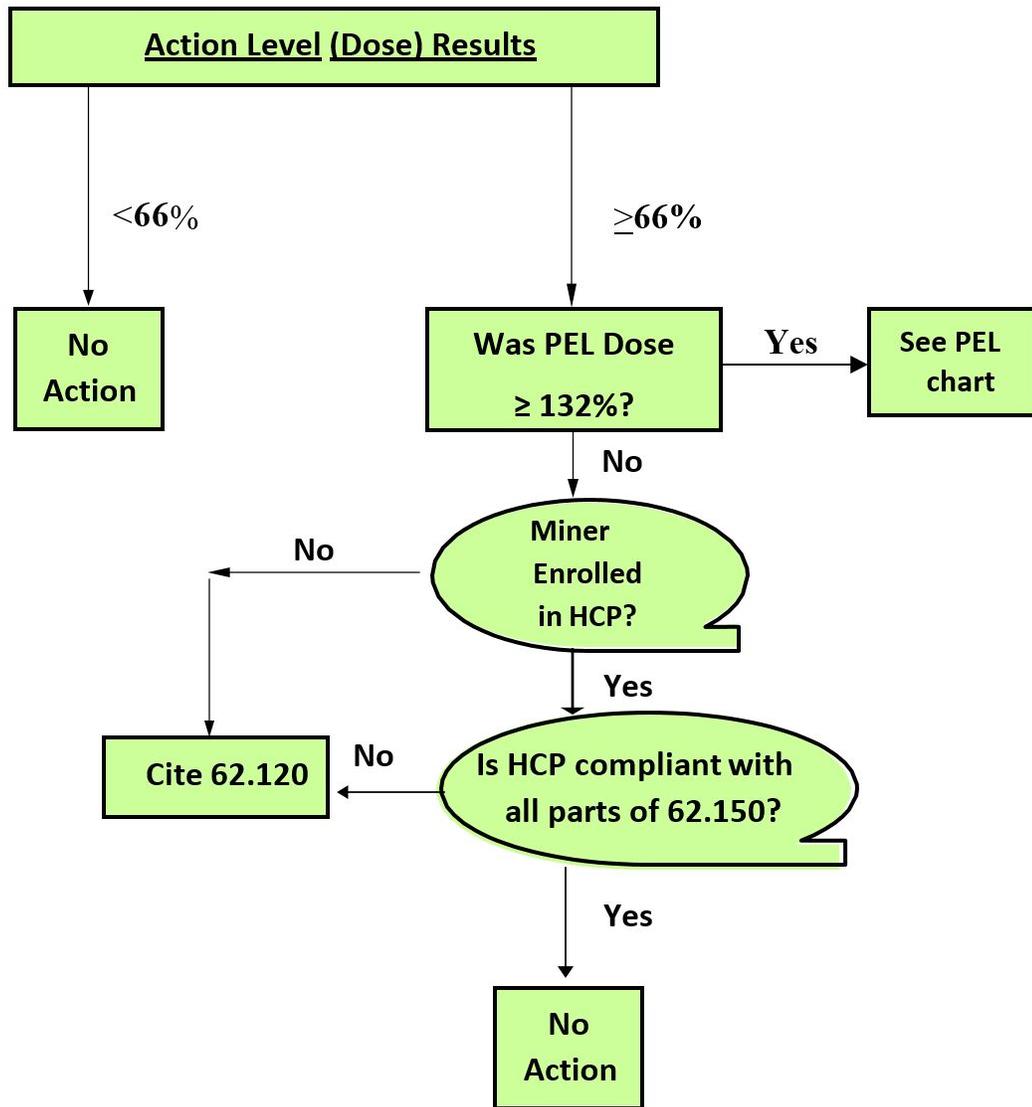
- Miner's name, job title/occupation code, and work location(s).

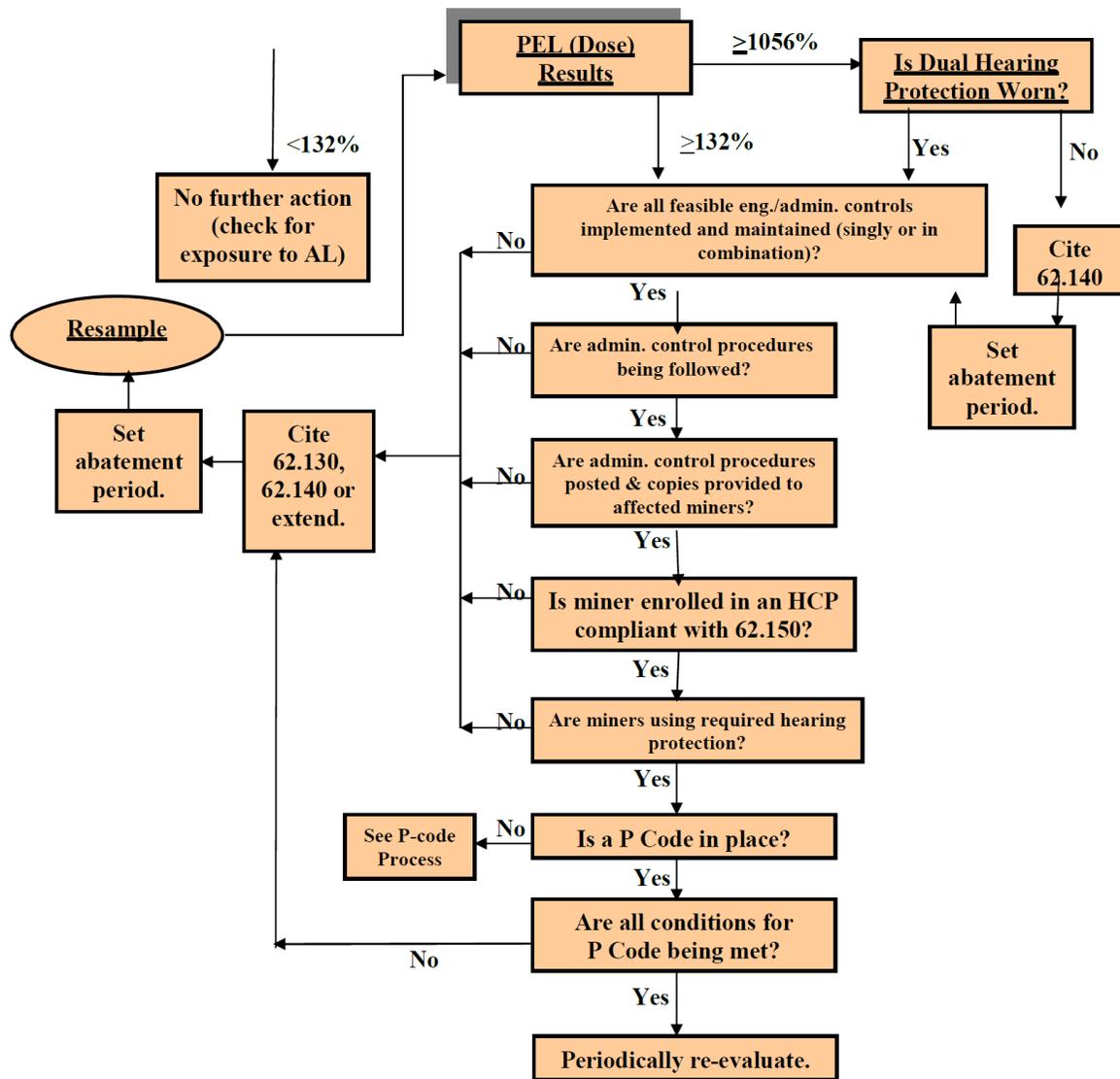
- The normal shift hours per day and days per week worked.
- Hearing protection worn (yes/no) (type).
- Hearing conservation program (yes/no). Miner enrolled (yes/no).
- The time the dosimeter was started.
- Posted administrative controls for noise exposure and adherence to those controls.
- Dosimeter and calibrator identification numbers.
- Ensure that the dosimeter(s) are properly worn.
- Ensure normal mining activities are taking place and the approximate time spent at each activity so the full work/shift/activity/exposure can be noted.
- Other equipment operating in the area.
- Provide a general description of the noise controls in use and whether or not they seem adequate.
- Noise sources – use a sound level meter to identify potential sources of exposure and a general description of what they are. The SLM should be held at arm's length and keep your body out of the noise path to obtain the most accurate readings.
- Changes that occur during the sampling shift which may affect the noise exposure to the miner(s).
- Times the dosimeter and microphone were checked and the condition of the instrument. Explanations for any interruption in the sample time.
- Results of other samples taken, if available (e.g. noise, detector tubes, direct reading instruments).
- Environmental conditions (such as wind, temperature, humidity, elevation, etc.).
- Collect the dosimeter from the miner when sampling is complete.

- Total sample time (displayed in hours and minutes).
- The dose percentage for the 85-dBA action level (80-dBA threshold) and associated time-weighted average (TWA₈) in dBA.
- The dose percentage for the 90-dBA Permissible Exposure Level (90-dBA threshold) and associated time-weighted average (TWA₈) in dBA.
- Record the upper limit (dBA) and duration of the upper limit exposure if the maximum was exceeded.
- Document the pre and post calibration checks.
- Review the survey results with the miner, the mine operator, and the miners' representative (if applicable).
- Input the health sample data in the inspector's computer system and upload it to MSHA's information database.

F. Compliance Determination

The survey results should be reviewed to determine compliance. The following flow charts will help with this evaluation.





G. Inspection Reports/Documentation

Inspection reports should include the following:

- The results of the sample(s);
- Issued citation(s), order(s) or subsequent actions; and
- Inspection notes and other supplemental information collected during the inspection.

H. P-code Process

P-code - An administrative code that allows MSHA to track overexposure situations where all feasible engineering and administrative controls are in place but compliance cannot be achieved. P-codes are not assigned to specific pieces of mining equipment or areas of the mine, but to the occupation.

The District Manager will assign a P-code if it is warranted based on inspector evaluation, implementation of all feasible engineering and administrative controls, and/or recommendations from MSHA Technical Support.

Inspectors will evaluate compliance with 30 CFR 62.130 and the minimum acceptable engineering and administrative controls specified in the P-code and/or citation termination language during subsequent inspections.

P-codes can be rescinded if:

- The operator fails to comply with the specified minimum acceptable engineering and administrative controls and conditions; or
- Full shift sampling demonstrates the operator has reduced miners' exposures to or below the PEL; or
- New feasible technology becomes available and the mine operator refuses to implement the technology; or
- Any of the requirements of the hearing conservation program are not complied with.

I. P-Code evaluation checklist

Date _____

District & Field Office _____

District Contact _____

Operator/Contractor Name and I.D. No. _____

1. Describe the operation and working conditions that resulted in overexposure.
2. List occupation, occupation code and brief description.
3. List equipment details:
 - a) Manufacturer's name.
 - b) Type and model of machine.
 - c) Serial number.
 - d) Date manufactured.
4. Describe engineering controls.
5. Describe administrative controls.
6. Any other information including SLM readings and time motion studies where applicable.
7. Compliance history.
8. Citation information.

CHAPTER 4 -ELECTRONIC DIRECT-READ INSTRUMENTS

A. Introduction

Electronic direct-read instruments (DRI) are battery operated devices that measure contaminant gases and vapors in real time. They may be used to obtain short term or continuous environmental measurements.

B. Definitions

Accuracy - how close instruments measure the “true” concentration based on calibration with a known standard.

Ceiling limit (C) - a maximum level established that miners should not be exposed. A single instrument reading may be used to determine an imminent danger situation.

Grab sample - a sample taken over a very short period of time to assess the concentration of a given contaminant.

Lower Explosive Limit (LEL) - the minimum concentration in air of a flammable vapor or gas-air mixture at which ignition can occur.

Error Factor - each model of direct reading instrument will have an assigned Error Factor for each of the contaminants it can measure. Citable concentrations of a contaminant will be defined by the TLV * EF for full-shift sampling or the Excursion Value * Error Factor for short-term sampling.

Excursion Limit - the maximum exposure that an individual may have to a particular chemical over a short period (usually 30 minutes) for those substances not given a (C) designation

Over-Range - concentration of a particular contaminant that exceeds the range of an instruments accuracy.

Sensitivity (lower detectable limit) - the minimum concentration detectable by the instrument.

Short-term exposure limit (STEL) - the acceptable average exposure over a short period of time (or times in a given period or shift) usually 15-minute period(s) as long as the threshold limit value (TLV) is not exceeded.

Span Calibration (spanning) - checking the accuracy of an instrument's

response using a gas of known concentration.

C. **Sampling Strategy**

The various sampling options are outlined below. The determination of which method to use should be based on the contaminant sources and the type of controls in place to protect miners from exposure. See the contaminant index for additional information.

1. **Records Review**

MSHA and operator sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports and the mine overview report (electronic mine file) are valuable sources of information.

2. **What to sample**

Sampling requirements are based upon the commodities being mined and the potential health hazards to which miners are exposed.

Underground coal mine diesel exhaust samples will be collected:

- During longwall moves where diesel equipment is utilized either on the teardown section, transportation, or set-up section;
- On sections utilizing diesel face haulage equipment; and
- On a representative number of diesel powered pieces of equipment operated in the outby areas of each mine utilizing such equipment (two-three different types of diesel equipment if available).

3. **Sample Duration**

The various sampling duration options are outlined below. The determination of which method to use should be based on the contaminant sources and the type of controls in place to protect miners from exposure.

- **Full-shift samples:** The inspector will collect samples during the miner's entire work shift to determine compliance when it appears sufficient feasible engineering and administrative controls are not in place. Full-shift sampling may be accomplished using data logging instruments or partial-period sampling.

- **Screening Samples:** The inspector may perform partial-shift personal samples to quantitatively verify controls are adequate when the inspector believes feasible engineering and administrative controls are in place. Sampling should continue for the full-shift for compliance determination if results and conditions observed during the screening samples warrant.

Screening samples will be prepared and conducted the same as full-shift samples but the sample duration will be shorter. Screening samples will be collected a minimum of 4 hours.

Note: Full-shift personal samples must be collected as soon as practicable if samples exceed the TLV.

Short-term exposure limit (STEL) and excursion limit: Use the contaminant index to determine the sample time corresponding to the exposure limit of the gas or vapor you intend to measure. Use a data logging instrument when available, otherwise use a direct reading instrument to take partial-period readings over the required time period and calculate the average concentration.

For example using a 15-minute STEL:

1. Take one DRI reading during the first 5-minute period;
 2. Take a second DRI reading during the second 5-minute period;
 3. Take the third DRI reading in the final 5-minute period; and
 4. Total all three readings and average (divide by 3) to obtain the concentration of the short-term exposure.
- **Grab samples** taken with electronic direct-read instruments may be used to corroborate full-shift sampling data. They can also be used as a stand-alone sample to determine if STEL excursion limits, or ceiling limits (C) have been exceeded during suspected periods of peak exposure. Refer to the minimum sampling times listed in the contaminant index.

Sampling Components

Each electronic direct-reading instrument has an operating manual that contains operating parameters, accuracy of the instrument reading, and instrument sensitivity.

All electronic battery-operated instruments used where explosive or hazardous atmospheres exist must be intrinsically safe (permissible), MSHA approved, and labeled accordingly.

Many variables can affect the measurement accuracy of DRIs and must be controlled.

- **Temperature and Humidity** - Contact your supervisor for guidance if sampling conditions are outside the manufacturer's specified limits.
- **Interferences** - The presence of other gases or vapors may adversely affect sampling. Different gases or vapors can react with the same sensor in the DRI. Refer to the instructions for each DRI and applicable sensor to ensure that your sampling result shows only the contaminant you intend to measure. Contact your supervisor for additional guidance.

D. Sampling Preparation

Check, calibrate, and maintain the instruments according to the manufacturer's recommendations. A record of the instrument calibration should be maintained.

E. Collecting the Sample(s)

1. Instrument Location

- Position the DRI (or its inlet port) in the breathing zone of the miner for **personal samples**. Attach the instrument to the miner's clothing so that it does not interfere with the miner's job performance and does not present a safety hazard.

Note: The instrument may be placed on another miner performing the same occupation/task if a miner objects to wearing it. Document the reason for the objection.

- Position the DRI in the area where the miners work for **area samples**.

2. Instructions to the Miner

- Explain the reason for the sampling, what the sampling device does, and what you are doing.
- Instruct the miner not to remove the instrument at any time or cover the instrument with clothing or other items.
- Instruct the miner not to bump, drop, or tamper with the instrument.

- Explain the need for the miner to continue to work in a routine manner and report to you any unusual occurrences during the sampling period. The miner needs to notify the inspector if they must leave the mine property during the shift.
- Inform the miner when and where the instrument will be removed and that you will be checking the instrument throughout the shift.

3. Sample Information

Observe and record the following information (if applicable) in the inspection notes:

- Miner's name, job title/occupation code, and work location(s).
- Location of area sample(s).
- The typical shift hours per day and days per week worked.
- The time the sample was started.
- Instrument identification numbers.
- Ensure that the instrument(s) are properly worn or placed.
- Ensure typical mining activities are taking place and the approximate time spent at each activity.
- Potential sources of exposure and provide a general description of what they are. Number of persons affected and additional control measures that could be recommended.
- Equipment operating in the area.
- Provide a general description of the controls in use and whether or not they seem adequate.
- Respiratory protection worn (yes/no) (type).
- Does a compliant respiratory protection program exist?
- Changes that occur during the sampling shift which may affect the miner's exposure.

- Times the instrument(s) were checked and the condition of the instrument. Explanations for any interruption in the sample time.
- Results of other samples taken, if available (e.g., noise, detector tubes, direct reading instruments).
- Environmental conditions (such as wind, temperature, humidity, elevation, etc.).
- Remove the instrument from the miner or area when sampling is complete and note the sample time.
- Input the health sample data in the inspector's computer system and upload it to MSHA's information database.
- **Underground Coal Mines Only:** Document the results of NO₂ and CO peaks and TWA for diesel exhaust surveys.

F. Compliance Determination

The inspector should determine compliance by comparing sample results to the appropriate standard. A citation/order shall be issued when the citable limit is exceeded after taking into account the applicable error factors.

Coal mines - The current TLVs for CO and NO₂ are listed in the 1972 American Conference of Governmental Industrial Hygienists (ACGIH) TLV book. Those limits are as follows:

CO:	8-hour TWA	50 ppm
	STEL (15 min)	400 ppm
NO ₂ :	Ceiling limit (C)	5 ppm

MNM mines - Threshold Limit Values® (TLVs®), short-term exposure limits (STELs), Ceiling Limits, and Excursion Limits for contaminants are listed or referenced in the *TLVs® Threshold Limit Values for Chemical Substances in Workroom Air Adopted by the ACGIH for 1973*.

G. Inspection Reports/Documentation

Inspection reports should include the following:

- Issued citation, orders, or subsequent actions.

- Completed health sample data worksheet(s).
- Inspection notes and any other supplemental information collected during the inspection.

CHAPTER 5 - IONIZING RADIATION (M/NM MINES)

A. Introduction

Ionizing radiation can cause cancer, and at high doses, causes radiation sickness. Ionizing radiation can be emitted by the mined ore, the surrounding rock, or nuclear gauges such as those that monitor the flow of materials. Miners can be exposed to hazardous levels of ionizing radiation at mines other than those producing radioactive minerals. This chapter includes sampling procedures for evaluating four types of ionizing radiation hazards: *alpha, beta, gamma, and x-ray*.

B. Definitions

Alpha Counter/Scaler - An instrument that counts alpha decay events when used with a scintillation detector.

Alpha Radiation - A particle that has a positive (+2) charge and is emitted from the nucleus of an atom. An alpha particle consists of two protons and two neutrons. Alpha particles are emitted by radon, uranium, and thoron.

Beta Radiation - A particle that has a negative (-1) charge and is emitted from the electron shell of an atom. A beta particle consists of one electron. Beta radiation has more penetrating capability than alpha radiation because the particle is much smaller.

Gamma Radiation - Short wavelength electromagnetic radiation emitted from radioactive elements such as uranium.

Geiger-Mueller counter - A small, hand-held instrument designed to measure x-ray and gamma radiation.

Half-life - The time required for a radioactive substance to lose 50% of its activity by decay.

Isotope - A form of an element that differs from other forms of the same element based on the number of neutrons in each atom's nucleus. Isotopes of the same element may have different levels of stability and potential radioactivity.

Kusnetz Method - A method for determining exposure to alpha radiation emitted from radon and thoron daughters/progeny.

Radon Daughters/Radon Progeny - Unstable, short-lived decay products of radon gas which emit alpha particles (terms are used interchangeably).

Roentgen (R) - A unit for measuring x-rays or gamma rays. For radiation protection, one R equals the dose measurement of one REM.

Roentgen Equivalent Man (REM) - A unit for measuring the absorbed dose by humans (and biological effects) of ionizing radiation.

Scintillation Detector - A type of instrument that analyzes a filter sample to determine alpha emissions.

Thoron - A gas formed from the radioactive decay of thorium (Th). It is an isotope of radon gas.

X-ray radiation - Is similar to gamma radiation in that it is a ray and not a particle, but different in that it is man-made versus naturally-occurring radiation.

C. Sampling Strategy

1. Records Review

MSHA and operator sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports and the mine overview report (electronic mine file) are valuable sources of information.

2. What to Sample

- **Underground M/NM Mines**

Inspectors should collect a few radon daughter samples from the main return airways (exhausts) and any poorly ventilated travel ways or work areas to get a preliminary evaluation of the mine conditions.

Note: Inspectors should sample new or reopened mines as soon as possible.

- **Underground Uranium Mines**

Inspectors should sample all active work areas for alpha radiation four times annually during regular inspections. Inspectors should conduct gamma radiation checks annually where radioactive ores are mined.

Inspectors should sample locations that are most representative of the high risk miner's average exposure. This includes prominent work stations, active stope areas, travel ways, shops, lunch rooms, and other occupied mine areas.

- **Nuclear Gauges**

Inspectors should review the Nuclear Regulatory Commission (NRC) license provisions at mines that have nuclear gauges or other radiation sources. The NRC office that issued the license should be informed if violations are found.

3. Sample Duration

Radon daughter samples will be collected for 5 minutes.

D. Sampling Components

1. Alpha Radiation (Radon) Sampling

- **Filter** –The inspector should use the 25-mm Gelman, Type AE, glass fiber filters. The fiberglass filter has a semi-smooth “waffled” pattern side and a rough side. Identify the filter with a unique number with a gel or felt tip pen. The filter should be placed in the cassette holder with the semi-smooth waffled side facing the sampling pump and the rough side exposed to the mine atmosphere.
- **Sampling Train** – Use a two-piece plastic filter holder or cassette which attaches to the pump, usually with a hose.
- **Sampling Pump** – A standard air sampling pump calibrated to 2.0 LPM.
- **Scalers** – Instrument used to determine radiation exposure. (e.g., Ludlum 2000)

Note: After a scaler and a detector are calibrated as a unit, they must not be interchanged with similar pieces from another instrument.

Note: Do not use the scaler near power supplies. Electrical noise may be picked up by the instruments and will be reflected in the background count.



Alpha Radiation Sampling Pump and Train



Scaler - Ludlum 2000 with accessories
Thorium Standard (Th-230)

2. Gamma/X-Ray Radiation Sampling

- Geiger-Mueller Scaler: Used as a direct read instrument to determine exposure. The exposure rate units are milli-Roentgens per hour (mR/hr).

E. Sampling Preparation**1. Alpha Radiation**

- Assemble the properly calibrated sampling pump and train.
- Check the **Alpha Detector and Scaler** for proper operation with the alpha radiation assigned standard by:
 - Performing a count with the Th-230 standard and ensuring it matches the calibration certificate $\pm 10\%$.
 - Performing a background count with nothing in the Ludlum detector.

2. Gamma radiation

- Check the **Geiger-Mueller Counter** for proper operation with the gamma radiation assigned source attached to the side of the instrument box.

F. Collecting the Sample(s)

Sample Information - Observe and record the following information (if applicable) in the inspection notes:

- Miner's name, job title/occupation code, and work location(s);
- The normal shift hours per day and days per week worked;
- Respiratory protection worn (yes/no) (type);
- Whether a compliant respiratory protection program exists;
- The time the sampling pump was started;
- Pump identification numbers;
- Ensure that the instrument(s) are properly placed;
- Ventilation quantity at the sampling location(s);
- Environmental conditions (such as wind, temperature, humidity, water, elevation, etc.); and

- Total sample run time.

G. Sample Analysis Preparation

Place the caps back on the cassette and place it in a safe place so the filter has time to properly decay and be counted.

Note: It may be possible to sample several areas before counting.

H. Sample Analysis

1. Alpha Radiation - Use the Ludlum 2000 to analyze the sample by:

- Count the filters within 40 to 90 minutes after the sample(s) were taken and record the results.
- Check the **Ludlum and Scaler** for proper operation with the alpha radiation assigned source.

The radon daughters working level (WL) is calculated by completing the following formula:

$$WL = \frac{CPM \times EF}{Vol \times TF}$$

Where:

WL	=	radon daughters concentration in working levels
CPM	=	count rate of sample in counts per minute
EF	=	efficiency factor of counter indicated on probe
Vol	=	total sample volume in liters
TF	=	time factor from Table 5A-1

Table 5A-1. Time Factor for Calculating Radon Daughters/Progeny Working Levels

Elapsed time after sampling, minutes	Time Factor	Elapsed time after sampling, minutes	Time Factor	Elapsed time after sampling, minutes	Time Factor
40	150	57	116	74	84
41	148	58	114	75	83
42	146	59	112	76	81
43	144	60	110	77	80
44	142	61	108	78	78
45	140	62	106	79	77
46	138	63	104	80	75
47	136	64	102	81	74
48	134	65	100	82	72
49	132	66	98	83	71
50	130	67	96	84	69
51	128	68	94	85	68
52	126	69	92	86	66
53	124	70	90	87	65
54	122	71	89	88	63
55	120	72	87	89	62
56	118	73	86	90	60

2. Gamma Radiation - Check the Geiger-Mueller Counter for proper operation with the gamma radiation assigned source attached to the side of the instrument box.

Inspectors need to perform the following calculations with the Geiger-Mueller counter readings to determine a miner's gamma radiation exposure when working in an area:

- Multiply the exposure rate (mR/hr) of the area by the time (hours) the worker is expected to remain in the area to get mR.

Note: Add daily exposures together to obtain the miner's cumulative exposure for the time period if taking samples over multiple days such as a working week.

- Divide mR by 1000 to convert to REMs. This is an estimated exposure level for a miner who may be in that work area for the period of time.
- Compare the calculated value with the company's individual exposure records and investigate differences greater than 10%.

I. Compliance Determination

The inspector should determine compliance by comparing sample results to the appropriate standard. A citation/order shall be issued when the citable limit is exceeded after taking into account the applicable error factors. The citation number is entered in the health sample data and uploaded.

The error factor for determining compliance using radiation instrumentation is 1.3 (or 30%).

J. Inspection Reports/Documentation

Inspection reports should include the following:

- The results of the sample(s).
- Radon Daughter Sampling Data Form.
- Issued citation(s), order(s) or subsequent actions.
- Inspection notes and other supplemental information collected during the inspection.

CHAPTER 6 - ASBESTOS FIBERS

A. Introduction

Asbestos fiber is an inhalation hazard that causes asbestosis, a chronic lung disease, and mesothelioma, which usually manifests as lung cancer. Asbestos is also an ingestion hazard that may cause digestive tract cancer, and other asbestos related diseases. Asbestos exposure can occur from mining natural ore deposits and from asbestos-containing building materials or other commercial products used at the mine.

B. Definitions

Asbestos - a generic term for several hydrated silicates that separate into flexible fibers when they are crushed or processed. The fibers are various sizes, colors, and textures. Asbestos is classified as either serpentized or amphibole with about 95% of all commercial asbestos being serpentized.

C. Sampling Strategy

The inspector should determine what sampling method to use based on the contaminant sources and the type of controls in place to protect miners from exposure.

1. Records Review

MSHA and/or operator sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports and the mine overview report (electronic mine file) are valuable sources of information.

2. What to Sample

Inspectors should consider sampling based on the following sources of asbestos fibers.

- **Naturally Occurring** at mines where asbestos is produced and mines where the following rock and minerals are found: talc, vermiculite, taconite, serpentine limestone, and banded ironstone. These products can be particularly hazardous when they are being disturbed while mining and milling.
- **Commercial Products Use** where miners are exposed to asbestos containing products brought onto the mine property, such as brake linings

and pads, cement boards, fire proofing, welding blankets, jointing and packing compounds, and electrical and heating insulation. These products are particularly hazardous when disturbed during installation, removal, demolition, or deterioration of asbestos containing products, and special precautions must be taken. Inspectors should encourage operators to replace these items with asbestos-free materials where possible. The hazardous material must also be appropriately disposed of in accordance with applicable state or Federal asbestos laws.

- Inspectors should ask the operator, contractors, and miners if there is asbestos present in the material being disturbed, and conduct sampling based on the response.
- The inspector should take personal fiber samples if asbestos is **known** to be present. Determine if the mine operator or contractor understands how to control or eliminate miner exposure and if they are aware of the hazards.

Note: Inspectors must use appropriate personal protective equipment when collecting samples.

- The inspector should contact their supervisor if the mine operator has not sampled the material and they **suspect** the material could contain asbestos. Inspectors can also collect bulk samples to send for analysis.

Note: Collect bulk samples only from locations where the material is already damaged or where active removal is underway.

3. Sample Duration

- **Full-Shift Samples:** The inspector will collect samples during the miner's entire work shift when miners are exposed to asbestos during their work shift.
- **Short-Term Samples:** The inspector will collect short-term samples independently or in conjunction with full-shift samples to determine if the excursion limits have been exceeded.

D. Sampling Components

The components used and the steps taken to conduct asbestos sampling are outlined below.

1. **Filter** Cassette

Inspectors must use an asbestos filter in accordance with manufacturer's instruction to sample for asbestos. Use pre-numbered media or uniquely identify the media. This will be the number used to identify the sample when it is sent to the lab for analysis.



Asbestos Filter Cassette

Note: Sample with inlet cover and outlet plug removed

Blank Filters

- Two Blank filters are needed from the same manufactured lot as the sample filters for each set of samples. The number of blanks will be 10% of the samples if more than 20 samples are collected. The blanks are submitted to determine if the filter was contaminated during manufacturing or to determine background levels.
- The inspector will prepare the blank filters at the same time as other cassettes prior to sampling. Remove the inlet cover and outlet plugs and store in a clean area such as a closed bag or box. Replace them when sampling is completed. A seal label (MSHA Form 4000-30) can be dated, signed, and the word "Blank" written on it. The label should be placed over the cassette end caps. The blanks shall be kept in the same environment as the exposure sample filters.

Sampling Pump

A properly calibrated sampling pump with the applicable flow rate must be used. **Note:** Use MSHA-approved permissible sampling pumps where required.

Calibrate the sampling pumps for fiber sampling.

- **Full-shift** personal sampling 1.7 LPM.

Note: Accurate fiber counting depends on the fiber loading on the filter. The sample duration must be long enough to accumulate a minimum density of 100 fibers per square millimeter on the filter. Dusty atmospheres may cause excessive background dust on the filter and the sample may not be able to be analyzed due to overloading.

- **Short term** sampling (15 to 30 minutes) 2.5 LPM or greater.

Area sampling will use the appropriate calibration rates based on the sample lengths above.



Calibration Set-up

Sampling Train

The sampling train components include hose, filter, holder, and clips to attach the sample to the miner or area. The end of the sampling hose is connected to a sampling pump inlet to complete the sampling train. Remove the cassette inlet cover and the outlet plug and place them in a clean plastic bag.

Assemble the components and attach the asbestos filter cassette to the holder. Make sure the cassette is installed in the correct airflow direction, all fittings are tight, and the filter cassette is secured.



Asbestos Fiber Sampling Train



Asbestos Filter-Cassette Holder

E. Collecting the Sample(s)

1. Instrument Location

- Attach the sampling pump and sampling train to the miner. Attach the tubing to the miner's clothing so that it does not interfere with the miner's job performance and does not present a safety hazard.
- Attach the sampler to the miner's clothing within the breathing zone facing downward.

Note: Area sampling may be conducted to evaluate the concentration or determine the potential presence of airborne asbestos.

Instructions to the Miner

- Explain to the miner the reason for the sampling, what the sampling device does, and what you are doing.
- Instruct the miner not to remove the sampling pump or sampling train at any time or cover the cassette with clothing or anything else.
- Instruct the miner not to bump, drop, or tamper with the sampling pump or sampling train.
- Explain the need for the miner to continue to work in a routine manner and report to you any unusual occurrences during the sampling period. The miner needs to notify the inspector if they must leave the mine property during the shift.
- Inform the miner when and where the sampler will be removed and that you will be checking the equipment throughout the shift.

Sample Information

Observe and record the following information (if applicable) in the inspection notes:

- Miner's name, job title/ occupation code, and work location(s).
- The normal shift hours per day and days per week worked.
- The time the sampling pump was started.
- Pump and filter cassette identification numbers.
- Observe if there are dusty conditions in the workplace and change the filter cassette to prevent overloading if necessary.

Note: Turn off sampling pump before removing the media. Document the times if the sampling pump needs to be changed out, stopped, or restarted for any reason during sampling.

- Ensure that the sampling devices are properly worn and maintained in the environment being sampled.

- Ensure normal mining activities are taking place and the approximate time spent at each activity.
- Equipment operating in the area. Provide a general description of the controls in use and whether or not they seem adequate.
- Potential sources of exposure and a general description of what they are. Number of persons affected, and additional control measures that could be recommended.
- Respiratory protection worn (yes/no) (type).
- Does a compliant respiratory protection program exist?
- Changes that occur during the sampling shift which may affect the dust exposure to the miner(s).
- Results of other samples taken, if available (e.g. noise, detector tubes, direct reading instruments).
- Environmental conditions (such as wind, precipitation, elevation, etc.).
- Remove the sampling train from the miner when sampling is complete.
- The total sampling time for each cassette.

F. Sample Analysis Preparation

- Remove the filter cassette from the sampling train and replace the inlet cover and outlet plug.
- A sample seal (MSHA Form 4000-30) can be dated, signed, and placed over the sample filter cassette end caps.
- Complete the health sample data and upload for each exposed filter cassette. A copy of the forms must be included with the samples when shipped for analysis.

Package all cassettes from each sampling inspection along with the blank filter cassettes. Package the cassettes to prevent jostling or damage. (**Do not use polystyrene foam for packing.**) All cassettes from the same inspection must be mailed together in one container or package **typically within 24 hours** to appropriate MSHA laboratory.

Multiple surveys may be packaged in the same mailing container if each survey is placed in a sealed plastic bag and the multiple bags are then placed in the mailing container.

G. Compliance Determination

An analytical report will be provided to the inspector. The inspector will compare the sample results to the appropriate regulation. A citation/order must be issued when samples exceed the citable limit. The citation number is entered in the health sample data and uploaded.

H. Inspection Reports/Documentation

Inspection reports should include the following:

- Laboratory analytical report(s).
- Completed health sample data worksheet(s).
- Issued citation, orders or subsequent actions.
- Requests for Laboratory Analysis.
- Inspection notes and any other supplemental information collected during the inspection.

CHAPTER 7 - MISCELLANEOUS SAMPLING METHODS

A. Introduction

This chapter addresses sampling methods that are used to sample in uncommon situations which require special expertise. The following sampling methods are included in this chapter: sorbent media sampling, vacuum sampling, detector and diffusion tube sampling, wipe sampling, bag sampling, and bulk sampling for “unknowns.” Heat stress will also be addressed.

B. Definitions

Active Sampling: Air is drawn through the sample media using a sampling pump to determine contaminant concentrations.

Charcoal Tube: A sorbent tube typically used for active sampling of air containing organic vapors.

Detector Tubes: Small contaminant specific glass tubes with reactive material inside. Inspectors use it as a short term active monitor for sampling mine gases and vapors. The ends are broken and contaminated air is drawn through one end of the tube. The contaminant causes a reaction and a color change (stain) can be read via a scale on the tube.

Diffusion: The natural passage of gas or vapor from an area of high concentration to an area of lower concentration.

Diffusion Tubes: A contaminant specific glass tube with reactive material inside. Inspectors use it as a passive monitor for sampling mine gases and vapors. Diffusion tubes are typically used during a work shift of up to eight hours and can be used to determine average concentrations over periods of several hours.

Heat Cramps: Painful muscle spasms that occur during profuse sweating in heat despite drinking large quantities of water because the body's salt loss is not adequately replaced.

Heat Exhaustion: A condition caused when losing large amounts of fluid with sweating, sometimes with excessive salt loss. A miner suffering from heat exhaustion still sweats but experiences extreme weakness or fatigue, nausea, or headache.

Heat Rash (Prickly Heat): Heat rash can occur in hot, humid environments where sweat is not easily removed from the surface of the skin by evaporation

and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears.

Heat Stroke: When the body's temperature regulatory system is overtaxed or fails and the body core temperature rises above 40° C (104° F). This is a medical emergency and can result in death within minutes if not treated.

Passive monitor: A sampling device which collects a contaminant using diffusion (i.e. without the use of a sampling pump or "passive sampling").

Sorbent tube: A sealed glass tube containing two sections of adsorbent material. The larger section is the sampling section and the smaller section is the back-up section. Collection on sorbent media can be done by active sampling or by passive sampling.

Vacuum Samplers: A glass container used to collect mine gas samples for analyses. There are two types of vacuum samplers: vacuum bottles (50 mL) and vacutainers (10 mL). Vacuum samplers should be used primarily for confirmation of electronic direct read instrument results and for methane liberation for 103(i) status.

Wipe Sampling: A method of sampling used to determine the presence of solid or liquid contaminants on surfaces.

C. Sampling Strategy

1. Records Review

MSHA and operator sampling history should be reviewed prior to beginning the onsite inspection. Previous inspection reports and the mine overview report (electronic mine file) are valuable sources of information.

What to Sample

The inspector should determine the type of sampling procedures to use based on the mine site contaminants and the health hazards they pose to miners.

- **Sorbent Media, Diffusion Tubes, Detector Tubes** are used to assess individual miner's exposures.
- **Detector Tubes, Vacuum, Wipe, Bag, and Bulk Samples** are used to assess contaminants in the environment or introduced commercial products: airborne, on surfaces, and in the mining or milling process.

- **Heat Stress** Heat stress is a concern for miners working in hot environments. Inspectors should consider high environmental temperatures and relative humidity when evaluating the possibility of heat stress. Miners who are not acclimated or have a medical condition are more at risk for heat stress. Heat stress evaluation requires specialized sampling equipment and expertise. There is not a direct regulation for heat stress. Contact your supervisor when heat stress is a concern.

Sample Duration

The inspector should determine the sampling duration based on the contaminant sources and the type of controls in place to protect miners from exposure. The manufacturer's instructions included with the sampling media can help determine the minimum and maximum sampling times and procedures. Discuss any questions with your supervisor. The various sampling durations are outlined below.

- **Full-shift Personal Samples** - The inspector will collect samples during the miner's entire work shift to determine compliance when it appears feasible engineering and administrative controls are not in place.

Note: Detector Tubes cannot be used for full-shift personal samples.

- **Screening Samples**- The inspector may perform partial-shift personal sampling to verify controls are adequate when the inspector believes feasible engineering and administrative controls are in place. Sampling should continue for the full shift for compliance determination if results and conditions, observed during the screening samples, warrant.

Note: Citations/orders cannot be issued on screening samples. Collect full-shift personal samples as soon as practicable if screening samples exceed 90% of the limits allowed by the regulations (TLV or PEL).

Screening samples will be prepared and collected the same as full-shift samples but the sample duration will be shorter. Screening samples will be collected a minimum of 4 hours.

- **Short-Term Samples** The inspector can collect short-term samples independently or in conjunction with full-shift samples to determine if the short-term exposure limits (STEL), ceiling limits (C) or excursion limits have been exceeded during the suspected periods of peak exposure.

- **Grab Samples:** These are used to evaluate conditions. The sampling media used for grab samples may include detector tube sampling, wipe samples, bulk samples, bag samples, and vacuum bottles. Miner exposure determinations are made from the contaminant present in the environment.

D. Sampling Components

The inspector will use the following components where applicable:

- The appropriate sampling media for the contaminant being sampled. See the Contaminant Index and the manufacturer's information.
- The appropriate control blank media. The control blank media and the exposure media must be from the same manufacturer lot. Inspectors should expose the control blank to the area and immediately close the control blank. The control blank shall be kept in the same environment as the exposure sample media.
- Inspectors must use a sampling pump calibrated to the applicable flow rate when air needs to be drawn through the sample media. See the contaminant index and manufacturer's instructions for applicable flow rates.
- The sampling train is unique for each type of sampling. Inspectors will assemble the necessary components and ensure that media orientation is correct, all fittings are tight, and the media is secure.

Specific guidance for each sample media type are outlined below:

1. Diffusion Tubes

All diffusion tubes are passive monitors. They are provided in numbered lots, but are not individually numbered. The tubes are directly read so they do not need to be analyzed by the laboratory.

The sampling train components include a tube holder and the tube.

Inspectors use the tube holder and break the tube along the perforation bead immediately before sampling. The empty glass portion is discarded. Insert the tube into the holder with the inlet facing down.



Diffusion Tube and Holder

Diffusion tubes can continue to react even after removed from the contaminant. Inspectors must immediately record the exposure and the sampling time after sampling is stopped or paused.

The contaminant index contains the sampling error factors needed for each contaminant to determine compliance when using diffusion tubes.

Correction Factors for Elevation: Elevation changes relative to sea level affect tube accuracy because they affect the density of the air diffused through the tube. Make appropriate corrections for elevation to diffusion tube readings by multiplying the concentration indicated on the tube by the correction factors given below.

Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor
-5000 (-1524)	0.83	500 (152)	1.02	7000 (2134)	1.31
-4500 (-1372)	0.85	1000 (305)	1.04	8000 (2438)	1.36
-4000	0.86	1500	1.06	9000	1.41

Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor
(-1219)		(457)		(2743)	
-3500 (-1067)	0.88	2000 (610)	1.08	10000 (3048)	1.46
-3000 (-914)	0.90	2500 (762)	1.10	11000 (3353)	1.52
-2500 (-762)	0.91	3000 (914)	1.12	12000 (3658)	1.58
-2000 (-610)	0.93	3500 (1067)	1.14	13000 (3962)	1.64
-1500 (-457)	0.95	4000 (1219)	1.16	14000 (4267)	1.71
-1000 (-305)	0.96	4500 (1372)	1.18	15000 (4572)	1.77
-500 (-152)	0.98	5000 (1524)	1.21	---	---
0 (sea level)	1.00	6000 (1829)	1.26	---	---

Inspectors determine compliance by reading the tube color change (stain) on the tube and correcting for equipment and environmental factors.

Input the health sample data in the inspector's computer system and upload it to MSHA's information database.

Example (Diffusion Tube Full-Shift Sample):

A 12-hour SO₂ sample was taken with 2 consecutive tubes. Samples were collected at 5000 feet above sea level. The 1st Tube reads 50 ppm*h after 8 hours. The 2nd Tube reads 20 ppm*h after 4 hours.

1. TLV * Error Factor (EF) = MSHA Citable Level
2. Corrected Diffusion Tube Reading (CDTR) = Uncorrected Diffusion Tube Reading * Elevation Correction Factor

$$3. \text{ SWA (ppm)} = \frac{\text{CDTR1 in ppm}\cdot\text{h} + \text{CDTR2} + \dots + \text{CDTRn}}{8 \text{ hours}}$$

4. Compare SWA (ppm) MSHA Citable Level

Therefore:

$$\text{SO}_2 \text{ TLV (5 ppm)} * \text{EF (1.25)} = \text{MSHA Citable Level (6.25 ppm)}$$

$$1^{\text{st}} \text{ Tube } 50 \text{ ppm}\cdot\text{h} * \text{Elevation Correction Factor (1.21)} = 60 \text{ ppm}\cdot\text{hr}$$

$$2^{\text{nd}} \text{ Tube } 20 \text{ ppm}\cdot\text{h} * \text{Elevation Correction Factor (1.21)} = 24 \text{ ppm}\cdot\text{hr}$$

$$\text{SWA} = (60 \text{ ppm}\cdot\text{h} + 24 \text{ ppm}\cdot\text{h}) / 8 \text{ hours} = 10.5 \text{ ppm}$$

Sorbent Tubes

Sorbent tubes are normally active monitors. Typically, these are charcoal tubes, silica gel tubes, or other media. The tubes are provided in numbered lots with expiration dates. The tubes are not individually numbered. A unique number must be noted on each sample tube to be used.

One media control blank is needed for each analysis requested from the lab.

The sample train components include a sample pump, hose, tube holder, and tube. Most tubes have an arrow printed on them to show the air flow direction during sampling. The inlet should always face down.



Sorbent Tube Sampling Train

Inspectors break off each end of the sample tube and place it in the tube holder immediately before sampling.

Place caps over the ends of the sampling tubes when sampling is complete. A sample seal (MSHA Form 4000-30) can be dated, signed, and placed over the end caps.

Complete the RLA for each exposed media and upload the form. A copy of the form must be included with the samples when shipped for analysis.

Package all media from each sampling inspection along with the laboratory blank. All media from the same inspection must be mailed together in one container or package typically **within 24 hours** to the appropriate MSHA laboratory.

Sorbent Badges

Sorbent badges are normally passive monitors. They are provided with unique numbers and instruction booklets. Typically, these are mercury or organic vapor badges.



Mercury Vapor Monitor Badge



Organic Vapor Monitor Badge

One media blank is needed for each analysis requested from the lab.

The sampling train consists of a passive badge with a clip for positioning. The badge must face outward.

Inspectors will remove the cap immediately before sampling.

Place caps over the sorbent badges when sampling is complete. A sample seal (MSHA Form 4000-30) can be dated, signed, and placed over the caps.

Complete the RLA for each exposed media and upload the form. A copy of the form must be included with the samples when shipped for analysis.

Package all media from each sampling inspection along with the laboratory blank. All media from the same inspection must be mailed together in one container or package typically **within 24 hours** to the appropriate MSHA Laboratory.

Detector Tubes

The inspector should use a contaminant specific detector tube and bellows-type sampling pump together as a direct-reading sampling system. This system can be used to determine the short-term concentration of gases or vapors in the air. Consult the manufacturer's instructions for the bellows pump and the type of tube you are using. Never interchange units or components from one pump-tube system to another.



Detector Tubes and Bellows Pump

Select the appropriate tube for the contaminant you are sampling. The contaminant index contains the sampling error factors needed for each contaminant to determine compliance when using detector tubes.

The amount of air required (number of strokes), the waiting period between strokes, and the chemical reaction time vary with the individual type of tube,

the tube manufacturer, and the concentration of the contaminant.

Determine the amount of time that is required for the chemical reaction to take place between the tube ingredients and the contaminant. This determines the period of time between the start of sampling and when the tube can be read.

Open both ends of the tube using a tube breaker or by inserting the tip gently into the tube opener hole in the bellows pump. The openings should be approximately one-half the internal diameter of the tube.

An arrow on the tube indicates the direction of air flow. Insert the proper end of the detector tube into the tube holder of the pump. Air to be sampled must not pass through any hose or tubing before entering the detector tube.

Inspectors should squeeze the bellows pump with the inserted sample tube the designated number of strokes and sample time for the contaminant and read the results.

Note: If the bellows pump is provided with a stroke counter, reset the counter before taking a sample.

Observe the color change length on the tube's indicating layer. A departure from a sharp demarcation between the reacted chemical and the un-reacted chemical in the tube is the "indicating layer." Read the stain length from the zero point to the end point of this layer.

The tubes may be marked in percent or in ppm, depending on the concentration range to be measured. Ensure you record the proper units.

Note: Some detector tubes are marked with "n=" to denote multiple scales depending on the number of strokes to be taken. Use the appropriate scale when reading the tube.



Multiple Scales

Inspectors determine compliance by reading the tube color change (stain) on the tube and correcting for equipment and environmental factors.

Note: Multiple stains in the tube designated by color differences, different end points, or uncolored areas between multiple end points, indicate interfering contaminants and the tube cannot be used for compliance.

Correction Factors for Elevation: Elevation changes relative to sea level affect tube accuracy because they affect the density of the air being drawn through the tube. Make appropriate corrections for elevation to detector tube readings by multiplying the concentration indicated on the tube by the correction factors given below.

Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor
-5000 (-1524)	0.83	500 (152)	1.02	7000 (2134)	1.31
-4500 (-1372)	0.85	1000 (305)	1.04	8000 (2438)	1.36
-4000 (-1219)	0.86	1500 (457)	1.06	9000 (2743)	1.41
-3500 (-1067)	0.88	2000 (610)	1.08	10000 (3048)	1.46
-3000 (-914)	0.90	2500 (762)	1.10	11000 (3353)	1.52

Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor	Elevation in feet (meters)	Correction Factor
-2500 (-762)	0.91	3000 (914)	1.12	12000 (3658)	1.58
-2000 (-610)	0.93	3500 (1067)	1.14	13000 (3962)	1.64
-1500 (-457)	0.95	4000 (1219)	1.16	14000 (4267)	1.71
-1000 (-305)	0.96	4500 (1372)	1.18	15000 (4572)	1.77
-500 (-152)	0.98	5000 (1524)	1.21	---	---
0 (sea level)	1.00	6000 (1829)	1.26	---	---

Inspectors can collect short term samples with detector tubes using the following procedures:

- Determine the time allowed for the exposure limit of the gas or vapor you intend to measure (typical range is from 5 to 30 minutes).
- Collect samples in the breathing zone at regular intervals and determine the average concentration during the time limit.

Example (for a 15 minute STEL):

- Take one grab sample during the first 5-minute period
- Take a second grab sample during a second 5-minute period
- Take a third grab sample in a final 5-minute period
- Add all three readings and average (divide by 3) to obtain the concentration of the short-term exposure.

Vacuum Samples

Inspectors use an evacuated bottle to pull a grab sample of mine air. The bottles have negative pressure inside. Inspectors use the following procedures to draw in the ambient mine air.

Vacutainers (10mL) - The bottles are pre-numbered and have an expiration date. Hold the bottle away from your body and away from your breathing zone to avoid contaminating the sample. Push the stopper into a plunger with a needle until the plunger punctures the stopper and the mine air enters, then remove the bottle and the stopper self-seals.

If the inspector does not have a needle with a plunger on hand, he or she may simply pop the stopper out of the vacutainer. If this method is used for sampling, it is important to ensure the stopper is placed back into the vacutainer completely.

Complete the Mine Atmosphere Sample Record and include a copy with the samples for the lab.



Vacutainer (10mL)

Vacuum bottles (50mL) – The bottles are pre-numbered and do not have an expiration date. Break the glass tip off the bottle neck and allow the mine gas to enter. Seal the bottle using a wax-filled cap. Apply firm, steady pressure to the cap until the bottle neck is filled along its length with wax.

Complete the RLA for each bottle and upload the form. A copy of the form must be included with the samples when shipped for analysis.



Vacuum Bottle (50mL)

Package all bottles from each sampling inspection and mail them together in one package typically **within 24 hours to** the appropriate MSHA Laboratory.

Note: Contact the lab or see contaminant index for special instructions. Some contaminants may require overnight mailing.

Bag Samples

Inspectors use a sampling pump to fill a sample bag with contaminated air. The bag should only be filled about half-full to prevent accidental rupture during transportation. The sample bag must be sent to the lab for analysis.

Typical mine gases are the most common contaminants sampled by this method. Inspectors should consult with your supervisor to determine the correct method to set up the sampling train.

Complete the RLA for each bag and upload the form. A copy of the form must be included with the samples when shipped for analysis.

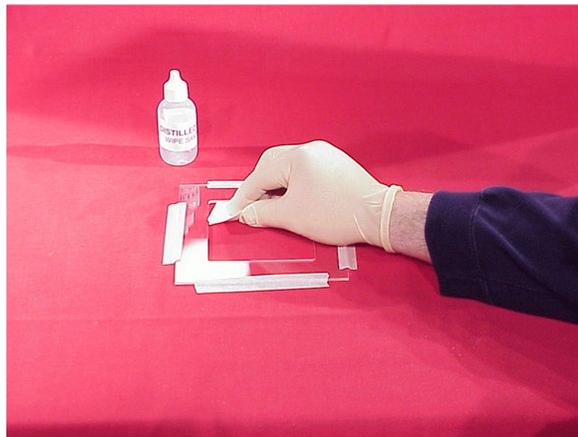
Package all bag samples from each sampling inspection and mail them together in one package typically **within 24 hours** to the appropriate MSHA laboratory.

Note: Contact the lab or see contaminant index for special instructions. Some contaminants may require overnight mailing.

Wipe Samples

Inspectors collect wipe samples to determine surface contaminants. Consult the Contaminant Index for specific filter paper and appropriate solution to use.

One blank (or unused) wipe is needed for each set of wipe samples. Blank wipes must be submitted in the same shipment, but placed in a separate vial. The blank wipe should be handled with clean disposable gloves.



Wipe Sample

Collecting the wipe sample:

- Wear clean, impervious, disposable gloves.
- Moisten the wipe filter with distilled water or the appropriate solution prior to use.

- Gently wipe a surface area covering at least 16 in² (4 in. x 4 in.) or 100 cm² (10 cm x 10 cm).
- Fold the wipe sample with the exposed side in.
- Transfer wipe sample into a plastic bag, vial, or jar. Seal the vial or jar with a nonmetallic (e.g., teflon) cap or lid and seal the cap or lid with vinyl or electrical tape.

Note: Wipe samples for mercury and mercury compounds should be placed into a 20-ml borosilicate glass scintillation vial, with a Teflon- or polypropylene-lined cap. Plastic bags should not be used as the primary container for mercury wipes.

- Mark the container with a sample number. A sample seal (MSHA Form 4000-30) can be placed on it so that the sample cannot be tampered with.

Complete the RLA for each wipe and upload the form. A copy of the form must be included with the wipe when shipped for analysis. Note any possible interferences on the RLA. Some wipe samples may have shorter hold times than others.

Package all wipes from each sampling inspection and mail them together in one package typically **within 24 hours** to the appropriate MSHA Laboratory.

Bulk Samples

Inspectors can collect bulk samples to identify “unknown” contaminants which may be present. The samples may be collected from accumulations of material at the mine site, when a hazard is suspected. The inspector should supply any information on the bulk sample relevant to the composition to help the laboratory select an appropriate analysis. This could include the location where the sample was collected, processes involved, and, whenever possible, Safety Data Sheets (SDS) and/or independent laboratory analysis reports.

Inspectors should consult with their supervisor to determine the correct collection containers and shipping instructions.

Note: Do not ship bulk samples in the same package as exposure samples.

Complete the RLA for each bulk sample and upload the form. A copy of the form must be included with the sample when shipped for analysis. Note any information that may identify possible contaminants present. Some bulk samples may have shorter hold times than others.

Package all bulk samples from each sampling inspection and mail them together in one package typically **within 24 hours** to the appropriate MSHA Laboratory.

E. Collecting Personal Sample(s)

1. Instrument Location

- The inspector should attach the sample train to the miner within the breathing zone. Attach the sample train to the miner's clothing so that it does not interfere with the miner's job performance and does not present a safety hazard.
- Ensure that the sampling train is unobstructed by clothing.
- The sample pump and train may be placed on another miner performing the same occupation/task if a miner objects to wearing it. Document the reason for the objection.

Instructions to the Miner

- Explain the reason for the sampling, what the sampling device does, and what you are doing.
- Instruct the miner not to remove the sampling train at any time or cover the inlet to the sampling media.
- Instruct the miner not to bump, drop, or tamper with the sampling pump or train.
- Explain the need to continue to work in a routine manner and report any unusual occurrences during the sampling period to you. The miner needs to notify the inspector if they must leave the mine property during the shift. Remove the sample media and record the time and when the miner returns, resume sampling with new sampling media.
- Inform the miner when and where the sampler will be removed, and that you will be checking the equipment throughout the shift.

Sample Information

Observe and record the following information (if applicable) in the inspection notes:

- Miner's name, job title/ occupation code, and work location(s).
- The typical shift hours per day and days per week worked.
- The time the sampling pump was started.

Note: Document the times if the sampling pump needs to be changed out, stopped, or restarted for any reason during sampling.

- Pump and sampling media identification numbers.

Note: Work environments in Metal Non-Metal mines with a significant amount of dust, fumes or mists may require changing sampling media to prevent overloading them during sampling. Use consecutive sampling with shorter sampling periods. Record the sample media identification number and the times for each sample taken.

- Ensure that the sampling devices are properly worn and maintained in the environment being sampled.
- Ensure typical activities are taking place and the approximate time spent at each activity.
- Potential sources of exposure and a general description of what they are. Number of persons affected, and additional control measures that could be recommended.
- Equipment operating in the area.
- Provide a general description of the controls in use and whether or not they seem adequate.
- Respiratory protection worn (yes/no) (type).
- Does a compliant respiratory protection program exist?
- Changes that occur during the sampling shift which may affect the exposure to the miner(s).

- Results of other samples taken, if available (e.g. noise, detector tubes, direct reading instruments).
- Environmental conditions (such as wind, temperature, humidity, elevation, etc.).
- Remove the sampling pump and train from the miner when sampling is complete.
- The time the pump was turned off.
- Tube reading, error factor, and any equipment and environmental factors used in the determination.
- A sample seal (MSHA Form 4000-30) can be dated, signed, and placed over the sample filter cassette end caps.

F. Compliance Determination

1. Direct Read Sampling

Compliance is determined by comparing sample results with error factor to the appropriate regulation. A citation/order shall be issued when the citable limit is exceeded after taking into account the applicable error factors. The citation number is entered in the health sample data and uploaded.

Laboratory Analysis Sampling

An analytical report will be provided to the inspector. The inspector will compare the sample results to the appropriate standard. A citation/order must be issued when samples exceed the citable limit. The citation number is entered in the health sample data and uploaded.

G. Inspection Reports/Documentation

Inspection reports should include the following (when applicable):

- Laboratory analytical report(s).
- Completed health sample data worksheet(s).
- Issued citations, orders, or subsequent actions.

- Requests for Laboratory Analysis or Mine Gas Sample Atmosphere report.
- Inspection notes and any other supplemental information collected during the inspection.

CHAPTER 8 - SAMPLING PUMPS & AIRFLOW CALIBRATORS

A. Introduction

Inspectors use constant-flow personal sampling pumps in conjunction with sampling media to collect several different types of occupational exposure samples. The sampling pump must be sufficiently charged, properly maintained, and properly calibrated to preserve the integrity of each sample and analytical result.

B. Definitions

Burette: A cylindrical glass or plastic tube, typically 1.0 - 2.0 liters in volume, which can be used to calibrate air sampling pumps and verify airflow meter calibration. It is considered a traceable primary standard and is compliant with the National Institute of Standards and Technology (NIST).

Dry Calibrator: A type of airflow calibrator that uses air to set and/or verify flow rate of a sampling pump. The electronic instrument automatically computes the airflow rate of the sampling pump.

Wet Calibrator: A type of airflow calibrator that uses a soap bubble to set and/or verify flow rate of a sampling pump. The electronic instrument automatically computes the airflow rate of the sampling pump.

C. Sampling Pump Calibration Procedures

1. Basic Airflow Calibration

Inspectors should use an appropriate airflow calibrator in accordance with manufacturer's instructions.

The calibration instrument must be used with the representative sampling train and media included to simulate the resistance of the complete sampling train.

Do not use the sample media from the calibration for sampling purposes.

The following are examples of calibration set up using various sampling media.

Cyclone Assembly

Some manufacturers require the use of the calibration jar when a cyclone is used. The cyclone with the sampling media is placed inside the jar. The jar must be air tight and should be periodically inspected for leaks, deformed tubing, cracked rubber grommets, etc. when it is used. Other calibration methods are acceptable when done in accordance with the manufacturer's instructions.



Respirable Dust

Calibration Jar with Cyclone

DPM

Open-Faced Sample Media

Inspectors must use a calibration jar when the sampling media does not have an inlet that can be used with tubing.



Calibration Jar with Open-Face Sample Media

Closed-Face Sample Media

The sample media will be installed inline when the media has an inlet and outlet that allows tubing to be installed.



Closed-Face Media

**Asbestos Media with
Calibration Cover**

Sampling Pump Information

The sampling pump automatically corrects for elevation within normal ranges. Inspectors should consult the manufacturer's literature for normal operating ranges. The inspector should calibrate the sampling pump at or

near sampling elevation if they are used at very high or low elevations if specified.

A fully charged and stabilized sampling pump shall be calibrated:

- Each 200 hours of use or more often if necessary.
- When the flow rate or sample media type is changed due to sampling method requirements.
- When required by manufacturer's instructions.

A record of sampling pump calibrations should be maintained.

Calibration Procedures

The inspector should perform the following steps:

- Connect the sampling pump to the calibrator using the sampling train or calibration jar.
- Turn on the sampling pump and let it run 10 minutes to stabilize.
- Turn on the calibrator and allow it to run through its self-check sequence.
- Use the calibrator procedures and take an average of 5 readings to determine the pump's operating flow rate. The average flow rate must be $\pm 5\%$ of the flow rate required by the sampling method.
- Adjust the pump, following the manufacturer's instructions and repeat procedures if the pump is not within $\pm 5\%$.
- The pump should be removed from service and repaired if it will not calibrate after the second time.

D. Annual Calibration Check Procedures for Wet Method Electronic Airflow Calibrators (e.g., Sensidyne, Gilian)

Electronic airflow calibrators consisting of a matched cell and base unit must be checked annually against a laboratory or factory certified instrument that has a known NIST traceability. One certified instrument should be designated as the master unit and other similar calibration instruments can be checked against it annually.

Note: The master unit should not be used in the field but kept for calibration check procedures only.

The following is needed to conduct the calibration check and complete the Calibration Verification Record.

- One fully charged and calibrated air sampling pump capable of small airflow adjustments.
- Two pieces of tubing approximately 2 feet in length to attach the wet airflow calibrator to the sampling pump.
- Record the property or serial numbers of the certified flow cell and the matched electronic base piece (master) from the factory calibration certificate or the laboratory data sheet. See the following example.

SENSIDYNE, INC.
CALIBRATION CERTIFICATE

CELL S/N: 0911014-S DATE: 06 - 02 - 2011

This is to certify that the above referenced GILibrator Flow Cell was calibrated using film flowmeter MCS-102-A, which has been calibrated by instruments directly traceable to the National Institute of Standards and Technology. NIST Report 8361604.

Results:

REFERENCE MCS-102-A cc/min	S/N 0911014-S cc/min	RELATIVE DIFF. cc/min	PERCENT DIFF.
2022	2025	3	0.15
2021	2025	4	0.2
2020	2020	0	0.0
2021	2021	0	0.0
2021	2020	-1	-0.05
2024	2020	-4	-0.2
2020	2020	0	0.0
2024	2021	-3	-0.15
2021	2017	-4	-0.2
2014	2014	0	0.0
MAX		4	0.2
MEAN 2020.8	2020.3		

CALIBRATED BY *Anne Bradford* DATE: 06 - 02 - 2011
CODE 000

- Record the calibration flow rate which is the referenced average (MEAN) flow rate to set the field unit to cc/min or liter per min (LPM) circled above.
- Calculate and record the $\pm 1\%$ flow rate range using the referenced average flow rate.

Example - for a referenced flow rate of 2020.3 cc/min:

+1% = 2040.5 cc/min or 2.0405 LPM

-1% = 2000.1 cc/min or 2.0001 LPM

- Record the pressure, temperature, and relative humidity, at the location and time the calibration check is performed (optional).
- Start the sampling pump and allow it to run for 10 minutes to warm up and stabilize.
- Attach the tubing to the certified calibrator (master), and the sampling pump. Let the pump stabilize.
- Adjust the air sampling pump to match the reference flow rate value from the certified calibrator (master). Allow the pump to stabilize for 1-2 minutes between any adjustments.

Example:

1. The reference flow rate is 2020 cc/min or 2.02 Liters/min.
 2. Adjust the sampling pump flow rate to 2020 cc/min (or 2.02 LPM) following manufacturer's procedures.
 3. Use the calibrator and take 3 sets of 5 readings recording each reading and averaging each set.
 4. Average the 3 average results and record this overall average value to demonstrate that the pump flow rate matches the referenced flow rate.
- **DO NOT TURN OFF THE SAMPLING PUMP.**
 - Carefully remove the tubing from the certified (master) calibrator and attach the pump to the field calibrator for comparison. Let the pump stabilize for 10 minutes. **DO NOT RE-ADJUST THE PUMP FLOW RATE.**
 1. Take 3 sets of 5 readings using the field calibrator recording each reading and averaging each set.
 2. Average the 3 average results and record this overall average value.

- This final overall average must be within $\pm 1\%$ tolerance of the referenced flow rate (master).

For the example the final overall average must be between 2.00 LPM and 2.04 LPM.

1. Calibration verification check results:

- Meets the $\pm 1\%$ tolerance. The Calibration Verification Record is signed by the person performing the check and also reviewed and signed by a supervisor.
- Does NOT meet the $\pm 1\%$ tolerance. Repeat the test again. If the unit checked fails the second verification test the unit must be removed from service and returned to the laboratory or factory for maintenance and certification. The Calibration Verification Record is signed by the person performing the check. Contact the District Industrial Hygienist or Health Specialist for maintenance assistance.

2. Retain record on file for the life of the instrument or minimum of five years. Provide a copy of the completed record to the District Industrial Hygienist/Health Specialist.

3. Once the calibration check has been verified, the flow cell and the microprocessor base piece must remain together as a unit. They must not be interchanged with other like parts unless a new calibration comparison check or laboratory/factory calibration is conducted and verified/certified as a unit.

Calibration Verification Record

Laboratory/Factory calibrated unit information (master):

Model:	Cell property/SN:	Base property/SN:
Date calibrated:	Referenced flow rate:	+1% upper limit:
		-1% lower limit:

1. Adjust the air sampling pump to match the reference flow rate value from the certified calibrator (master).

- a. Use the calibrator and Take 3 sets of 5 readings recording each reading and averaging each set.
- b. Average the 3 average results and record this overall avg value to demonstrate the pump flow rate matches the referenced flow rate. **Do not turn off the sampling pump.**

	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
1.						
2.						
3.						
						Overall Avg

Field instrument for calibration verification check information:

Note: Instrument must be same brand as the laboratory/factory calibrated unit.

Model:	Cell property/SN:	Base property/SN:

1. Carefully remove the tubing from the certified (master) calibrator and attach the pump to the field calibrator for comparison.

- a. Use the calibrator and Take 3 sets of 5 readings recording each reading and averaging each set.
- b. Average the 3 average results and record this overall average value. This overall average must be within $\pm 1\%$ tolerance of the referenced flow rate (master) calculated above.

	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Average
1.						
2.						
3.						
						Overall Avg

[Note: Units that fail two verification tests shall be removed from service and returned to the laboratory or factory for maintenance and certification.]

Calibration verification was conducted at the _____ District or _____ field office using a constant flow air sampling pump and following electronic calibration quality assurance program procedures. (Optional) °F _____, %Relative Humidity, _____, Atmospheric Pressure _____

This field use flowmeter calibrator was found to: _____ **Meet** or _____ **Not Meet** the $\pm 1\%$ tolerance.

Retain calibration record on file for five years. Provide a copy to District Industrial Hygienist/Health Specialist.

Calibration checked by: _____

Date

Reviewed by: _____

Date

CHAPTER 9 - CHEMICAL STORAGE, USE, AND PERSONAL PROTECTIVE EQUIPMENT

A. Introduction

This chapter addresses chemical storage and use on mine sites including the use of alternative fuel sources in the milling process. Inspectors should consider sampling to determine exposures to miners if deficiencies in chemical storage and/or use are noted during an inspection. Inspectors should contact their supervisor to report concerns about chemical storage and use on mine property.

Inspectors should evaluate the safety measures in place including the use, care, and maintenance of personal protective equipment.

B. Definitions

Alternative Fuel - Any substitute or supplemental fuel used to fire a kiln, dryer, or other industrial furnace. Some alternative fuels may be classified by EPA as Hazardous Waste Fuels (HWF).

Breakthrough - When a contaminant contact overwhelms the ability of the protective equipment to filter or resist the contaminant and provide protection. The contaminant, the concentration, and/or the duration of exposure may be a factor.

Breakthrough Time - The time lapse from the initial contact of the chemical on the outside surface of the protective equipment until detection on the inside surface. Longer breakthrough times provide greater protection.

UN Number - A four-digit number used on placards or labels to identify materials for regulation of their transportation. Inspectors can use these to obtain information on the referenced chemicals.

Flash Point - The minimum temperature where sufficient vapor is released by a liquid or solid to form a flammable vapor-air mixture at atmospheric pressure.

Hazardous Waste Number - A four-digit alphanumeric identification code assigned by the Environmental Protection Agency (EPA) per the Resource Conservation and Reclamation Act (RCRA) to identify wastes. Inspectors can use these to obtain information on the referenced chemicals.

Immediately Dangerous to Life or Health (IDLH) – Likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment.

pH – The acidity or alkalinity value of a solution. Pure water has a pH of 7. A pH below 7 indicates an acidic solution with 1 being the most acidic. A pH above 7 indicates an alkaline solution with 14 being the most alkaline.

Polymerization - A chemical reaction in which one or more small molecules combine to form larger molecules. Some polymerization reactions take place at rates that release large amounts of energy that can cause fires or explosions or burst containers.

C. Identifying the Hazard

The inspector should carefully review labels, Material Safety Data Sheets (MSDSs) or Safety Data Sheets (SDSs)), and any other available reference information for chemicals used and/or stored on mine property. The Contaminant Index in this Handbook and the *NIOSH Pocket Guide to Chemical Hazards* also provide information.

These documents are good sources of information on the hazards the chemical may present, appropriate personal protective equipment, the proper spill and emergency procedures, etc. For more information or questions concerning identifying chemical hazards, contact your supervisor.

Review the following from the Mine Operator:

- HazCom Program
- Solid waste inventory, shipping manifests and/or profile sheets
- Process flow charts
- Any other process information related to chemical storage and use
- Chemical inventory with location including:
 - Raw Materials
 - Additives
 - Catalysts
 - Wastes

Do any of the chemicals, if released, have the potential to cause a catastrophic incident? Contact your supervisor if you need help evaluating the hazard.

D. Evaluating the Work Environment

Inspectors should evaluate areas where the chemicals are stored and used once the hazard information is carefully reviewed.

1. Chemical Incompatibility

The accidental mixing of incompatible chemicals may result in explosions, fires, or toxic releases. Chemicals are improperly stored if a chemical can be spilled and come in contact with an incompatible chemical or material.

Chemicals are classified into compatibility groups based on the reactivity and corresponding storage criteria of each group. Inspectors should evaluate the following compatibility groups when inspecting work areas:

- a. **Corrosives** - Chemicals that can cause visible destruction or irreversible alterations in living tissue by chemical action at the site of contact. They can also destroy metallic materials. They must be handled with care.
 - **Acid** - Inorganic or organic compound that has a pH of less than 7.0.
 - Corrosive acids have a pH less than or equal to 2.0.
 - May react with metals to yield hydrogen.
 - Turns blue litmus paper to red.
 - **Base (also called alkali or caustic)** - Inorganic or organic compound that has a pH of greater than 7.0.
 - Corrosive bases have a pH greater than or equal to 12.
 - Turns red litmus paper to blue.

Guidelines for Safe Storage and Use of Corrosive Chemicals:

- Segregate acids from bases.
- Isolate from toxic materials, organic materials, flammable materials, and substances that may release corrosive, toxic, or flammable vapors on reaction.
- Store in cool, dry, well-ventilated areas not subject to rapid temperature changes, and that are protected from direct sunlight.
- Store liquid containers in trays with compatible absorbent material of sufficient volume to contain and prevent leakage onto materials stored below if storage cabinets are used.
- Structural material where chemicals are stored should be corrosion

resistant metal and should be covered with acid-fume resistant paint or made of other suitable materials.

- Proper type of fire-fighting equipment readily available.
- b. Reactive Materials** - Chemicals or mixtures that vigorously polymerize, decompose, condense, or become self-reactive due to shock, pressure, and/or temperature.
- **Oxidizers** - Chemicals (usually gases or liquids) that spontaneously release oxygen at room temperature or with slight heating, accelerating combustion. They may cause a fire or explosion on contact with incompatible material.
 - **Water Reactives** - A substance or mixture that reacts with water releasing heat, and/or flammable/ toxic gas.
 - **Pyrophoric Materials** - Materials that ignite spontaneously in air below 54° C (130° F).

Guidelines for Safe Storage and Use of Reactive Materials:

- **Oxidizers**
 - Isolate from organic materials, flammable solvents, corrosives, toxic materials.
 - Store in cool, dry, well-ventilated areas out of direct sunlight.
 - Protect from temperature extremes.
 - Do not store containers directly on wooden shelves or on paper shelf liners (spills may react with the organic portion of the shelf or paper and ignite spontaneously).
 - Storage buildings should be fireproof and provided with a fire suppression system.
- **Water Reactive and Pyrophoric Materials**
 - Isolate from moist air, aqueous acids and bases, flammable storage areas, and other reactive chemicals.
 - Store in cool, dry, well-ventilated areas.
 - Store pyrophors under (immersed in) nonflammable, inert solvents.
 - Storage areas should be fireproof, without an automatic sprinkler system, and located where water cannot get into the area.
 - Do not use water to clean off soiled clothing or wash off after handling. Consult the SDS or NIOSH *Pocket Guide to Chemical*

Hazards for alternative to water (specific for each chemical).

- c. **Toxic Materials** - Any chemical or material that can poison or otherwise injure the organs or tissues of the body.

Guidelines for Safe Storage and Use of Toxic Materials:

- Secure in locked area to minimize access.
- Minimize stored quantities.
- Store in cool areas with constant humidity.
- Use an independent and filtered ventilation system.
- Isolate from areas where workers gather.
- Post poison control, first aid, and other safety information.
- Post warning signs where appropriate, for example, "Danger - Poison."

The National Fire Protection Association (NFPA) has many useful pamphlets on chemical storage.

Laboratories

The facilities should be specifically designed and engineered for doing work with hazardous chemicals. Inspectors should check that fume hoods and other appropriate methods of containment are used, safe work practices are followed, and that laboratory and support personnel use the appropriate personal protective equipment.

Bulk Storage

Proper design and construction of large and small bulk storage tanks provided with suitable diking systems for spill containment can minimize the impact of hazardous spills and vapor releases. Chemical filters may be needed to prevent tank vapors from escaping due to "tank breathing" during use, particularly during filling operations.

E. Personal Protective Equipment

Personal protective equipment (PPE) are items or materials worn by a miner to prevent injury or illness resulting from exposure to a chemical, physical, biological agents or physical trauma. Guidance for PPE selection may be found in the following:

- NIOSH "*Recommendations for Chemical Protective Clothing*" - available over the Internet links from the MSHA home page, the NIOSH *Pocket Guide to Chemical*

Hazards, or the contaminant index.

- Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) (Caution: In many cases these documents are very general or only offer PPE recommendations for emergency use. Do not rely on them as a sole source of information.)
- Equipment manufacturer selection tables.

PPE must be maintained after it is properly selected to ensure adequate protection. Chemicals gradually permeate and degrade the material, allowing possible chemical contact with the skin. Inspectors should evaluate cleaning schedules, retirement criteria, usage, and mine conditions.

Inspectors should evaluate the following types of PPE and their use:

1. Respiratory Protection

Respirator types are grouped by air supplied or filtered, and if the pressure inside the mask during inhalation is positive or negative.

- **Air-purifying respirators** filter contaminants from the air.
- **Supplied air respirators** provide breathable air from an uncontaminated source.
- **Negative pressure respirators** - the pressure inside the respirator during inhalation is less than the pressure outside the respirator.
- **Positive pressure respirators** - the pressure inside the respirator always remains greater than the pressure outside the respirator.

Respirator Types

- **Air-Purifying Respirators (APR)** include negative pressure, tight-fitting respirators and **Powered Air-Purifying Respirators (PAPRs)**. These respirators remove contaminants from the outside air prior to inhalation, by passing it through a filter or cartridge containing a solid sorbent such as activated charcoal. Air-purifying respirators do not provide oxygen and must never be used in an oxygen-deficient atmosphere.
- **Supplied-Air Respirators (SAR)** may be either positive or negative pressure. The **Air-Line Respirator (ALR)** and the **Self-Contained Breathing Apparatus (SCBA)** are the two types of SARs. Only SARs are

safe for use in oxygen-deficient atmospheres.

Note: IDLH atmospheres Air-Line Respirators must have:

- Auxiliary self-contained breathing capability for escape purposes.
 - Bottled air must be of Grade D quality.
 - Compressors must be protected from contaminating the air supply with engine exhaust or the thermal decomposition products of lubricating oils (e.g., carbon monoxide).
 - Current NIOSH certifications also limit hose length as a function of approved assemblies.
- **Escape-Only Respirators** are intended for use only during escape (emergency exit) from a hazardous atmosphere. The capacity of the unit must be sufficient to allow escape. They are not to be used to enter or re-enter a hazardous atmosphere for any purpose.

Respirator Cartridge Types

- **Particulate Cartridges** filter only aerosols such as dusts, mists, fumes, smoke, mold, bacteria, etc. Some filters also have nuisance-level gas and vapor capabilities.
- **Gas & Vapor Cartridges** filters only gases and vapors. There are different kinds of cartridges for different kinds of gases and vapors.
- **Combination Cartridge/Filters** filter particles, gases and vapors. Different combination particulate/cartridge filters are used depending on the gas or vapor present in the air.
 - Organic Vapor
 - Acid Gases
 - Organic Vapor/ Acid Gases
 - Ammonia/ Methylamine
 - Formaldehyde/ Organic Vapor
 - Multi-Gas/ Vapor
 - Mercury Vapor/ Chlorine Gas

Note: See contaminant index for additional respirator recommendations.

Respiratory Protection Programs

The following checklist of elements are considered a minimally acceptable respiratory protection program. Not all elements are applicable to all situations. Inspectors should refer to **ANSI Z88.2-1969** for more specific guidance.

- The operator must establish a written standard operating procedure (SOP) governing the selection, use, and maintenance of respirators. All contaminants requiring respirators should be addressed in the SOP. The SOP should be written so that anyone reading it will understand how all of the minimum requirements are addressed, including routine and emergency use.
- The mine operator must select the respirator on the basis of the hazards to which the miner is exposed. The respirator must be approved for the specific hazards. Other factors such as atmospheric oxygen content, anticipated exposure levels, properties of the contaminant, work environment, and other physical factors must be considered. Each respirator has distinct limitations on its use and the manufacturer's literature will list them.
- The miner shall be instructed and trained in the proper use of respirators and their limitations. The minimum training should include the following:
 - Instruction in the nature of the hazard, whether acute, chronic, or both, and an appraisal of what may happen if the respirator is not used.
 - Explanation of why more positive control is not immediately feasible. This shall include recognition that every reasonable effort is being made to reduce or eliminate the need for respirators.
 - A discussion of why this is the proper type of respirator for the particular purpose.
 - A discussion of the respirator's capabilities and limitations.
 - Instruction and training in actual use of the respirator (especially a respirator for emergency use) under close, frequent supervision to ensure that it continues to be properly used.
 - Classroom and field training to recognize and cope with emergency

situations.

- Other special training as needed for special use.
- Mine operators shall provide the miners opportunity to handle the respirator, have it fitted properly, and wear it in normal air for a long familiarity period. All miners required to use respirators must be fit-tested prior to initial use of that particular make, model and size of respirator. Periodic re-testing is advisable but not required unless factors affecting the fit such as weight gain or loss, or the presence or absence of dentures or scarring is observed. Fit testing may be either quantitative or qualitative.
- The operator must be able to demonstrate that the proper respirator was issued to the respirator wearer. Fit test records will provide this information.
- Respirators must be inspected routinely before and after each use. Worn or deteriorated parts must be replaced to maintain proper approval. Self-contained breathing apparatus must be thoroughly inspected at least once per month and after each use. The mine operator must keep a record of the inspection dates and findings for respirators maintained for emergency use.
- ANSI states that cleaning and disinfection shall be done “as frequently as necessary to ensure proper protection is provided to the wearer.” Daily cleaning of respirators is recommended. Most filtering facepiece units are discarded after use (i.e., dust masks). If respirators are shared, the used respirator will be thoroughly cleaned and disinfected before being issued to another miner.
- Respirators shall be stored in a convenient, clean, and sanitary location to help maintain the respirator’s ability to function properly. Store in a manner that protects them against contamination, temperature extremes, and other potentially damaging conditions.
- One individual shall administer the respiratory protection program. The administrator must have “sufficient knowledge of the subject to properly supervise the program.” The respirator program must include regular inspection and evaluation to determine the effectiveness of the program.
- Additional sources of information for mine operators regarding respiratory protection program formats, methods for establishing SOPs,

and appropriate respirator selection and use criteria include:

- Respirator manufacturers.
- NIOSH Publications (available through NIOSH Publication Dissemination Center at 1-800-356- 4674): “Guide to Industrial Respiratory Protection” (Pub. No. 87-116); “NIOSH Respirator Selection Logic 2004”, 2005-100; “Respirator Decision Logic” (Pub. No. 87-108); and “NIOSH Guide to the Selection and Use of Particulate Respirators Certified Under 42 CFR Part 84.”
- Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS).

Chemical Protection for Skin and Eyes

Miners must have suitable protection to prevent/minimize absorption of toxic substances through the skin and eyes as well as prevent damage to the skin and eyes. Inspectors should consider pH in the mining process since both high and low pH materials can cause damage to the skin and eyes. Extremely high and low pH materials can cause permanent, irreversible injury.

Physiological reactions to acids and caustics may occur immediately, and/or may become more severe over time or even post-exposure. Once the tissue is damaged, absorption of other chemicals and/or susceptibility to infection can occur more rapidly through the damaged skin or tissue.

- **Analyses of Parts of the Body at Risk:** Identify the body parts that need to be protected and the extent of time the protection is needed. Anticipate the accidents that could most likely occur.
- **Identification of PPE Needed:** Consider the duration and degree of exposure. Several different types of PPE may need to be worn at the same time to protect against multiple hazards.
- **Selecting Suitable PPE:** There is no single material that is a barrier against all chemical exposures. A protective item has to have a sufficient breakthrough time for a specific chemical.

Physical Agents Protection

Physical agents, such as ultraviolet radiation and high and low temperatures, can cause injury to the skin and eyes, as well as cause other injuries and illness.

- **Analyses of the Parts of the Body at Risk:** Identify the body parts that need protected and the extent of time the protection is needed.
- **Identification of PPE Needed:** Consider the degree of risk to the miner.
- **Selecting Suitable PPE -** Review the equipment manufacturer's information to ensure that the equipment being used by the miner provides the necessary protection. Inspectors should contact your supervisor if you have questions.

F. Alternative Fuel Operations

Alternative fuels are either combustible or flammable, and may be explosive. Inspectors should ask what fuels are being used at operations where fuels are burned. Determine the fire and explosion prevention and protection systems provided and if they are properly maintained. Inspectors should also evaluate the practices and procedures used to prevent injury to miners.

1. Non-Hazardous Alternative Fuel Operations

Non-hazardous alternative fuels are used by some mining operations with kilns or dryers as a substitute or supplement to standard fuels. These fuels will likely be regulated or permitted by federal or state environmental agencies even though the EPA may not classify them as hazardous.

Hazardous Waste Fuel Operations

Hazardous waste fuels are various types of used fuels or combustible chemicals which may contain one or more hazardous wastes as listed by the EPA or state agencies.

Three categories of waste fuels defined by EPA are as follows:

- **Used Oil Fuel** - Used oil that has been refined from crude oil and is contaminated by physical or chemical impurities. Used oil fuel includes any fuel produced from oil by processing, blending, or other treatment which is burned for energy recovery.

The used oil fuel suppliers are required to document analytical results demonstrating the oil meets the appropriate EPA specifications. The used oil fuel may also be tested at the mine site for other chemical and physical properties such as specific gravity, PCBs, pesticides, sulfur, heavy metals, and BTU output.

- **Off-Specification Used Oil Fuel** - Used oil fuel that exceeds EPA specifications. It can be burned for energy recovery only in EPA-approved industrial furnaces and boilers and is handled in the same manner as hazardous waste fuel.
- **Hazardous Waste Fuel (HWF)** - Fuel containing an assorted mixture of chemical compounds from industrial waste processes and exhibits any of the following characteristics: ignitability, corrosiveness, reactivity, or toxicity.

The following are some health and safety hazards when HWF is used:

- a. **Fire Hazard** - Fire hazard conditions may occur when receiving and off-loading fuel shipments, blending, maintaining/repairing storage tanks, fuel lines, pumps, etc., and burning of HWF.

Note: The pressurized transfer lines located near sources of ignition may also rupture during burning operations.

HWF fires are National Fire Protection Association (NFPA) Class B fires that occur in the vapor-air mixture formed above the surface of flammable or combustible liquids. These fires produce intense heat and noxious, debilitating smoke, fumes, and gases. They are extremely difficult to control, may cause death and may do extensive damage to the facility and the environment.

HWF fires may be controlled and/or extinguished by depriving them of oxygen and additional fuel. EPA permits and MSDSs specify the appropriate fire response for permitted hazardous waste fuels.

- b. **Chemical Reactivity Hazard** - The following chemical types can cause reactivity that is extremely hazardous for mine operators and miners working at HWF sites.
 - **Strong Oxidizers** - HWF may react violently with oxidizing agents such as peroxides, nitric acid, and bottled oxygen, causing a fire or explosion. HWF facilities should be kept free and clear of oxidizing agents.
 - **Polymer Materials** - HWF may be incompatible with a variety of polymer materials such as seals, gaskets, linings, and PPE.

- **Metals, Water, and Alcohols** - HWF may contain organic compounds which can react with these materials. Organic acids will corrode metals. Some organic chlorides will decompose and form hydrochloric acid on contact with metals, water, or alcohols.
- c. **Polymerization Hazard** - Certain mixtures of HWF may polymerize in storage depending on content, storage time and conditions. These are chemical reactions within the mixture that may cause complex, heavier, and more viscous or solid substances to form within the storage vessel. This could cause a fire or explosion.
- d. **Toxicological Hazards** - The toxicological hazards depend on the chemistry of the fuel, how miners are exposed, the duration of the exposures, and the toxic mechanisms of the fuel components.

The potential hazard of HWF is based on the toxicities of the liquid organic constituents in the mixture. Combinations of different organic materials in the fuel mixture will often enhance the hazard of the mixture as a whole.

There are three common exposure routes of entry to HWF materials: skin absorption through direct contact, inhalation, and ingestion.

- e. **Health Exposure Hazards** - A waste fuel circuit is normally a closed-circuit process to the burn point and exposure to HWF is limited to a few points in the waste fuel operation. Miners may be at risk as a result of either routine or accidental exposures.

Routine Exposures - Routine exposures usually occur when the circuit is open for quality control sampling, during transfer from a delivery vehicle or tank, blending, or during cleaning and disposal of normal spillage.

- **Quality Control Sampling** - Exposures may occur during the collection of core samples from delivery vehicles, storage tanks, and sample valves. Laboratory personnel also risk exposure during handling and storage of raw fuel samples.
- **Transfers** - Exposures may occur while opening hatches, unloading, handling transfer hoses, cleaning and discharging in-line fuel filters, or emptying the sump.
- **Blending** - Exposures may occur when multiple waste products are being mixed together to achieve a usable end product for safe and

efficient combustion.

- **Maintenance Activities** - Exposures may occur during regular maintenance of waste fuel circuit equipment. These procedures include disassembling, cleaning, or other servicing of storage vessels, piping, valves, pumps, agitators, filters, and tanks.
 - HWF may deposit toxic chemical residue in the kiln and which could be encountered during the removal of an old refractory lining in preparation for re-bricking.
 - Toxic elements such as heavy metals may be deposited in the storage and processing equipment and may be encountered (including hazardous vapors) during maintenance and/or cleaning activities.
 - Cutting and welding operations on metals contaminated with HWF in confined spaces present a significant potential for exposure to hazardous contaminants.
- **Accidental Release Exposures** - Spillage, leakage, or vapors vented from unloading operations, ruptured or improperly vented tanks, disconnected or ruptured lines, or defective seals, pumps, or valves could result in exposures to miners. Proper facility design and maintenance, and adherence to safe operating and repair procedures can minimize accidental exposures. Inspectors should determine miners' knowledge of spill response procedures and proper PPE.

DOT and EPA Hazardous Material and Emergency Regulations That May Apply at Mine Sites		
Agency	Recommended Regulations	Regulated Activity
Department of Transportation (DOT)	<ol style="list-style-type: none"> 1. Hazardous Materials Transportation Act 2. Natural Gas Pipeline Safety Act 3. Hazard Liquid Pipeline Safety Act 4. Hazardous Materials Regulations and Procedures, Title 49 CFR Parts 100-185 	Shipping of hazardous materials: packing, handling, labeling, marking, placarding, level of training, safety assurance during shipment, hazard classes, UN ID numbers, and quantity restrictions. 49 CFR 172 lists the hazardous materials subject to these laws.
Environmental Protection Agency (EPA)	<ol style="list-style-type: none"> 1. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - (Superfund Act) (42 U.S.C. 9620) 2. Title III, Superfund Amendments and Reauthorization Act (SARA) - Community Right to Know (42 U.S.C. 11001) 3. Resource Conservation and Recovery Act (RCRA)(42 U.S.C. 6901) 4. Clean Water Act (40 CFR §§100 - 140, §§400 - 470) (33 U.S.C. 1251) 5. Clean Air Act, "National Emission Standard for Hazardous Air Pollutants" (40 CFR 61 Subpart M) 6. Risk Management Program, (40 CFR 68.130) 7. Toxic Substances Control Act (TSCA) (regulations 40 CFR 761 Subpart B) (15 U.S.C. 2601) Solid Waste Disposal Act (42 U.S.C. 6901) 	Chemical Entering the Environment: Reportable Quantities List [of Chemicals stored at a site]; Emergency planning, reporting & training requirements; Hazardous Waste treatment disposal and storage; Accidental Release Prevention Requirements (including a facility risk management plan & list of regulated substances); Accidental Release Reporting; and Permit Requirements (approval and issuance).

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ATTACHMENT - CONTAMINANT INDEX

This attachment 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 supervisor 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 your supervisor.

The inspector, prior to any unusual non-routine or rush sampling, should contact their supervisor. In these cases, arrangements may be made for special sampling equipment, media, or vials that can be sent from the laboratory directly to the district or field office.

A list of abbreviations used in the descriptions of each contaminant is contained in Appendix A of this chapter.

The American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values for Chemical Substances in Workroom Air Adopted 1972* has been incorporated by reference for coal mines at 30 CFR Part 70.1900(c), 30 CFR Part 71.700(a), and 30 CFR Part 75.322. Permissible exposure levels for many contaminants are listed in this document. NOTE: Some contaminants have specific permissible exposure limits stated elsewhere in 30 CFR.

The ACGIH *Threshold Limit Values for Chemical Substances in Workroom Air Adopted 1973* has been incorporated by reference into MSHA health standards for metal and nonmetal mines at 30 CFR Parts 56/57.5001. Permissible exposure levels and ceiling limits for many contaminants are listed in this document. NOTE: There are exceptions found in the above referenced standards. Some contaminants have specific permissible exposure limits stated elsewhere in 30 CFR.

The 1968 Pennsylvania Department of Health exposure limits (PA Rules) for Short Term Exposure Limits (STEL) are included in the ACGIH *Threshold Limit Values for Chemical Substances in Workroom Air Adopted 1973 (M/NM only)*.

Throughout the contaminant index the TLV for contaminants are stated with reference to the appropriate ACGIH year and therefore the appropriate enforcement level for the given contaminant. The contaminant index states the 1968 PA Rules STEL, the listed

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1972 or 1973 ACGIH STEL or Excursion Value, or 30 CFR standard for each contaminant, whichever is applicable. The contaminant index includes the Ceiling Limit (C) or maximum allowable concentration for each contaminant and the appropriate ACGIH year or 30 CFR standard reference.

SPECIAL NOTES

Analyses

- Send ALL samples to the appropriate MSHA Laboratory typically within 24 hours 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.

References

The following references were used in the preparation of this index. 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)*
- 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]. The best source of current information on material compatibility is from the PPE manufacturer. Manufacturers have chemical resistance charts that show actual test data or their own recommendations for specific chemicals. Always consult the PPE manufacturer (chemical resistance data) to select materials that resist permeation, degradation, and penetration of the specific chemical. 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)

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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 $>0.1\text{g}/\text{cm}^2/\text{min}$.

4 hr = At least 4 but less than 8 hours of resistance to breakthrough $>0.1\text{g}/\text{cm}^2/\text{min}$.

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).

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Acetic Acid - CH₃COOH 50 ppm IDLH (NIOSH, 1995)

Contaminant Codes: 433

1972 ACGIH TLV 10 ppm	1972 ACGIH Excursion STEL 20 ppm - 15 min	1973 ACGIH TLV 10 ppm	1968 PA Rules STEL 40 ppm - 5 min.
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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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: diffusion tube

Note: up to 8 hours per tube (EF = 1.41).

Grab Sampling:

Collection Media: detector tube, range 5 - 80 ppm (EF = 1.25).

CONTAMINANT INDEX

Acetone - CH₃COCH₃
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: 243

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1000 ppm	1250 ppm - 15 min.	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, Trelchem, Tychem
Eyes: Prevent eye contact

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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: diffusion tube

Note: up to 8 hours per tube. (EF = 1.33).

Grab Sampling:

Collection Media: detector tube, range 100 - 12000 ppm (EF = 1.33).

CONTAMINANT INDEX

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: Methanol, ethanol, n-propanol, i-propanol, n-butanol, 2-butanol, i-butanol, and t-butanol

Special Instructions

Specify group of three contaminants desired.

CONTAMINANT INFORMATION, Contaminant Codes, TLVs: see individual contaminants

SAMPLING INFORMATION

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.

CONTAMINANT INDEX

Aluminum - Al as Aluminum Oxide (Al₂O₃)

Contaminant Codes: 151 (aluminum oxide dust, as Al₂O₃)
703 (aluminum oxide fume, as Al₂O₃)
123 (nuisance dust)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10.0 mg/m ³	20.0 mg/m ³ - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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.

CONTAMINANT INDEX

Ammonia - NH₃ 300 ppm IDLH (NIOSH, 1995)

Contaminant Codes: 401

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
50 ppm	37.5 ppm - 15 min.	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, Trelchem, 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: diffusion tube

Note: up to 8 hours per tube (EF = 1.41).

Grab Sampling:

Collection Media: detector tube, range 5 to 700 ppm. (EF = 1.25).

CONTAMINANT INDEX

Amorphous Silica - SiO₂ (Diatomaceous Earth) **3,000 mg/m³ IDLH (NIOSH, 1995)**

Contaminant Codes: 519

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
20 mppcf (1.5 mg/m ³)	40 mppcf (3.0 mg/m ³) - 15 min.	20 mppcf (1.5 mg/m ³)	40 mppcf (3.0 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/m³, (APF = 5), any dust and mist respirator

Skin: None specified

Eyes: None specified

Special Precautions: none reported

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling: Note: cannot be used for enforcement

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

Enforcement, Full Shift/Time Weighted - Partial Period Sampling: Note: for use in determining compliance with TLV

Collection Media: Contact your supervisor

Sample Flow Rate: 2.8 LPM

Antimony & Compounds (as Sb)
50 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 611 (dust)
705 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.5 mg/m ³ (500 µg/m ³)	1.5 mg/m ³ (1500 µg/m ³) -15 min.	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 Code: 311 stibine, SbH₃

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.1 ppm (100 ppb)	0.3 ppm (300 ppb) - 15 min.	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/m³ (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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 613 (dust)
707 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.5 mg/m ³ (500 µg/m ³)	1.5 mg/m ³ (1500 µg/m ³) - 15 min	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/m³ [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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 - AsH₃
3 ppm IDLH (NIOSH, 1995)

Contaminant Code: 313

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.05 ppm (50 ppb)	0.15 ppm (150 ppb) - 15 min.	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/m³ [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

SAMPLING INFORMATION

Grab Sampling:

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

Asbestos (Fibers)

Contaminant Code: 501

30 CFR 56/57.5001(b) MSHA PEL 0.1 fibers/cc	30 CFR 56/57.5001(b) MSHA Excursion 1 fibers/cc - 30min.	30 CFR 71.702 MSHA PEL 0.1 fibers/cc	30 CFR 71.702 MSHA Excursion 1 fibers/cc - 30min.
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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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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:

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:

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 Transmission Electron Microscope (TEM) analysis.

Notes: For optimal filter loading without overloading, the initial flow rate setting or the sampling times may need to be adjusted. Do not change pump flow rate after starting sampling sequence.

Barium (Soluble Compounds)
50 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 641

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
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)	0.5 mg/m ³ (500 µg/m ³)	1.5 mg/m ³ (1500 µg/m ³) - 15 min.

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/m³, (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 - C₆H₆
500 ppm IDLH (NIOSH, 1995)

Contaminant Code: 603

1972 ACGIH TLV 25 ppm (Skin) (C)	1973 ACGIH TLV 25 ppm (Skin) (C)
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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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling

- 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:

Collection Media: detector tube, range 0.5 -10 ppm (E.F. = 1.49)

Beryllium - Be
4 mg/m³ (as Be) IDLH (NIOSH, 1995)

Contaminant Code: 541 (dust)
709 (fumes)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.002 mg/m ³ (2 µg/m ³)	0.006 mg/m ³ (6 µg/m ³)	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/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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:

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:

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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 161

1972 ACGIH TLV 10 mg/ m ³	1972 ACGIH Excursion STEL 20.0 mg/m ³ - 15 min.	1973 ACGIH TLV 10 mg/m ³	1973 ACGIH Excursion STEL 20.0 mg/m ³ - 15 min.
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CONTAMINANT INFORMATION

- Synonyms:** boracic acid anhydride, 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
- Incompatibilities:** 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/m³: (APF = 5) any dust and mist respirator
- Skin:** Prevent contact; contact the manufacturer for recommendations
- Eyes:** Prevent contact

Special Precautions: NA

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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.

Bromoform - CHBr₃
850 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.5 ppm (Skin)	1.5 ppm - 15 min.	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; 1972/1973 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 exposed to air and light producing **toxic and corrosive fumes including hydrogen bromide and bromine.**

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

SAMPLING INFORMATION

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 - CH₃COO(CH₂)₃CH₃
1,700 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations
(i.e., being 10% of the lower explosive limit of 1.7%)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
150 ppm	187.5 ppm - 15 min.	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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- Collection Media:** Passive monitor, 3M, 3500 series -
- Note:** maximum 8-hour sample per badge.
- 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:

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 - CH₃CH₂CH₂CH₂OH
1,400 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations
(i.e., being 10% of the lower explosive limit of 1.4%)

Contaminant Code: 245

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	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, ingestion, skin and eye contact
- 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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- 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:

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 - CH₃CH(OH)CH₂CH₃
2,000 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
150 ppm	187.5 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- Collection Media:** Passive monitor, 3M, 3500 series
- Note:** maximum 8-hour sample per badge
- 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 - (CH₃)₃COH
1,600 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

- Synonyms:** 2-methyl-2-propanol, TBA, t-butanol, trimethyl carbinol
- Sources:** Lacquers, chemical intermediates, paint remover, gasoline octane booster
- Description:** Colorless crystal or liquid; strong, pleasant odor (camphor-like)
- Incompatibilities:** Strong mineral acids, strong hydrochloric acid, 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- 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:

- 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/m³ (as Cd) dust, IDLH (NIOSH, 1995)

Cadmium Oxide fume, as Cd
9 mg/m³ (as Cd) fume, IDLH (NIOSH, 1995)

Contaminant Code: 623 (metal dust)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	ANSI Z37.5-1970 Ceiling (C)
0.2 mg/m ³ (200 µg/m ³)	0.6 mg/m ³ (600 µg/m ³) - 15 min.	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 Code: 711 (oxide fume, as Cd)

1972 ACGIH TLV	1973 ACGIH TLV
0.1 mg/m ³ (C) (100 µg/m ³)	0.1 mg/m ³ (C) (100 µg/m ³)

(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 (CdCO₃)
- 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/m³ (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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

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

Short Term Sampling:

Sample Duration: 15 min.

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

Sample Flow Rate: usual sampling is 1.7 LPM

Wipe Sampling:

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/m³ (as As) IDLH (NIOSH, 1995)

Contaminant Code: 995 Ca₃(AsO₄)₂

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1 mg/m ³	3 mg/m ³ - 15 min.	1 mg/m ³	3 mg/m ³ - 15 min.

CONTAMINANT INFORMATION

Synonyms: *Calcium arsenate* [Ca₃(AsO₄)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/m³ [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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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:

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 - CaCO₃

Contaminant Code: 121, 123 (CaCO₃)
523 (CaCO₃)

1972 ACGIH TLV 1973 ACGIH TLV
10.0 mg/m³ 10.0 mg/m³

If respirable fraction >1% quartz % SiO₂ + 2

Calcium Oxide - CaO 25 mg/m³ (CaO) IDLH (NIOSH, 1995)

Contaminant Code: 451 (CaO)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
5.0 mg/m ³	10.0 mg/m ³ - 15 min.	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 [CaCO₃]: - limestone, chalk, marble, dolomite, aragonite, calcite, calclidia, calcium salt, carbonic acid, citric acid, 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: CaCO₃ - 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: CaCO₃ - suitable for nuisance dusts if <1% quartz, suitable for silica if respirable fraction >1% quartz;

CaO- Respirator Recommendations: NIOSH, Up to 10 mg/m³: (APF = 5) any dust and mist respirator; up to 20 mg/m³: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirator.

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.

CaCO₃ - 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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: *CaCO₃*: use a pre-weighed, 37-mm diameter, 5- μ m 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- μ m 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:

Sample Duration: 30 min.

Collection Media: *CaCO₃*: use a pre-weighed, 37-mm diameter, 5- μ m 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- μ m 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 - CO₂
40,000 ppm IDLH (NIOSH, 1995)

Contaminant Code: 105

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.5 % (5000 ppm)	1.5 % - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- Collection Media:** diffusion tube
- Note:** up to 8 hours per tube. (EF = 1.41).

Grab Sampling:

- Collection Media:** detector tube, range 0.1% to 6% (EF = 1.17).
- Collection Media:** Evacuated 50 mL gas-sampling bottle, gas sampling bag 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 bottle or bag samples and 7-day hold time for vacutainers. Submit sample as soon as possible to MSHA Laboratory.

Carbon Disulfide - CS₂
500 ppm IDLH (NIOSH, 1995)

Contaminant Code: 631

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
20 ppm (Skin)	37.5 ppm - 15 min.	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, 1972/1973 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, Trelchem, Tychem; 4 hr: Teflon
- Eyes:** Prevent contact
- Special Precautions:** Class IB flammable liquid, vapors can be easily ignited, for example, by ordinary light bulb

SAMPLING INFORMATION

Grab Sampling:

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

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

Contaminant Code: 111

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
50 ppm	75 ppm - 15 min.	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) full-facepiece respirator (gas mask) with a supplied air respirator, 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: diffusion tube; 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:

- **Collection Media:** Detector tube, range 5 - 700 ppm (EF = 1.25).
- **Collection Media:** Evacuated 50 mL gas-sampling vacuum bottle (EF = 1.11).
- **Collection Media:** Electronic Direct Reading Instrument.

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

Carbon Tetrachloride* - CCl4

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

Contaminant Code: 601

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10 ppm (Skin)	20 ppm - 15 min	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; 1972/1973 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

Note: 8-hour max sample/badge

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 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 - Cl₂
10 ppm IDLH (NIOSH, 1995)

Contaminant Code: 485

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
1 ppm	3 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

Grab Sampling:

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

Chlorine Dioxide - ClO₂ 5 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.1 ppm	0.3 ppm - 15 min	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.

SAMPLING INFORMATION

Grab Sampling:

Collection Media: detector tube, 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 ClO₂ reading.

Chloroform - CHCl₃
500 ppm IDLH (NIOSH, 1995)

Contaminant Code: 661

1972 ACGIH TLV	1973 ACGIH TLV	1973 ACGIH Excursion STEL 75 ppm - 15 min
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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, Trelchem, Tychem; 4 hr: Teflon
Eyes: Prevent contact
Special Precautions: Suspected carcinogen (National Toxicology Program); strong irritant; when heated to decomposition, forms phosgene gas.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

- 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 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 CrO₃
15 mg/m³ as Chromium(VI) IDLH (NIOSH, 1995)

Contaminant Code: 543 (chromic acid and chromate dusts as CrO₃)
713 (fumes, chromate)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.1 mg/m ³ (100 µg/m ³)	0.3 mg/m ³ (300 µg/m ³) - 15 min.	0.1 mg/m ³ (100 µg/m ³)	0.3 mg/m ³ (300 µg/m ³) - 15 min.

(PEDS units of measure in parentheses)

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:** CrO₃: 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/m³ 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

SAMPLING INFORMATION

- Full-Shift/Time Weighted Sampling:**
- 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 6-8 days). Submit sample as soon as possible to MSHA Laboratory.

Chromium, Soluble Chromic, Chromous Salts as Cr

250 mg/m³ [as Cr(II)] IDLH (NIOSH, 1995)

25 mg/m³ [as Cr(III)] IDLH (NIOSH, 1995)

Chromium, Metal and Insoluble Salts

250 mg/m³ (as Cr) IDLH (NIOSH, 1995)

Contaminant Code: 545 (chromium, soluble chromic, chromous salts as Cr)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.5 mg/m ³ (500 µg/m ³)	1.5 mg/m ³ (1,500 µg/m ³) - 15 Min.	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)

Contaminant Code: 547 (Cr, metal and insoluble salts)

1972 ACGIH TLV	1973 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	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/m³: (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 non-combustible solid in bulk form, but finely divided dust burns rapidly if heated in a flame.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

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

Wipe Sampling:

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/m³

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

NOTE: For respirable/quartz standards at Coal Mines see applicable 30 CFR regulation

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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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/m³ IDLH (NIOSH, 1995)**

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.2 mg/m ³ (200 µg/m ³)	0.6 mg/m ³ (600 µg/m ³) - 15 min.	0.2 mg/m ³ (200 µg/m ³)	0.6 mg/m ³ (600 µg/m ³) - 15 min.

(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/m³ 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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/m³ (as Co) IDLH (NIOSH, 1995)

Contaminant Code: 649 (dust)
715 (metal fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.1 mg/m ³ (100 µg/m ³)	0.3 mg/m ³ (300 µg/m ³) - 15 min.	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/m³: (APF = 5) any dust and mist respirator; up to 0.5 mg/m³: (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.

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 Duration: 30 min.

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

Sample Flow Rate: Usual sampling is 1.7 LPM.

Wipe Sampling:

Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water

Copper - Cu
100 mg/m³ (as Cu) IDLH (NIOSH, 1995)

Contaminant Code: 171 (dust, mist)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	1.0 mg/m ³	3.0 mg/m ³ - 15 min.

Contaminant Code: 717 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.1 mg/m ³ (100 µg/m ³)	0.3 mg/m ³ (300 µg/m ³) - 15 min.	0.1 mg/m ³ (100 µg/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/m³: (APF = 5) any dust and mist respirator; up to 10 mg/m³: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators (if not present as a fume); up to 25 mg/m³: (APF = 25) any powered, air-purifying respirator with a dust and mist filter; up to 50 mg/m³: (APF = 50) any air-purifying, full-facepiece respirator with a high-efficiency particulate filter. *Fumes:* NIOSH/OSHA: Up to 1 mg/m³: (APF = 10) any dust, mist, and fume respirator; up to 2.5 mg/m³: (APF = 25) any powered, air-purifying respirator with a dust, mist, and fume filter; up to 5 mg/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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:

Collection Media: Whatman Filter (41 or 42) or smear tabs, wetted with distilled water

Cresol (all isomers) - CH₃C₆H₄OH
250 ppm IDLH (NIOSH, 1995)

Contaminant Code: 447

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
5.0 ppm (Skin)	10 ppm - 15 min.	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

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:

Collection Media: detector tube, 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 - SiO₂ (Respirable)
25 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 525

1972 ACGIH TLV	1973 ACGIH TLV
<u>5 mg/m³</u>	<u>5 mg/m³</u>
% SiO ₂ + 2	% SiO ₂ + 2

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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; Up to 1.25 mg/m³: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; Up to 2.5 mg/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: MSHA P-2, 37mm 5µm PVC

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

Cyanide - CN
25 mg/m³ (as CN) IDLH (NIOSH, 1995)

Contaminant Code: 419

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
5.0 mg/m ³ (Skin)	10 mg/m ³ - 15 min.	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/m³): (APF = 10)
any supplied-air respirator

KCN: NIOSH/OSHA - Up to 25 mg/m³: (APF = 10) any
supplied-air respirator; (APF = 50) any self-contained
breathing apparatus with a full facepiece

NaCN: NIOSH/OSHA - Up to 25 mg/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m 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 Duration: 30 min.

Collection Media: 37-mm diameter, 0.8- μ m pore size polyvinyl chloride (PVC)
filter, followed by glass midget bubbler containing 15 mL 0.1 N KOH, Detector
Tube for Cyanide -- 2 to 15 mg/m³

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.

Contact MSHA lab before sampling. Make arrangements to ship directly to contract lab due to short stability time.

Cyclohexanone - C₆H₁₀O
700 ppm IDLH (NIOSH, 1995)

Contaminant Code: 265

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
50 ppm	75 ppm - 15 min.	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 of 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

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

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 Duration: 15 min.

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

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 - ClCH₂CH₂Cl (Ethylene Dichloride)
50 ppm IDLH (NIOSH, 1995)

Contaminant Code: 263

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
50 ppm	75 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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)	<u>10 mg/m³</u> % resp quartz + 2	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

Note: For Coal respirable dust standards see applicable 30 CFR section

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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m³: (APF = 25) any powered, air-purifying respirator with a high-efficiency particulate filter; up to 2.5 mg/m³: (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/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: Cyclone and filter [10-mm nylon cyclone and pre-weighed 37-mm diameter, 5 μ m 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 ₂ O ₃), calcium carbonate, cellulose (paper fiber), portland cement, corundum (Al ₂ O 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® <i>Threshold Limit Values for Chemical Substances in Workroom Air Adopted by the ACGIH for 1973</i>
Description:	When toxic impurities are not present (e.g. quartz < 1%), Appendix E listed contaminants include: alundum (Al ₂ O ₃); calcium carbonate; cellulose (paper fiber); portland cement; corundum (Al ₂ O 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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.

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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m 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 - CH₃COOCH₂H₅
2,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit
of 2.0%)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
400 ppm	500 ppm - 15 min.	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, Trelchem, Tychem; 4 hr: PVA, Teflon
Eyes: Prevent eye contact
Special Precautions: Class IB flammable liquid

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

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

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

Note: maximum 8-hour sample per badge

Short Term Sampling:

Sampling Duration: 15 min.

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

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 - CH₃CH₂OH
3,300 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit
of 3.3%)

Contaminant Code: 247

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1000 ppm	1250 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

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 Duration: 15 min.

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

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 - CH₃CH₂C₆H₅
800 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit
of 0.8%)

Contaminant Code: 267

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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 - F₂
25 ppm IDLH (NIOSH, 1995)

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

Contaminant Code: 487 (F₂, fluorine gas)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
1.0 ppm	3.0 ppm - 15 min.	1.0 ppm	0.5 ppm - 5 min.

Contaminant Code: 719 (fluoride fume)
417 (fluoride dust, as F)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
2.5 mg/m ³	5 mg/m ³ - 15 min.	2.5 mg/m ³	10.0 mg/m ³ - 30 min.

CONTAMINANT INFORMATION

- Synonyms:** Fluorine gas (F₂): fluorine-19
- Sources:** Fluoride dust: metallic ores & mining of fluorspar, fluorspar, 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 H₂O 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media: Fluorides, aerosol and gas: filter and treated pad [37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-treated cellulose pad]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 12-800

Short Term Sampling:

Sampling Duration: F₂, 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- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-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:

Collection Media: fluorine: detector tube range 0.05-40 ppm (EF = 1.33)

Formaldehyde - HCHO
20 ppm IDLH (NIOSH, 1995)

Contaminant Code: 441

1972 ACGIH TLV	1973 ACGIH TLV
2.0 ppm (C)	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; [established carcinogen by NIOSH, OSHA, IARC,]

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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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- μ m 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 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 μ m 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- μ m 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°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:

Collection Media: detector tube, range 0.04-25 ppm (EF = 1.49).

Gas (Profile)

Gases Analyzed:

Vacutainers (10 mL): Nitrogen, Oxygen, Methane, Ethane and CarbonCarbonCarbon Dioxide

Vacuum bottles (50 mL50mL): Acetylene, Argon, Carbon Dioxide, Carbon Monoxide, Ethane, Ethylene, Hydrogen, Methane, Nitrogen and Oxygen

CONTAMINANT INFORMATION

SeeSeeSee individual contaminants

SAMPLING INFORMATION

Grab Sampling:

Collection Media: 50 mL vacuum bottle or 10 mL vacutainer (EF = 1.11).

Sample Flow Rate: Minimum - Maximum (LPM): N/A

Air Collection Volume: Minimum - Maximum (L): 10 mL - 50 mL

Grab Sampling:

Collection Media: Direct Reading Instrument. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

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

Gasoline

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

**** 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 of 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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

Sample Flow Rate: Sampling flow rate - 0.1 LPM, Must use a pump adaptor or arrange for low flow pumps.

Air Collection Volume: 10 L

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

Note: Maximum 8-hour sample per badge.

Short Term Sampling:

Sampling Duration: 30 min.

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

Sample Flow Rate: Sampling flow rate – 0.1 LPM. 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/m³ (as C) IDLH (NIOSH, 1995)

Contaminant Code: 517 (< 1 % quartz)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
15 mppcf (1.9 mg/m ³)	30 mppcf (3.8 mg/m ³) - 15 min.	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/m³: (APF = 5) any dust respirator; up to 25 mg/m³: (APF = 10) any dust respirator except single-use and quarter-mask respirators/ (APF = 10) any supplied-air respirator; up to 62.5 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling: Note: cannot be used for enforcement
MSHA P-2

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Full-Shift/Time Weighted Average: Note: must be used to determine compliance with TLV

Collection Media: Contact your supervisor

Sample Flow Rate (LPM): 2.8

Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support.

n-Heptane -CH₃[CH₂]₅CH₃
750 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
500 ppm	625 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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 - CH₃(CH₂)₄CH₃
1,100 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations (i.e., being 10% of the lower explosive limit
of 1.1%)

Contaminant Code: 659

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
500 ppm	625 ppm - 15 min.	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 of 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, Trelchem, Tychem; 4-hr.: Barricade
- Eyes:** Prevent eye contact
- Special Precautions:** Class IB flammable liquid

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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) - CH₃COCH₂CH(CH₃)₂
500 ppm IDLH (NIOSH, 1995)

Contaminant Code: 249

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	125 ppm - 15 min.	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 of 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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 - CH₃(CH₂)₄CH₃]
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 Code: 659

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
500 ppm	625 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 Duration: 15 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:

Collection Media: detector tubes:

- A. Hexane: range 50-3,000 ppm (EF = 1.33).
- B. Hydrocarbons: range 0.1-0.8 vol. (% butane) and 0.5-1.3 vol. (% propane) (EF = 1.66).
- C. Hydrocarbons: range 2-23 mg/L (EF = 1.66).
- D. Petroleum hydrocarbons: range 10-300 ppm (n-octane) (EF = 1.41).
- E. Petroleum hydrocarbons: range 100-2,500 ppm (n-octane) (EF = 1.25).

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

Contaminant Code: 413

1972 ACGIH TLV	1973 ACGIH TLV
5.0 ppm (C)	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: substances 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, Trelchem, 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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube; range 1-10 ppm (EF = 1.25), range 50-5,000 ppm (EF = 1.25).

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

Contaminant Code: 309

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
10 ppm (Skin)	20 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

Collection Media:

1. NIOSH 6010 (IV): 600/200 mg: solid sorbent tube (soda lime)
2. NIOSH 7904 (IV): 37-mm diameter, 0.8- μ m pore size polyvinyl chloride

(PVC) filter, followed by glass midget bubbler containing 15 mL 0.1 N KOH
3. diffusion tube; 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):

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

Air Collection Volume: Minimum - Maximum (L):

NIOSH 6010 (IV): 2-90

Short Term Sampling:

Sampling Duration: 30 min.

Collection Media:

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

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

Air Collection Volume: Minimum - Maximum (L):

NIOSH 6010 (IV): 2-90

Special Instructions:

Grab Sampling:

Collection Media: detector tuberange 1-150 ppm (EF = 1.25).

Hydrogen Fluoride - HF

30 ppm (as F) IDLH (NIOSH, 1995)

Contaminant Code: 415

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
3.0 ppm	6.0 ppm - 15 min.	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

SAMPLING INFORMATION

Full-Shift/Time Weighted Sampling:

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- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-treated cellulose pad]
3. NIOSH 7906 (IV): filter and treated pad [37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-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 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- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-treated cellulose pad]
3. NIOSH 7906 (IV): filter and treated pad [37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter with Na₂CO₃-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:

Collection Media:

- a. Hydrogen fluoride: detector tube, range 0.5-90 ppm, range 1.5-15 ppm (EF = 1.33)
- b. Fluorine: detector tube, range 0.111 to 2ppm (EF = 1.33)

Hydrogen Peroxide - H₂O₂ 75 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 ppm	3.0 ppm - 15 min.	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

Special Instructions: N/A

SAMPLING INFORMATION

Grab Sampling:

Collection Media: detector tube range 0.1-3 ppm (EF = 1.25).

Hydrogen Sulfide - H₂S

100 ppm IDLH (NIOSH, 1995)

Contaminant Code: 305

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
10 ppm	20 ppm - 15 min.	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 H₂S]
- 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.
Special Precautions: Flammable gas

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

- 1. Collection Media:** diffusion tube; 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- μ m 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 (without low flow pump)
Air Collection Volume: Minimum - Maximum (L): 1.2-40

Short Term Sampling:

Sampling Duration: 15 min.

NIOSH 6013 (IV):

Collection Media: filter [25-mm diameter, 0.45- μ m 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 (without low flow pump)

Air Collection Volume: Minimum - Maximum (L): 1.2-40

Special Instructions: N/A

Grab Sampling:

Collection Media: detector tube; range 0.05-150 ppm (EF = 1.49), range 0.2-6 ppm (EF = 1.33), range 0.2-50 ppm (EF = 1.17), range 222-60 ppm (EF = 1.17), range 1-200 ppm (EF = 1.17), range 1-200 ppm (EF = 1.25), range 2-200 ppm (EF = 1.17), range 5-600 ppm (EF = 1.17), range 10-2,000 ppm (EF = 1.17), range 0.02-7 vol. % (EF = 1.17), range 0.2-40 vol. % (EF = 1.17).

Iron Oxide (dusts & fumes) - Fe₂O₃
2,500 mg/m³ (as Fe) IDLH (NIOSH, 1995)

Iron Salts (Soluble) as Fe

Contaminant Code: 175 (dust - Soluble salts as Fe)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	1.0 mg/m ³	3.0 mg/m ³ - 15 min.

Contaminant Code: 721 (fume - Fe₂O₃)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10.0 mg/m ³	20.0 mg/m ³ - 15 min.	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 [FeSO₄]: ferrous sulfate *iron(II) chloride* [FeCl₂]:
ferrous chloride *iron(III) nitrate* [Fe(NO₃)₃]: ferric nitrate *iron(III)*
sulfate [Fe₂(SO₄)₂]: ferric sulfate *iron(III) chloride* [FeCl₃]: 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 to eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting; possible liver damage

PPE: Respirator: *Iron oxide:* NIOSH: Up to 50 mg/m³: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 125 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Short Term Sampling:

Sampling Duration: 15 min.

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Special Instructions: N/A

Wipe Sampling:

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 - (CH₃)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 Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
400 ppm	500 ppm - 15 min.	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: if 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 1973 ACGIH Excursion
TLV: N/A STEL/Ceiling (C): N/A

**** 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/m³: (APF = 10) any chemical cartridge respirator with organic vapor cartridge(s); (APF = 10) any supplied-air respirator; Up to 2500 mg/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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/m³ (as Pb) IDLH (NIOSH, 1995)

Contaminant Code: 635 (dust)
723 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.15 mg/m ³ (150 µg/m ³)	0.45 mg/m ³ (450 µg/m ³) - 15 min.	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 (PbSO₄), cerrusite (PbCO₃), 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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 1.25 mg/m³: (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/m³: (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/m³: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode; up to 100 mg/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Short Term Sampling:

Sampling Duration: 15 min.

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Special Instructions: N/A

Wipe Sampling:

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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 725 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10 mg/m ³	20 mg/m ³ - 15 min.	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/m³: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 375 mg/m³: (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/m³: (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 general 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Short Term Sampling:

Sampling Duration: 15 min.

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Special Instructions: N/A

Manganese - Mn (Compounds and Fume) 500 mg/m³ (as Mn) IDLH (NIOSH, 1995)

Contaminant Code: 647 (dust)
725 (fume)

1972 ACGIH TLV 1973 ACGIH TLV
5.0 mg/m³ (C) 5.0 mg/m³ (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/m³: (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/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

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/m³ [except (organo) alkyls compounds] (as Hg) IDLH (NIOSH, 1995)

2 mg/m³ [(organo) alkyls compounds] (as Hg) IDLH (NIOSH, 1995)

**Contaminant Code: 625 [dusts & vapors, except (organo) alkyl compounds]
729 [fume, except (organo) alkyl compounds]**

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.05 mg/m ³ (50 µg/m ³)	0.15 mg/m ³ (150 µg/m ³) - 15 min.	0.05 mg/m ³ (50 µg/m ³)	0.15 mg/m ³ (150 µg/m ³) -15 min.

Contaminant Code: 995 [(organo) alkyl compounds]*

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.01 mg/m ³ (Skin)	0.03 mg/m ³ - 5 min.	0.01 mg/m ³ (Skin)	0.03 mg/m ³ - 5 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 vermilion
(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/m³: (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/m³: (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/m³: (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/m³: (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/m³: (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/m³: (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/m³: (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/m³: (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/m³: (APF = 10) any supplied-air respirator; up to 0.25 mg/m³: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 0.5 mg/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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- μ m pore size mixed cellulose ester (MCE) filter **Sample Flow Rate (LPM):** 2.0

Air Collection Volume (L): 10

Short Term Sampling:

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- μ m 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:

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:**Collection Media:**

1. Detector Tube [*mercury vapor*]: detector tube range 0.05-2 mg/m³ (EF = 1.30)
2. Direct Reading Instrument [*mercury vapor*]: Jerome (Model 411) Gold Film Mercury Vapor Analyzer, range 0.003 - 1.999 mg/m³ (EF = 1.09); Jerome (Model 431X) Gold Film Mercury Vapor Analyzer, range 0.003 - 0.999 mg/m³ (EF = 1.09).

Mercury, Solids (Bulk)

CONTAMINANT INFORMATION

See "Mercury - Hg" above

SAMPLING INFORMATION

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

SAMPLING INFORMATION

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

SAMPLING INFORMATION

Collection: Bulk Material - 20 grams (in water and wastes)

Special Instructions: Coordinate with MSHA laboratory.

Methyl Alcohol (Methanol) - CH₃OH
6,000 ppm IDLH (NIOSH, 1995)

Contaminant Code: 231

1972 ACGIH TLV	1973 ACGIH TLV	ANSI Z37.14- 1971 Ceiling (C)
200 ppm	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, Trelchem, Tychem

Eyes: Prevent eye contact

Special Precautions: Class IB Flammable Liquid

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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°C.

Methyl Chloroform - CH₃CCl₃
700 ppm IDLH (NIOSH, 1995)

Contaminant Code: 205

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
350 ppm	437.5 ppm - 15 min.	350 ppm	1500 ppm - 5 min.

CONTAMINANT INFORMATION

Synonyms: Chloroethene, 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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) - CH₃COCH₂CH₃
3,000 ppm IDLH (NIOSH, 1995)

Contaminant Code: 251

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
200 ppm	250 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 - CH₃COCH₂CH₂CH(CH₃)₂

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Sampling

Collection Media: N/A

Sample Flow Rate: Minimum - Maximum (LPM): N/A

Air Collection Volume: Minimum - Maximum (L): N/A

Short Term Sampling:

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 - (CH₃)₂CHCH₂CH(OH)CH₃
400 ppm IDLH (NIOSH, 1995)

Contaminant Code: 233

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
25 ppm - (Skin)	37.5 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 513

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
20 mppcf (3.0 mg/m ³)	40 mppcf (6.0 mg/m ³)- 15 min.	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/m³: (APF = 5) any dust and mist respirator; up to 30 mg/m³: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 75 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling: -

Note: cannot be used for enforcement

Collection Media: cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Full Shift/Time Weighted Sampling: Enforcement -

Note: for compliance with TLV

Collection Media: Contact your supervisor

Sample Flow Rate (LPM): 2.8 Air

Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support.

Mine Gas (Profile)

Gases Analyzed: Acetylene, Argon, Carbon Monoxide*, Carbon Dioxide, Ethane, Ethylene, Hydrogen, Oxygen, Methane, Nitrogen

SAMPLING INFORMATION

Grab Sampling:

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:

Collection Media: Direct Reading Instrument TMX 410 or TMX412 (EF = 1.25): for carbon monoxide (CO), oxygen (O₂), methane (CH₄/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/m³ (insoluble compounds, as Mo) IDLH (NIOSH, 1995)

1,000 mg/m³ (soluble compounds, as Mo) IDLH (NIOSH, 1995)

**Contaminant Code: 163 (insoluble dust)
731 (fume)**

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10 mg/m ³	20 mg/m ³ - 15 min.	10 mg/m ³	20 mg/m ³ - 15 min.

Contaminant Code: 645 (soluble compounds)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
5 mg/m ³	10 mg/m ³ - 15 min.	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/m³: (APF = 5) any dust and mist respirator (if not present as a fume); up to 150 mg/m³: (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/m³: (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/m³: (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/m³: (APF = 1000) any supplied-air respirator operated in a pressure-demand or other positive-pressure mode

soluble compounds: Recommendations - OSHA: Up to 25 mg/m³: (APF = 5) any dust and mist respirator (note: substance reported to cause eye irritation or damage; may require eye protection); up to 50 mg/m³: (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/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Short Term Sampling:

Sampling Duration: 15 min.

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Special Instructions: N/A

Wipe Sampling:

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 [10% LEL] 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 Code: 253

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	100 ppm	150 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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/m³ (as Ni) IDLH (NIOSH, 1995)

Contaminant Code: 621 (metal & soluble compounds)
733 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	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 (Ni₃S₂) 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/m³): (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Short Term Sampling:

Sampling Duration: 15 min.

Collection Media: 37-mm diameter, 0.8- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 1.7

Special Instructions: N/A

Wipe Sampling:

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 - HNO₃
25 ppm IDLH (NIOSH, 1995)

Contaminant Code: 491

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
2.0 ppm	4.0 ppm - 15 min.	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, Trelchem, Tychem; 4 hr:

Neoprene, PE, PE/EVAL, Responder

Eyes: Prevent eye contact

Special Precautions: Noncombustible liquid, but increases the flammability of combustible materials

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube range 1-50 ppm (EF = 1.25).

Nitric Oxide - NO
100 ppm IDLH (NIOSH, 1995)

Contaminant Code: 301

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
25 ppm	37.5 ppm - 15 min.	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, NH₃, 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 (NO₂⁻); 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 (NO₂⁻); 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 NO₂ to NO₂⁻. The middle tube oxidizes the sampled NO to NO₂. The back TEA-IMS tube then captures and converts this NO₂ to NO₂⁻. Both TEA-IMS samples are desorbed using an aqueous TEA solution and analyzed as NO₂⁻ by IC. The front tube analytical results are reported as NO₂ 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

Short Term Sampling:

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 (NO₂⁻); 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 (NO₂⁻); 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 NO₂ to NO₂⁻. The middle tube oxidizes the sampled NO to NO₂. The back TEA-IMS tube then captures and converts this NO₂ to NO₂⁻. Both TEA-IMS samples are desorbed using an aqueous TEA solution and analyzed as NO₂⁻ by IC. The front tube analytical results are reported as NO₂ 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 - NO₂
20 ppm IDLH (NIOSH, 1995)

Contaminant Code: 493

1972 ACGIH TLV	1973 ACGIH TLV
5.0 ppm (C)	5.0 ppm (C)

CONTAMINANT INFORMATION

Synonyms: Dinitrogen tetroxide (N₂O₄), 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 N₂O₄]
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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. Collection Media: diffusion tube; 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 (NO₂); 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 (NO₂); 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 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 (NO₂); 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 (NO₂); 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:

- 1. Collection Media:** detector tube, range 0.5-25 ppm (EF = 1.25).
- 2. Collection Media:** Various electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants

Octane - CH₃(CH₂)₆CH₃
1,000 ppm IDLH (NIOSH, 1995),
based strictly on safety considerations
(i.e., being 10% of the lower explosive limit of 1.0%)

Contaminant Code: 271

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
400 ppm	500 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 535 (total particulate)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
5.0 mg/m ³	10 mg/m ³ - 15 min.	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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 125 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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°C. Ship in sample storage containers at ambient temperature. Submit samples via overnight carrier to MSHA Laboratory.

Ozone - O₃
5.0 ppm IDLH (NIOSH, 1995)

Contaminant Code: 481

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.1 ppm (100 ppb)	0.3 ppm (300 ppb)	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 SO₂ is suspected of being present in the sampled air.

Grab Sampling:

Collection Media: detector tube; range 0.005-1.4 ppm (EF = 1.15), 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 - (CCl₂)₂
150 ppm IDLH (NIOSH, 1995)

Contaminant Code: 218

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
100 ppm	150 ppm - 15 min.	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, Trelchem, Tychem
- Eyes:** Prevent eye contact
- Special Precautions:** Noncombustible liquid, but decomposes in a fire to hydrogen chloride and phosgene

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube; range 0.1-4 ppm (EF = 1.25), range 2-300 ppm (EF = 1.20), range 10-500 ppm (EF = 1.20), range 50-10,000 ppm (EF = 1.25).

Perlite

Contaminant Code: 515

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
30 mppcf (8.6 mg/m ³)	60 mppcf (17.2 mg/m ³) -15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Note: cannot be used for enforcement

1. NIOSH 0500 (IV):

Collection Media: Filter [37-mm diameter, 5- μ m 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 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/Time Weighted Sampling: Enforcement - **Note: for compliance with TLV**

Collection Media: Contact your supervisor

Sample Flow Rate (LPM): 2.8

Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support.

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)

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 - COCl₂
2.0 ppm IDLH (NIOSH, 1995)

Contaminant Code: 495

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.1 ppm (100 ppb)	0.3 ppm (300 ppb) - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube; range 0.02-1 ppm (EF=1.15), range 0.25-25 ppm (EF=1.25).

Phosphine - PH₃
50 ppm IDLH (NIOSH, 1995)

Contaminant Code: 315

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.3 ppm (300 ppb)	0.9 ppm (900 ppb) - 15 min	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube; range 0.01-3 ppm (EF=1.15), range 0.01-40 ppm (EF=1.20), range 1-200 ppm (EF=1.20), range 25-10,000 ppm (EF=1.15), range 50-3,000 ppm (EF=1.15)

n-Propyl Alcohol - CH₃CH₂CH₂OH
800 ppm IDLH (NIOSH, 1995)

Contaminant Code: 255

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
200 ppm	250 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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) - SiO₂ (Respirable)
50 mg/m³ IDLH (NIOSH, 1995)

Contaminant Codes	1973 ACGIH TLV	1973 ACGIH Excursion STEL/Ceiling (C)
523 (dust, respirable fraction, > 1% quartz)	<u>10 mg/m³</u> % resp SiO ₂ + 2	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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. NIOSH 7500 (IV):

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5- μ m 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- μ m 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/m³ (as Se) IDLH (NIOSH, 1995)

Contaminant Code: 627

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.2 mg/m ³ (200 µg/m ³)	0.6 mg/m ³ (600 µg/m ³) - 15 min	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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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:

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) - SiO₂ (Respirable)
50 mg/m³ IDLH (NIOSH, 1995)

Contaminant Codes	1973 ACGIH TLV	1973 ACGIH Excursion STEL/Ceiling (C)
523 (dust, respirable fraction, > 1% quartz)	<u>10 mg/m³</u> % resp SiO ₂ + 2	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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. NIOSH 7500 (IV):

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 408-816

Bulk Sampling:

1. NIOSH 7500 (IV): [high-volume air]

Collection Media: 37-mm diameter, 5- μ m 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/m³ (as Ag) IDLH (NIOSH, 1995)

Contaminant Code: 653 (dust)
735 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
0.01 mg/m ³ (10 µg/m ³)	0.03 mg/m ³ (30 µg/m ³) - 15 min.	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/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 additional information to distinguish soluble from insoluble silver in workplace air samples.

Wipe Sampling:

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-4SiO₂-H₂O
3,000 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 511 (talc, nonfibrous, < 1% quartz)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
20 mppcf (3.3 mg/m ³)	40 mppcf (6.6 mg/m ³)- 15 min.	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, cor pulmonale
- PPE: Respirator:** Recommendations - NIOSH: Up to 30 mg/m³: (APF = 5) any dust and mist respirator; up to 60 mg/m³: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 150 mg/m³: (APF = 25) any powered, air-purifying respirator with a dust and mist filter; up to 300 mg/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling: - Note: cannot be used for enforcement

1. NIOSH 0500 (IV):

Collection Media: filter [37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Short Term Sampling:

Sampling Duration: 15 min.

1. NIOSH 0500 (IV):

Collection Media: filter [37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Full Shift Sampling: Enforcement - **Note: for compliance with TLV**

Collection Media: Contact your supervisor
Sample Flow Rate (LPM): 2.8
Air Collection Volume (L): 168

Sodium Hydroxide - NaOH

10 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 455

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV
2.0 mg/m ³	4.0 mg/m ³ - 15 min.	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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 1.0- μ m 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 Duration: 15 min.

Collection Media: 37-mm diameter, 1.0- μ m 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/m³ (3,390 ppm) IDLH (NIOSH, 1995)

Contaminant Code: 241

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
200 ppm	250 ppm - 15 min.	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/m³ [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/m³ [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/m³ [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/m³ [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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 - SO₂
100 ppm IDLH (NIOSH, 1995)

Contaminant Code: 421

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
5.0 ppm	10 ppm - 15 min.	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 (H₂SO₃)]
- Exposure:** Inhalation, skin and/or eye contact
- Health Effects:** Irritation: eyes, nose, throat; rhinorrhea (discharge of thin nasal mucus); 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1.

Collection Media: diffusion tube, 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- μ m pore size cellulose ester (CE) membrane filter; Back cassette = 37-mm diameter, cellulose filter (Whatman 40 or equivalent) saturated with Na₂CO₃ 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 H₂SO₄ mist); second

part = 100/50 mg IABC (to collect SO₂).

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 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- μ m pore size cellulose ester (CE) membrane filter; Back cassette = 37-mm diameter, cellulose filter (Whatman 40 or equivalent) saturated with Na₂CO₃ 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 H₂SO₄ mist); second part = 100/50 mg IABC (to collect SO₂).

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:

1. **Collection Media:** detector tube; range 0.1-3 ppm (EF = 1.15), range 0.5-25 ppm (EF = 1.15), range 1-25 ppm (EF = 1.15), range 10-2,000 ppm (EF = 1.20), range 50-8,000 ppm (EF = 1.15).

2. **Collection Media:** Various electronic direct-reading instruments are available. Consult the manufacturer's instructions and specifications to determine suitability for particular contaminants.

Sulfuric Acid - H₂SO₄
15 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 423

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	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/m³: (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, Trelchem, Tychem; 4 hr: Viton

Eye: Prevent eye contact

Special Precautions: Noncombustible liquid, but capable of igniting finely divided combustible materials

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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/m³ IDLH (NIOSH, 1995)

Contaminant Code: 503 (talc, fibrous, <1% quartz)

30 CFR §§56/57.5001(b)	30 CFR
MSHA TLV	§§56/57.5001(b)
	MSHA STEL
2.0 fibers/mL	10.0 fibers/mL - 15 min.

Contaminant Code: 511 (talc, nonfibrous, <1% quartz)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
20 mppcf (3.3 mg/m ³)	40 mppcf (6.6 mg/m ³)- 15 min.	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/m³: (APF = 5) any dust and mist respirator; up to 20 mg/m³: (APF = 10) any dust and mist respirator except single-use and quarter-mask respirators; (APF = 10) any supplied-air respirator; up to 50 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling: - Note: cannot be used for enforcement

1. NIOSH 0500 (IV):

Collection Media: filter [37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Short Term Sampling:

Sampling Duration: 15 min.

1. NIOSH 0500 (IV):

Collection Media: filter [37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 20-400

Full Shift/Time Weighted - Partial Period Sampling: Enforcement

Note: for compliance with TLV

Collection Media: Contact your supervisor

Sample Flow Rate (LPM): 2.8

Air Collection Volume (L): 168

Special Instructions: Coordinate with MSHA Technical Support.

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

- Asbestos Fibers [note: for optimal filter loading without overloading, sampling times or flow rate may need to be adjusted]

1. Personal:

Collection Media: 25-mm diameter, 0.8- μ m 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:

- Asbestos Fibers

Sample Duration: 15-30 minutes

Collection Media: 25-mm diameter, 0.8- μ m 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 achieve quantifiable loadings, however, do not overload the filter with background dust.

Bulk Sampling:

- 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 - TiO₂
5,000 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 153 (dust)
739 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
10 mg/m ³	20 mg/m ³ - 15 min.	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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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:

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

Toluene - C₆ H₅CH₃
500 ppm IDLH (NIOSH, 1995)

Contaminant Code: 221

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	100 ppm	150 ppm - 15 min.

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, Trelchem, Tychem
- Eyes:** Prevent eye contact
- Special Precautions:** Class IB flammable liquid

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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): ≤12

4. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: maximum 8-hour sample per badge

5. :

Collection Media: diffusion tube, 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 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:

Collection Media: detector tube: range 5-600 ppm (EF = 1.15), range 50-400 ppm (EF = 1.20), range 50-400 ppm (EF = 1.15), range 100-1,800 ppm (EF = 1.20).

Trichloroethylene - ClCH=CCl₂
1,000 ppm IDLH (NIOSH, 1995)

Contaminant Code: 211

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
100 ppm	150 ppm - 15 min.	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, Trelchem, Tychem; 4 hr: Teflon, Responder
- Eyes:** Prevent eye contact
- Special Precautions:** Combustible liquid (but burns with difficulty)

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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): ≤ 12

3. 3M:

Collection Media: Passive monitor, 3M, 3500 series

Note: Maximum 8-hour sample per badge

4. :

Collection Media: diffusion tube, 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 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:

Collection Media: detector tube; range 2-250 ppm (EF = 1.15), range 50-2,000 ppm (EF = 1.40), range 50-2,000 ppm (EF = 1.40).

Tridymite - SiO₂ (Respirable)
25 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 527

1972 ACGIH TLV	1973 ACGIH TLV
<u>5 mg/m³</u>	<u>5 mg/m³</u>
% SiO ₂ + 2	% SiO ₂ + 2

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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; up to 1.25 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. NIOSH 7500 (IV):

Collection Media: Cyclone and filter [10-mm nylon cyclone and 37-mm diameter, 5- μ m 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- μ m pore size polyvinyl chloride (PVC) filter]

Sample Flow Rate (LPM): 1.7

Air Collection Volume: Minimum - Maximum (L): 408-816

Bulk Sampling:

1. NIOSH 7500 (IV): [high-volume air]

Collection Media: 37-mm diameter, 5- μ m 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.

Trimethyl benzene - C₆H₃(CH₃)₃

Contaminant Code: 269

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
25 ppm	37.5 ppm - 15 min.	25 ppm	37.5 ppm - 15 min.

CONTAMINANT INFORMATION

- Synonyms:** *1,2,3-trimethylbenzene:* hemellitol; [note: hemimellitite 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: hemimellitite 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Sampling

Collection Media: N/A

Short Term Sampling:

Sampling

Sampling Duration: N/A

Special Instructions: N/A

Grab Sampling:

Collection Media: *all isomers:* detector tube range 10-100 ppm (EF = 1.20).

Tungsten and Compounds (as W)

**Contaminant Code: 741 (fumes)
155 (insoluble dusts, as W)**

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
5.0 mg/m ³	10 mg/m ³ - 15 min.	5.0 mg/m ³	10 mg/m ³ - 15 min.

Contaminant Code: 323 (soluble compounds, as W)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
1.0 mg/m ³	3.0 mg/m ³ - 15 min.	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/m³: (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/m³: (APF = 10) any air-purifying respirator with a high-efficiency particulate filter; (APF = 10) any supplied-air respirator; up to 25 mg/m³: (APF = 25) any supplied-air respirator operated in a continuous-flow mode; up to 50 mg/m³: (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)

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. NIOSH 7074 (IV):

Collection Media: 37-mm diameter, 0.8- μ m 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- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 2

Air Collection Volume (L): 480

Short Term Sampling:

Sampling Duration: 15 min.

1. NIOSH 7074 (IV):

Collection Media: 37-mm diameter, 0.8- μ m 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- μ m pore size mixed cellulose ester (MCE) filter

Sample Flow Rate (LPM): 2

Air Collection Volume (L): 30

Special Instructions: N/A

Bulk Sampling:

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:

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 - C₁₀ H₁₆
(approx) 800 ppm IDLH (NIOSH, 1995)

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
100 ppm	150 ppm - 15 min.	100 ppm	150 ppm - 15 min.

CONTAMINANT INFORMATION

- Synonyms:** Gumsprits, 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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 - V₂O₅
35 mg/m³ (as V) IDLH (NIOSH, 1995)

Contaminant Code: 471 (vanadium dust)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
0.5 mg/m ³ (500 µg/m ³)	1.5 mg/m ³ (1500 µg/m ³) - 15 min.	0.5 mg/m ³ (500 µg/m ³)	0.5 mg/m ³ (500µg/m ³) - 30 min.

Contaminant Code: 743 (V₂O₅ fume, as V)

1972 ACGIH TLV	1973 ACGIH TLV
0.05 mg/m ³ (C) (50 µg/m ³)	0.05 mg/m ³ (C) (50 µg/m ³)

(PEDS unit of measure in parentheses)

CONTAMINANT INFORMATION

- Synonyms:** Divanadium pentoxide, vanadic anhydride, vanadium pentoxide
- Sources:** *Dust:* ores of patronite (polysulfide - VS₄), 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/m³: (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/m³: (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/m³: (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/m³: (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 conditions 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

Collection Media: 37-mm diameter, 0.8- μ m 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 Duration: 15 min.

Collection Media: 37-mm diameter, 0.8- μ m 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:

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 - CH₂=CHCl

Contaminant Code: 995

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
200 ppm	250 ppm - 15 min.	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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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:

Collection Media: detector tube; range 0.125-30 ppm (EF = 1.35), range 1-50 ppm (EF = 1.15), 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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. OSHA ID-125G:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 Duration: 15 min.

1. OSHA ID-125G:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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:

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) - C₆H₄(CH₃)₂
900 ppm IDLH (NIOSH, 1995)

Contaminant Code: 223

225 (m-xylene)

227 (o-xylene)

229 (p-xylene)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	ANSI Z37.10- 1971 Ceiling (C) 200 ppm (C)
100 ppm	150 ppm - 15 min.	100 ppm	

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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

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 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): ≥ 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:

Collection Media: detector tube range 10-1,000 ppm (EF = 1.30).

Zinc Oxide - ZnO
500 mg/m³ IDLH (NIOSH, 1995)

Contaminant Code: 745 (fume)

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1968 PA Rules STEL
5.0 mg/m ³	10 mg/m ³ - 15 min.	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/m³: (APF = 10) any dust, mist, and fume respirator; (APF = 10) any supplied-air respirator; up to 125 mg/m³: (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/m³: (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/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. NIOSH 7502 (IV):

Collection Media: 25-mm diameter, 0.8- μ m 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- μ m pore size polyvinyl chloride (PVC) filter

Sample Flow Rate (LPM): 2

Air Collection Volume (L): 960

Short Term Sampling:

Sampling Duration: 30 min.

1. NIOSH 7502 (IV):

Collection Media: 25-mm diameter, 0.8- μ m 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- μ m 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/m³ (as Zr) IDLH (NIOSH, 1995)

Contaminant Code: 643

1972 ACGIH TLV	1972 ACGIH Excursion STEL	1973 ACGIH TLV	1973 ACGIH Excursion STEL
5.0 mg/m ³	10 mg/m ³ - 15 min.	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, sandstone, 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/m³: (APF = 5) any dust and mist respirator; up to 50 mg/m³: (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

SAMPLING INFORMATION

Full Shift/Time Weighted Sampling:

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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 Duration: 15 min.

1. OSHA ID-121:

Collection Media: 37-mm (or 25-mm) diameter, 0.8- μ m 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- μ m 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:

Collection Media: Whatman Filter (No. 41 or 42), moistened with distilled water

Special Instructions: Seal wipe sample in plastic bag, vial, or jar.

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