IH75100
Airborne Chemical Sampling

1.0 Purpose & Scope This document describes the IH Group procedure to follow for airborne contaminant sampling with a pump connected to a sorbent tube/impinger/or filter, passive dosimeters, indicator tube, and direct reading meters. The goal of the procedure is to provide a uniform methodology to collect representative samples of chemical vapor, fumes, mists or particulates. The use of this procedure is appropriate for DOE, OSHA and ACGIH occupational exposure limit (OEL) compliance testing.

NIOSH or OSHA sampling and analysis methods must be followed for the particular sampling parameters for each contaminant to be sampled. Employee exposure assessments for occupational exposure compliance should be made with a personal, breathing zone sample collected on a sorbent/filter/impinger. Area samples (fixed location) using high volume samplers, may be necessary in limited situations for employee exposure assessments to attain the needed limit of quantification to determine OEL compliance. In these instances, the operations must be of short duration (15 to 30 minutes) and involve limited employee movement so that the fixed sample can measure the actual employee exposure.

An area survey meter can be used for conducting surveys to locate problem sources and measuring the effectiveness of engineering controls. It can be used as a screening tool to determine the need for personal monitoring.

2.0 Responsibilities

2.1 This procedure is administered through the SHSD Industrial Hygiene Group.

2.2 ***Industrial Hygiene Professional:*** SHSD and other BNL organization's personnel using this procedure are to be qualified by the organization's manager or designee to meet the qualification criteria in Section 7. These individuals will conduct or supervise industrial hygiene hazard assessments and personal exposure monitoring using this procedure. These *IH Professionals* are responsible for:

- Interpreting, reporting, and documenting personal exposure monitoring in accordance with the requirements of this procedure, other appropriate SOPs, and generally accepted professional standards and practices.
- Ensuring a quality report is prepared that documents the exposure, evaluates the relevance to exposure standards, and recommends protective and corrective actions.
- Ensuring the final report is provided in a timely manner to all appropriate parties.
- Ensuring that the appropriate data is correctly and completely entered into the BNL IH exposure monitoring database (i.e. *Compliance Suite*®).

- Ensuring that original records of sampling and analysis enter the SHSD *Record Custodian* filing system.

2.3 ***Industrial Hygiene Technician (Sampler)*:** The industrial hygiene technician is to be qualified by their supervision to meet the qualification criteria in Section 7 for conducting industrial hygiene personal exposure monitoring under the direction of his/her organization's *IH Professional.* The sampler is responsible for collecting personal exposure monitoring samples in accordance with the guidance of the *IH Professional* and the requirements of all SOP's pertinent to the particular monitoring requirements (i.e. Chain of custody, equipment check in/out, equipment operation, recordkeeping, etc.).

2.4 **Chain of Custody procedures:** The collector of the sample is responsible for the integrity of sample media and data sheets until it has been properly transferred to the SHSD IH Laboratory.

2.5 **Hazard Analysis of the Sampling Task:** It is the responsibility of the person using this method and his/her supervisor to ensure that the appropriate personal protective equipment is worn while performing this procedure. In addition, the person performing this procedure and his/her supervisor are responsible to ensure that all required training and qualification for hazards that may be present in areas where this procedure will be used (such as respiratory protection or radiation contamination) have been met. The person performing this procedure and his/her line supervisor are responsible to comply with all work planning and work permit system requirements.

3.0 Definitions

Detector Tubes: Thin tubes made of glass having two break off tips on either end. The tubes are filled with treated chemical granules specific for sampling a variety of substances. Most detector tubes are packaged 10 in a box and have a shelf life of 24 to 30 months.

Direct Reading Instrument: An analytical meter capable of instantaneous or near instantaneous detection of the presence and concentration of an airborne contaminant. Examples would be combustible and toxic gas meters, photoionization detectors, gas chromatographs, and infrared analyzers.

Integrated Sampler: A sampling train including an analytical media and associated sampling device capable of collecting an airborne contaminant for subsequent analysis and quantifying of the concentration. Examples would be a carbon tube or MCEF filter used with a calibrated air sampling pump or a sorbent containing passive sampling badge.

4.0 Prerequisites

4.1 **Training prior to using this procedure:** Obtain appropriate training for the area to

be entered (check with ESH Coordinator or FS Representative for the facility).

4.2 **Area Access**:

4.2.1 Contact the appropriate Facility Support Representative or Technician to obtain approval to enter radiological areas. Verify with the appropriate Facility Support Representative or Technician if a Work Permit or Radiological Work Permit is needed or is in effect. If so, review and sign the permit.

4.2.2 Use appropriate PPE for area.

5.0 Precautions

5.1 **Hazard assessment:** The actual task of taking a sample typically does not cause significant employee health risks. (Note: some impinger solutions are hazardous.) But by its very nature, this SOP may be performed in areas with chemical or radiation contamination, and these hazards must be assessed on a case-by-case basis. Some meters (XRF, FAM, GC-ECD) have hazard sources within the meters that can harm the users in exposed to. This SOP does not authorize any worker to open the meter housing on any IH meter. Return the meter immediately if the housing is found damaged or is damaged during use.

5.2 **Personal Protective Equipment:** Appropriate personal protective equipment to protect the person collecting the sample is required to protect from the potential hazards in the area to be sampled.

- **Hand:** Sample collection in areas of known or suspected chemical or radiological contamination requires the use of disposable gloves. Exam-style, splash gloves are acceptable. Acceptable elastomers are: Nitrile, PVC, and Natural Rubber.
- **Body:** If contact of the body with contaminated surfaces is anticipated, use a disposable suit. Acceptable chemical protective equipment materials include: Tyvek®, KleenGuard®, and cotton. Discard disposable garments as per the direction of the ECR/WMR if contact with contamination has occurred. If personal clothing items become contaminated, they must be surrender for BNL cleaning or disposal.
- **Foot:** If contact of the feet is anticipated with contaminated surfaces, use disposable shoe coverings, boots or booties. Acceptable CPC material include: Tyvek®, KleenGuard®, and rubber. If personal shoes become contaminated, they must be surrendered for BNL cleaning or disposal.
- **Respiratory:** Under normal use, respiratory protection is not required. If chemical or radiological levels from contamination in the area exceed or are likely to exceed the OSHA, ACGIH, or DOE standards, respirators are required. A half face or full face APR or PAPR respirator with appropriate cartridge or an air line respirator may be used up to the assigned protection factor listed in the BNL's Respiratory Protection Selection and Issuance SOPs.

- **Eye:** Safety Glasses with side shields are required in laboratories, construction, and general industry areas.

5.3 **Radiation Contamination:** It is possible that some surfaces in areas to be tested may have radiation contamination. In these cases, personal protective equipment and administrative controls must be implemented for the radiation contaminant hazard in addition to the chemical hazard. In addition, the collected sample from these areas must be analyzed for the radiation hazard before it can be submitted to the SHSD IH Laboratory for analysis. At no time will the SHSD IH Laboratory accept a sample with radiation contamination above permissible limits for the general public.

5.4 **Work Planning:** All requirements of work permits and work planning system reviews must be met in performing this procedure.

5.5 **Environmental Impact and Waste Disposal:** This sampling may have very minor adverse impact on the environment or create waste for disposal. See Attachment for an analysis and required actions.

5.6 **Job Risk Assessment:** Consult the *Job Risk Assessment* IHG-JRA-05 for the risk analysis of this operation based on the hazards and controls of this SOP.

6.0 Procedure

6.1 Plan and conduct hazard assessments and exposure monitoring using the procedure outlined in *IH 60500 Reporting Personnel Exposure Monitoring Results.*

6.2 Follow a generic or specialized chemical sampling procedure appropriate for the operation to be sampled and hazard to be evaluated, such as:
- Integrated Sampling Procedure (Attachment 9.1),
- Direct Reading Meter Procedure (Attachment 9.2),
- Soldering/Welding Sampling Procedure (Attachment 9.3), or
- Indicator Tube Testing (Attachment 9.4)

6.3 Record filed data on an appropriate data collection form, such as:
- *Air Sampling Survey* Form (Attachment 9.5),
- *Direct Reading Instrument* form (IH60500),
- Add a sketch to the Sampling form or attach a photo of the sample area. Use the sketch or photo to identify the location of the hazard source, worker and by-stander locations, and sample location(s).
- Some meters can log data. Whenever possible, use this feature, save an electronic version, and print a hardcopy of the data and supply it to the IH Laboratory.

6.4 Return media, pump and original field sampling form to the SHSD IH Laboratory. The IH Group will maintain a copy of sampling results for at least 75 years.

6.5 A competent person from the organization taking the samples writes a hazard evaluation report that evaluates the survey data and summarizes the potential for occupational exposure and compliance with OSHA and ACGIH Occupational Exposure Limits.

6.6 Notify workers of sampling results as per IH60500.

6.7 Distribute the hazard evaluation report to the worker, supervisor, and ESH Coordinator.

6.8 Complete an entry in the BNL IH Exposure Monitoring Database (*Compliance Suite*). Ensure that a copy of the hazard evaluation report is sent to the IH Laboratory and is included in the ESH Directorate Recordkeeping system *Compliance Suite.*

6.9 Ensure that a summary of the written hazard evaluation report is sent to the Occupational Medicine Clinic with the worker(s) BNL Life Number(s) noted.

7.0 Implementation and Training

Prior to using this procedure, document user training using the Attachment 9.6 *Job Performance Measure Completion Certificate.*

8.0 References

8.1 NIOSH Manual of Analytical Methods
8.2 OSHA SLC Laboratory Methods
8.3 MSA Document: Detector Tubes and Dosimeters Data Sheet #08-00-02, (1989).

9.0 Attachments

9.1 Media & Filter Integrated Sampling Procedure
9.2 Direct Reading Meter Procedure
9.3 Solder/Welding Evaluation Procedure
9.4 Indicating Tube Procedure
9.5 Sample of the *Air Sampling Survey* form
9.6 Chemical Sampling & Measurement Qualification record

10.0 Procedure Documentation

ISM Review - Hazard Categorization:	☐ High	☒ Moderate	☐ Low/Skill of the craft
Validation:	☐ Formal Walkthrough	☒ Desk Top Review	☐ SME Review

Rev	Revision Log

BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division - INDUSTRIAL HYGIENE GROUP Standard Operating Procedure		Number	**IH75100**
		Revision	**FINAL Rev2**
Subject:	**Airborne Chemical Sampling**	Date	**07/08/14**
		Page	**6** OF 21

0	This version is a merger of existing SOPs 75140, 75170, 75180, & 75250. Those SOPs are rescinded with this publication. SME Reviewer/Date: R. Selvey 09/23/09
1	Revised Section 2 to link to section 7. Updated format of Section 9. Reviewer: R. Selvey 03/04/14
2	Revised Attachment s and text to update any out-of-date IH procedure numbers. Revised Attachment 9.5 Air Sampling form to streamline the Chain of Custody process. Reviewed by: S. Retenski, Approved by: R. Selvey 07/08/14

Attachment 9.1

Media and Sorbent Integrated Sampling Procedure

Equipment-

- **Media-** adsorbent, absorbent, filter, or impinger solution.
- **Pump:** active sampling- portable, battery or line voltage operated, sampling device worn on the employee's belt or a fixed location sampler.
- **Passive Dosimeter:** an adsorbent containing device with a permeable membrane. The dosimeter is worn on the worker's lapel that samples passively by diffusion.

1. **Selection of Media:** Contact an IH Group professional or other competent individual for assistance in selecting the appropriate media, sampling equipment, sampling parameters (flow rate), precautions or special handling needs, and post sampling storage requirements. Particulate media will be selected by the IH Lab based criteria listed below.

2. **Preparation & Handling of Sampling Equipment**
   a. **Pre-calibration:** The IH Laboratory will pre-calibrate the sampling train using the field media or a representative media sample in line prior to field sampling.
   b. **Post-calibration:** The IH Laboratory will post-calibrate the sampling train in accordance with IH51100 using the field media or a representative media sample in line after field sampling.

3. **Sampling Technique Principles:**
   a. OEL compliance sampling for employee exposure monitoring is done with a portable sampler with sorbent/filter attached in the breathing zone (lapel) of the worker, whenever possible. Fixed sampling is only permitted when portable sampling cannot provide the needed analytical sensitivity or the sampling equipment would cause a safety risk.

   b. Observe the sampling over the entire period, when possible. During lunch and break periods, if the workers leave the area of hazard, then pumps may be removed and shut off and placed back on the worker and restarted after the break. Record the stop and re-start time. The pump may be left on the worker during breaks if practical.

   c. Carefully record the pump start and stop time to the nearest 1 minute. Use the sample watch (or synchronized) for the entire sampling period.

   d. Area samples may also provide useful information. Determining the NUMBER and LOCATION of samples varies case-by-case. Professional judgment is needed in determining the sampling parameters based on factors such as the size of the area to be tested, the predicted uniformity of contamination within the area, relative hazard of the contaminant, and the accuracy, precision (repeatability), & sensitivity of the analytical method and the time of sampling. It is appropriate to take samples in:
      - areas where workers predominately spend time or frequently access,
      - at sources of the contamination (such as process equipment & lab apparatus),
      - areas where contamination is not expected (serves as a control), and

- areas where contamination would not be permissible (such as lunch rooms and offices).

4. **Sample Storage:** The IH Laboratory will store exposed media in accordance with the NIOSH/OSHA method in the interim between return of the media from the field, post calibration, and shipment of the media to the analytical laboratory.

5. **Chain of Custody:** All provisions of IH51200 will be followed in processing samples for field use and shipment to the analytical laboratory.

6. **Laboratory Analysis:**
   - BNL may analyze lead filters at the IH Laboratory using a factory calibrated XRF meter as per the NIOSH/OSHA method.
   - BNL will ship samples to an AIHA PAT certified laboratory for quantitative analysis by Gas Chromatography, High Performance Liquid Chromatography, Atomic Absorption Analyzer, Inductively Coupled Plasma Spectroscopy, or other analytical technique described in a NIOSH or OSHA method.

Particulate Sampling Parameters

Compound	Fraction	Sampler	Media	Flow (L/min)**
Asbestos	Total	Non-conductive Cassette, Open Faced	25 mm MCE	0.5 - 5
Arsenic	Total	Cassette	37mm MCE	1 – 3
	Total	Cassette	37mm MCE	1 – 3
Beryllium	Total- TWA8	Cassette	37mm MCE	1 – 4
	Total- STEL	Cassette	37mm MCE	1 – 4
	Total	Cassette	37mm MCE	2 – 2.5
	Total	Cassette	37mm MCE	1 – 4
Cadmium	Inhalable	IOM	25mm MCE	2.0
	Respirable	Cyclone	37mm MCE	2.5
	Fume	Cassette	37mm MCE	1 – 3
	Dust- Total	Cassette	37mm MCE	1 – 3
Chromium Metal	Total	Cassette	37mm MCE	1 – 3
	Total	Cassette	37mm MCE	1 – 3
Chromium III	Total	Cassette	37mm MCE	1 – 3
	Total	Cassette	37mm MCE	1 – 3
Chromium VI	Total	Cassette	37mm MCE	1 – 3
Copper	Fume	Cassette	37mm MCE	1 – 3
	Dust	Cassette	37mm MCE	1 – 3
	Fume	Cassette	37mm MCE	1 – 3
	Dust	Cassette	37mm MCE	1 – 3
Dust, PNOC	Respirable	Cyclone	37mm PVC (1)	2.5
	Inhalable	IOM	25mm PVC (1)	2.0
	Respirable	Cyclone	37mm PVC (1)	2.5
	Total	Cassette	37mm PVC (1)	1.5 – 2
Fiberglass	Total	Cassette	25mm MCE	0.5 – 16
	Total	Cassette	37mm PVC	1 – 3
	Respirable	Cyclone	37mm PVC	2.5
	Total	Cassette	37mm PVC	1 – 3
Iron Oxide	Total	Cassette	37mm MCE	1 – 4
	Total	Cassette	37mm MCE	1 – 4
Lead	Total	Cassette	37mm MCE	1 – 4
	Total	Cassette	37mm MCE	1 – 4
Nickel	Inhalable	IOM	25mm MCE	2.0
	Total	Cassette	37mm MCE	1 – 4
Silica	Respirator	Cyclone	37mm PVC (1)	1.7 Nylon; 2.5 Aluminum
Welding Fumes	Total	Cassette	37mm PVC	1

Media abbreviations: (1) All gravimetric analysis on matched weight filters or tared filter. Except for Asbestos, and cyclones all cassettes are CLOSED faced.	Flow Rate and Media based on NIOSH Method unless noted below: • IOM flow of 2.0 based on SKC, Inc. sampler specifications

37mm MCE = 37mm diameter Mixed Cellulose Ester Membrane, 0.8 micron pore size 25mm MCE = 25mm diameter Mixed Cellulose Ester Membrane, 0.8 micron pore size 37mm PVC = 37mm diameter Poly Vinyl Chloride Membrane, 5.0 micron pore size	for 100 micron cutpoint) • Cyclone flow of 2.5 based on SKC, Inc. sampler specifications for 4 micron cutpoint (ACGIH) • Cyclone flow of 1.7 based on NIOSH method for 10 micron midpoint (OSHA)

3M® Passive Vapor Badges Chemical Compound List

Acetone (2) (c)	Cyclohexene (8)	Methyl t-Butyl Ether (MTBE) (8)
Acetonitrile (2) (c)	n-Decane	Methyl Butyl Ketone (MBK) (8)
Acrylonitrile (8)	Diacetone Alcohol (8)	Methyl Cellosolve (8)
Allyl Alcohol (8)	o-Dichlorobenzene (8)	Methyl Cellosolve Acetate (8)
Amyl Acetate (8)	p-Dichlorobenzene (8)	Methylene Chloride (m) (3530 only)
n-Amyl Alcohol	trans-1,2-Dichloroethylene (6)	Methyl Ethyl Ketone (MEK) (8)
s-Amyl Alcohol	Diisobutyl Ketone (DIBK) (8)	Methyl Isobutyl Ketone (MIBK) (8)
Benzene (8)	p-Dioxane (8)	Methyl Methacrylate (8)
Benzyl Chloride (8)	Dipropylene Glycol Methyl	Methyl Propyl Ketone (8)
Bromoform (8)	Ether Acetate	Naptha (VM&P) (8)
1-Bromopropane (m)	Enflurane (8)	n-Octane (8)
n-Butyl Acetate (8)	Epichlorohydrin (8)	Perchloroethylene (8)
s-Butyl Acetate (8)	Ethoxy Perfluorobutane	Phenyl Ether (8)
t-Butyl Acetate (8)	Ethyl Acetate (6)	n-Propyl Acetate (8)
Butyl Acrylate (8)	Ethyl Acrylate (8)	n-Propyl Alcohol (6)
n-Butyl Alcohol (8)	Ethyl Benzene (8)	Propylene Dichloride (8)
s-Butyl Alcohol (8)	Ethylene Chlorohydrin (8)	Propylene Glycol Mono Methyl Ether (8)
t-Butyl Alcohol (8)	Ethylene Dichloride (EDC) (8)	Propylene Glycol Mono Methyl Ether Acetate
Butyl Cellosolve Acetate	Ethyl Ether (4) (c)	Stoddard Solvent (8)
Butyl Cellosolve (8)	Furfural (8)	Styrene (8)
Butyl Glycidyl Ether (8)	Halothane (8)	1,1,2,2-Tetrachloroethane (8)
p-tert Butyl Toluene (8)	n-Heptane (8)	Tetrahydrofuran (8)
Camphor (8)	n-Hexane (8)	Toluene (8)
Carbon Tetrachloride (8)	iso-Amyl Acetate (8)	1,1,1-Trichloroethane (Methyl Chloroform)
Cellosolve (8)	iso-Butyl Alcohol (8)	(m)
Cellosolve Acetate (8)	Isoflurane (Forane)	Trichloroethylene (8)
Chlorobenzene (8)	Isopar G	1,1,2-Trichloro-1,2,2-trifluoroethane (1) (c)
Chloroform (8)	Isophorone (8)	Vinyl Acetate (8)
o-Chlorostyrene (8)	Isopropyl Acetate (7)	Vinyl Toluene (8)
o-Chlorotoluene (8)	Isopropyl Alcohol (m) (c)	Xylene (8)
Cumene (8)	Mesitylene (8)	Total Hydrocarbons as n-Hexane †`
Cyclohexane (6)	Mesityl Oxide (8)	
Cyclohexanol (8)	Methoxy Perfluorobutane (HFE-7100)	
Cyclohexanone (8)	Methyl Acrylate (8)	

The number in parenthesis is the recommended sampling period in hours. This time has been estimated using the capacity of the 3510 organic vapor monitor, a relative humidity of <50% and the 1998 ACGIH TLVs. Use of the 3530 allows the sampling time to increase.

(c) Because of their high vapor pressures (low boiling points), the (c) compounds are best sampled initially with the 3520 monitor (with back-up section). Subsequent sampling may be done with the 3500/3510 monitor if determined, by 3520 results, that contaminant concentrations are within the 3500/3510 capacity limits.

†NOTE: certain compounds (e.g. acetone, methyl ethyl ketone, vinyl acetate, etc.) may show a decreased recovery when sampled in high relative humidity. Refrigerate and/or expedite for analysis to help ensure accurate results.

(m) See technical bulletin.

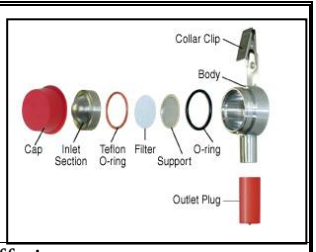
Organic Vapor Monitors provide accurate results if they are used within their performance limitations and if the analytical laboratory conducting the analysis can accurately provide correct information. Some of the more common sampling errors are overloading the sorbent pad, sampling for contaminants that cannot be captured and retained by carbon, and the laboratory using incorrect recovery coefficients.

Sampling a full workshift is recommended in order to determine the workers' daily exposure level to organic contaminants. When monitoring some organic contaminants, sampling shorter than a full shift may be required in order to be within the recommended capacity of the organic vapor monitor. Under these circumstances, sequential sampling with several monitors can be performed to assess the 8 hour exposure.

			
3M 3500 Organic Vapor Passive Air Monitoring Badge	**3M 3520** Organic Vapor w/Back-Up Section Passive Air Monitoring Badges	**3M 3550** Ethylene Oxide Passive Monitoring Badge	**3M 3720** Formaldehyde Passive Monitoring Badge (not acceptable for STEL monitoring).

SHSD Environmental Evaluation of Air Sampling With Adsorbent Tubes or Filters

Operation Description: Ambient air is drawn through glass tubes with an adsorbent or filters to collect chemicals in the ambient air. The tubes or filters are sent to AIHA Accredited laboratories off-site for analysis. The tubes and filters are disposed by those facilities in accordance with regulatory regulations that is verified in the AIHA Accreditation validation.



Frequency of Operation: 10-20 times per month for collection of samples to be sent off-site.

Environmental impact:

No environmental impact at BNL. Disposal is handled by off-site vendor laboratory. Conformance of proper disposal by the off-site vendor laboratory is validated to BNL IH Group's satisfaction in the AHIA Accreditation process.

When unused media (that is treated by the manufacturer) has expired, it is disposed of as per the manufacturer's instruction.

Waste Disposal:

- None at BNL.
- When unused media (that is treated by the manufacturer) has expired, it is disposed of as per the manufacturer's instruction.

Attachment 9.2

Direct Reading Meter Procedure

Equipment- This procedure is applicable for many instruments with operating aid prepared for the meters. Contact an IH Group professional Industrial Hygienist or other competent individual for assistance in selecting the appropriate meter for analysis of an airborne contaminant.

1. Signing out Meter:
   a. Prior to the sampling day, contact the IH Group Laboratory via the SHSD Equipment Request web page. Follow IH51200 for the procedure to obtain the meter.
   b. The IH Lab meters are intended for short duration use (i.e. one day). You may contact the IH Group for assistance in locating suitable rental equipment for extended monitoring projects. Equipment is due back by 9:00 a.m. the following day unless other provisions are made with the IH *Equipment Custodian*. Only by special agreement with the IH Lab *Equipment Custodian* can a meter be kept out for longer periods.

2. Preliminary check of the meter: Check the meter for a calibration sticker. Do not use the meter if a calibration sticker is not present, or if the date on a calibration sticker indicates that the meter's calibration has expired. If applicable, BUMP TEST the meter with a sample of the compound to verify that the meter is operating correctly.

3. Sampling Technique: Determining the NUMBER and LOCATION of samples varies on a case-by-case basis. Professional judgment is needed in determining the sampling parameters based on factors such as the size of the area to be tested, the predicted uniformity of contamination within the area, and relative hazard of the contaminant, and the accuracy, precision (repeatability), and sensitivity of the instrument. It is appropriate to take samples in:
   - areas where workers predominately spend time or frequently access,
   - at sources of the contamination (such as process equipment & lab apparatus),
   - areas where contamination is not expected (serves as a control), and
   - areas where contamination would not be permissible (such as lunch rooms and offices).

4. Operate the meter as per the appropriate Operator Aid.

SHSD Environmental Evaluation of Gas Detection Meter Sensors

Operation Description: Gas Detection Meters (such as the *Crowcon® Triple Plus or Scott® Scout*) are taken into the field to measure ambient air concentrations of certain contaminants. Sensors contain reactive chemicals (in the ppm to low % range). Content is known via the manufacturer's MSDS or meter's Operating Manual.

Frequency of Operation: 10-40 days per year
On a periodic basis, the sensors need to be replaced. They are removed by SHSD IH. Frequency of Operation: Approximately 30 sensors are changed per year.

Environmental impact:

- At end of the field test, the meters are returned to the IH lab. No environmental impact results because the meters do not produce emissions.
- When the sensors in the meters need to be replaced, they are removed by the SHSD IH Technician. They are disposed of as non-hazardous waste, as per manufacturer's recommendations.
- The *Perkin-Elmer Photovac Voyager* portable gas chromatograph (GC) has a carrier gas of ultra-pure nitrogen that continuously flows over the GC column and sensor at <5 cc/min. The nitrogen gas is exhausted to the atmosphere. It is not considered hazardous as it is incapable of depleting the oxygen levels to a hazardous level to room occupants. Nitrogen is the chief ingredient in atmospheric air and the concentration of the environment is not measurably impacted by this small release.

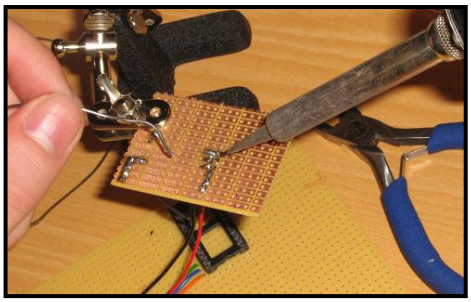
Waste Disposal:

- Used chemical cell sensor are disposed of as hazardous waste through EPD, unless the manufacturer documentation indicates the sensor is not hazardous waste.

Attachment 9.3

Soldering and Welding Evaluation Procedure

The purpose of the procedure is to provide a uniform methodology to collect representative samples of airborne particulates of metals and thermal decomposition fumes. This method is appropriate for collection of metal particulates and the colophony fumes from the heating of acid and rosin based fluxes. Using this method will ensure repeatability between various sampling personnel and ensure consistent evaluations among soldering operation configurations.



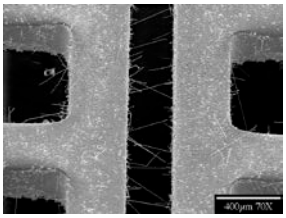
Definitions

Brazing (silver soldering or hard soldering) is a joining process whereby a non-ferrous filler metal or alloy is heated to melting temperature **above 800°F (425)°C** and flowed between close-fitting parts by capillary action. At its liquid temperature, the molten filler metal and flux interacts with a thin layer of the base metal, cooling to form an exceptionally strong, sealed joint due to grain structure interaction. Brazing requires a much higher temperature than soft soldering, sometimes over 850 °C. As well as removing existing oxides, rapid oxidation of the metal at the elevated temperatures has to be avoided. This means that fluxes need to be more aggressive and to provide a physical barrier. There are different fluxes available, often using active chemicals such as fluorides, as well as wetting agents. Many of these chemicals are toxic and due care should be taken during their use

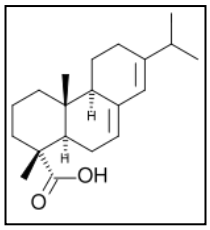
Flux is a substance which facilitates soldering, brazing, and welding by chemically cleaning the metals to be joined. Common fluxes are ammonium chloride or rosin for soldering tin and borax for brazing or braze-welding ferrous metals. The primary purpose of flux is to prevent oxidation of the base and filler materials. Tin-lead solder alone attaches very well to copper, but poorly to the various oxides of copper, which form quickly at soldering temperatures. Flux is a substance which prevents the formation of metal oxides. Flux also allows solder to flow easily on the working piece rather than forming beads.

Lead-free Electronic Soldering: European environmental legislation has specifically targeted lead in the electronics industry. The Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) required many new electronic circuit boards to be lead free by July 1, 2006. Technical challenges of lead free electronic soldering are:

- Traditional lead-free solders have a significantly higher melting point than lead-based solders, which renders them unsuitable for use with heat-sensitive electronic components and their plastic packaging. To overcome this problem, solder alloys with a high silver content and no lead have been developed with a melting point slightly lower than traditional solders.
- Lead-free components, pins, and connectors use copper frames, and either lead, tin, gold or other finishes. Tin finishes are the most popular of lead-free finishes. Nevertheless, this creates a problem of tin-whiskers (a phenomenon whereby the metal grows tiny tin hairs that can cause short circuits and arcing in electrical equipment.) The phenomenon was discovered by telephone companies in the late 1940s and was addressed with the addition of lead to tin solder.



Rosin (colophony) is a solid form of resin obtained from pines and some other plants. It is semi-transparent and varies in color from yellow to black. It chiefly consists of different resin acids, especially **abietic acid**. Rosin is the precursor to the flux used in soldering. The lead-tin solder commonly used in electronics has about 1% rosin as a flux core helping the molten metal flow and making a better connection.



Abietic Acid

Soldering (soft soldering) is the process in which two metals are joined together by a third metal having a relatively low melting point, **below 450°C (842°F)**. The third metal is called solder. Soldering is distinguished from brazing by use of a lower melting-temperature filler metal; it is distinguished from welding since the base metal is not melted during the joining process. In soldering, heat is applied to the parts to be joined, causing the solder to melt and be drawn into the joint by capillary action and to bond to the materials to be joined by wetting action. After the metal cools, the resulting joints are not as strong as the base metal, but have adequate strength, electrical conductivity, and water-tightness for many uses.

Thermal decomposition is a chemical reaction whereby a chemical substance breaks up into at least two chemical substances when heated.

Equipment

- Sampling Pumps: SKC-224-44XR (1-4 l/min), Aircheck® 52 (1-2.5 l/min) and SKC-224-3 (1-250 cc/min), or equivalent.
- Collection Media: media and flow rates as per the following table:

Contaminant	Method, Media, Sampling Rates
Aldehydes Screening: Formaldehyde; Acetaldehyde; Propionaldehyde; Acrolein; Butraldehyde; Isobutyraldehyde; Crotonaldehyde; Valeraldehyde; Isovaleraldehyde; Hexanal; Heptanal; Furfural	NIOSH 2016 Tube: SKC- 226-119 Silica Gel coated with 2,4-Dinitrophenyl hydrazine 150/300 mg 15 minute sample at 0.2 liters/min for ceiling OEL
Elements by ICP: Tin & Lead or Metal Screening: Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel, Selenium, Silver, Tin, Tungsten, Vanadium, Zinc	NIOSH 7301 Filter 0.8Um MCE or Filter 5.0 Um PVC At least a 15 minute sample at 2.5 liters/min
Limonene, pinene, nopinene, isodiprene **& Terpenes** by GC-FID: Allyl alcohol; Allyl chloride; n-Amyl acetate; sec-Amyl acetate; Benzyl chloride; Bromoform; Butyl acetate; sec-Butyl acetate; tert-Butyl acetate; Butyl alcohol; sec-Butyl alcohol; tert-Butyl alcohol; n-Butyl glycidyl ether (BGE); p-tert-Butyltoluene; Camphor; Carbon tetrachloride; Chlorobenzene (monochlorobenzene); Chlorobromomethane; Cumene; Cyclohexane; Cyclohexanol; Cyclohexene; Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone); o-Dichlorobenzene; p-Dichlorobenzene; 1,1-Dichloroethane; 1,2-Dichloroethylene; Dichloroethyl ether; 1,1-Dichloro-1-nitroethane; Difluorodibromomethane(F-12-B2); Diisobutyl ketone; Dioxane (diethylene dioxide); Epichlorohydrin; Ethyl acetate; Ethyl sec-amyl ketone (5-methyl-3-heptanone); Ethyl bromide; Ethyl butyl ketone (3-heptanone); Ethylene chlorohydrin; Ethyl ether; Ethyl formate; Glycidol (2,3-epoxy-1-propanol); n-Heptane; Hexachloroethane; n-Hexane; 2-Hexanone (MBK); sec-Hexyl acetate; Isoamyl acetate; Isoamyl alcohol; Isobutyl acetate; Isobutyl alcohol; Isophorone; Isopropyl acetate; Isopropyl ether; Isopropyl glycidyl ether; Mesityl oxide; Methyl acetate; Methylal (dimethoxymethane); Methyl-(n-amyl)ketone; Methylcyclohexane; Methyl isobutyl carbinol; a-Methyl styrene; Octane; Pentane; 2-Pentanone; Phenyl glycidyl ether; n-Propyl acetate; Propyl alcohol; Propylene dichloride; n-Propyl nitrate; 1,1,1,2-Tetrachloro-2, 2-difluoroethane; 1,1,2, 2-Tetrachloro-1, 2-difluoroethane; 1,1,2,2-Tetrachloroethane; Tetrahydrofuran; Tetramethyl succinonitrile; 1,2,3-Trichloropropane; Vinyl toluene.	OSHA 7 Tube: Coconut Shell Charcoal SKC-226-01 or SKC-226-09 At least a 15 minute sample at 0.2 liters/min

1. Prior to performing air sampling: Collect information on the soldering/brazing operation, including:

a. Identify the materials in use: Manufacturer Brand & name of solder metal (determine the lead and other metal content); Manufacturer Brand & name of flux (determine if acid or rosin based), and Manufacturer Brand and Model number of soldering tool (iron or torch).
b. Record the engineering controls being used- local capture system (Brand and model), dilution ventilation, fans, etc.
c. Record the Personal Protective Equipment and Administrative Controls being used- lab coat, uniform, gloves, respirator, etc.
d. Review the Work Planning documentation for inclusion of appropriate controls.
e. Observe the housekeeping and cleanliness of the area; observe the safety of combustible and flammable materials in the area. Recommend/ initiate any immediate corrective actions

2. Measure the airborne levels of rosin/acid flux thermal decomposition products. At a minimum, measure Aldehydes (Aldehydes Screening: NIOSH 2539) and Terpenes (NIOSH 1552). Make sure the full 8-hour shift is accounted for with monitoring or a work history (See IH60500).

3. Measure the airborne levels of metal fumes in the area from brazing operations. Make sure the full 8-hour shift is accounted for with monitoring or a work history. (See IH60500.).
(Note: During the ISM Corrective Action validation of the current SBMS *Lead* Subject Area requirements for *Electronic Soldering Operations*, take airborne METALS measurements for each electronic solder component - analyze for all metals in the base solder and lead if the soldering is re-work on lead solder or unknown components.)

4. For each type of sample, include at least 1 un-exposed media with each set of samples (provide 1 blank per 6 samples). If more than six (6) samples are to be taken, it is suggested that at least one (1) duplicate sample be taken in close proximity to one other to verify the precision (repeatability) of the sampling.

5. Measure the surface levels of metals in the area from brazing & soldering operations using IH75190.

6. Reporting results: Report personal sample results in accordance with IH60500. The assessment of results of airborne & surface wipe sampling should be conveyed to the requestor of the sampling, that organization's ESH Coordinator and the management of the building's occupants in the form of a written analysis documenting:
   - Sampling and analysis methods,
   - Contamination levels measured,
   - Impact of the levels on regulatory compliance and occupant safety including a comparison to Occupational Exposure limits (ACGIH TLV and OSHA PEL), and
   - Recommendations on corrective actions (if corrective action is necessary).

Short Guide to Soldering/Brazing Evaluations

Note: This can be used as an Attachment to the Airborne Sampling form.

Solder metal (Manufacturer Brand & name; determine the lead and other metal content)
Flux (Manufacturer Brand & name; determine if acid or rosin based)
Soldering tool (Manufacturer Brand and Model number of iron or torch)
Engineering controls being used- local capture system (Brand and model), dilution ventilation, fans, etc.
Administrative controls being used
Personal protective equipment ☐ safety glasses ☐ goggles ☐ face shield ☐ lab coat ☐ uniform ☐ long sleeves shirt ☐ gloves type: ☐ respirator ☐ other:
Review the Work Planning documentation for inclusion of appropriate controls. ☐ Adequate ☐ Not Applicable ☐ Not Addressed
Housekeeping and cleanliness of the area; observe the safety of combustible and flammable materials in the area.
Airborne Levels of Rosin/Acid Flux thermal decomposition products. At a minimum, Aldehydes Screening and Terpenes. Account for the full 8-hour shift with monitoring or a work history.
Airborne Levels of Metal Fumes in the area from brazing operations. Account for the full 8-hour shift with monitoring or a work history. Sample locations:
- Breathing zone
- Close to the point of soldering/brazing
- Areas where other workers predominately spend time or access
- Areas where contamination is not expected (control)
- Areas where contamination not permissible (lunch rooms & offices)
Surface Levels of Metals in the area

Attachment 9.4

Indicating Tube Sampling Procedure

Kwik-Draw Pump: A manually operated bellows pump of 100-cc capacity sold by MSA, Inc. Components of the *Kwik-Draw* pumps include:

- Tube holder: Rubber mounting for attaching detector tubes or remote sampling lines.
- Filter Disc: Porous plastic disc, mounted in the rubber tube holder to protect the pump from dirt and dust particles which may alter the flow or damage the pump.
- Exhaust Valve: Valve located under the valve cover that closes as the bellows re-inflates, and opens on the exhaust stroke so that blowback through the tube holder is negligible.
- Stroke Counter: Indicator of stroke count incorporated into the pump handle.
- End-of-stroke indicator: Eyeball type indicator that turns high visibility yellow. As the bellows begins to re-inflate. When the vacuum decreases, the eye rolls back to black.

Precautions

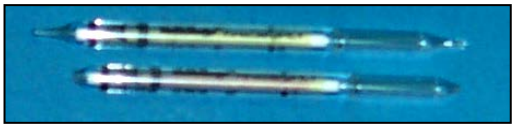
- Do not perform any test with a previously used Detector tube.
- Do not perform any test with a Detector tube with an unknown or expired manufacturer's expiration date.
- Verify that an interfering compound, listed in the tube instruction sheets or MSA publications, is not present.

Routine Maintenance (to be performed by the SHSD IH Group Technician or other competent equipment owner)

1. If shaft becomes dirty or if bellows inflation is jerky, remove the shaft by unscrewing; then clean with wax or oil.
2. Periodically check the performance of the pump.
   - Plug pump inlet by inserting an unbroken Detector tube into the tube holder.
   - Deflate pump fully, release, and wait 10 minutes. The pump is leak free if the distance from the bellows to the frame is ½" or greater after 10 minutes. If the pump leaks, check the tube holder and, if necessary, the replace valves.
3. Check operation of the valves (when operating performance decreases or fails)
   - With valve cover removed, check the valves for dirt or debris.
   - Remove dirt with a gentle puff of air or by using a soft brush.
   - Replace valve if necessary.
4. Periodically remove filter disc (when operating performance decreases or fails)
   - 4.1 Remove the filter disc from the tube holder by rolling flange part of tube holder down and away from the disc.
   - 4.2 Gently tap or blow on the surface to remove any foreign matter.
   - 4.3 Replace Disc so previously exposed surface is once again facing away from pump.

Test Protocol

5. Re-Zero stroke counter on pump, by pressing the indicator advance button until "0" is displayed.
6. Using the breaker on the pump, break off both tips of the detector tube.
7. Using a twisting motion, insert the tube into the rubber tube holder. The arrow on the tube must point toward the pump.



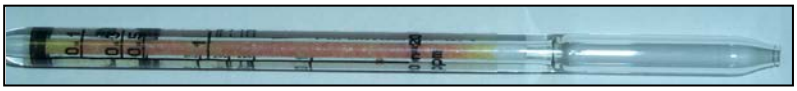
8. Check the number of strokes needed to complete test. (number of strokes can be found on the instruction in the box of tubes and on the tube itself; labeled as n= (number of strokes)
9. With all four fingers on the handle, depress the knob with your palm until stroke counter changes number.
10. Release knob.
11. As pump re-inflates, the end-of-stroke indicator turns to high visibility yellow. During this time the indicator must be held in the sampling area. When the pump has consumed 100cc of the sample the *end-of-stroke indicator* will return to its black color.

12. Continue making complete strokes of the pump until the n= (number of strokes) have been done. Be sure to allow the pump *end-of-stroke indicator* to return to black before each subsequent stroke.
13. At the end of n= (number of strokes), determine the air concentration by reading the appropriate scale value on the tube. The reading should at the front of the band of color change.

***MSA Samplair* pump**

Test Protocol

1. Using the breaker on the pump, break off both tips of the detector tube.
2. Using a twisting motion, insert the tube into the rubber tube holder. The arrow on the tube must point toward the pump.
3. Check the number of strokes needed to complete test. (number of strokes can be found on the instructions in the tube box and on the tube itself; labeled as n= (number of strokes)
4. Grasp the handle and pull back until "100" is visible on the plunger. Align the handle notches and the line on the syringe barrel.
5. Release the handle, it should remain at "100".
6. Wait 45 - 60 seconds between strokes to allow vacuum to completely pull the full volume of air into tube.
7. Continue making complete strokes of the pump until the n= (number of strokes) have been done. Be sure to allow the pump *end-of-stroke indicator* to return to black before each subsequent stroke.
8. At the end of n= (number of strokes), determine the air concentration by reading the appropriate scale value on the tube. The reading should be made at the front edge of the band of color change.



Waste Disposal:

- After a Detector tube has been used or identified age expired, return the tube to the original manufacturer's package (tube box.).
- When all tubes in the package have been used or the whole package expired, dispose of the package with its tubes via the Waste Management Division. Determination of the hazardous waste category can be determined based on the chemical reactants used on the tubes. The contents of the tube can be found on the instruction sheet enclosed with the tube package.

SHSD Environmental Evaluation of Air Sampling With Indicator Tubes

Operation Description: *Glass Indicator tubes* are taken into the field to measure ambient air concentrations of certain contaminants. The tubes contain small quantities of reactive chemicals (ppm to low % range) on a support media. Content of the chemicals on the tube is known via the manufacturer's published handbook.

Frequency of Operation: (Calibration) 0-1 times per year.

Environmental impact:

At end of the test, the used tubes are returned to the IH lab and held for disposal as hazardous waste. Out of date tubes are handled the same. The content of chemicals in the tubes, listed in the manufacturer's published handbook or MSDS, is recorded on the ESWMD Hazardous Waste form.

Waste Disposal:

- Used tubes are returned to the IH lab for disposal as hazardous waste.
- Out of date tubes are handled the same.

Attachment 9.5
Sample of the Air Sampling Survey Form

Brookhaven National Laboratory
Safety & Health Services Division - Industrial Hygiene Group

AIR SAMPLING SURVEY FORM
IH75100 Attachment 9.5 Rev: 07/08/14 page 1 of 1

Chain of Custody #	IH Service Request#	Sampler's Name:	Sample Date:
☐ EM- ☐			

Sample#: - - -	Contaminant(s):
----- Area Date (MM DD YY) Contaminant Sample Number -----	

Source / Area Sample Information

Dept:	Bldg:	Room:
Location Description:		
Hazard Source Description:		
Engineering Controls:		

Employee Sample Information ☐ Not Applicable

First Name:	Last Name:	BNL #:
Dept:	Bldg:	Title:
Exposure Duration (Hrs):	Exposure (Days Per Yr):	
Job Performed:		

Exposure Represents:
☐ Sampling is representative of worker exposure
☐ Sampling is Not representative of worker exposure
ed Shift had similar exposure to contaminant
ed Shift had No exposure to contaminant

Additional Workers Represented By Sampling: All with Same Job Title: ☐ Yes ☐ No	Additional Workers Represented By Sampling:		
	Name:	Name:	Name:
	BNL#:	BNL#:	BNL#:

Exposure Represents:
☐ Typical Work Activities
☐ Typical Area Conditions
☐ Unusual Event/Special Circumstances
Describe:

Respirator:	PPE Glove:	PPE Body:
☐ None ☐ Not Applicable ☐ _____	☐ None ☐ Not Applicable ☐ _____	☐ None ☐ Not Applicable ☐ _____

Sampling Information

Time On	Time Off

☐ **Personal Sample:** Worn On Workers Lapel (Breathing Zone)
☐ **Fixed Breathing Zone:** Fixed Location Near Workers Nose/Mouth

Area Sample (Select Choice Below)
☐ **Source:** Located At The Source
☐ **Background:** Located In Area Without Exposure To Source
☐ **Other** (Describe):

☐ **Blank:** Air Not Drawn Through Media/ Not Opened In Field
☐ **Blank:** Air Not Drawn Through Media/ Opened In Field
☐ **Blank:** Air Drawn Through Media In In Lab/ Not Opened In Field
☐ **Blank:** Air Drawn Through Media In In Lab/ Opened In Field

Cassette Sampling:
☐ N/A
☐ Open Face
☐ Closed Face

Type of Sampler
☐ I.O.M.
☐ Cyclone
☐ Other:

Temperature during Sampling (°C):

Pump Calibration & Media Preparation Information

Instrument (Pump):	Model:		Serial#:	
Media:	Mfgr/Part#:		Lot#:	
Calibration Method: X Bios Dc-1 Calibrator ___Soap Film Burette	Pre-Cal Date:	By:	Post Cal Date:	By:
	Flow (L/Min):	Calib Temp: (°C)	Flow (L/Min):	Calib Temp: (°C)
Total Time (Min):	Avg. Flow (L/Min):		Total Volume (L):	

Chain of Custody (SHSD field sampling portion of C of C documentation)

	Date	Time	Name Print	Signature
Released to SHSD Lab: ☐ Lock box ☐ Delivered In Person				
Received by SHSD Lab:				

Sample
See IH SOP web page for current version

BROOKHAVEN NATIONAL LABORATORY

Industrial Hygiene Group

IH75100 Attachment 9.6

HP-IHP-75100

Chemical Sampling Procedure

Job Performance Measure (JPM) Qualification Certificate

Candidate's Name	BNL#

Topic	Criteria	Unsat.	Recov.	Satisf.
1. Personal Protective Equipment	*Sampler* understands the need to be aware of the potential surface contamination and airborne levels of contaminants and knows how to determine the need for PPE and how to obtain the correct PPE for the hazard.			
2. Pre-Testing Inspection	Demonstrates knowledge to verify that the system to be monitored is operational and represents typical operation. Knows to makes notation in sampling record if the operating conditions are atypical.			
3. Sampling Equipment	*Sampler* can show where equipment needed for the procedure is located and how to properly sign it out.			
4. Sampling Protocol	*Sampler* understands the exposure monitoring logic necessary to appropriately select sampling locations to accurately measure worker, public and environmental exposure potential.			
5. Media/Filter Integrated Sampling	Knows the scope and limitations of the sampling procedure and describes the steps in the procedure adequately			
6. Direct Meter Sampling	Knows the scope and limitations of the sampling procedure and describes the steps in the procedure adequately			
7. Solder/Welding Analysis	Knows the scope and limitations of the sampling procedure and describes the steps in the procedure adequately			
8. Indicating Tubes	Knows the scope and limitations of the sampling procedure and describes the steps in the procedure adequately			
9. Record forms	*Sampler* can show where field sampling forms are located and how to correctly and completely fill them out.			

I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: