FAQ- What does "employee exposure monitoring" mean?

What is meant by an "employee exposure measurement"?

The goal of the employee exposure sampling is to provide an accurate measurement of employee's contact with hazards during the work shift. Sampling is done using an approved method to collect samples of physical hazards (e.g. noise, heat stress) or chemicals (e.g. vapor, fumes, mists or particulates). Sampling and analysis methods must be followed which is designed for the particular hazard to be sampled. The NIOSH's Manual of Analytical Methods or OSHA Salt Lake City lab method should be used unless another equivalent method is approved by the BNL Industrial Hygiene Group. In most cases, the collect sample is sent to an off-site laboratory for analysis. Some techniques use meters that measure the hazard in real-time. See NIOSH Manual at: http://www.cdc.gov/niosh/docs/2003-154/

Employee exposure measurements for airborne chemical contaminants are primarily conducted with a calibrated air pump connected to a sorbent tube/impinger/or filter that adsorbs the chemical. They form what is known as the "sampling train" (See image on right)

When available, a passive dosimeters can be used. (See image on left.) The dosimeter does not need a pump. See Attachment 2 for the list of chemicals for which passive dosimeters are available.

An exposure assessment is valid when it measures the exposure at the point of entry of the hazard into the worker. With both pump and dosimeter sampling techniques, the collection device (i.e pump/collect or dosimet) is worn on the worker being sampled. The measurements are called "personal samples" because they measure the actual concentration that the worker is exposed to as they move through the work area. For chemicals, the sampler is worn on the lapel so it is close to the nose and mouth, the primary points of entry. (See image on right) For noise, the microphone is worn on the top of the shoulder to be close to the ear.

Employee exposure samples are also known as "integrated samples" because the measurement determines the average concentration over the time of sampling (i.e. they measure a time weighted average, a.k.a. TWA). The typical sampling time is the full shift (8 hours), known as the TWA-8. But some occupational exposure limits are for shorter periods (STEL and Ceiling). In these instances, the sample time is short, usually 15 to 30 minutes.

Integrated sampling is done for some physical hazards (such as noise or heat stress) using a meter that records measurements of the hazard. These meters are known as dosimeters. Dosimeters store measurements and calculate the average concentration over the time of sampling (TWA). The typical sampling time is the full shift (8-10 hours).

Other techniques can occasionally be used to quantify airborne chemical levels (e.g. detector tubes or direct reading meters). Methods that measure an area sample are best used as a screening tool to determine the need for personal samples. For employee exposure measurements, area surveys are allowed only in limited circumstances when a "personal

samples/integrated sampling" technique is not approved. The plan to use of an area survey to prove compliance with occupational exposure limits must be submitted to the BNL SHSD Technical Services Industrial Hygiene Support Group.

What do you compare an employee sample's measurement against to prove compliance?

Once sampling is completed and the results obtained, employee exposure measurements are compared to DOE, OSHA and ACGIH occupational exposure limit (OEL) to determine compliance or the need for additional controls. Because DOE regulations are applicable at BNL, the list of OELs is broader and includes more standards than what is enforced by OSHA at non-DOE work sites. See the document: BNL Expectations for Industrial Hygiene Monitoring of Construction, Renovation and Demolition Projects by Contractors/Sub-contractors for a full description of the occupational exposure limits (OELs) that are enforced at BNL.

Who can do an employee exposure measurement?

Industrial Hygiene Professional: An *Industrial Hygiene Professional* is the appropriate person to lead the collection of exposure monitoring samples. Persons with American Board of Industrial Hygiene (ABIH) certification in Comprehensive Practice (i.e. C.I.H.) are qualified to conduct sampling themselves or to lead a sampling team. Persons without the C.I.H. certification can only be approved to be the *Industrial Hygiene Professional* if they have extensive experience and education. Name, work history and education credentials of *Industrial Hygiene Professionals* without C.I.H. certification must be submitted to the SHSD Technical Services Industrial Hygiene Support Group prior to commencement of sampling.

The *Industrial Hygiene Professional* conducts or supervises the industrial hygiene exposure assessments and personal exposure monitoring. The *IH Professional* is responsible to:

- Ensure appropriate sampling methods and parameters are used.
- Ensure all job classes are represented in the sampling plan.
- Interpret, report, and document personal exposure monitoring in accordance with accepted professional standards and practices.
- Ensure a quality report is prepared and provided in a timely manner to all appropriate parties. The report must document the exposure, evaluate the relevance to exposure standards, and recommend protective and corrective action if appropriate.
- Ensure that the appropriate exposure sampling data is transmitted to BNL.

See the document BNL Expectations for Industrial Hygiene Monitoring of Construction, Renovation and Demolition Projects by Contractors/Sub-contractors for a full description of expectations of the sampling process.

***Industrial Hygiene Technician*:** Persons with American Board of Industrial Hygiene/Board of Certified Safety Professional's certification as an Occupational Safety & Health Technologist (OSHT) or NIOSH 582 sampling course certification or an OSHT certificate program are accepted as qualified to conduct sampling under an *Industrial Hygiene Professional*. Persons without OSHT or NIOSH 582 certification can only be approved to be the *Industrial Hygiene Technician* if they have extensive experience and education. Name, work history and education credentials of persons without the OSHT or NIOSH 582 certification must be submitted to the SHSD Technical Services Industrial Hygiene Support Group prior to commencement of sampling.

The *Industrial Hygiene Technician* is responsible for collecting personal exposure monitoring samples under the guidance of the *IH Professional.* The *Industrial Hygiene Technician* is responsible to meet all

monitoring requirements (e.g. Chain of custody, equipment operation, sample technique, recordkeeping, etc.).

IH Consultants

If persons with the appropriate Industrial Hygiene certifications are not available within your organization, consulting firms can be sub-contracted to conduct employee exposure assessment and monitoring. Appropriate firms are listed by the American Industrial Hygiene Association:

- AIHA Consultant online registry at: http://www.aiha.org/about-ih/Pages/Find-an-Industrial-Hygienist.aspx
- AIHA Consultant printed list: http://www.flipdocs.com/showbook.aspx?ID=10005138_287416.

Typical fees for industrial hygiene monitoring by a consulting firm are:

Activity	Hourly cost	Typical Project Cost
Field sampling by IH technician working under a IH Professional	$50 - 100/hr x 8 hours	$400-800/day
Cost of laboratory analysis	Lab fees range for $10 to $100+ per sample (minimum of 3 samples required)*	$ 30-300 minimum*
Analysis of results and preparation of Assessment Report by a IH Professional	$150 to 200/hr x 4 hours	$600-800

* Minimum of 3 samples is required for statistical validity. Many more samples may be needed on long projects or for operations with more than one hazard. Sample cost depends on the contaminant to be analyzed.

Typical Sampling Process:

1. Develop a sampling plan to ensure representative samples are taken of all worker activities and job classifications with the potential of exposure to the hazard(s). The plan should specify how many samples per day, how many days to sample, and which workers will be sampled.
2. Collect sampling data using a published procedure, appropriate for the operation and hazard to be sampled.
   a. Consult the NIOSH's Manual of Analytical Methods (http://www.cdc.gov/niosh/docs/2003-154/).
   b. Use of non-NIOSH method requires the approval of SHSD Technical Services Industrial Hygiene Support.
   c. If Direct Reading Meter or Indicator Tubes are to be used, submit the sampling plan to SHSD Technical Services Industrial Hygiene Support for approval prior to commencement of sampling.
3. Record field data on an appropriate form. A sample of an acceptable form is available from OSHA https://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_1_text_version.html.
4. Write a hazard evaluation report that evaluates the survey data and summarizes the potential for occupational exposure and compliance with current OSHA PELs and 2016 ACGIH Threshold Limit Values®.
5. Notify workers of sampling results.
6. Provide a copy of the sampling records, laboratory analysis, and hazard evaluation report is sent to the BNL Point of Contact.

Attachment1
Integrated Sampling Procedure

1. **Selection of Media and sampling device:** Contact an *IH professional* for assistance in selecting the appropriate media, sampling equipment, sampling parameters (flow rate), precautions or special handling needs, and post sampling storage requirements.

2. **Preparation & Handling of Sampling Equipment**
   a. **Pre-calibration:** Pre-calibrate the sampling train using the field media or a representative media sample in line prior to field sampling.
   b. **Post-calibration:** Post-calibrate the sampling train using the field media or a representative media sample in line after field sampling.

3. **Sampling Technique Principles:**
   a. Conduct OEL compliance sampling for employee exposure monitoring with a portable sampler's 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, remove the pumps and shut off. Place the sampling train 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 same watch (or synchronized) for the entire sampling period.

   d. Area samples can be taken to supplement the personal samples information. Professional judgment is needed in determining area sampling needs based 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 & sensitivity of the analytical method and the time of sampling. It is useful to take area 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:** 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:** Use a chain of custody when processing samples for field use and shipment to the analytical laboratory.

6. **Laboratory Analysis:** Have samples analyzed by an AIHA IHPAT certified laboratory for quantitative analysis by the analytical technique described in a NIOSH or OSHA method.

Attachment 2

Sample of Passive Vapor Badges Chemical Compound List (3M®)

3M 3500 and 3520 sampling device		
Acetone (2) (c)	Cyclohexanol (8)	Mesitylene (8)
Acetonitrile (2) (c)	Cyclohexanone (8)	Mesityl Oxide (8)
Acrylonitrile (8)	Cyclohexene (8)	Methoxy Perfluorobutane (HFE-7100) (8)
Allyl Alcohol (8)	n-Decane	Methyl Acrylate (Methyl t-Butyl Ether (MTBE) (8)
Amyl Acetate (8)	Diacetone Alcohol (8)	Methyl Butyl Ketone (MBK) (8)
n-Amyl Alcohol	o-Dichlorobenzene (8)	Methyl Cellosolve (8)
s-Amyl Alcohol	p-Dichlorobenzene (8)	Methyl Cellosolve Acetate (8)
Benzene (8)	trans-1,2-Dichloroethylene (6)	Methylene Chloride (m) (3530 only)
Benzyl Chloride (8)	Diisobutyl Ketone (DIBK) (8)	Methyl Ethyl Ketone (MEK) (8)
Bromoform (8)	p-Dioxane (8)	Methyl Isobutyl Ketone (MIBK) (8)
1-Bromopropane (m)	Dipropylene Glycol Methyl	Methyl Methacrylate (8)
n-Butyl Acetate (8)	Ether Acetate	Methyl Propyl Ketone (8)
s-Butyl Acetate (8)	Enflurane (8)	Naptha (VM&P) (8)
t-Butyl Acetate (8)	Epichlorohydrin (8)	n-Octane (8)
Butyl Acrylate (8)	Ethoxy Perfluorobutane	Perchloroethylene (8)
n-Butyl Alcohol (8)	Ethyl Acetate (6)	Phenyl Ether (8)
s-Butyl Alcohol (8)	Ethyl Acrylate (8)	n-Propyl Acetate (8)
t-Butyl Alcohol (8)	Ethyl Benzene (8)	n-Propyl Alcohol (6)
Butyl Cellosolve Acetate	Ethylene Chlorohydrin (8)	Propylene Dichloride (8)
Butyl Cellosolve (8)	Ethylene Dichloride (EDC) (8)	Propylene Glycol Mono Methyl Ether (8)
Butyl Glycidyl Ether (8)	Ethyl Ether (4) (c)	Propylene Glycol Mono Methyl Ether Acetate
p-tert Butyl Toluene (8)	Furfural (8)	Stoddard Solvent (8)
Camphor (8)	Halothane (8)	Styrene (8)
Carbon Tetrachloride (8)	n-Heptane (8)	1,1,2,2-Tetrachloroethane (8)
Cellosolve (8)	n-Hexane (8)	Tetrahydrofuran (8)
Cellosolve Acetate (8)	iso-Amyl Acetate (8)	Toluene (8)
Chlorobenzene (8)	iso-Butyl Alcohol (8)	1,1,1-Trichloroethane (Methyl Chloroform) (m)
Chloroform (8)	Isoflurane (Forane)	Trichloroethylene (8)
o-Chlorostyrene (8)	Isopar G	1,1,2-Trichloro-1,2,2-trifluoroethane (1) (c)
o-Chlorotoluene (8)	Isophorone (8)	Vinyl Acetate (8)
Cumene (8)	Isopropyl Acetate (7)	Vinyl Toluene (8)
Cyclohexane (6)	Isopropyl Alcohol (m) (c)	Xylene (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.		
(m) See technical bulletin.		
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).