TGG: JCL: ERP: MJH: AJO: RF

TO: Distribution

XF: None

FROM: T. G. Grumbles
DATE: November 29, 1989

Interoffice Communication

SUBJ: ADDITIONAL TRAINING MANUAL INFORMATION

VISTA

George Cveganovich has provided additional information on recordkeeping, statistical calculations and CV's for analytical methods, and references. The attached should be added to your manual that was received at the IH meeting.

T. G. Grumbles

dlj

Attachment

Distribution

K. Fogg, B. White, R. Martin, D. Jackson, H. Pierce, J. Harris, M. Tonkovich, B. Kruszynski, R. Gantz, G. Shirley, B. Jones, B. Trego

TGC: JCL: ERT: MJH: AJO: RF

XR:

RECORDKEEPING

Chapter XIV

RECORDKEEPING

The recording of data obtained in any activity necessitates the development of necessary forms and their orderly completion in a neat and efficient manner if the data is to serve the purposes for which it is obtained. The Federal Occupational Safety and Health Act (OSH-Act), and the various standards promulgated thereunder, requires the collection and recording of considerable data on the exposures of employees to toxic materials and hazardous physical conditions for review by the OSHA compliance officers and the employees so exposed. The neatness and thoroughness with which such records are maintained not only reflects upon the quality of the industrial hygiene or environmental health program, but allows plant personnel to readily review the test data and establish conclusions relative to compliance with OSHA standards. The maintenance of these records is specifically provided for under the OSH-Act in Sections 8 (c) and 20 (a) (5). However, in developing a recordkeeping program, it is desirable to go beyond the mere statutory requirements and to anticipate future needs which may be for plant use or for possible proposed standards in the future. Therefore, the necessity for maintaining thorough accurate records on the work environment should be quite clear to all plant personnel responsible for environmental health tests.

Records to be of value must be accurate, complete, appropriate, and at the same time as concise as possible. There are many reasons for keeping records applicable to industrial hygiene or environmental health activities. The most important reason is to periodically document an employee's (or group of employees) exposure to known atmospheric contaminants or physical conditions. Such records do not only determine whether or not an exposure of an employee is in conjunction with OSHA standards but can provide data and the potential influence, if any, of his working environment upon him during his total employment period. From the Corporation's viewpoint, environmental health records can also be beneficial in grievances, arbitrations and compensation cases. All of these aspects point up the great need for concise and accurate records.

Good records require, among other factors, good measurements. The need for accurate samples, when monitoring the worker's environment, has been emphasized in previous chapters. Unless this is done, the data derived from the sample has little value. Accurate sampling involves more than good instrumentation. It necessitates recording data on the operations under scrutiny, whether or not the conditions observed are representative, the operating rate of the instrumentation, the location and duration of the sample and other information. In other words, it is just as important to record all the data pertinent to a sample as it is to collect the sample. Good instrumentation is only one phase of collecting good environmental data.

Environmental Health Inventory

Before an industrial hygiene (environmental health) sampling program can be effectively undertaken, knowledge must be developed on where potentially toxic materials and harmful physical conditions are or may be present. This requires a walk-thru type of survey by an industrial hygienist or one adequately trained in associating work conditions and materials with potential health hazards, to determine for each job classification (1) a brief job description; (2) the materials used, by-products and products formed and equipment used; and (3) measures afforded for health protection. An appropriate form on which to record this data is shown in Figure 14-1. In completing this form, it is vital to be brief in recording the pertinent information. Excessive wordage should be avoided. The most important information in this form is recorded in Columns (3) and (4) which relate to the materials used and control measures. The potential health hazards will be derived from Column (3). The control measures which are to be recorded in Column (4) are indicated by merely checking the appropriate space and noting in the spaces afforded other pertinent information relative to the control measures. For example, if respirators are provided, it would be pertinent to note the manufacturer and type, such as "MSA Dustfoe-66."

Upon completion of Figure 14-1 for any division, department or room, the last column is completed by indicating the exposures in each job category utilizing a code consisting of the material abbreviations and materials shown in Figure 14-2. This should be done by a professional industrial hygienist at the start of the program. Therefore, Environmental

INDUSTRIAL HYGIENE SURVEY

WORKROOM DATA

Facility: _____ Page _____ of _____

Division: _____ Department: _____ Building: _____

Data Source: _____ Surveyed by: _____ Date: _____

OCCUPATION (1)	NATURE OF JOB (2)	RAW MATERIALS AND BY-PRODUCTS (3)	CONTROL MEASURES (4)							REMARKS (5)	ENVIRON. CODE
			LOCAL EXH.	MECHANICAL VENTILATION	WET METHODS	PROTECTIVE EQUIPMENT	RESPIRATOR				

EXPOSURES, CLASSIFIED BY OCCUPATION AND TYPE

Facility:_____ Division:_____ Dept.:_____ Date:_____

DEPT.	OCCUPATION	DUSTS – FUMES							GASES – VAPORS – MISTS									PHYSICAL CONDITIONS						
		SiO_2	Mn	Lime		Lead	CR_2O_3		HCN	NO	Cl	BTX	Chromates	Pitch	H_2SO_4			IR	Noise	Heat				
		FeO	Coke	Ore		Fluor	NiO		NH3	H2S	SO2	HCL	CO	Tar	Alk.			UV	Vib.					

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Health — Pittsburgh should be contacted when the form is completed. Figure 14-2 is a form for summarizing the exposures by department, occupation and type. From this form one can readily review the location of the exposures to air contaminants and physical conditions. The presence of these exposures is denoted by merely an "x" mark in the appropriate box. After thoroughly reviewing the data recorded on these forms, one can establish the sampling or testing program.

Sampling Data

It has been previously stated that the adequacy and accuracy of the sampling data largely determine the validity of the evaluation derived from the test results. Therefore, such data should be as complete as possible and obtained during sampling. The data collected in the field during testing should be recorded for each test on an appropriate form such as the one shown in Figure 14-3 or logged in a field notebook. Certain basic information is required in all sample data or measurements of physical conditions, and in addition, notes should be made regarding special situations which may influence the sample or the interpretation of the analytical results. The data recorded, as a minimum, should include (1) where the sample was taken, (2) when it was taken, and (3) the volume of air that was sampled, (4) the name of the sampling instrument, (5) the type of sample (breathing zone or fixed position), and (6) the operating conditions. Sample location should be specified first by noting the plant name and geographical location; next, the department, and finally the specific location in that department. Most samples will be collected by a worker wearing a personal sampling device. In such cases, the employee's name and/or identification number, as well as his occupation should be recorded. For area samples, it is possible to describe the sampling location by reference to numbers on the building columns or other designations used within a given plant. The records should be sufficiently detailed that another individual would be able to locate the sampling area without the assistance of the person recording the data. When there are a number of singular work stations, machines or jobs in a given department and only one is sampled, then reference should be made to that one location.

The date on which the sample was taken must be recorded, as well as the time the sampling period began and the time sampling ended. If for some reasons sampling is performed discontinuously the individual times at which the sampling started and stopped should be noted. Finally the total number of hours and/or minutes during which the sample was taken should be recorded. Summarizing the following information regarding the sample itself should be recorded: (1) the type and manufacturer of the sampling device, such as MSA Monitaire Model S, MSA Universal Tester, General Radio Model 1565-B sound level meter, etc.; (2) the number or identification of a filter, indicator tube or other collection device; (3) the type of contaminant, i.e., fume, respirable dust, gas, etc.; (4) the type of sample, i.e. breathing zone or fixed position; and (5) the sampling rate at the start and at each check period during the shift.

Finally, a brief description of the work operation being sampled, making special reference to any features of the job which relate directly to the production of air contaminants for which sampling was being performed. This description should include reference to local exhaust or mechanical general ventilation or its absence. For example, are there windows and if so, are they opened or closed? Is there an overhead ventilator or a roof monitor? Are there roof exhaust fans? Is the point of contaminant generation enclosed and provided with exhaust ventilation and does the system appear to be effective? Under remarks, it will usually be useful to make some notation about the presence or absence of visible dustiness in the air, of an odor or irritation to the eyes, nose or throat. Figure 14-3 is an example of a useful form. Others may be developed for each plant's use but it would be desirable to standardize.

Analytical Records

Air samples require analysis of the collected material and/or weighing. These should be placed in an appropriate container together with the form requesting analysis and mailed to ARL-Environmental Health Laboratory, Monroeville. The form requesting laboratory analysis (Figure 14-4) should be completed in full. To insure accurate records, it is imperative that the sample number, location or

FIELD SAMPLING DATA

Division: _____ Bldg.: _____ Date: _____

Sampling Instrument: _____ Sampling Rate: _____

Contaminants: - Principal: _____ Other: _____

Processes in Area: _____

Type of Contaminant Control: _____

SAMPLE NO.	TYPE OF SAMPLE		FILTER WEIGHT		TIME OF SAMPLING	DURATION OF SAMPLE	SAMPLE VOLUME	OPERATING CONDITIONS
	BZ	Fixed	Tare	Final				

Sampled By: _____

ENVIRONMENTAL HEALTH

SAMPLES FOR ANALYSIS

Date Submitted_____

Facility:_____ By_____ Ext._____

Location:_____ Date Reported_____ Lab.#_____

Dept.:_____ OSHA Insp._____ Complaint_____ By_____

SAMPLE DATA									ANALYTICAL RESULTS					
NO. (1)	DIVISION DEPARTMENT (2)	JOB, OPERATION or LOCATION (3)	DATE (4)	TIME MIN. (5)	RATE LPM (6)	FINAL WEIGHT (7)	INITIAL WEIGHT (8)	ANALYSIS DESIRED (9)						

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operation involved, date, flow rate, sampling time, initial filter weight and the analysis required be indicated. All of this information is necessary to insure complete and accurate records regarding potential exposure to toxic materials.

Many gas and vapor samplers and instruments which measure physical agents are direct reading devices. In the use of these instruments it is necessary to gather most of the previous data and in addition, record the reading. As indicated earlier, when using a direct reading instrument, such as a combustible gas analyzer or a sound level meter, the needle or indicating device generally fluctuates constantly. In general, the intent is to record the average reading along with the range (maximum and minimum).

In addition to records of samples taken as just described, it is important to keep good records concerning the case and maintenance of sampling equipment. Every instrument ought to have a log sheet (a sample was shown in Chapter X, Figure 10-2) on which is recorded the date that instrument was acquired and dates on which calibrations, battery charges or maintenance were performed. A separate sheet should be maintained for the purpose of recording the actual calibration data when it is obtained. Reference should always be made to this sheet when sampling so that suitable corrections for sampling rate or interpretation of instrument readings can be made. Frequently it is desirable to construct a small calibration chart or curve and attach it to the instrument for convenience, but the primary reference should be in the log book.

Exposure Record (Permanent)

The previously noted forms are employed to obtain data from which the exposures of workers, to toxic material and harmful physical conditions, may be determined. Accordingly, it is necessary to compile exposures on an appropriate form. The one used by Headquarters Environmental Health is shown in Figure 14-5. Only the data on this form needs to be revealed to an OSHA or NIOSH representative or to the employee. An exposed employee is entitled to be informed only on the extent of his exposure and not on that of other employees.

Figure 14-5 is used to record only time-weighted average concentrations (TWAC), derived from breathing zone samples, or mean average concentrations of air in plant areas. The former represent exposure while the latter represent data from which exposure may be calculated. This information must be derived from a 4-hour sample, as a minimum, and preferably over the full 8-hour shift. The duration of the sample must be determined from knowledge of the variability of the contaminant concentration over a full-shift and the mobility of the employee. The exposure information is recorded by department and job involved.

ENVIRONMENTAL HEALTH
INDUSTRIAL HYGIENE SURVEY REPORT

Plant_____
Dates of Survey_____
Project No._____
Survey Eng._____

TEST LOCATION		JOB EXPOSURE – FULL SHIFT (mg/m^3)												AREA CONCENTRATION – (mg/m^3)									
		DUST		FUME										DUST		FUME							
Dept.	Job	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$	No.	$\bar{X}$

Federal Stds.:

Notes:
No._____ Number of Tests
X_____ Mean Avg. Value

Date of Report: _____

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D. AIR SAMPLING DATA (OSHA-91)

1. **Purpose.** The Air Sampling Data form (OSHA-91) provides OSHA's field personnel with a standard medium for recording the data required to support a health violation. It also serves as a Lab submission form for samples requiring analysis at the Salt Lake City Laboratory. By serving as the input document for the Management Information System MIS), it eliminates the Inspection Test/Sample Log (OSHA-35).

2. **Benefits.** The OSHA-91 will consolidate calibration records, sampling data, and analysis into one preformated page with continuation sheets. It will help to ensure that all necessary information for supporting an air violation is recorded and will facilitate case file review. Moreover, by serving as the MIS input document it will provide the National Office with a data base which can be used to develop new standards and respond to queries from field offices and the general public.

3. **Prescribed Use.** The OSHA-91 is mandatory for all sampling data used for citation purposes, and is optional for screening samples. If the form is used for screening, a photocopy shall not be submitted to MIS. If the reading were for screening purposes, indicate this fact clearly so that the clerk responsible for MIS function will know that a copy shall not be made.

4. **Special Instructions.**

a. If more than one sample form is used for a given employee, complete only the identifying data (items 10, 11, 12, 13, 14, and 17) on the additional form(s).

b. Date stamps may be used for all the date entries (items #8, 15, 16, and 54) on this form.

5. **Form.** See Figure XIV-5 for example of OSHA-91.

6. **Instructions.** Complete the OSHA-91 as follows. (See Figure XIV-6.)

Figure XIV-5
INDUSTRIAL HYGIENE FOM

CALIBRATION RECORDS

PRE-SAMPLE CALIBRATION

1. Pump Mfg. & SN	4. Flow Rate Calculations			
2. Voltage Checked? ☐ Yes ☐ No				
3. Location / T & Alt.				
	5. Flow Rate	6. Method ☐ Bubble ☐ PR	7. Initials	8. Date/Time

POST-SAMPLE CALIBRATION

50. Location / T & Alt.	51. Flow Rate Calculations
52. Flow Rate	
53. Initials / 54. Date/Time	

SAMPLE WEIGHT CALCULATIONS

55. Filter No.						
56. Final Weight *(mg)*						
57. Initial Weight *(mg)*						
58. Weight Gained *(mg)*						
59. Blank Adjustment						
60. Net Sample Weight *(mg)*						

61. Calculations:

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INDUSTRIAL HYGIENE FOM

Occupational Safety & Health Admin.
AIR SAMPLING DATA

U.S. Department of Labor

9. Establishment		10. Area 11. Area	Inspection ID 12. OSHO No. 13. Report No.
14. Person Performing Sampling (Signature)	OSHO NO.	15. Sampling Date	16. Shipping Date
17. Employee (Name)		21. Exposure Information a. Number	b. Duration
(address)		c. Frequency	
		22. Weather Conditions	23. Photo Y
(Phone)	18. Job Title	JIT Code	
19. PPE (Type and Effectiveness)		PPE Code	24. Pump Checks & Adjustments
		Eng. Code	

25. Job Description, Operation, Work Location(s), Ventilation and Controls

Cont'd.

Pump No. SAMPLING DATA

26. Sample Type/Media						
27. Filter/Tube No.						
28. Sample Submission No.						
29. Time On						
30. Time Off						
31. Total Time (in Min)						
32. Flow Rate ☐ l/Min ☐ cc/Min						
33. Volume (in Liters)						
34. Net Sample Weight (in mg)						
35. Lab Sample No. →						
36. Substance ↓ & Results →						
a.						
b.						
c.						
d.						

37. Interferences and IH Comments to Lab

38. Supporting Samples
a. Blanks:
b. Bulks:
c. Other:

39. Analyst's Comments

† CITATION DATA * W=wipe B=bulk A=area † Units: P=PPM M=mg/m³ F=Fibers/cc

42. Substance Codes	43.*	44. TWA/C	45. †	46. PEL	47. SEV.	48. Citation ID Type No. Item No.
a.						
b.						
c.						
d.						

49. Additives

40. Seals Intact? ☐ YES ☐ NO

41. Chain of Custody:

a. Rec'd Lab	
b. Rec'd by Analyst	
c. Analysis Complete	
d. Calc. Checked	
e. Supr. Ok.	

Case File Page of

Form OSHA - 91 (January 1979)

Figure XIV-6

INSTRUCTIONS FOR COMPLETING OSHA-91

Item

PRE-SAMPLING CALIBRATION (See the back of the OSHA-91)

1. *Pump Mfg. & SN.* Enter the manufacturer and serial number.

2. *Voltage Checked?* Check the appropriate box to indicate whether the battery's voltage was checked.

3. *Location/T&Alt.* If calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include altitude and temperature, when necessary (see the IHFOM, Chapter VIII, G.1.d.).

   If the pumps are calibrated at the same place and time, the address should be noted on the first form used and a slash drawn through the item on subsequent forms.

4. *Flow Rate Calculations.* (OPTIONAL) Use the space provided here to perform the calculations made during the calibration. (The rotometer or other setting may be recorded here rather that in item #5.)

5. *Flow Rate.* Record the flow rate which will be used in the sampling, including the rotometer or other setting.

6. *Method.* Indicate the method used to calibrate the pump by checking "Bubble" for bubble meter or "PR" for precision rotometer.

7. *Initials.* The person performing the pre-sampling calibration must certify that standard procedures have been followed by initialing the form in this space. (Refer to the IHFOM, Chapter VIII, Section G.)

8. *Date/Time.* Record the date and time of the pre-sampling pump calibration.

INSPECTION IDENTIFIERS (See the front of the OSHA-91)

The inspection identifiers Region (#10), Area (#11), CSHO No. (#12), and Report No. (#13) must be recorded on every sampling form submitted to MIS.

9. *Establishment.* (NOT ENTERED IN THE FIELD) Enter the legal name of the establishment. This need only be entered once for the sample forms in a case file. When they are assembled for MIS submission, the name should be entered on the first form of the batch.

   If the CSHO prefers to enter the establishment name on all forms submitted to the laboratory in order to aid in the identification of the appropriate case file when the analysis results are returned, only a

shortened version need be entered on those sheets. Only the first form of each set submitted to MIS need contain the legal name.

10. *Rgn.* Enter the Region code of the Region in which the inspection is being conducted.

11. *Area.* Enter the Area Office code of the area in which the inspection is being conducted.

NOTE: 1. If the samples recorded on a sample form require lab analysis, and the CSHO performing the sampling works out of a District Office or Field Station and wishes to receive the analysis results at that office, enter an appropriate abbreviation for that office's city name above items #10 and 11.

2. If the CSHO performing the sampling has been detailed to the Area Office identified by items 10 and 11 and wishes to receive the analysis results in the home office, enter this request in item #37.

Inspection ID

12. *CSHO No.* Enter the CSHO No. from the OSHA-1.

13. *Report No.* Enter the Report No. from the OSHA-1.

14. *Person Performing Sampling (Signature and CSHO No.).* The CSHO who is performing the sampling must sign the sampling form to verify that the method(s) prescribed by the IHFOM or recommended by the laboratory have been followed. If the CSHO No. of the person performing the sampling is different from the one on the OSHA-1 (i.e., it is a team inspection), enter the CSHO No. of the person actually doing the sampling in the space provided to the right in block 14. If the CSHO Nos. are the same, leave the CSHO No. in item 14 blank.

15. *Sampling Date.* Enter the date on which the sample(s) is collected.

16. *Shipping Date.* (NOT ENTERED DURING SAMPLING.) Record the date on which the sample(s) is transmitted to the laboratory.

NOTE: The certification stub or other receipt should indicate to which samples it corresponds. It should then be attached to one of the appropriate sample forms to eliminate the need to record the receipt number on every form.

EMPLOYEE DATA

17. *Employee:* Name/Address/Phone. Enter the name (First, Last), address (include zip code), and telephone number of the employee being sampled.

18. *Job Title (Code).* Enter the job title (and/or job code, when available) of the employee being sampled.

NOTE: The codes for job classifications are being developed by the Office of Management. Data and Statistical Analysis (OMDS). Until these are issued, record the employee's job title only.

19. *PPE.* Record the type(s) of personal protective equipment (PPE) the employee is using, including the manufacturer's name, the model number, and the type and concentration of the contaminant against which it protects. If no PPE is in use, enter "NONE"

NOTE: Codes for personal protective equipment are being developed by OMDS. Until these codes are available, leave this space blank.

20. *Eng. Code.* = Engineering Control Code.

NOTE: Codes for engineering controls are being developed by OMDS. Until these codes are available, leave this item blank.

21. *Exposure Information.*

a. *Number.* Record an estimation of the number of employees who potentially would be removed from risk if the hazard were corrected. Include employees potentially exposed on all shifts. This number is recognized as a subjective assessment of the scope of the exposure problem.

This number will be recorded only once for each hazard area. Enter the appropriate number on the first OSHA-91 for a particular hazard area and draw a slash through this space on all subsequent OSHA-91s for the same area.

NOTE: It is essential that this number not be repeated on sample forms relating to the same hazard area. Repeated entries will result in multiple counting and will invalidate the MIS data.

b. *Duration.* Record the length of time that the alleged violation has existed. This number indicates how long the hazard(s) has existed, not how long the sampled employee has been exposed to the hazard. It is not necessary to record the duration on al[1] OSHA-91s for an area unless the information is different.

c. *Frequency.* Describe, as concisely as possible, the general frequency of exposure in the sampling area. Convey the complete picture for all overexposed employees, not just that of the sampled employee. This may require several frequency descriptions and the number exposed at each frequency.

Example: 2 for 8 hrs/day
8 for 3 hrs/week

SAMPLING-RELATED INFORMATION

22. *Weather Conditions.* Record, when necessary, temperature, altitude

and other weather conditions existing during the sampling period which may affect the sample data (see IHFOM, Chapter VIII, G.1.d.)

Items

23. *Photo.* If a photo(s) was taken, circle the "Y" then enter the Photo Identification Number (e.g., roll and frame numbers) and the Photo Worksheet (OSHA-89) page number, if applicable. If no photo was taken, draw a slash through the item.

24. *Pump Checks and Adjustments.* Record the time at which each pump flow rate check is made. If the flow rate has changed, record the time and the rotometer setting before adjustment.

OPERATION-RELATED INFORMATION

25. *Job Description, Operation, Work Location(s), Ventilation and Controls.* Record a detailed description of the work environment of the sampled employee.

Identify the operation, equipment associated with the hazard (include identifying numbers), and the work locations. All pertinent information about the work being performed should be covered. Include information such as the employee's activities during non-sampling periods when it might affect the exposure, general observations of work practices and environment, unusual events which the CSHO observes, etc.

Be sure to include observations on the following when they affect exposure or issuance of a citation:

1. Employee comments, recorded verbatim if possible, on the exposure (including how long they have worked at the job and the frequency of their exposure to the hazard) or the employers' health and safety program. Be sure to include notes on symptoms exhibited or mentioned by the employee.

2. Account of employee movements and duties in each area of the plant.

3. Notes on visible dust, fumes, vapors, etc.

4. Source of exposure.

5. Ventilation and other significant air movements affecting contaminant concentrations. Include descriptions and measurements.

6. Reference to other sampling data which supports this exposure situation. For instance, wipe samples which are not referenced on this form.

7. Engineering and/or administrative controls, present and feasible.

8. Employer knowledge of the hazard.

9. Other employer information. If the employer neither created nor

controlled the hazardous condition, state the name of the responsible party and its relationship to the employer.

Begin your description here and continue on the back or on additional pages of the "Note-Taking Sheet" (OSHA-94). Always precede the continuation with the appropriate item number and indicate to which sampling data form it relates (e.g., "Jones-item 21" for the job description of employee Jones who is wearing the pump or "p.4-21" for item 21 on field page number 4.).

When the case file has been organized and the pages numbered, enter the case file page number(s) in the "Cont'd" box to indicate where any continuation page for this job description can be found. This is not necessary if the continuation page directly follows the sample form.

SAMPLING DATA

Items 26-37 are entered in columns, one column for each sample taken including area, bulk, or wipe samples.

Pump No. [OPTIONAL] The pump's serial number may be noted here for reference during sampling.

26. *Sample Type/Media.* Indicate the type of sample collected in the columns above the sample data to which it relates. In general, use the manufacturer's designation of sampling media. Some suggested abbreviations follow.

Sample Media Abbreviations

Silica gel tubes	SGT
Florisil tubes	FT
XAD-2 resin tubes	XAD
Tenax GC tubes	Tenax
Chromosorb 104 tubes	Chrom 104
Chromosorb 106 tubes	Chrom 106
Charcoal tubes	CT
TEA-molecular seive tube	TEA-MS
Glass fiber filter	GFF
Fluoropore filter	FH
Silver membrane/glass fiber	AgM
Millipore AA filter	AA
Millipore HA filter	HA
Gelman GN-4 filter	GN-4
Mine Safety Appliance FWS-B filter	FWS-B

For a solid sorbent, specify what the sorbent was and its lot number, if appropriate.

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For example:

Pump No.		SAMPLING DATA		
26. Sample Type/Media	charcoal			
27. Filter/Tube No.				
28. Sample Submission No.				

For a liquid sorbent, specify what solution was used.

For example:

Pump No.		SAMPLING DATA		
26. Sample Type/Media	water			
27. Filter/Tube No.				
28. Sample Submission No.				

For a filter, note the filter type (e.g., AA, FWS-B, etc.). If the filter is an FWS-B, indicate whether it is "Total" or "Respirable" by the letter "T" or "R", respectively.

For example:

Pump No.		SAMPLING DATA		
26. Sample Type/Media	FWS-B-T			
27. Filter/Tube No.				
28. Sample Submission No.				

The sample type/media need only be entered once for all the samples on a sheet if they are all of the same type. If two types of samples are recorded on one form, it must be clear which samples are of each type. See the examples below.

Pump No.	SAMPLING DATA				
26. Sample Type/Media	AA →		FWS-G-T →		
27. Filter/Tube No.					
28. Sample Submission No.					

When bulk or other samples are collected to support the exposure data (See Chapter IX, Section E, of the IHFOM) and the CSHO desires the semi-quantitative analysis results, the sample data for these samples may be noted in one of the columns on this same form. If the sample is for reference only (i.e., it requires qualitative analysis only or is for use by the laboratory) or its analysis will be reported on another form, enter the reference number in item 39.

NOTE: The CSHO shall indicate if a bulk sample is settled dust sample.

EXAMPLE:

Pump No.	
26. Sample Type/Media	Settled Dust
27. Filter/Tube No.	
28. Sample Submission No.	

38. Supporting Samples

a. Blanks: _____

b. Bulks: _____

c. Other: Settled Dust

For these supporting samples which require qualitative analysis, enter the type of sample in this space (e.g., "WIPE" or "BULK."), assign a sample submission number in item 28, and leave items 29 through 34 blank in that column.

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EXAMPLE: In the following case, four air samples are supported by a bulk which the CSHO desires analysis.

Pump No.	SAMPLING DATA				
26. Sample Type/Media	← AA				Bulk
27. Filter/Tube No.	1	2	3	4	5
28. Sample Submission No.					

27. *Tube/Filter No.* (OPTIONAL) Record the tube or filter number assigned by the CSHO to aid in the identification of samples in the field.

28. *Sample Submission No.* Record the sample number assigned to each sample by the CSHO for submission to the lab. In the case of an inspection having more than one person taking samples, the team leader must ensure that each sample has a unique sample submission number under that report number (item 13).

29. *Time on.* Each time the pump is turned on, record the time.

30. *Time Off.* Each time the pump is turned off, record the time.

NOTE: If the pump is turned on and off during the course of the day and the filter or other sampling media is not changed, enter the subsequent times in the same column or in adjacent columns.

31. *Total Time (in min.).* Record the total sampling time in minutes.

32. *Flow Rate.* Record the flow rate at which the pump is operated. Indicate what units are correct by checking the appropriate box—either "L/min" or "cc/min". If a change in the flow rate is observed during pump checks, record that value in item #25 (Pump Checks and Adjustments). Refer to the IHFOM, Chapter X, Section A. to determine what flow rate to use if adjustments have been made or if pre- and post-sampling calibrations were different.

33. *Volume (in liters).* Record the total air volume sampled (in liters). This should be the volume the laboratory will use in its calculations. If the sampled air volume needs correction for temperature or pressure, record the corrected air volume sampled (in liters). The volume should be recorded to 2 to 3 significant figures, in the units sampled (e.g., 625 or 62.5 or 6.25).

34. *Net Sample Weight (mg).* Record the net sample weight (in mg) entered in item 60 on the back of this form.

35. *Lab Sample No.* (NOT ASSIGNED BY CSHO.) The laboratory will assign a "Lab Sample Number" to each sample and enter it in this row.

36. *Substance and Results.* Identify the substances for which analysis is requested. Record, in priority order, the analyses desired.

ed on the same OSHA-91, complete this item and draw an "X" through the box in the columns of the samples for which the identified analyses are not required.

EXAMPLE: In this example, samples 1 and 2 require analysis for nickel and copper, but not for sulphur dioxide. Samples 3 and 4 require analysis for sulphur dioxide only.

Pump No.	SAMPLING DATA			
26. Sample Type/Medium	AA			
27. Filter/Tube No.	1	2	3	4
28. Sample Submission No.	S2280-122	S2280-123	S2280-124	S2280-125
29. Time On	7:35	10:05	12:35	2:90
30. Time Off	10:04	12:00	2:00	4:00
31. Total Time (in Min)	149	115	85	100
32. Flow Rate ☐ L/min ☐ ml/min	2.0	2.0	2.0	2.0
33. Volume (in Liters)	29.8	23.0	17.0	20.0
34. Net Sample Weight (for step)				
35. Lab Sample No. →				
36. Substrate + B. Result →				
a. Nickel			X	X
b. COPPER			X	X
c. Sulphur Dioxide	X	X		
d.				

Results. (NOT COMPLETED BY CSHO.) The laboratory will enter the results of its analysis in these rows. Detection limits may be entered, if appropriate. The following codes may be used:

DL = Detection Limit
ND = None Detectable.

NOTE: If for some reason, a CSHO has a question about the results reported by the Laboratory, he or she may call the Salt Lake City Laboratory and request the samples' mass and desorption efficiency, etc. in order to check the calculations.

37. *Interferences and IH Comments to Lab.* Identify any known or suspected substances present during sampling which might affect the laboratory's analysis, and record any additional information which the laboratory may need (i.e., special handling and storage instructions, etc.). (Refer to the IHFOM, Chapter IX, Section D.) Include here the name of any laboratory personnel consulted on sampling strategy. Also enter the name of the office to which the results should be sent if different from that office entered in item #11. For liquid sorbents whose substance names cannot be fit into item #26, identify the sorbent here.

NOTE: If different analyses are requested for different samples record-

38. *Supporting Samples.* For a supporting sample, enter the sample number in the space alongside the type of sample involved. Reference samples (i.e., blanks, bulks, etc.) for which quantitative analysis results are not desired or are reported on another form should be recorded in this item (#38).

Example:

Pump No.	SAMPLING DATA			
26. Sample Type/Media				Bulk
27. Filter/Tube No.				
28. Sample Submission No.	G7642-164	G7642-165	G7642-166	G7642-167
29. Time On				

38. Supporting Samples
a. Blanks: _____
b. Bulks: G7642-167
c. Other: _____

If a supporting sample does *not* relate to *all* the samples identified on the sheet, indicate to which samples each supporting sample refers by recording the appropriate sample number(s) in parentheses after the reference number.

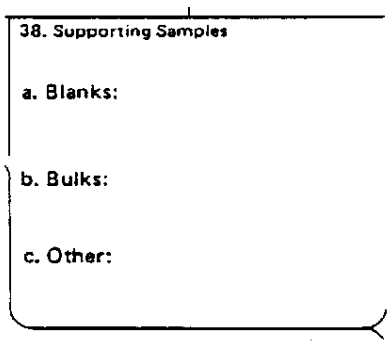
NOTE: The lab needs a separate blank for each type of analysis.

EXAMPLE: The entry in subitem a indicates that blank no. 392 supports all the samples, but the CSHO does not require the analysis results.

38. Supporting Samples
a. Blanks: 392
b. Bulks: _____
c. Other: _____

NOTE: If a single blank supports more than one sample form, the blank's reference number should be recorded on each form.

Indicate other supporting samples, such as area samples, as shown by the following example: The samples on this sheet are supported by an area sample (#393). The bulk sample (#394) supports only sample number 490.



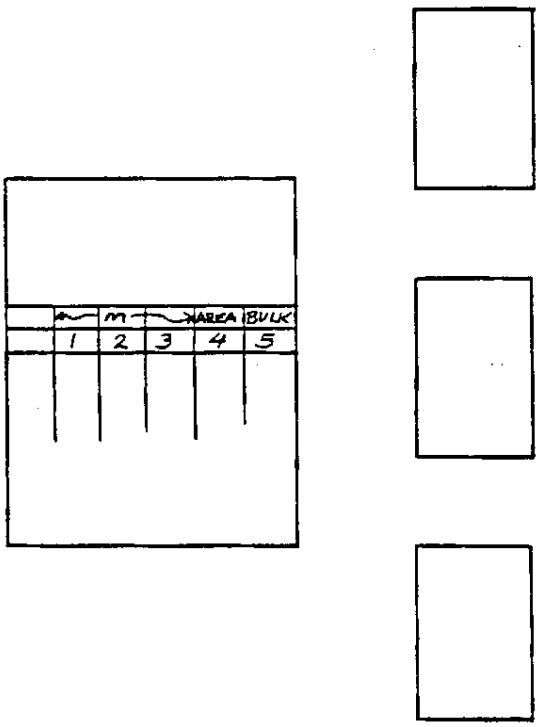
Shipment to Lab

When preparing samples to be sent to the lab, the person doing the shipping should make photocopies of the OSHA-91 to accompany the various types of samples. For instance, when organic and inorganic samples are recorded on the same sheet, they must be shipped separately to different parts of the laboratory; Air Sampling Data forms must accompany both shipments.

Send the original of the OSHA-91 to the Laboratory with the main group of samples to be analyzed. Send one photocopy of the *front* of the OSHA-9 with each additional group of samples.

NOTE: The forms transmitting bulks to the lab should identify *all* the samples to which they relate. Keep one phototcopy of *both sides* of the OSHA-91 for the case file.

The following flow chart shows this procedure graphically.



In the above example, the lab will return the original and photocopy #1 with the results of their analyses noted in item 36. At that time, the original and photocopy #1 will *replace* photocopy #2 in the case file.

39. *Analyst's Comments.* (NOT COMPLETED BY CSHO.) The lab analyst may enter here any remarks which are deemed sugnificant to the CSHO's evaluation of the sampling data and analysis results. This will include the results of the analysis of blanks, and the method of analysis if the standard method is not followed.

40. *Seals Intact?* (NOT COMPLETED BY CSHO.) The laboratory will check the appropriate block to indicate whether or not the sample seals were intact when the shipment was received by the laboratory.

41. *Chain of Custody.* (NOT COMPLETED BY CSHO.) The laboratory will complete this item in order to certify the proper handling of samples in the lab. The person performing the activity identified in each subitem will initial and date the form.

CITATION DATA

When the CSHO receives all the results of the laboratory analyses recorded on

one OSHA-91, discard the case file photocopy of that OSHA-91 and insert the original (and photocopies, if applicable) which contains the original lab entries of the results. All originals (both field and laboratory) must be retained in the case file.

Items 42 thru 48 must be completed whether or not a citation is issued. Complete one row for each substance entered in items #36 and 42.

All substances in item #36 must be entered in item #42 and items #43-47 completed on the original. A copy of the front of that form must be sent to MIS.

42. *Substance Code.* After the results come back from the laboratory, record the substance code for each of the chemicals sampled, one code per line, in the same order as item 36. Thus, up to four (4) substance codes may be recorded on one OSHA-91.

    NOTE: OSHA will soon adopt the Chem Abstract' nine digit substance codes (CAS #) to make our computer data compatible with the other IRLG agencies. Until the new codes are adopted, continue to use the present four-digit codes found in the MIS Manual and enter them in the first four spaces provided (see Example under item 44 below).

43. If the sample on which a citation is to be based is a wipe, bulk, or area sample, or if no other type of sample was taken in a hazard area the information in items #42-48 must be completed as appropriate.

    Indicate what type of sample the data relates to by means of the following codes: W=Wipe, B=Bulk, A=Area and O=Other. No entry is required for personal samples.

44. *TWA or C.* Record the eight-hour time-weighted average or ceiling value for each contaminant as calculated on the reverse of the form (item #61). The value recorded here should not include the statistical and analytical error.
    (SAE). (See instructions in the IHFOM, Chapter II, Section A.11.). In the block provided to the left, enter a "T" if the value recorded is a TWA and a "C" if it is a ceiling.

    The TWA/C must be reported in the same units as the PEL and those units indicated in item #45.

    NOTE: If both a TWA and ceiling value are determined, draw a line dividing the space for items 44-49 in half and enter the values for both. If fewer than four substances are sampled for, two adjacent lines may be used for reporting the two values.

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EXAMPLE:

† CITATION DATA	* W=wipe	B=bulk	A=area	† Units: P=PPM	M=mg/m³	F=Fibers/cc
42. Substance Codes	43.*	44. TWA/C	45. †	46. PEL	47. SEV.	48. Citation ID
a. 1290		T .		3.	1.1	Type No. Item No. S01003
b.		C .		5.	1.2	S01 003
c.		.		.	.	
d.		.		.	.	
49. Additives						

45. Indicate by the following codes, the units of measure which apply to both the TWA/C (item #45) and the PEL (item #47).

P=PPM M=mg/M³

If a TWA and/or Permissible Exposure Limit (PEL) is expressed in micrograms (μg), it must be converted to milligrams (mg).

46. *PEL.* Record the PEL of each contaminant.

If, because of novel work schedule or other unusual circumstance, the PEL is adjusted (according to the instructions in Chap. XIII of the IHFOM), record the equivalent PEL. When the PEL is adjusted, enter an "A" beside the PEL.

47. *SEV.* = Severity. Record the severity code (ratio of TWA to PEL) for each exposure. Calculate the value to the nearest hundredth.

48. *Citation (Type, No., Item).* If a citation is issued based on the exposure documented in this row on the sampling form, record the citation type (*one* of the following: S-Serious, R-Repeated, W-Willful, O-Other), citation number and item number of this exposure. If no citation is issued based on this survey data, enter the appropriate MIS code (from the following list) under "Type" to indicate why.

Codes:

Citation ID for samples collected to establish a failure to correct a violation shall not be recorded. MIS will pick up this information from the OSHA-2B. Enter "FTC" in the citation ID box. (Note that the sample results are still entered in the appropriate boxes.)

49. *Additives.* If substances, due to their similar physiological effects, are considered additive, and if a citation results from the additive effects, enter the line letters (i.e. a, b, c, and/or d) of the substances identified in item 42 that are additive. Record under "SEV" (item 47) on this line the equivalent exposure for the mixture, as referenced in 29 CFR 1910.1000(d)(2)(i). This value is equivalent to the sum of the severity ratios for each substance contributing to the additive effect. In item 48 on this line, enter the Citation ID.

Case File Page/Of. When the case file is organized, the sampling data forms and their continuation sheets should be placed immediately behind the Worksheet [OSHA-1B(IH)] to which they relate. All sample sheets which do not support a violation should be placed together at the back of the case file. After the case file has been organized, all of the pages should be numbered sequentially (see OSHA Instruction ADM 12.3A).

POST—SAMPLING CALIBRATION (See the back of the OSHA-91)

NOTE: Be sure to use the same calibration method for pre- and post-sampling calibration.

50. *Location/T&Alt.* If calibrated in the office, enter "OFFICE" If calibrated elsewhere, record the address of the location at which the calibration is performed. Include altitude and temperature when necessary.

If all pumps are calibrated at the same place and time, the address should be noted on the first form used during the calibration an a slash drawn through this time on subsequent forms. If the pre- and post-sampling calibration were done at the same location, draw a slash through this item, but record the temperature, if needed, on the first form used.

51. *Flow Rate Calculation.* (OPTIONAL) Use the space provided to perform the calculations made during the calibration.

52. *Flow Rate.* Record the flow rate of the pump as determined by post-sampling calibration.

53. *Initials.* The person performing the post-sampling calibration must certify that standard calibration procedures have been followed by initialing the form in this space.

54. *Date/Time.* Record the date and time of the post-sampling pump calibration.

SAMPLE WEIGHT CALCULATIONS (See the back of the OSHA-91)

From the data recorded in the *Weighing Log*, calculate the Net Sample Weight for each filter in a column (items 55-60) according to the following instructions. The filter numbers should be listed in the same order as on the front of the form to decrease the likelihood of transcription errors.

55. *Filter No.* Enter the filter number from the front of the OSHA-91 (item 27 or 28) which is the same as item #2 on the Weighing Log (OSHA-96).

56. *Final Weight (in mg).* Transcribe from the Weighing Log the average weight (in mg.) from the post-sampling weighing.

57. *Initial Weight (in mg).* Transcribe from the Weighing Log the average weight (in mg.) from the pre-sampling weighing.

58. *Weight Gained (in mg).* Subtract the "Initial Weight" (item 57) from the "Final Weight" (item 56) and enter the difference (in mg.).

59. *Blank Adjustment (in mg).* In the space provided below for calculations (item 61), or in any extra columns that are available here (items 55-57), calculate the blank's Weight Gained" as described in the instructions for item 58. Record that weight in each column used for sample weight calculation.

60. *Net Sample Weight (in mg).* If the blank has gained weight during handling, subtract the Blank Adjustment (item 59) from the "Weight Gained" (item 58). If the blank lost weight, make no adjustment. Record the result (in mg.) for each filter in this space and in the corresponding space for item 34 on the front of the OSHA-91. If no blank adjustment is made, enter the "Weight Gained" (item 58) in item 34 (Net Sample Weight) on the front of the form.

61. *Calculations.* This space is provided for performing your calculations of TWA, severity, correction factors, sampling and analytical errors, etc.

NOTE: Perform all calculations according to the instructions in the IHFOM.

The remaining space on the back of the form may be used for continuing any item from the front or for any other purpose the CSHO desires.

E. Noise Survey Data (OSHA-92)

1. **Purpose.** The Noise Survey Data form (OSHA-92) provides OSHA's field personnel with a standard medium for recording the data required to support a health violation. Its use also eliminates the Inspection Test/Sample Log (OSHA-35) now submitted by CSHOs.

2. **Benefits.** The Noise Survey Data form will consolidate calibration records, survey data, and post-survey analysis into one preformated page with continuation sheets. It will help to ensure that all necessary information for supporting a noise violation is recorded, and will facilitate case file review. Moreover, because a photocopy serves as the MIS input document, it will provide the National Office with a data base which can be used to develop new standards and to respond to queries from field offices and the general public.

3. **Prescribed Use.** The Noise Survey Data form is mandatory for all noise survey data used for citation purposes, and is optional for screening samples. If the form is used for screening, a photocopy shall not be submitted to MIS. If the readings recorded were for screening, indicate this fact clearly so that the clerk responsible for the MIS function will know that a copy shall not be made.

4. **Special Instructions.**

a. If more than one sample form is used for a given employee, complete only the identifying date (items #15, 16, 17, 18, and 21 on the additional forms.

b. Date stamps may be used for all the date entries (items 7, 13, 20, 48, 53, and 60) on this form.

5. **Form.** See Figure XIV-7 for an example of OSHA-92.

Occupational Safety & Health Administration
NOISE SURVEY DATA

U.S. Department of Labor

17. OSHO No | 18. Report No.

19. Person Performing Sampling (Signature)

21. Employee: (Name)

24. Exposure Information | b. Duration

c. Frequency

(address)

25. Weather Conditions | 26. Photo Y

(phone)

28. Job Description, Operation, Work Location(s) and Controls.

Cont'd.

29. SLM DATA

a. Time	b. dBA	c. dBC	d. Location of Test & Remarks

DOSIMETER DATA

30. SN:					
31. CELL NO(S)					
32. TIME ON					
33. TIME OFF					
34. READOUT %					

35. Readout SN

36. Total Time | 37. Equivalent dBA

CITATION DATA

Type | No. | Item No.

Case File Page / of

* 10 = Continuous / Intermittent
30 = Impact

Form OSHA-92 (January 1979)

VVV 000000656

INDUSTRIAL HYGIENE FOM

—DOSIMETER CALIBRATION—

PRE-SURVEY

1. DOSIMETER	3. CELL NO(S)	4. READOUT %
a. SN		
b. Mfg.		
c. Battery Check ☐ YES ☐ NO	5. Location/T & B.P.	
d. Calibrator SN		
2. READOUT		
a. SN		
b. Voltage Check ☐ YES ☐ NO	6. Initials	7. Date/Time

POST-SURVEY

42. DOSIMETER	44. CELL NO(S)	45. READOUT %
a. Battery Check ☐ YES ☐ NO		
b. Calibrator SN		
	46. Location/T & B.P.	
43. READOUT		
a. SN		
b. Voltage check ☐ YES ☐ NO	47. Initials	48. Date/Time

—SOUND LEVEL METER CALIBRATION—

PRE-SURVEY

8. SLM Mfg/SN	9. Calibrator SN
10. Location/T & B.P.	

POST-SURVEY

49. Calibrator SN
50. Location/T & B.P.

11. RESULTS	125	250	500	1000	2000
a. dBA					
b. dBC					

12. Initials	13. Date/Time

51. RESULTS	125	250	500	1000	2000
a. dBA					
b. dBC					

52. Initials	53. Date/Time

OCTAVE BAND ANALYSIS and IMPACT NOISE

CALIBRATION

54. Octave Band Analyzer (Mfg, SN & Model No.)

PRE-SURVEY

55. Calibrator S.N.	57. Location/T&BP
56. Battery Check ☐ Yes ☐ No	

POST SURVEY

64. Calibrator S.N.	66. Location/T&BP
65. Battery Check ☐ Yes ☐ No	

58. RESULTS	125	250	500	1000	2000	59. Initials
a. dBA						60. Date/Time
b. dBC						
c. Band						

67. RESULTS	125	250	500	1000	2000	68. Initials
a. dBA						69. Date/Time
b. dBC						
c. Band						

61. TIME	62. REMARKS	63. READINGS													
		Peak	A	C	LIN	31.5	63	125	250	500	1K	2K	4K	8K	16K

6. Instructions. Complete the Noise Survey Data form (OSHA-92) according to the instructions in Figure XIV-8.

FIGURE XIV-8

INSTRUCTIONS FOR COMPLETING OSHA-92

Item

DOSIMETER CALIBRATION (Pre-Survey) [See the back of the OSHA-92.]

1. *Dosimeter.*

   a. *SN.* Enter the serial number of the dosimeter which will be used to perform the survey.

   b. *Mfg.* Enter the dosimeter manufacturer's name.

   c. *Battery Check.* Check the appropriate box to indicate whether the battery was checked.

   d. *Calibrator SN.* Enter the serial number(s) of the calibrator(s) used to calibrate this dosimeter.

2. *Readout.* (IF APPROPRIATE.) If a separate readout is used, enter the information for subitems a and b. If the same readout is used with all the dosimeters calibrated during a session, record the following on the first form used and draw a slash through this item on all additional forms.

   a *SN.* Enter the serial number of the readout.

   b. *Voltage Check.* (IF APPROPRIATE.) Check the appropriate box to indicate if the voltage was checked.

3. *Cell No(s).* (IF APPROPRIATE.) Enter the number(s) of the cell(s) which is being calibrated. Only those cells which will be used in the survey need be calibrated.

4. *Readout %.* Record the result of the calibration. If cells are used, record the result of each cell's calibration. If the instrument does not use cells, leave item 3 blank and record the dosimeter readings here.

5. *Location/T&BP.* If the dosimeter is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include barometric pressure and temperature, when necessary (refer to the IHFOM, Chapter IV, Section B.6.).

   If all the dosimeters are calibrated at the same place and time, the address should be noted on the first form used during the calibration and a slash drawn through this item on subsequent forms on which dosimeter calibration data was recorded.

6. *Initials.* The person performing the pre-survey calibration must certify that the standard procedures have been followed by initialing the form in this space. (Refer to the IHFOM, Chapter VIII, Section H for standard procedures.)

7. *Date/Time.* Record the date and time of the pre-survey dosimeter calibration.

SOUND LEVEL METER (SLM) CALIBRATION (Pre-survey).

If the same SLM is used for all the employee data, record the following data on the first sheet and enter a page reference in item #8 of the SLM block on subsequent forms used in that day's survey to indicate where the pre-survey SLM calibration data can be found.

8. *SLM Mfg/SN* Record the sound level meter's manufacturer's name and its serial number.

9. *Calibrator SN.* Enter the serial number of the calibrator used with the SLM. Include the manufacturer's name if different from that of the SLM (item 8).

10. *Location/T&BP.* If the SLM is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include barometric pressure and temperature, when necessary.

If all your SLMs are calibrated at the same place and time, the address should be noted on the first form used and a slash drawn through this item on subsequent forms on which SLM calibration data was recorded.

If the SLM and dosimeter were calibrated at the same place and time, enter "SAME".

11. *Results.* Record the calibration results. It is necessary to calibrate the SLM at 1000 Hz only; the other listed frequencies are optional.

12. *Initials.* The person performing the pre-survey calibration must certify that the standard procedures have been followed by initialing the form in this space.

13. *Date/Time.* Record the date and time of the pre-survey SLM calibration.

NOTE: If the dosimeters and SLMs were calibrated at the same place and time, this data need only be entered under "Dosimeter" (items 5 and 7) and "SAME" recorded under SLM (item #10 and 13).

INSPECTION IDENTIFIERS [See the front of the OSHA-92.]

The inspection identifiers Region (#15), Area (#16), CSHO No. (#17 & 19), and Report No. (#18) must be recorded on every survey form submitted to MIS.

14. *Establishment.* (NOT ENTERED IN THE FIELD) Enter the legal

name of the establishment. This need only be entered once for the sample forms in a case file. When they are batched for MIS submission, the name should be entered on the first form of the batch.

15. *Rgn.* Enter the Region code of the Region in which the inspection is being conducted.

16. *Area.* Enter the Area Office code of the area in which the inspection is being conducted.

Inspection ID

17. *CSHO No.* Enter the CSHO No. from the OSHA-1.

18. *Report No.* Enter the Report No. from the OSHA-1.

NOTE: A page number may be added in the upper margin to identify the survey forms in the field. This number can be used instead of the employee name to identify the survey sheet to which a continuation page relates.

19. *Person Performing Sampling* (Signature and CSHO No.) The CSHO who is performing the survey must sign the survey form to verify that the methods prescribed by the IHFOM have been followed. (Refer to the IHFOM, Chapter IV, Section C.) If the CSHO number of the person performing the survey is diffenert from the one on the OSHA-1 (i.e., it is a team inspection), enter the CSHO No. of the person actually doing the survey in the space provided to the right in block 19. If the numbers are the same, leave CSHO No. in item 19 blank.

20. *Survey Date.* Enter the date on which the survey is conducted.

EMPLOYEE DATA

21. *Employee:* Name/Address/Phone. Enter the name (First, Last), address (include zip code), and telephone number of the employee being surveyed.

22. *Job Title.* Enter the job title of the employee being sampled.

NOTE: The codes for job classifications are being developed by the Office of Management Data and Statistical Analysis (OMDS). Until these are issued, record the employee's job title only.

23. *PPE (Type and effectiveness).* Describe the type(s) and the effectiveness of the personal protective equipment (PPE) the employee is using, including the manufacturer's name, the model number, and the approval number (if available). If no PPE is in use, enter "NONE".

NOTE: Codes for personal protective equipment are being developed by OMDS. Until these codes are available, leave this space blank.

24. *Exposure Information.*

a. *Number.* Record an estimation of the number of employees who

potentially would be removed from risk if the hazard were corrected. Include employees potentially exposed on all shifts. This number is recognized as a subjective assessment of the scope of the exposure problem.

This number will be recorded only once for each hazard area. Enter the appropriate number on the first OSHA-92 for a particular hazard area and draw a slash through this space on all subsequent OSHA-92s for the same area.

NOTE: It is essential that this number not be repeated on sample forms relating to the same hazard area. Repeated entries will result in multiple counting and will invalidate the MIS data.

b. *Duration.* Record the length of time that the alleged violation has existed. This number indicates how long the hazard(s) has existed, not how long the sampled employee has been exposed to the hazard. It is not necessary to record the duration on all OSHA-92s for an area unless the information is different.

c. *Frequency.* Describe, as concisely as possible, the general frequency of exposure in the sampling area. Convey the complete picture for all overexposed employees, not just that of the sampled employee. This may require several frequency descriptions and the number exposed at each frequency.

Example: 2 for 8 hrs/day
8 for 3 hrs/week

SURVEY-RELATED INFORMATION

25. *Weather Conditions.* Record, when necessary, wind velocity, temperature, barometric pressure and other weather conditions existing during the survey period which may affect the noise survey data. (Refer to the IHFOM, Chapter IV, Section B.6)

26. *Photo.* If a photo(s) was taken, circle the "Y"; then enter the Photo Identification Number (e.g., roll and frame numbers) and Photo Worksheet (OSHA-89) page number, if applicable. If no photo was taken draw a slash through this item.

27. *Engineering Controls: Code.*

NOTE: Codes for engineering controls are being developed by OMDS. Until these codes are available, leave this item blank.

OPERATION-RELATED INFORMATION

28. *Job Description, Operation, Work Location(s) and Controls.*

Record a detailed description of the work environment of the employee being surveyed. All pertinent information, as described in Chapter IV, Section D of the IHFOM should be included. Additional information such as the employee's activities during non-survey periods, general observations of the work environment, and unusual events the CSHO

observes should be included if it is pertinent. Be sure to include observations on the following when they may affect exposure or the issuance of a citation:

1. Employee comments, recorded verbatim if possible, on the exposure (including how long they have worked at the job and the frequency of the exposure to the hazard) or the employer's health and safety program.

2. Employer knowledge of the hazard.

3. Other employer information. If the employer neither created nor controlled the hazardous condition, state the name of the responsible party and its relationship to the employer.

Begin your description here and continue on the reverse or on additional pages of the "Note-Taking Sheet" (OSHA-94). Always precede the continuation with the appropriate item number and indicate to which survey form it relates (e.g., "Jones-item 28" for the job description of employee Jones who is wearing the dosimeter or "p.4-28" for the job description on field page number 4, item 28).

When the case file has been organized and the pages numbered, enter the case file page number(s) in the "Cont'd" box to indicate where any continuation pages for this job description can be found. This is not necessary if the continuation page directly follows the survey form..

SOUND LEVEL METER DATA

29. *SLM Data.* The SLM data which relates to the employee exposure documented on a survey sheet may be recorded here in the columnar layout, on a drawing, or in the narrative of the job description (item 28).

a. Time. Enter the time at which each SLM reading was taken.

b. dBA. Record the SLM reading taken on the A scale, slow mode.

c. dBC. Record the SLM reading taken on the C scale.

d. Location of Test and Remarks. Enter the location at which each SLM reading was taken. Note the employee's activity at that moment and any other observations such as the employee's proximity to the noise source.

DOSIMETER DATA

30. *SN.* [OPTIONAL] The dosimeter's serial number may be entered here for reference during sampling.

31. *Cell No(s).* (IF APPROPRIATE.) Record the number of each cell as it is used.

NOTE: If one cell is used throughout the survey, but the dosimeter is turned off during the day, record the times in items 32 and 33 in the next column without repeating the cell number.

Example:

30. SN:	DOSIMETER DATA				
31. CELL NO(S)	1				
32. TIME ON	7:30	10:15	1:10	3:10	
33. TIME OFF	10:03	12:35	3:00	4:00	
34. READOUT %					

If an instrument which does not need cells (e.g., General Radio Dosimeter) is used, leave this item blank.

32. *Time On.* Record the time(s) dosimeter is turned on.

33. *Time Off.* Record the time(s) the dosimeter is turned off or is read.

34. *Readout %.* Enter the percent exposure recorded on each cell. If exposures are read throughout the day, this space may be used to record the percent exposure indicated at each reading. Precede such readouts by the time read, as described in the Note in item 31.

35. *Readout SN.* If a readout is used with the cells, record its serial number. If the same readout was used for the dosimeter calibration, the serial number will be recorded in item 2a, and a slash may be drawn through this item.

36. *Total Time.* Record the total duration of the survey, in minutes.

37. *Equivalent dBA.* (OPTIONAL) The CSHO may record the calculated equivalent dBA in this item. (Refer to the IHFOM, Chapter IV, Section E.)

CITATION DATA

Items #38-41 must be completed whether or not a citation is issued. All data on one employee to be sent ot MIS (items #15-20,22-24, 27, and 38-41) should be on one sheet. A copy of the *front* of that form must be sent to MIS.

38. *Total %.* Record the total percent exposure. This may be equivalent to the sum of the readout %'s in item 31 [for dosimeters which require cells and return to zero on readout (e.g., DuPont)] *or* the final percent exposure [for instruments which do not return to zero on readout (e.g., General Radio)].

39. *Severity.* Record the severity of the noise exposure, calculated to the nearest hundredth. This may be equivalent to item 35 divided by 100

when using dosimeter data, or time and motion calculations (ΣCn/Tn) see 29 CFR 1910.95, Table G-16) when using SLM data.

40. *Citation ID (Type, No., Item).* If a citation is issued on the exposure documented on this survey form, record the citation type (one of the following: S=serious, R=Repeated, W=Willful, O=Other), citation number, and item number of this exposure. If no citation is issued based on this survey data, enter the appropriate MIS code (from the following list) under "Type" to indicate why.

Codes:

Citation ID for samples collected to establish a failure to correct a violation shall not be recorded. MIS will pick up this information from the OSHA-2B. Enter "FTC" in the citation ID box. (Note that the sample results are still entered in the appropriate boxes.)

41. *Type of Noise.* Indicate the type of noise by the last two digits in the MIS codes.

Codes: 10 = Intermittent/Continuous
30 = Impact

Case File Page/Of. When the case file is organized, the survey forms and their continuation sheets should be placed immediately behind the Worksheet [OSHA-1B(1H)] to which they relate. All survey forms which do not support a violation should be placed together at the back of the case file. *After* the case file has been organized, all of the pages should be numbered sequentially (see OSHA Instruction ADM 12.3A).

DOSIMETER CALIBRATION (Post-Survey) [See the back of the OSHA-92.]

42. *a. Battery Check.* Check the appropriate box to indicate whether the battery was checked.

b. Calibrator SN. Enter the serial number(s) of the calibrator(s) used. If the same calibrator was used for the pre-survey calibration (item 1d), draw a slash through this item.

43. *Readout.* (IF APPROPRIATE) If a separate readout is used, enter the information in subitems a and b. If the same readout is used for the pre-survey calibration (item #2), draw a slash through this item. If the same readout is used with all dosimeters calibrated during a session, record the following on the first form used and draw a slash through this item on all additional forms. If no readout is used, leave this item blank.

a. SN. Enter the serial number of the readout if different from item 2a.

b. Voltage Check. (IF APPROPRIATE) Check the appropriate box to indicate whether the battery's voltage was checked.

44. *Cell No(s).* (IF APPROPRIATE) Enter the number of the cell(s) used during post-survey calibration. Only those cells used during the survey need be recalibrated.

45. *Readout %.* Record the result of the post-survey calibration. If more than one cell was used, record the result of each cell's calibration.

46. *Location/T&BP.* If the dosimeter is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include barometric pressure and temperature, when necessary.

    If all the dosimeters are calibrated at the same location, the address should be noted on the first form used during the post-survey calibration and a slash drawn through this item on subsequent forms. If the pre- and post-survey calibrations were done at the same location, draw a slash through this item but record the temperature and barometric pressure, if necessary, on the first form used.

47. *Initials.* The person performing the post-survey calibration must certify that the standard procedures have been followed by initialing the form in this space.

48. *Date/Time.* Record the date and time of the post-survey dosimeter calibration.

SLM CALIBRATION (Post-Survey)

If the same SLM was used for all the employee exposure data, record the following information on the first form used and enter a page reference in item #50 of the SLM block on subsequent forms used in that day's survey to indicate where the post-survey SLM calibration data can be found.

NOTE: If any single item is the same for all (pre- or post-) calibrations, enter it once and draw a slash through the item on additional forms.

49. *Calibrator SN.* Enter the serial number of the calibrator used with the SLM. Include the manufacturer's name if different from that of the SLM (item 8).

50. *Location/T&BP.* If the SLM is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include barometric pressure and temperature when necessary.

    If all your SLMs are calibrated at the same location, the address should be noted on the first form used and a slash should be drawn through this item on subsequent forms on which SLM calibration data was recorded that day. If the pre- and post-sampling calibration were done at the same location, draw a slash through this item, but record the temperature and altitude, if necessary.

    If the SLM and dosimeter were calibrated at the same location, enter "SAME".

51. *Results.* Record the results of the SLM calibration in the chart provided. It is necessary to calibrate the SLM at 1000 Hz only; the other frequencies are optional.

52. *Initials.* The person performing the post-survey calibration must certify that the standard procedures have been followed by initialing the form in this space.

53. *Date/Time.* Record the date and time of the post-survey SLM calibration.

NOTE: If the dosimeters and SLMs were calibrated at the same place and time, this data need only be entered under Dosimeter (item 51) and "SAME" recorded in item #53.

Example:

—DOSIMETER CALIBRATION—

POST-SURVEY

4. READOUT %	42. DOSIMETER	44. CELL NO(S)	45. READOUT %
	a. Battery Check ☐ YES ☒ NO		
	b. Calibrator SN		
		46. Location/T & B.P.	
	43. READOUT	OFFICE	
	a. SN		
Date/Time	b. Voltage check ☐ YES ☐ NO	47. Initials SRM	48. Date/Time 6/6/78 9:30

—SOUND LEVEL METER CALIBRATION—

POST-SURVEY

Calibrator SN	49. Calibrator SN
	50. Location/T & B.P.
	51. RESULTS

1000	2000		125	250	500	1000	2000
		a. dBA					
		b. dBC					

52. Initials	53. Date/Time
SRM	SAME

VVV 000000666

Figure XIV-8

OCTAVE BAND ANALYSIS AND IMPACT NOISE (See the back of the OSHA-92.)

NOTE: Octave Band Analyses (OBA) and impact noise studies are not required in all noise surveys. If the Industrial Hygienist desires to conduct one of these studies, this form may be used to facilitate the recording of the readings taken during the survey. If an octave band analysis applies to more than one surveyed employee, the IH may record the following information on the first form used and enter a page reference number in item #54 on subsequent forms used during that survey to indicate where the OBA data can be found.

Calibration

If the same SLM is used for both the spot readings and octave band analysis, the calibration data need only be entered once (in items 8-13) and a slash drawn through this entire block (items 54-60).

NOTE: If the same SLM is used, it must be calibrated at all of the frequencies listed on the "results chart".

54. *Equipment I.D.* (Mfg, SN and MOdel No.). Identify the instrument(s) used in the octave band analysis or impact noise study by recording the serial number(s), manufacturer(s), and model number(s).

55. *Calibrator SN.* Record the manufacturer (if different from that recorded in item 54) and the serial number of the calibrator used with the sound serial number and the level meter or octave band analyzer (SLM/OBA). If the same calibrator is used for all SLMs/OBAs, enter the serial number only once and draw a slash through this item on subsequent forms.

56. *Battery Check.* Check the appropriate box to indicate whether the instrument's battery was checked.

57. *Location/T&BP.* If the SLM/OBA is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed.

58. *Results.* Record the results of the SLM/OBA calibration on the chart provided.

59. *Initials.* The person performing the calibration must certify that the standard procedures have been followed by initialing the form in this space.

60. *Date/Time.* Record the date and time of the calibration of the SLM/OBA used for the octave band analysis or impact noise study.

ANALYSIS

61. *Time.* Record the time of each set of readings.

62. *Remarks.* Note any significant information which relates to the readings at a given time. For impact studies, this should include repetition rates and total impacts per shift.

63. *Readings.* For impact noise studies, record the maximum level on the impact meter in the "Peak" column. For octave band analyses, record the readings on the A and C scales and at the various frequencies in the appropriate columns.

NOTE: The columnar heading "Lin" is equivalent to the flat response on the SLM.

64. *Calibrator SN.* Record the manufacturer (if different from that recorded in item 54) and the serial number of the calibrator used with the sound level meter or octave band analyser (SLM/OBA). If the same calibrator is used for all SLMs/OBAs, enter the serial number only once and draw a slash through this item on subsequent forms.

65. *Battery Check.* Check the appropriate box to indicate whether the instrument's battery was checked.

66. *Location/T&BP.* If the SLM/OBA is calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include temperature and barometric pressure, when necessary.

67. *Results.* Record the results of the SLM/OBA calibration on the chart provided.

Additional information (e.g., for job description or OBA descriptive information) may be recorded below the OBA analysis block or on continuatin sheets (OSHA-94)

F. DIRECT READING DATA (OSHA-93)

1. **Purpose.** The Direct Reading Data form (OSHA-93) provides OSHA's field personnel with a standard medium for recording the data required to support a health violation. By serving as the input document for the Management Information System (MIS), it eliminates the Inspection Test Sample Log (OSHA-35) now submitted by CSHOs.

2. **Adaptability.** This is a general form which can be adapted to most direct reading instruments. Adapt it to you, not vice-versa.

3. **Benefits.** The Direct Reading Data form will consolidate calibration records, survey data, and post-survey analysis into one preformated page with continuation sheets. It will help to ensure that all necessary information for a violation is recorded and will facilitate case file review. Moreover, because a photocopy serves as the MIS input document, the OSHA-93 will provide the National Office with a data base which can be used to develop new standards and respond to queries from our field offices and the general public, thus eliminating the Inspection Test/Sample Log (OSHA-35).

4. **Prescribed Use.** The Direct Reading Data form is mandatory for all direct reading data used for citation purposes, and optional for screening samples. If the form is used for screening samples, a photocopy shall not be submitted to MIS. If the readings were for screening, indicate this fact clearly so that the clerk responsible for the MIS function will know that a copy need not be made.

a. If more than one sample form is used for a given employee, complete only the identifying data (items 8, 9, 10, 11, and 14) on the additional forms. The first form should contain all the final information (i.e., items #28-33) and a copy of the front of it should be sent to MIS.

b. Date stamps may be used for all the date entries (items 6, 13, 38) on this form.

6. **Form.** See Figure XIV-9 for an example of OSHA-93.

INDUSTRIAL HYGIENE FOM

Occupational Safety & Health Administration
DIRECT READING DATA

U.S. Department of Labor

10. OSHO NO. 11. REPORT NO.

12. PERSON PERFORMING SAMPLING (SIGNATURE)

14. EMPLOYEE (NAME)

18. Exposure Information

b. DURATION

(ADDRESS)

c. FREQUENCY

19. WEATHER CONDITIONS

20. PHOTO

(PHONE)

16. PPE.

21. INTERFERENCES

22. JOB DESCRIPTION, OPERATION, WORK LOCATION(S), VENTILATION AND CONTROLS

CONT'D

DIRECT READING DATA

23. SUBSTANCE/AGENT	24. TIME	25. READING	26. LOCATION AND REMARKS

CITATION DATA

	TYPE	NO.	ITEM NO.
a			
b			
c			
33. ADDITIVES			

* UNITS: P = ppm m = mg/m^3

Form OSHA-93
January 1979

CASE FILE PAGE / OF

VVV 000000669

Figure XIV-9

INDUSTRIAL HYGIENE FOM

	PRE-SAMPLING CALIBRATION			POST-SAMPLING CALIBRATION	
INSTRUMENT 1	1. INSTRUMENT (TYPE,MFG, MODEL NO.,SN)		4. RESULTS	35. CALIBRATION SOURCE	36. RESULTS
	2. LOCATION/T&BP	3. CALIBRATION SOURCE		37. LOCATION	
	5. INITIALS	6. DATE/TIME		38. INITIALS	39. DATE/TIME
INSTRUMENT 2	1. INSTRUMENT (TYPE,MFG, MODEL NO.,SN)		4. RESULTS	35. CALIBRATION SOURCE	36. RESULTS
	2. LOCATION/T&BP	3. CALIBRATION SOURCE		37. LOCATION	
	5. INITIALS	6. DATE/TIME		38. INITIALS	39. DATE/TIME
INSTRUMENT 3	1. INSTRUMENT (TYPE,MFG, MODEL NO.,SN)		4. RESULTS	35. CALIBRATION SOURCE	36. RESULTS
	2. LOCATION/T&BP	3. CALIBRATION SOURCE		37. LOCATION	
	5. INITIALS	6. DATE/TIME		38. INITIALS	39. DATE/TIME

7. Instructions. Complete the OSHA-93 according to the instructions in Figure XIV-10.

FIGURE XIV-10

INSTRUCTIONS FOR COMPLETING OSHA-93

Item

PRE-SAMPLING CALIBRATION (See back of the OSHA-93)

NOTE: 1. Since often more than one direct reading instrument will be used to document an exposure, space has been allotted for the calibration of up to three instruments. Care must be taken, however, to ensure that the pre- and post-survey calibration data for a given instrument are all in the same block on the form.

NOTE: 2. For leakage tests, only items #1, 2, 4, 5, and 6 need to be completed.

1. *Instrument (Type, Mfg, Model No., SN).* Enter the type of direct reading instrument being calibrated, its manufacturer's name and model number, and the instrument's serial number.

2. *Location/T&Alt.* If calibrated in the office, enter "OFFICE". If calibrated elsewhere, record the address of the location at which the calibration is performed. Include altitude and temperature, when necessary (see IHFOM, Chapter XI). If all instruments are calibrated at the same place and time, the address should be noted on the first form used and a slash should be drawn through this item on subsequent forms. If more than one instrument is used for a given exposure documentation and they are calibrated at the same location, record the location for the first instrument and enter "SAME" in item #2 for the additional instruments.

3. *Calibration Source.* Describe completely the calibration source used.

   EXAMPLE: For the Ecolyzer: Eco-Span Gas, 51 ppm
   For the G.C.A.: 1.23 mg/M3 GCA disc

4. *Results.* Record the results of the calibration.

   EXAMPLE: For the Ecolyzer: 52 ppm
   For the G.C.A.: 10 readings averaged: 1.22 mg/M3
   For Leakage test: ok

5. *Initials.* The person performing the pre-sampling calibration must certify that standard procedures have been followed by initialing the form in this space.

6. *Date/Time.* Record the date and time of the pre-sampling calibration.

INSPECTION IDENTIFIERS (See the front of the OSHA-93.)

7. *Establishment.* (NOT ENTERED IN THE FIELD) Enter the legal name of the establishment. This need only be entered once for the sample forms in a case file. When they are batched for MIS submission, the name should be entered on the first form of the batch.

8. *Rgn.* Enter the Region code of the Region in which the inspection is being conducted.

9. *Area.* Enter the appropriate Area Office code of the area in which the inspection is being conducted.

Inspection ID

10. *CSHO No.* Enter the CSHO No. from the OSHA-1.

11. *Report No.* Enter the Report number from the OSHA-1.

    NOTE: A page number may be added in the upper margin to identify the sampling forms in the field. This number can be used instead of employee name to identify the form to which a continuation page relates.

12. *Person Performing Sampling (Signature & CSHO No.).* The CSHO who is performing the sampling must sign the sampling form to verify that the methods prescribed by the IHFOM have been followed. If the CSHO No. of the person performing the sampling is different from the one on the Report (OSHA-1), (i.e., it is a team inspection) enter the CSHO No. of the person actually doing the sampling in the space provided to the right in item #12. If the numbers are the same, leave "CSHO No." in item #12 blank.

13. *Sampling Date.* Enter the date on which the sample(s) is collected.

EMPLOYEE DATA

14. *Employee: Name/Address/Phone.* Enter the name (First, Last), address (include zip code), and telephone number of the employee being sampled.

15. *Job Title (Code).* Enter the job title (and/or job code, when available) of the employee being sampled.

    NOTE: The codes for job classifications are being developed by Office of Management Data and Statistical Analysis (OMDS). Until these are issued, record the employee's job title only.

16. *PPE.* Record the type(s) personal protective equipment the employee is using, including the manufacturer's name and model number, the approval number, if available, and the type and concentration of the contaminant against which it protects, If no PPE is in use, enter "NONE"

    NOTE: Codes for personal protective equipment are being developed by OMDS. Until these codes are available, leave the space reserved for it blank.

17. *Eng. = Engineering Controls:* Code.

NOTE: Codes for engineering controls are being developed by OMDS. Until these codes are available, leave this item blank.

18. *Exposure Information.*

a. Number. Record the CSHO's estimation of the number of employees who potentially would be removed from risk if the hazard were corrected. Include employees potentially exposed on *all* shifts. This number is recognized as a subjective assessment of the scope of the exposure problem. This number will be recorded only *once* for each hazard area. Enter the appropriate number on the first OSHA-93 for a particular hazard area and draw a slash through this space for all subsequent OSHA-93s for the same area.

NOTE: It is essential that this number *not* be repeated on sampling forms relating to the same hazard area. Repeated entries will result in multiple-counting and will invalidate the MIS data.

b. Duration. Record the length of time that the alleged violation has existed. This number indicates how long the hazard(s) has existed, *not* how long the sampled employee has been exposed to the hazard. It is not necessary to record the duration on all OSHA-93s for an area unless the information is different.

c. Frequency. Describe, as concisely as possible, the general frequency of exposure in the sampling area. Convey the complete picture for all overexposed employees, not just that of the sampled employee. This may require several frequency descriptions and the number exposed at each frequency.

Example: 2 for 8 hrs/day
8 for 3 hrs/day.

SAMPLING-RELATED INFORMATION

19. *Weather Conditions.* Record, when necessary, temperature, altitude and other weather conditions existing during the sampling period which may affect the sample data.

20. *Photo.* If a photo(s) was taken, circle the "Y" then enter the Photo Identification Number (e.g., roll and frame numbers) and the Photo Worksheet (OSHA-89) page number, if applicable. If no photo was taken, draw a slash through the item.

21. *Interferences.* Identify any known or suspected substances or conditions (e.g., magnetic fields) present during sampling which might affect the sampling results. If no interferences are present, draw a slash through this block. (Refer to the IHFOM, Chapter IX, Section D.)

OPERATION-RELATED INFORMATION

22. *Job Description, Operation, Work Location, Ventilation and Controls.* Record a detailed description of the work being performed by the

sampled employee, including a description of the operation, equipment associated with the hazard (including identifying numbers), and the work location(s). Include all pertinent information such as the subject's activities during non-sampling periods when it might affect the exposure, general observations of work practices and environment, unusual events which the CSHO observes, etc.

Be sure to include observations on the following when they affect exposure or issuance of a citation:

1. Employee comments, recorded verbatim, if possible, on the exposure (including how long they have worked at the job and the frequency of their exposure to the hazard) or the employer's health and safety program. Be sure to include notes on symptoms exhibited or mentioned by the employee.

2. Account of employee movements and duties in each area of the plant.

3. Notes on visible dust, fumes, vapors, etc.

4. Source of exposure.

5. Ventilation and exterior openings affecting contaminant concentrations. Include descriptions and measurements.

6. Reference to other sample data which supports this exposure situation. For instance, screening samples taken previously.

7. Engineering and/or administrative controls, present and feasible.

8. Employer knowledge of the hazard.

9. Other employer information. If the employer neither created nor controlled the hazardous condition, state the name of the responsible party and its relationship to the employer.

Begin your description here and continue on the reverse or on additional pages of the "Note-Taking Sheet" (OSHA-94). Always precede the continuation with the appropriate item number and indicate to which sampling data form it relates (e.g., Jones-18" for the job description of employee Jones who is the subject of the test *or* "p. 4-18" for item 18 on field page number 4).

When the case file has been organized and the pages numbered, enter the case file page number(s) in the "Cont'd" box to indicate where any continuation page for this job description can be found. This is not necessary if the continuation page directly follows the sample form.

SAMPLING DATA.

23. *Substance/Agent.* Identify the substance being sampled for.

24. *Time.* Record the time on and off *or* the time of each reading.

25. *Reading.* Record the reading of the instrument or detector tube.

26. *Location and Remarks.* Enter the specific location at which the reading was taken. Note the employee's activity at that moment and any other observations such as employee proximity to the hazard. Include here or on continuation pages, an explanation of your sampling strategy or the standard method used. In that explanation, be sure to reference the substance or agent to which the strategy or method relates.

If more than one instrument is used for the same substance, the instrument relating to each reading must be identified.

Example:

			DIRECT READING D
23. SUBSTANCE/AGENT	24. TIME	25. READING	
CO		80 PPM	DT
		83 PPM	Eco.

CITATION DATA.

After sampling has been conducted, items #28 thru 34 are completed whether or not a citation will be issued.

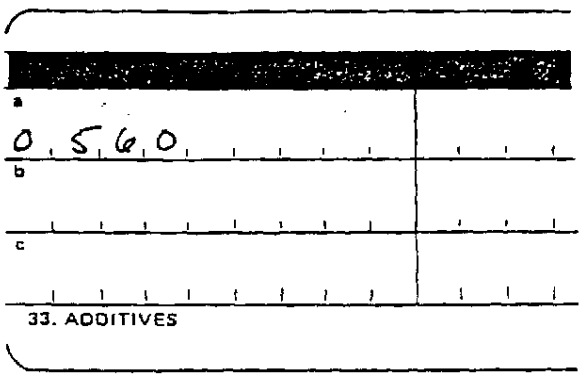
All substances (other than screening samples) identified in item #23 (Substance/Agent) must be entered in item #27 and items #29-32 completed. A copy of the front of the form must be sent to MIS.

27. *Substance Code.* Record the substance code for each contaminant or agent sampled for, one code per line.

NOTE: OSHA will soon adopt the *Chem Abstracts'* digit substance codes to make our computer data compatible with the other IRLG agencies. Until the new codes are adopted, contunue to use the present four-digit codes and enter them in the first four spaces provided.

VVV 000000675

Example:



28. *Average Exposure.* Record the sampled employee's time-weighted average exposure to the substance identified in "Substance Code" (item 28). This value is derived from the sample data. (See the instructions in the IHFOM XI.) The average exposure must be reported in the same units as the PEL and those units indicated in item #29.

29. *Units.* Indicate, by the following codes, the units of measure which apply to both the exposure (item #28) and PEL (#30).

    P=ppm M=mg/M³

    If the PEL or TWA is expressed in micrograms, it must be converted to milligrams.

30. *PEL.* Record the PEL of each contaminant.

    If, because of a novel work schedule or other unusual circumstances the PEL must be adjusted (according to the instructions in the IHFOM, Chapter XIII), record the equivalent PEL and enter an "A" beside it.

31. *Sev.* Severity. Record the severity code (ratio of TWA to PEL) for each exposure. Calculate the value to the nearest hundredth.

32. *Citation ID (Type, No., Item).* If a citation is issued based on the exposure documented in this row on the sampling form, record one of the following for the citation type: *S*=serious, *R*=Repeated, *W*=Willful, *O*=other; citation number and item number of this exposure.

    If no citation is issued based on this survey data, enter the appropriate MIS code (from the following list) under "Type" to indicate why.

    Codes:

    Citation ID for samples collected to establish a failure to correct a violation shall not be recorded. MIS will pick up this information from the

OSHA-2B. Enter "FTC" in the citation ID box. (Note that the sample results are still entered in the appropriate boxes.)

33. *Additives.* If substances are considered additive due to their similar physiological effects, and if a citation results from the additive effects, enter the line letters (i.e., a, b, and/or c) of the substance identified in item #27 that are additive. Record under "SEV" (item 31) on this line, the equivalent exposure for mixtures, as referenced in 29 CFR 1910.1000(d)(2)(i). This value is equivalent to the sum of the severity ratios for each substance contributing to the additive effect. In item #32 on this line, enter the Citation ID.

Case File Page/Of. When the case file is organized, the sampling data forms and their continuation sheets should be placed immediately behind the Worksheet [OSHA-1B(IH)] to which they relate. All sample forms which do not support a violation should be placed together at the back of the case file. *After* the case file has been organized, all of the pages should be numbered sequentially (see OSHA Instruction ADM 12-3A).

POST-SAMPLING CALIBRATION. (See the back of the OSHA-93)

Note: Be sure that each instrument's post-sampling calibration record is in the block to the right of its pre-sampling calibration record.

34. *Calibration Source.* Describe completely the calibration source. (See examples for item #3.) If the same calibration source was used for the pre-sampling calibration, draw a slash through this item.

35. *Results.* Record the results of the calibration. (See examples for item 4.)

36. *Location/T&Alt.* If calibrated in the office, enter "OFFICE." If calibrated elsewhere, record the address of the location at which the calibration is performed. Include altitude and temperature, when necessary.

If all your instruments are calibrated at the same place and time, address should be noted on the first form used and a slash drawn through this item on subsequent forms.

If the pre- and post-sampling calibrations were done at the same location, draw a slash through this item, but record the temperature and altitude, if needed, on the first form used.

If more than one instrument is used for a given exposure documentation and they are calibrated at the same location, record the location for the first instrument and enter "SAME" in item #37 for the additional instruments.

37. *Initials.* The person performing the post-sampling calibration must certify that standards procedures have been followed by initialing the form in this space.

38. *Date/Time.* Record the date and time of the post-sampling calibration.

TECHNICAL APPENDIX D

COEFFICIENTS OF VARIATION AND ACCURACY REQUIREMENTS FOR INDUSTRIAL HYGIENE SAMPLING AND ANALYTICAL METHODS

The relative variation of a normal distribution (such as the randomly distributed errors occurring in industrial hygiene sampling and analytical procedures) is commonly described by the *coefficient of variation (CV)*. The *CV* is also known as the *relative standard deviation (RSD)*. The *CV* is a useful index of dispersion in that limits computed from the true mean of a set of data plus or minus twice the *CV* will contain about 95% of the data measurements. Thus, if an analytical procedure with a *CV* of 10% is used to repeatedly measure some constant physical property (such as the concentration of a chemical in a beaker of solution), then about 95% of the measurements will fall within plus or minus 20% (2 times the *CV*) of the true concentration.

The accuracy required of airborne concentration measurements in the proposed OSHA health standards takes into account (1) random variations in the sampling device (repeatability of the sampling device), (2) random variations in the analytical procedure (repeatability of the replicate analyses of a given sample), (3) systematic errors in the sampling method (determinate errors or bias in the collection technique), and (4) systematic errors in the analytical procedure (determinate error or bias in the analysis).

The term *accuracy* in the proposed OSHA health standards and in this Manual refers to the difference between a measured concentration and the true concentration of the sample. Thus, it includes both the random variation of the method about its own mean (commonly referred to as precision) and the difference between the average result from the method and the true value (commonly referred to as the bias of the method). The term accuracy does not refer to the difference between a measured concentration and the true employee exposure. There are additional considerations that affect the difference between a measured airborne concentration and the true employee exposure. These include sampler location in relation to the breathing zone of the employee and sampling strategy of exposure measurement — both numbers of samples and duration. (Refer to Chapter 3.)

The proposed OSHA health standards state that the accuracy of a method shall have a *confidence level of 95%*. This means that 95% of the measurements must be as accurate as the standard requires. If one assumes the method is unbiased and errors are normally distributed, the *CV* (or relative standard deviation) can be used to judge if the method has the required accuracy. The *CV* in percentage units is defined as the standard deviation of the method, times 100, divided by the true value. The required *total coefficient of variation* (CV_T) of the sampling and analytical method is obtained by dividing the required accuracy by 1.96 (statistical standard normal deviate for 95% two-sided confidence limits, also referred to as *z*-value). Typical required CV_T's would be:

Concentration	*Required accuracy (plus or minus)*	*Required* CV_T
Above permissible exposure	25%	< 12.8%
At or below the permissible exposure and above the action level	35%	< 17.9%
At or below the action level	50%	< 25.5%

The statistical decision techniques in Chapter 4 utilize CV_T. Table D-1 lists some CV_T's for specific NIOSH sampling and analytical procedures. If a specific method is not listed for

TABLE 0-1. TOTAL COEFFICIENTS OF VARIATION FOR SOME SPECIFIC NIOSH SAMPLING/ANALYTICAL PROCEDURES

Air contaminant	CV_T	NIOSH method number
Acetic anhydride	0.06	S170
Acetone	0.08	S1
Acetonitrile	0.07	S165
Acetylene tetrabromide	0.10	S117
Acrylonitrile	0.07	S156
Allyl alcohol	0.11	S52
Allyl chloride	0.07	S116
Alpha-methyl styrene	0.05	S26
n-Amyl acetate	0.05	S51
sec-Amyl acetate	0.07	S31
Antimony and compounds (as Sb)	0.09	S2
Arsenic and compounds (as As)	0.06	S309
Arsine	0.06	S229
Asbestos	0.24-0.38	P&CAM239
Barium, soluble compounds	0.05	S198
Benzyl chloride	0.10	S115
Beryllium and beryllium compounds (as Be)	0.06	S339
Butadiene	0.06	S91
2-Butanone	0.07	S3
2-Butoxyethanol	0.06	S76
Butyl acetate	0.07	S47
sec-Butyl acetate	0.05	S46
tert-Butyl acetate	0.09	S32
Butyl alcohol	0.07	S66
sec-Butyl alcohol	0.07	S53
tert-Butyl alcohol	0.08	S63
n-Butyl glycidyl ether	0.07	S81
p-tert-Butyltoluene	0.07	S22
Calcium oxide	0.06	S205
Camphor	0.07	S10
Carbaryl (Sevin)	0.06	S273
Carbon tetrachloride	0.09	S314
Chlorinated camphene	0.08	S67
Chlorobenzene	0.06	S133
Chlorobromomethane	0.06	S113
Chlorodiphenyl (54% chlorine)	0.06	S121
Chloroform	0.06	S351
Chromic acid and chromates	0.08	S317
Chromium, metal, and insoluble compounds	0.08	S352
Chromium, soluble chromic, and chromous salts (as Cr)	0.08	S323
Copper dusts and mists	0.05	S186
Cresol (all isomers)	0.07	S167
Cumene	0.06	S23
Cyanide (as Cn)	0.10	S250
Cyclohexane	0.07	S28
Cyclohexanol	0.08	S54
Cyclohexanone	0.06	S19
Cyclohexene	0.07	S82
Diacetone alcohol	0.10	S55
Diazomethane	0.08	S137
Dibutyl phthalate	0.05	S33
o-Dichlorobenzene	0.07	S135
p-Dichlorobenzene	0.05	S281
1, 1-Dichloroethane	0.06	S123
1, 2-Dichloroethylene	0.05	S110
1, 1-Dichloro-1-nitroethane	0.05	S213
Diethylamine	0.07	S139
Di-2-ethylhexylphthalate	0.06	S40
Difluorodibromomethane	0.09	S107
Diisobutyl ketone	0.07	S358
Dimethyl acetamide	0.07	S254
Dimethylamine	0.06	S142
Dimethylaniline	0.05	S164
Dimethyl formamide	0.06	S255
Dioxane	0.05	S360
Dipropylene glycol methyl ether	0.06	S69
di-sec-Octyl phthalate (see di-2-ethylhexylphthalate)		
Epichlorohydrin	0.06	S118
2-Ethoxyethylacetate	0.06	S41
Ethyl acetate	0.06	S49
Ethyl acrylate	0.05	S35
Ethyl alcohol	0.06	S56
Ethyl benzene	0.04	S29
Ethyl bromide	0.05	S106
Ethyl butyl ketone	0.09	S16
Ethyl ether	0.05	S80
Ethyl formate	0.08	S36
Ethyl sec-amyl ketone (see 5-methyl-3-heptanone)		
Ethyl silicate	0.06	S264
Ethylamine	0.11	S144
Ethylene chlorohydrin	0.08	S103
Ethylene dichloride (1, 2-dichloroethane)	0.08	S122
Ethylene glycol dinitrate and/or nitroglycerin	0.10	S216
Ethylene oxide	0.10	S286
N-ethylmorpholine	0.10	S146
Glycidol	0.08	S70
Heptane	0.06	S89
Hexachloronaphthalene	0.06	S100
Hexane	0.06	S90
2-Hexanone	0.05	S178
Hexone (methyl isobutyl ketone)	0.06	S18
Hydrazine	0.09	S237
Hydrogen bromide	0.07	S175
Hydrogen chloride	0.06	S246
Hydrogen fluoride (HF)	0.06	S176
Hydrogen sulfide (aqueous)	0.12	S4
Isoamyl acetate	0.06	S45
Isoamyl alcohol	0.08	S58
Isobutyl acetate	0.07	S44
Isobutyl alcohol	0.07	S64
Isophorone	0.06	S367
Isopropyl acetate	0.07	S50
Isopropyl alcohol	0.06	S65
Isopropylamine	0.07	S147
Isopropyl glycidyl ether	0.07	S77
Ketene	0.06	S92
Lead and inorganic lead compounds	0.07	S341
LPG (liquefied petroleum gas)	0.05	S93
Magnesium oxide fume	0.06	S369
Manganese and compounds (as Mn)	0.06	S5
Mesityl oxide	0.07	S12
Methyl acetate	0.06	S42
Methyl acrylate	0.07	S38
Methyl alcohol	0.06	S59
Methyl (n-amyl) ketone	0.07	S1
Methyl "Cellosolve"	0.07	S79
Methyl "Cellosolve" acetate	0.07	S39
Methyl chloroform (1, 1, 1-trichloroethane)	0.05	S6
Methyl cyclohexane	0.05	S94
5-Methyl-3-heptanone	0.10	S13

TABLE D-1. TOTAL COEFFICIENTS OF VARIATION FOR SOME SPECIFIC NIOSH SAMPLING/ANALYTICAL PROCEDURES (cont.)

Air contaminant	CV_T	NIOSH method number
Methyl iodide	0.07	S98
Methyl isoamyl acetate	0.06	S37
Methyl isobutyl carbinol	0.08	S60
Methyl isobutyl ketone (see Hexone)		
Methyl methacrylate	0.13	S43
Methylal (dimethoxymethane)	0.06	S71
alpha-Methylstyrene	0.05	S26
Molybdenum, soluble compounds	0.09	S193
Monomethyl aniline (N-methylaniline)	0.09	S153
Morpholine	0.06	S150
Naphtha, coal tar	0.05	S86
Naphthalene	0.05	S292
Nickel, metal and soluble compounds (as Ni)	0.06	S206
Nicotine	0.07	S293
Nitrobenzene	0.06	S217
p-Nitrochlorobenzene	0.10	S218
Nitrotoluene	0.06	S223
Octachloronaphthalene	0.07	S97
Octane	0.06	S378
Ozone (alkaline MI)	0.08	S8
Parathion	0.08	S295
Pentane	0.05	S379
2-Pentanone	0.06	S20
Petroleum distillate (naptha)	0.05	S380
2-Pentyl acetate (see sec-amyl acetate)		
Phenol	0.07	S330
Phenyl ether	0.07	S72
Phenyl ether-biphenyl mixture	0.09	S73
Phenylglycidyl ether	0.06	S74
Phenylhydrazine	0.06	S160
Phosphoric acid	0.06	S333
Phthalic anhydride	0.09	S179
Platinum, soluble salts	0.06	S191
Propane	0.05	S87
n-Propyl acetate	0.06	S48
Propyl alcohol	0.08	S62
Propylene dichloride	0.06	S95
Propylene oxide	0.08	S75
n-Propyl nitrate	0.05	S227
Pyridine	0.06	S161
Rhodium, metal fume and dust	0.08	S188
Rhodium, soluble salts	0.07	S189
Selenium compounds	0.09	S190
Stoddard solvent	0.05	S382
Styrene	0.06	S30
Sulfuric acid	0.08	S174
Tellurium	0.06	S204
Tellurium hexafluoride	0.05	S187
Terphenyls	0.10	S27
1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane	0.07	S131
1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane	0.05	S132
1, 1, 2, 2-Tetrachloroethane	0.06	S124
Tetrahydrofuran	0.06	S78
Tetranitromethane	0.08	S224
Tetryl	0.06	S225
Thallium, soluble compounds (as Tl)	0.06	S306
Tin, inorganic compounds except oxides	0.06	S185
Titanium dioxide dust	0.11	S385
o-Toluidine	0.06	S168
Tributyl Phosphate	0.08	S208
1, 1, 2-Trichloroethane	0.06	S134
Trichloroethylene	0.08	S336
1, 2, 3-Trichloropropane	0.07	S126
1, 1, 2-Trichloro-1, 2, 2-trifluoroethane	0.07	S129
Trifluoromonobromethane	0.06	S125
Triorthocresyl phosphate	0.07	S209
Triphenyl phosphate	0.07	S210
Turpentine	0.05	S88
Vinyl chloride	0.08	—
Vinyl toluene	0.06	S25
Xylidine	0.06	S162
Yttrium	0.05	S200
Zirconium compounds (as Zr)	0.05	S185

a chemical, then the general coefficients of variation in Table D-2 may be used with care. Tables D-1 and D-2 apply only to laboratories with adequate maintenance and calibration facilities for sampling equipment (such as pumps) and a quality control program for the analytical laboratory.

The CV_T's in Table D-1 were reported by the NIOSH Measurement Research Branch and obtained from NIOSH Contract CDC-99-74-45, Laboratory Validation of Air Sampling Methods Used to Determine Environmental Concentrations in Work Places, June 26, 1974 to July 30, 1976. Additional work in this area was performed by Reckner and Sachdev (D-1) under NIOSH Contract HSM 99-72-98.

TABLE D-2. GENERAL COEFFICIENTS OF VARIATION FOR SOME SAMPLING/ANALYTICAL PROCEDURES

Sampling/analytical procedure	CV	Data sources*
Colorimetric detector tubes	0.14	A
Rotameter on personal pumps (sampling only)	0.05	B
Charcoal tubes (sampling/analytical)	0.10	C
Asbestos (sampling/counting)	0.24-0.38	D
Respirable dust, except coal mine dust (sampling/weighing)	0.09	E
Gross dust (sampling/analytical)	0.05	E

*Data source references

A. Leidel, N. A., and K. A. Busch: Statistical Methods for the Determination of Noncompliance with Occupational Health Standards, NIOSH Technical Information, HEW Pub. No. (NIOSH) 75-159, Cincinnati, Ohio 45226, 1975.

B. NIOSH Engineering Branch estimate of typical calibrated pumps capable of the range 1.5 to 3.0 lpm.

C. Conservative estimate by the authors. Recent work under NIOSH Contract CDC-99-74-45 have shown typical CV_T's (precision only) of 0.05 to 0.09 for charcoal tubes.

D. Leidel, N. A., S. G. Bayer, R. D. Zumwalde, and K. A. Busch: USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers, NIOSH Technical Information Report, Cincinnati, Ohio 45226 (to be published, 1977).

E. NIOSH Engineering Branch estimate based on the use of pumps in the flow range 1.5 to 3.0 lpm and a collected mass of at least 1.0 milligram.

If an analytical coefficient of variation different from that given in Tables D-1 and D-2 is available from a laboratory, it is better to use a computed total coefficient of variation. It is important to realize that CV's are not directly additive, but that the CV_T increases as the square root of the sum of the squares of component CV's. In general there are only two component CV's: the CV_P for the sampling pump and the CV_A for the analytical method. Thus, the CV_T would be calculated from

$$CV_T = \sqrt{(CV_P)^2 + (CV_A)^2}$$

where

CV_P = pump CV, generally taken as 0.05

CV_A = analytical CV

Example:

Charcoal tubes were used to sample for acetone and were taken to a local laboratory for analysis. The laboratory reported that its CV_A for acetone on charcoal tubes was 0.09. The CV_T is calculated as

$$CV_T = \sqrt{(0.05)^2 + (0.09)^2} = 0.10$$

Another example dealing with coal mine dust samples was given by Leidel and Busch (D-2).

REFERENCES

D-1. Reckner, L. R., and J. Sachdev: Collaborative Testing of Activated Charcoal Sampling Tubes for Seven Organic Solvents. NIOSH Technical Information, HEW Pub. No. (NIOSH) 75-134, Cincinnati, Ohio 45226, 1975.

D-2. Leidel, N. A., and K. A. Busch: Comments — Statistical Methods for Determination of Noncompliance. American Industrial Hygiene Association Journal, 36:839-840, 1975.

CHAPTER II

DETERMINATION OF COMPLIANCE AND CLASSIFICATION OF VIOLATIONS FOR AIR CONTAMINANTS

A. Determination of Compliance for Air Quality Standards. The following procedures and policies shall be followed to determine compliance with air quality standards ("Permissible Exposure Limits" or PELs).

1. **Personal Exposure.**

a. The determination of noncompliance with PELs requires measurement and documentation of an overexposure to at least one employee. For air contaminants having PELs sampling must be conducted within the breathing zone. (Some standards; e.g., beryllium and cotton dust, may necessitate area sampling.) OSHA defines the breathing zone to be a sphere approximately 2 feet in diameter surrounding the head.

b. In some instances (e.g., substances in 29 CFR 1910.1002-1014) personal sampling is not necessary to establish the presence of the material in order to substantiate a violation.

2. **Full-shift Sampling.** To eliminate error associated with fluctuations in exposure, full-shift sampling for air contaminants shall be conducted.

a. Full-shift sampling is defined to be a minimum of the total time of the shift less 1 hour; e.g., 7 hours of an 8-hour workshift or 9 hours of a 10-hour workshift. Every attempt shall be made to sample the greatest exposure periods. Such exposure may occur during set-up and take-down.

b. Pumps may be changed to avoid pump failure due to excessive sampling periods.

c. Single or multiple samples should be taken to determine any 8 hours of exposure for comparison with the PEL. A separate sample should be used to determine any additional exposure beyond 8 hours. (See Chapter XIII, Modification of PELs for Prolonged Exposure Periods.)

3. **Calculation of Time-Weighted Average (TWA) Exposures.**

a. **Full-Shift Sampling** (e.g., 7 hours or more for an 8-hour shift).

(1) Professional judgment is necessary for making any conclusions or assumptions regarding the unsampled period (i.e. the set-up and/or take-down time which is not to exceed 1 hour). For example, if the workshift is 8 hours, and sampling was conducted for 7 hours and 15 minutes, the Industrial Hygienist needs to make some professional judgment regarding the unsampled 45-minute period.

(2) A zero exposure shall be assumed unless the Industrial Hygienist can defend a professional judgment on the magnitude of the exposure for the unsampled period. Thus, a TWA should generally be calculated by dividing the sample results by 8 hours rather than the actual time sampled.

(3) Given sufficient information, a professional judgment on estimated exposure for the unsampled period could be defended.

(a) For example, if an 8-hour operation is continuous and the concentration of the substance would not be likely to vary substantially due to the process; and if the employee by virtue of the job could be assumed to be exposed continuously to essentially the same concentration, it would then be acceptable to assume that the exposure for the unsampled time would be the same as that measured for the actual sample time.

(b) In this situation it would be acceptable to calculate a TWA by dividing the sample results by the actual time sampled and compare the resulting TWA with the 8-hour standard.

(4) The Industrial Hygienist should carefully document the rationale for any professional judgment regarding unsampled exposure periods.

b. Less than Full-shift Sampling (e.g., less than 7 hours of an 8-hour shift). If the employee is exposed for less than 7 hours, or if less than a 7-hour sample is collected, the unsampled time shall be calculated as zero exposure, and the sample results shall be divided by 8 hours. A determination that an employer is in compliance shall not be made in this case unless the sampled period is representative of the employee's normal exposure.

4. Grab Sampling for 8-Hour TWA Determination. If technology has not been developed to allow full-shift sampling, a series of "grab" or "spot" samples taken randomly throughout the workshift is acceptable. A defensible statistical approach should be used to design the sampling strategy. Assistance from the Assistant Regional Administrator (ARA) for Technical Support shall be obtained.

5. Prolonged Work Shifts. To arrive at an adjusted PEL for prolonged exposures in excess of 8 hours, see Chapter XIII.

6. Lunchbreaks.

a. Generally it is not advisable to sample during lunchbreaks unless lunches are eaten in areas where significant exposure exists. In most cases, the pump should simply be turned off by the Industrial Hygienist prior to lunch, and then turned on again after lunch.

b. Generally it is not necessary to remove the pump unless the employee leaves the company premises. Care should be taken to assure that contamination of the collection medium does not occur (i.e. the sample should be capped and/or removed).

c. If the pump is turned off for lunch, the time it is off should not be counted as sample time for calculation of the TWA.

7. Collection and Analytical Methods. All industrial hygiene samples must be collected and analyzed using OSHA standard methods, where available, or by methods developed in consultation with or approved by the Salt Lake City Analytical Laboratory (SLCAL). (See Chapter IX, Analytical Laboratory Policies and Procedures.)

8. Interpretation of 29 CFR 1910.1000, Tables Z-1, Z-2, and Z-3. Guidance regarding interpretation of Tables Z-1, Z-2 and Z-3 should be sought from the Regional Office.

a. Interpretation of 29 CFR 1910.1000, Table Z-1—Ceiling Standards. Materials in Table Z-1 of 29 CFR 1910.1000 preceded by a "C" are ceiling limits which theoretically should never be exceeded instantaneously. Practically, the Industrial Hygienist should generally use a 15-minute sampling period to evaluate compliance with ceiling standards, unless direct-reading instrumentation or methods with sufficient analytical accuracy are available.

b. Interpretation of Table Z-2.

(1) Materials in Table Z-2 have both "acceptable ceiling concentrations" (column 2) and "maximum peak concentrations" (column 3) up to which exposures are allowed for the period specified in column 4. Generally a 15-minute sample is used by OSHA to evaluate ceiling limits due to analytical accuracy.

(a) All the time periods specified in column 4 are less than 15 minutes with the exception of beryllium, formaldehyde and carbon disulfide. Therefore, if a 15-minute continuous exposure (minus total error, see paragraph A.11.) exceeds the ceiling value in column 2, noncompliance is established.

(b) Where less than a 15-minute sample is taken, a citation may be issued if one of two conditions exists:

1 Column 2 is exceeded and the sampling time is beyond the time allowed by column 4.

2 Column 3 is exceeded even instantaneously.

(c) For the exceptions of beryllium, formaldehyde and carbon disulfide, a continuous sample period in excess of 30 minutes should be used. If the exposure found

exceeds the ceiling values in column 2, noncompliance is established.

(2) The last two entries in Table Z-2, "mercury" and "chromic acid and chromates", should be considered as 8-hour TWA standards and not ceiling standards.

c. Interpretation of Table Z-3.

(1) The "talc (fibrous)" standard should not be enforced under 29 CFR 1910.1000. Talc containing tremolite (or any other "asbestos" as defined by 29 CFR 1910.1001(a)) shall be enforced under the asbestos standard, provided the laboratory can verify the presence of "tremolite fibers" or any other asbestos fibers.

(2) The nuisance dust standard applies to both organic and inorganic dusts. The standard should not be used when evaluating an exposure to a substance listed in Table Z-1, Z-2, or Z-3.

(a) Where toxicity information exists for a substance with no PEL and a serious hazard exists below the nuisance dust standard, a citation under Section 5(a)(1) of the Act should be considered.

(b) In this case where the nuisance dust PEL is insufficient to protect the employee, correction for the 5(a)(1) citation will consist of requiring reduction of exposure to appropriate levels.

(3) Where the employee is exposed to combinations of silica dust (i.e. quartz, cristobalite, and tridymite), the additive effects of the mixture will be considered, as detailed in 29 CFR 1910.1000(d)(2).

(a) For the PEL calculation specified in Table Z-3, the percent silica will be determined by doubling the percentage of cristobalite and/or tridymite and adding it to the percentage of quartz, according to the following formula. The PEL mixture pertains to the respirable fraction.

$$PEL = \frac{10}{\%\ \text{quartz} + 2\ (\%\ \text{cristobalite}) + 2\ (\%\ \text{tridymite})} \quad \text{(Equation II-1)}$$

NOTE: This formula can be mathematically derived from the mixture formula in 29 CFR 1910.1000(d)(2).

(b) If the calculation results in a value greater than 5 mg/M³ (the value of the nuisance dust standard), the percentage components of silica will be low, and the sample will contain a large percentage of nuisance dust. In this situation, the Industrial Hygienist should also require compliance with the respirable nuisance dust standard (5 mg/M³).

1 For example, if the calculation resulted in a PEL for the mixture of 7 mg/M³ and the exposure was 8 mg/M³, the employer should be cited for noncompliance with both the nuisance dust standard (respirable) 29 CFR 1910.1000(c), and the mixture formula 29 CFR 1910.1000(d)(2) as one item with abatement required down to 5 mg/M³ (respirable).

2 The violation would be serious since the exposure poses a silicosis risk (i.e. exposure is greater than the mixture PEL of 7 mg/M³).

3 If, however, the exposure in this example were 6 mg/M³, an "other" violation for the respirable nuisance dust standard only would be issued.

4 Example 1: Two continuous samples were taken for a combined exposure to silica dusts with the following results:

Sample	Sampling Period (min)	Total Volume (l)	Respirable Weight (mg)	Respirable Concentration (mg/M³)	Laboratory Results
A	238	405	0.855	2.1	30% quartz 14% cristobalite Nondetectable-Tridymite
B	192	326	0.619	1.9	40% quartz 10% cristobalite Nondetectable-Tridymite
Total	430	731	1.474		

Calculate the TWA from the sampling and analytical data:

a Calculate the percentage of quartz, cristobalite and tridymite in the total particulate collected.
Quartz:

$$30\% \frac{(0.885)}{1.474} + 40\% \frac{(0.619)}{1.474} = 17.4 + 16.8 = 34.2\%$$

Cristobalite:

$$14\% \frac{(0.855)}{1.474} + 10\% \frac{(0.619)}{1.474} = 8.1 + 4.2 = 12.3\%$$

b Calculate the PEL for the mixture.

$$\text{PEL (mixture)} = \frac{10 \text{mg/M}^3}{\%\ \text{Quartz} + 2(\%\ \text{Cristobalite}) + 2(\%\ \text{Tridymite})}$$

$$= \frac{10}{34.2 + 2(12.3) + 2(0)} \cong \frac{10}{58.8} = 0.17\ \text{mg/M}^3$$

c Calculate the employee's exposure.

$$\text{Exposure} = \frac{(\text{Sample wt.A}) + (\text{Sample wt.B})}{\text{Total volume}}$$

$$= \frac{0.855 + 0.619}{0.731} = 2.0\ \text{mg/M}^3$$

d Adjust (where necessary) for inadequate sample length.

$$\text{TWA} = (2.0\ \text{mg/M}^3)\frac{(430\ \text{min})}{(480\ \text{min})} = 1.8\ \text{mg/M}^3$$

Calculate the upper and lower confidence limits. (See paragraph A.11.)

9. **Imminent Danger.**

a. An imminent danger condition is one in which "a danger exists which could reasonably be expected to cause death or serious physical harm immediately or before the imminence of such danger can be eliminated through the enforcement procedures otherwise provided by this Act" (FOM Chapter IX). Examples would include acute exposures to life-threatening concentrations of gases (e.g., hydrogen sulfide and hydrogen cyanide), and levels of radiation capable of causing irreversible damage.

b. Air sampling is not required to initiate imminent danger proceedings. However, air samples should be taken, if possible, in order to substantiate citations which may be issued.

c. The Substance Toxicity Table will be amended to provide approximate imminent danger levels for certain substances when data become available.

10. **Wipe Samples.** Wipe samples can be used to document the presence of toxic materials. Specific guidelines for such sampling are presented in Chapter VI, Wipe Sampling Procedures.

11. **Sampling and Analytical Errors (SAEs).**

a. **Definition of SAEs.** When an employee is sampled and the results analyzed, the measured exposure will rarely be the same as the true exposure. This variation is due to sampling and analytical errors (SAEs). The total error is dependent upon the combined effects of the contributing errors inherent in sampling, analysis and pump flow.

b. Definition of Confidence Limits. Error factors determined by statistical methods shall be incorporated into the sample results to obtain the lowest value that the true exposure could be (with a given degree of confidence) and also the highest value the true exposure could be (also with some degree of confidence).

(1) The lower value is termed the lower confidence limit (LCL) and the upper value is termed the upper confidence limit (UCL). (See Figure II-1.)

(2) These confidence limits are termed "one-sided" since we are concerned only with being confident that the true exposure is on one side of the PEL.

c. **Sampling and Analytical Errors.** SAEs which provide a 95 percent confidence limit have been developed and are presented in the Sampling and Analytical Techniques Table in Chapter IX. If there is no SAE listed in the manual for specific instruments, apply the manufacturer's recommended error or other generally recognized error factor (e.g., $\pm$25% for detector tubes).

d. **Confidence Limits.** One-sided confidence limits can be used to classify the measured exposure into one of three categories. (See Figure II-2.)

(1) If the measured exposure exceeds the PEL and the LCL of that exposure also exceeds the PEL, we can be 95 percent confident that the employer is in noncompliance, and a citation would be issued. (See example A in Figure II-2.)

(2) If the measured exposure exceeds the PEL, but the LCL of that exposure is below the PEL, we cannot be 95 percent confident that the employer is in noncompliance. (See example B1 in Figure II-2.) Likewise, if the measured exposure does not exceed the PEL, but the UCL of that exposure does exceed the PEL, we cannot be 95 percent confident that the employer is in compliance. (See example B2 in Figure II-2.) In both of these cases, our measured exposure falls into a region which is termed "possible overexposure".

(a) A citation shall not be issued if the measured exposure falls into the "possible overexposure" region. It should be noted that the closer the LCL comes to exceeding the PEL, the more probable it becomes that the employer is in noncompliance.

(b) If measured results are in this region, the Industrial Hygienist should consider further sampling, taking into consideration the seriousness of the hazard, pending citations, and how close the LCL is to exceeding the PEL.

(c) If further sampling is not conducted, or if additional measured exposures still

fall into the "possible overexposure" region, the Industrial Hygienist should carefully explain to the employer and employee representative in the closing conference that the exposed employee(s) may be overexposed but that it cannot be established. The employer should be encouraged to voluntarily reduce the exposure and/or to conduct further sampling to assure that exposures are not in excess of the standard.

(3) If the measured results do not exceed the standard and the UCL also does not exceed the standard, we can be 95 percent confident that the employer is in compliance. (See example C in Figure II-2.)

e. Sampling Methods. The LCL and UCL are calculated differently depending upon the type of sampling method used. Sampling methods can be classified into one of three categories:

(1) Full-period, continuous single sampling is defined as sampling over the entire sample period with only one sample. The sampling may be for a full-shift sample or for a short period ceiling determination.

(2) Full-period, consecutive sampling is defined as sampling using multiple consecutive samples of equal or unequal time duration which, if combined, equal the total duration of the sample period. An example would be taking four 2-hour charcoal tube samples.

(3) Grab sampling is defined as collecting a number of short-term samples at various times during the sample period which, when combined, provide an estimate of exposure over the total period. Common examples include the use of detector tubes or direct-reading instrumentation (with intermittent readings).

f. Calculation Method for a Full-period, Continuous Single Sample.

(1) **Procedure.**

(a) Obtain the full-period sample (value X), the PEL, and the SAE. The SAE can be obtained from the Sampling and Analytical Techniques Table.

(b) Divide X by the PEL to determine Y, the standardized concentration. That is:

$$Y = \frac{X}{PEL} \qquad \text{(Equation II-2)}$$

(c) Compute the LCL (95%) as follows:

$$LCL\ (95\%) = Y - SAE \qquad \text{(Equation II-3)}$$

(d) Compute the UCL (95%) as follows:

$$UCL\ (95\%) = Y + SAE \qquad \text{(Equation II-4)}$$

(e) Classify the exposure according to the following classification system:

- If $LCL \geq 1$, a violation exists.
- If $LCL \leq 1$ and the $UCL \geq 1$, classify as possible overexposure.
- If the $UCL \leq 1$, a violation does not exist.

(2) **Example 2.** A fiberglass filter and personal pump were used to sample for a 7-1/2 hour period. The Industrial Hygienist was able to document that the exposure during the remaining unsampled one-half hour of the 8-hour shift would equal the exposure measured during the 7-1/2 hour period. The laboratory reported 5.65 mg/M³. The SAE for this method is 0.15. The PEL is 5.0 mg/M³. (See the Sampling Analytical Techniques Table.)

1 Calculate the standardized concentration.

$$Y = \frac{5.65}{5.0} = 1.13$$

2 Calculate confidence limits.

$$LCL = 1.13 - 0.15 = 0.98$$

Since the LCL does not exceed 1.0 noncompliance is not established and the UCL must be calculated.

$$UCL = 1.13 + 0.15 = 1.28$$

3 Classify the exposure.

Since the LCL < 1.0 and the UCL > 1.0, classify as possible overexposure.

g. Calculation Method for Full-period Consecutive Sampling.

(1) The use of multiple consecutive samples will result in slightly lower sampling and analytical errors than the use of one continuous sample since the inherent errors tend to partially cancel each other. The mathematical calculations, however, are somewhat more complicated. If preferred, the Industrial Hygienist may first determine if compliance or noncompliance can be established using the calculation method noted for a full period, continuous, single sample measurement. If results fall into the "possible overexposure" region using this method, a more exact calculation should be performed as follows:

(2) Procedure for Full-period, Consecutive Sampling.

(a) Obtain $X_1, X_2, \ldots, X_n$, the n consecutive concentrations on one workshift and their time durations, $T_1, T_2, \ldots, T_n$. Also obtain the SAE in the Sampling and Analytical Techniques Table.

(b) Compute the TWA exposure.

(c) Divide the TWA exposure by the PEL to find Y, the standardized average TWA/PEL).

(d) Compute the LCL (95%) as follows:

$$LCL = Y - \frac{SAE\sqrt{T_1^2X_1^2 + T_2^2X_2^2 + \ldots T_n^2X_n^2}}{PEL \quad (T_1 + T_2 + \ldots T_n)}$$ (Equation II-5)

(e) Compute the UCL (95%) as follows:

$$LCL = Y + \frac{SAE\sqrt{T_1^2X_1^2 + T_2^2X_2^2 + \ldots T_n^2X_n^2}}{PEL \quad (T_1 + T_2 + \ldots T_n)}$$ (Equation II-6)

(f) Classify the exposure according to the following classification system:

- If LCL ≥ 1, a violation exists.
- If LCL ≤ 1, and the UCL = 1, classify as possible overexposure.
- If UCL ≤ 1, a violation does not exist.

(3) **Example 3.** If, in example 2, two consecutive samples had been taken for carbaryl instead of one continuous sample, and the following results were obtained:

Sample	A	B
Sampling Rate (lpm)	2.0	2.0
Time (min)	240	210
Volume (l)	480	420
Weight (mg)	2.592	2.400
Concentration (mg/M^3)	5.400	5.936

The SAE for carbaryl is 0.15.

(a) Calculate the UCL and the LCL from the sampling and analytical results:

1 $TWA = \frac{(5.4\ mg/M^3)\ 240\ min + (5.936\ mg/M^3)\ 210\ min}{450\ min}$

$= 5.65\ mg/M^3$

2 $Y = \frac{5.65\ mg/M^3}{PEL} = \frac{5.65}{5.0} = 1.13$

3 Assuming a continuous sample:

$LCL = 1.13 - 0.15 = 0.98$

$UCL = 1.13 + 0.15 = 1.28$

(4) Since the LCL < 1.0 and UCL > 1.0, the results are in the possible overexposure region, and the Industrial Hygienist must analyze the data using the more exact calculation for full-period consecutive sampling as follows:

$$LCL = Y - \frac{SAE\sqrt{T_1^2X_1^2 + T_2^2X_2^2 + \ldots T_n^2X_n^2}}{PEL \quad (T_1 + T_2 + \ldots T_n)}$$

(Equation II-5)

$= 1.13\text{-}0.15\ (240\ min)^2\ (5.400\ mg/M^3)^2 +)$

$$= 1.13\text{-}\frac{0.15\sqrt{(240\ min)^2\ (5.400\ mg/M^3)^2 + (210\ min)^2\ (5.936\ mg/M^3)^2}}{5.0\ mg/M^3\ (240+210\ min)}$$

$= 1.13\text{-}0.12$
$= 1.01$

Since the LCL 1.0, a citation would be issued.

h. **Grab Sampling.** If a series of grab samples (e.g., detector tubes) are used to determine compliance with either an 8-hour TWA standard or a ceiling standard, consultation regarding sampling strategy and the necessary statistical treatment of the results obtained shall be sought from the ARA for Technical Support.

12. Use of the General Duty Clause (Section 5(a)(1)).

a. The use of Section 5(a)(1) of the Act shall be considered when the Industrial Hygienist identifies a situation involving employee exposure to a substance that does not have a standard but is believed to constitute a serious health hazard at the levels found and which is published in the health literature, or recognized by industry or the employer.

b. Exposure to a substance which has been added to the ACGIH TLV list since 1968, or identified as a serious hazard by federal agencies such as NIOSH, EPA, or the National Cancer Institute, should be considered for a possible 5(a)(1) citation where an OSHA PEL does not exist. In some cases an 8-hour OSHA PEL exists but no OSHA ceiling standard exists. If a ceiling standard has been recommended by NIOSH or others, which is equal to or greater than the 8-hour OSHA PEL, a 5(a)(1) citation may be considered for exposures in excess of the recommended ceiling standard (even if the employer is in compliance with the 8-hour OSHA PEL). If the recommended ceiling standard is below the 8-hour OSHA PEL, a 5(a)(1) citation should only be issued when approved by the National Office.

c. The use of Section 5(a)(1) shall be considered when inadequate work practices result in a potentially serious ingestion or skin hazard and 29 CFR 1910.132 or .141(g)(2) cannot be applied. The use of (5)(a)(1) shall also be considered for work practices which could lead to a potential inhalation hazard in excess of the PEL.

d. In the case of overexposure to substances not having a PEL, correction will consist of engineering and work practice controls to achieve a level where a serious hazard no longer exists. Where the hazard is serious and no safe level can be determined; e.g., carcinogens, engineering and work practice controls shall be required to reduce exposure to the lowest feasible level.

e. For all 5(a)(1) citations, careful and complete documentation must be made.

(1) This may include, but is not limited to, extensive sampling, employee interviews and supporting medical evidence (although the Industrial Hygienist must only establish the possibility of the illness).

(2) In addition, it may be necessary to gather supporting data from medical experts and the Directorate of Technical Supiort and to evaluate the information upon which the recommended standard is based (e.g., the NIOSH Criteria Document, etc.).

(3) Consultation shall be sought from the ARA for Technical Support prior to using the general duty clause.

B. Classification of Violations of Air Quality Standards.

1. **Type of Citation.** When it has been established that an employee is exposed to a toxic substance in excess of the PEL, a citation for exceeding the air contaminant standard shall be issued. The violation shall be classified as serious or other than serious on the basis of the requirements in the Substance Toxicity Table and the use of respiratory protection at the time of the violation.

a. Classification of violations is dependent upon the determination that the illness is reasonably predictable at that exposure level, whether the illness is serious or other and that the employer knew or could have known through reasonable diligence that a hazardous condition existed.

b. For any substance listed as serious in the Substance Toxicity Table, a serious citation shall be issued for excessive exposure and failure to utilize engineering and/or administrative controls. If however, the employer is exhibiting good faith by having a respirator program in use which is effective in reducing actual employee exposure to below the applicable standard (i.e. all elements of the required respiratory program in 29 CFR 1910.134 are being met—see Chapter III) and has a written engineering compliance plan and is following it, an other citation shall be issued for excessive exposure and failure to utilize feasible engineering and/or administrative controls.

c. The Industrial Hygienist shall consider protection factors for the type of respirator is use as well as the possibility of acute overexposure if the respirator fails. If protection factors are exceeded, (see Figures III-4 and III-5) or if the potential for acute overexposure exists, a citation for failure to control excessive exposure shall be issued as serious.

2. **Promptness of Issuance.** Citations for violations of air standards must be issued within 6 months following the date the air sample or measurement was taken (i.e. the date the violation occurred).

C. Classification of Violations for the New Health Standards.

1. **Purpose.** The intent of the procedures listed in the New Health Standards Guidelines is to reduce to a general reference guide the detailed program directives that are issued with each new standard. Any major deviations from these procedures will be released in a program directive.

2. **Description.** The Guidelines briefly describe the major requirements of the expanded standards (e.g., DBCP, arsenic), the procedure necessary to determine whether or not compliance exists, and the recommended procedure for citing. Normally the Industrial Hygienist shall follow these procedures for compliance purposes. In cases where deviations from the procedures seem to be warranted, the Industrial Hygienist shall note the reasons for the deviations in the case file.

3. **Grouping.** The recommended classification assigned to the specific entries is what is deemed appropriate for that single violation.

a. If specific paragraphs with different classifications are to be grouped (e.g., monitoring and the appropriate recordkeeping requirement), the more serious classification should be followed.

b. Several closely related violations having the same basic purpose may be found in the guide with a recommendation for grouping.

c. Where there is compliance with only a part of the requirement, professional judgment must be exercised to determine if citing the entire section is warranted.

4. **Minor Deficiencies.** If the employer has minor deficiencies in the requirements, an other citation will be issued.

5. **Explanation of "General".** Several paragraphs are preceded by a "General" subparagraph. Generally these subparagraphs are not cited but incorporated into the SAVE manual.

CHAPTER IX

ANALYTICAL LABORATORY POLICIES AND PROCEDURES

A. General.

1. **Content.** This chapter contains instructions for the collection, packaging, and shipping of samples to the Salt Lake City Analytical Laboratory (SLCAL).

2. **Sampling.** Samples should be collected in accordance with the Sampling and Analytical Techniques Table. Particular attention should be given to those substances which must be submitted as a single analytical request per sample. These substances are indicated by a "B" in the "notes" column. Other important information, such as dust vs. fume, and the analysis of oxides, is also contained in the "notes" column.

3. **Shipping.** Samples sent to the laboratory shall be packaged with the original Air Sampling Data form (OSHA-91). All samples shall be sent by certified mail or its equivalent to maintain a chain of legal professional accountability.

B. Sampling Considerations.

1. **Charcoal Tubes and Other Solid Sorbents.**

a. The ability of solid sorbents to adsorb and retain a given compound is dependent on a number of factors. These include: temperature, humidity, sampling flow rate, time, concentration, and the presence of other chemicals.

b. The sample volumes are recommended in the Sampling and Analytical Techniques Table are applicable for determining the permissible exposure limit (PEL) under normal circumstances. Smaller volumes (1/2 the maximum) may be required for solid sorbents when high humidity (above 90 percent) or relatively high concentrations of other organic vapors may be present in the environment sampled.

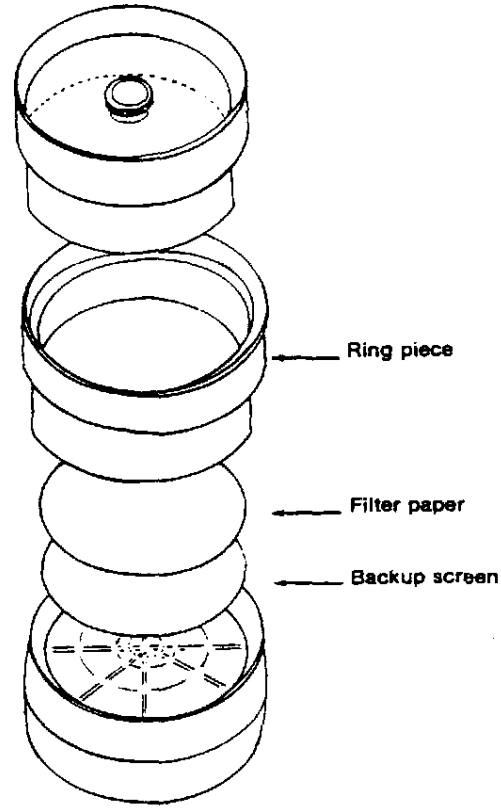
2. **General Membrane Filter Types and Uses.**

Filter Type	Examples	Pore Size	Uses
MCEF	AA, GN-4	0.8 um	Asbestos, metals
LAPVC	FWS-B	5.0 um	Silica, carbon black
GFF	A/E	——	Pesticides, herbicides
AgM	——	0.8 um	Coal tar pitch volatiles, Coke oven emissions

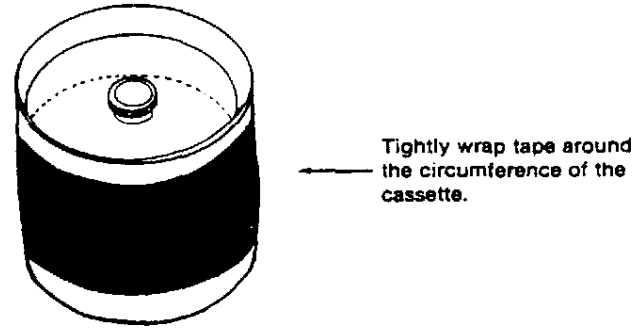
MCEF—Mixed cellulose ester filter
LAPVC—Low ash polyvinyl chloride
GFF—Glass fiber filter
AgM—Silver membrane (supplied by SLCAL)

Figure IX-1 demonstrates the preparation of the filter and cassette.

Figure IX - 1 Sketch of Preparation of Three Piece Cassette



Step 1. Assemble the three piece cassette as illustrated or the 2 piece cassette as illustrated above without the ring piece.



Step 2. Tape the cassette with black electrical tape or cellulose shrink bands.

3. **Shelf-Life of Sampling Media Provided by the SLCAL.**

a. Hydrogen sulfide collecting solution ($CdSO_4$/ NaOH)—shelf-life of 6 months, or when the precipitate will no longer stay in suspension for several minutes after shaking, whichever period is shorter.

b. Ozone sampling solution—shelf-life of 6 months or when the solution turns yellow, whichever period is shorter.

c. Nitro reagent for MDI/TDI—one month shelf-life.

d. The following have shelf-lives of 6 months or more (generally, disposal dates of 6 months after the preparation date is set):

- All normalities of NaOH, HCl, H_2SO_4 and sodium acetate.
- All percent volume/volume of methanol.
- ClO_2 reagents (oxalic acid, sodium arsenite).

e. All organic solvents ordered in their pure state have indefinite shelf-lives.

f. Bis-chloromethyl ether (BCME) collecting solution has a two month shelf-life. The solution must be stored in a dark bottle.

g. The collecting solution for acetic anhydride must be mixed in the field and has a shelf-life of only 2 hours after preparation.

h. Hydrogen peroxide (0.3N) for sulfur dioxide collection—stable for six months if it is protected from light and kept refrigerated.

i. The mercury monitor has a 90-day shelf-life. (Note the expiration date on the monitor.)

C. Blank Samples.

1. **Submission.** A blank sample shall be submitted to SLCAL with each type of sample collected. For example, if toluene and xylene were collected on a given set of charcoal tubes; and, in the same workplace, benzene was collected on another set of charcoal tubes; and chloroform and methyl chloroform were collected on a third set of charcoal tubes, three blanks should be submitted to the laboratory; one for each specific group of analyses.

2. **Number of Blanks.** For any given analysis, one blank will suffice for up to 20 samples collected. Should more than 20 samples be collected in a given inspection, additional blanks should be provided.

3. **Treatment.** Blank samples should be treated in the same fashion as real samples. They should be opened in the plant environment, immediately closed, packaged with the samples which were collected, and shipped to SLCAL in the same fashion as the samples.

4. **Purpose.** In the laboratory, blanks are used primarily to assess contaminants in the sampling media. However, they are also used to monitor potential contamination of samples both in the field and in the laboratory.

5. **Laboratory Action.** The blank analyses which are completed in the laboratory are normally subtracted from the analytical data produced for the samples. This provides the Industrial Hygienist with data which have been corrected for any contamination which may have been present in the sampling media or which may have been added by way of reagents used in the analytical process.

D. Interferences.

1. **Purpose.** The laboratory methods of analysis are susceptible to interferences by various compounds sometimes present in the sample. For greater accuracy, the laboratory must be notified if an interference is suspected.

2. **Potential Interferences.** The following are some potential interferences that should be noted on the OSHA-91:

Solvents—all other solvents, especially those with similar boiling points and/or polarities (specify the substances present).

Free silica—graphite, zirconium silicate, mica, feldspar, potash, iron carbide, and/or talc.

Asbestos—all fibrous materials and/or high non-fibrous dust levels.

Metals—high concentrations of other metals and inorganic dusts.

E. Bulk Samples.

1. Bulk samples should be submitted to the laboratory only in the following circumstances:

a. When the analysis is required to support a potential violation (e.g., 1 percent silica in sand-blasting operations).

b. When required by the laboratory to assess interferences or for use as an analytical reference. (See paragraph E.3.)

c. When all other means of obtaining information regarding the chemical composition of the material have been exhausted. This includes a discussion with the senior Industrial Hygienist as well as the manufacturer of the material.

2. Generally, the analysis of bulk samples will be semi-quantitative and can not be evaluated on the basis of the sampling analytical errors (SAE's) found in the Sampling and Analytical Techniques Table.

3. **Bulk Sample Analysis.** Bulk samples are needed for analysis of the following:

Asbestos; Chlorinated camphene; Chlorinated diphenyl oxide; Chlorodiphenyl; Gasoline; Hydrogenated terphenyls; Kerosene; Mineral oil; Naphtha; Petroleum distillates; Silica (quartz and cristobalite); Stoddard Solvent; Turpentine.

F. Shipping Instructions.

1. **Instructions for Shipping Filter Cassettes.**

a. The containers used by OSHA for shipping filters are made in four parts.

(1) A reuseable exterior brown cardboard mailing carton.

(2) Two brown cardboard flapped inserts.

(3) A white box to hold the filter cassettes. This box is shipped inside the brown exterior carton.

(4) An interior white die-cut cardboard tray to hold the cassettes in place.

b. All of the container parts are reuseable. Do not discard the brown exterior mailing carton or the flapped inserts.

c. The containers should be used as follows:

(1) Place the cassettes in the circular slots of the die-cut white cardboard tray. (See Figure X-1 for proper sealing of samples.) The samples should be sealed as shown to ensure sample stability.

(2) Remove or obliterate all old mailing labels.

(3) Include a copy of the OSHA-91 in the box.

2. **Instructions for Shipping Charcoal Tubes.**

a. Charcoal tubes may be shipped to SLCAL in the cylindrical containers provided or in other small sturdy containers.

b. Bulk solvent samples should *never* be mailed to the laboratory in the same package with any type of air sample.

c. Include a copy of the OSHA-91 in the box.

3. **Instructions for Shipping Samples Collected in Midget Impingers.**

a. Follow the directions outlined in paragraph F, Chapter X, for preparing samples collected in midget impingers for SLCAL.

b. Wrap packing material around the bottle(s) and place them in the cylindrical containers provided, or in some other sturdy containers.

c. Include the OSHA-91 in the container.

d. Ship by certified airmail to the SLCAL. If necessary, use precautionary labels on the shipping container as discussed in paragraph F.4.

4. **Instructions for Shipping Bulk Samples.**

a. Bulk solvent samples should be shipped in 20 cc vials with Teflon liners, should be well packaged in absorbent material and sent in the round containers provided.

b. A copy of the OSHA-91 (if the original is with the samples) must accompany each bulk sample. The sheet must identify that the sample is a bulk and must give the air sample numbers to which the bulk sample refers. It shall also identify the mode of shipment to the laboratory.

c. No air samples should be placed in the container with the bulks.

5. **Shipping Regulations.** When shipping samples to the laboratory, regulations imposed by Federal agencies having jurisdiction over interstate transportation must be adhered to. Such regulations may prohibit the use of the Postal Service.

a. The shipper is responsible for compliance with applicable postal laws and regulations governing mailability and preparation for mailing, as well as other laws and regulations pertaining to the shipment of particular matter.

(1) All items that are acceptable for mailing are subject to provisions of Part 124, Postal Service Manual.

(2) Additional postal information can be obtained in *Acceptance of Hazardous or Perishable Articles*, Publication 52, of the U.S. Postal Service.

(3) The passage of the Transportation Safety Act of 1974 has extended the Department of Transportation's authority over hazardous/restricted materials transportation. The full text of the hazardous materials regulations is contained in Title 49, Code of Federal Regulations, Part 100-199.

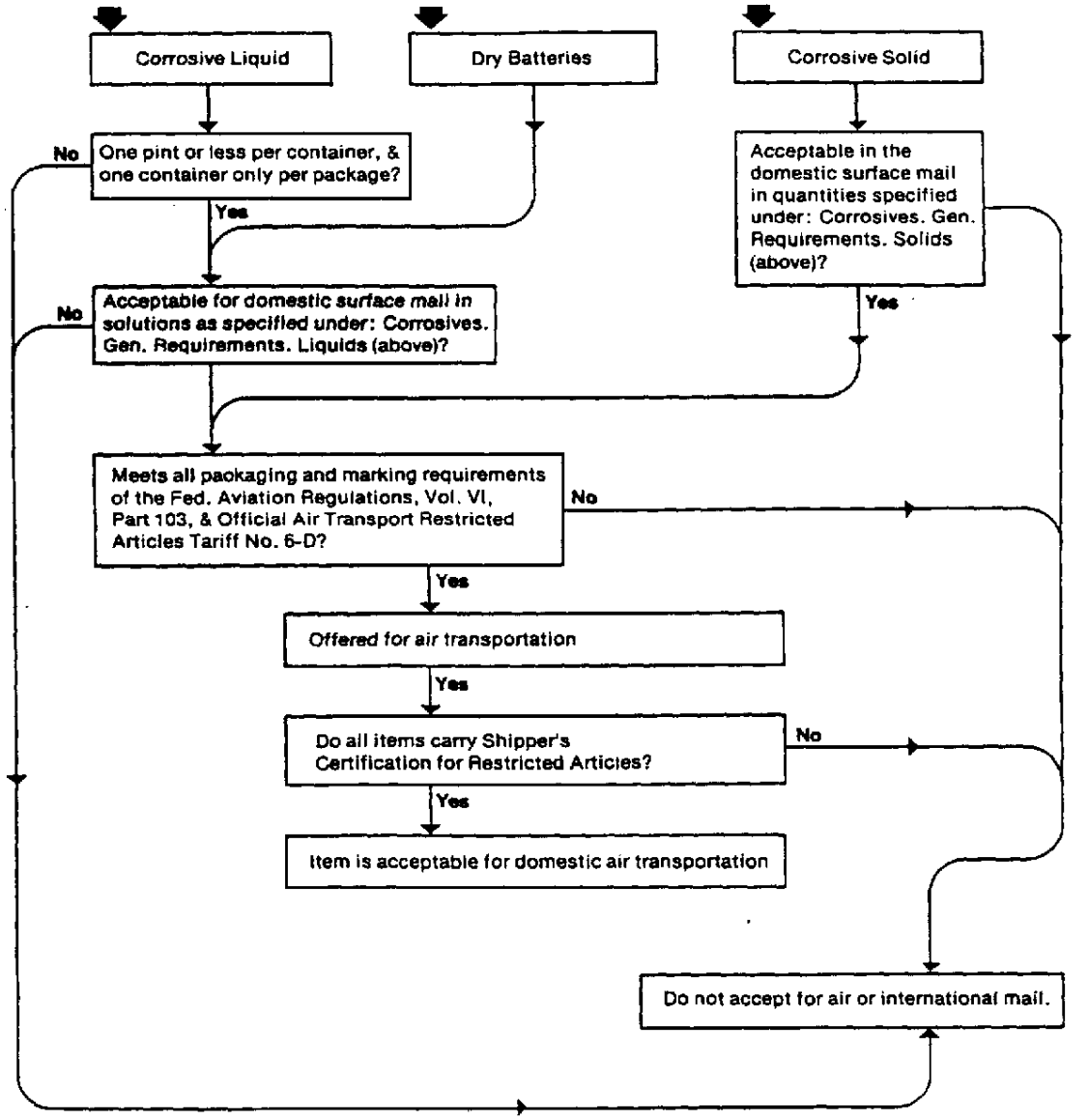
b. The main categories of hazardous materials sent to the laboratory are poisons, flammable liquids, oxidizers, flammable solids, corrosive materials (acids and alkalis), or irritating materials. These items are mainly bulk or impinger samples.

c. For all modes of transportation, the carrier must be aware that hazardous material is being tendered. Notification must be given. Any person who violates a provision of Title 49 in shipping a hazardous material, shall be subject to a civil penalty of not more than $10,000 per violation, and if any such violation is a continuing one, each day of the violation constitutes a separate offense. A person who willfully violates a provision of this title and is convicted of a criminal offense is subject to a fine of not more than $25,000, imprisonment for a term not to exceed 5 years, or both.

d. The great variety of chemicals precludes the listing of each item that may be mailed.

(1) Figure IX-2 (Air and International Mail Requirements for Corrosives) and Figure IX-3 and 4 (Air and International Mail Requirements for Flammable Liquids) from Publication 52, of the United Postal Service gives an indication of what can be mailed.

Figure IX - 2 Air and International Requirements for Corrosives



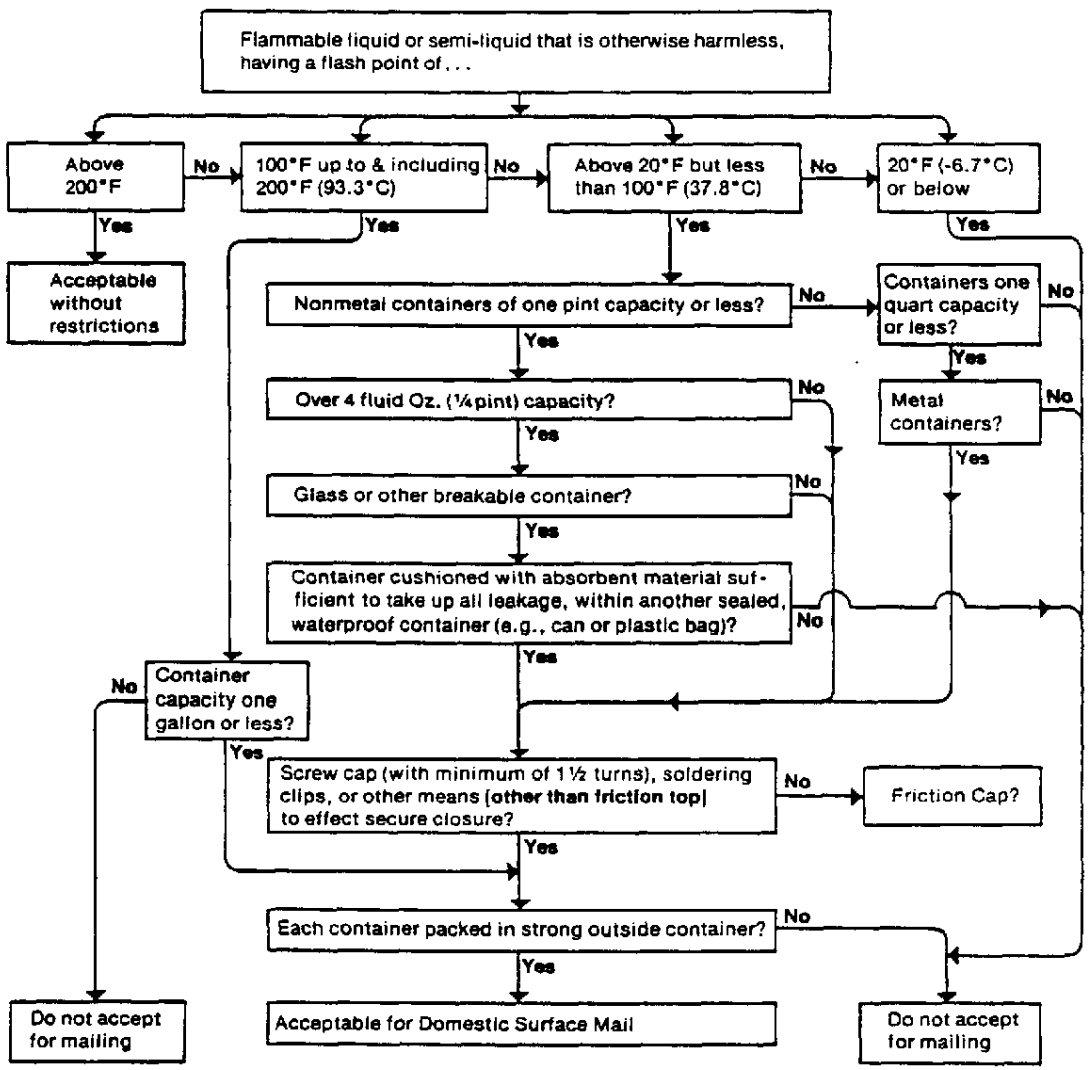
Reference U.S. Postal Service. Pub. 52, TL-1, 2-4-77

Figure IX - 3 Air and International Mail Requirements for Flammable Liquids

Definition

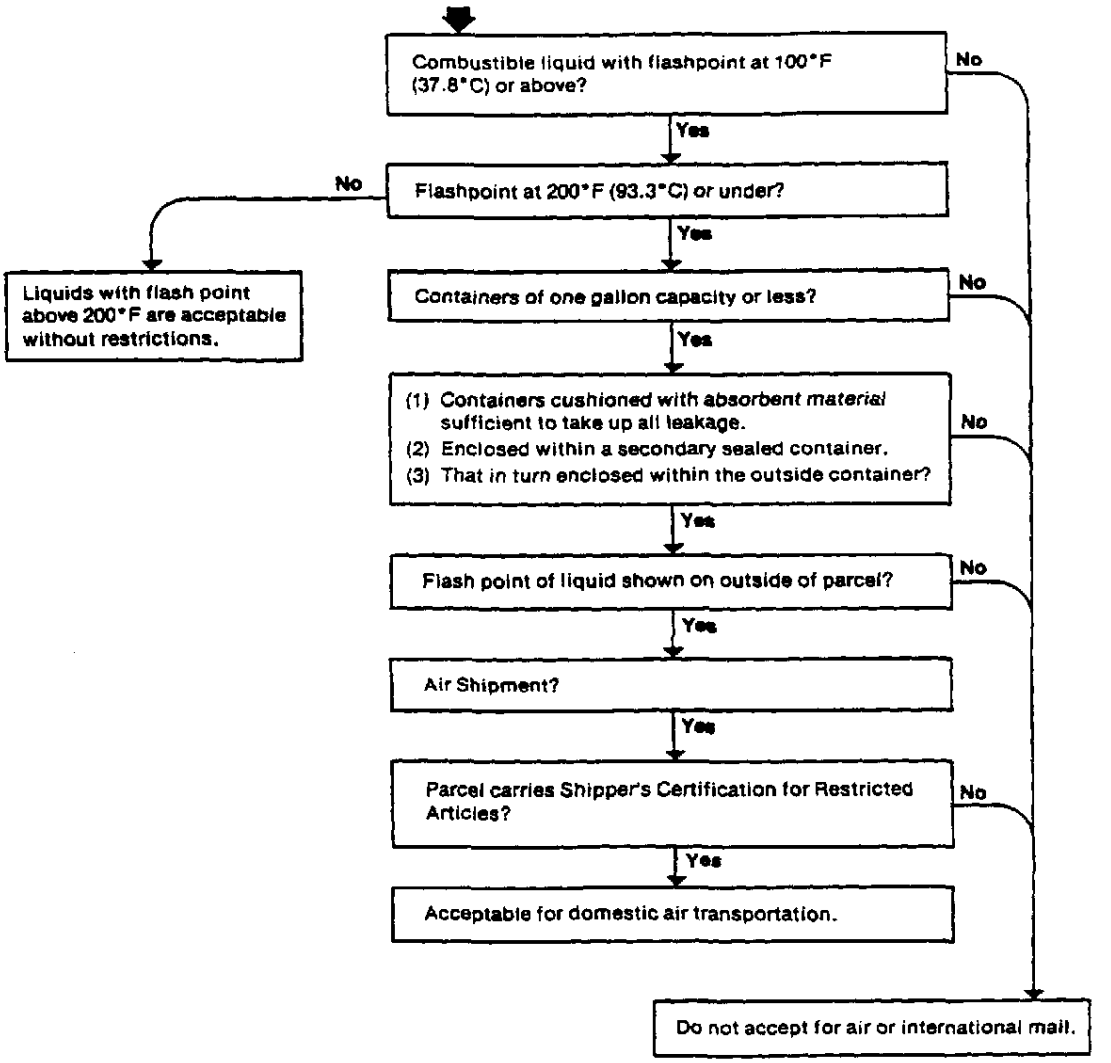
Title 49 of the Code of Federal Regulations defines "flammable liquid" as any liquid that gives off flammable vapors below a temperature of 100° F. (49 CFR 173.115)

General Requirements*



Reference U.S. Postal Service Pub. 52, TL-1, 2-4-77

Figure IX - 4 Air and International Mail Requirements for Flammable Liquids



Reference U.S. Postal Service Pub. 52, TL-1, 2-4-77

(2) Various chemicals are not mailable. The chemicals listed below are examples only:

Nitric acid; Gasoline; Percholoric acid; Benzyl peroxide; Class A poisons; Aniline; Chloropicrin; Organic phosphate compounds; Parathion (liquid).

(3) Charcoal tubes, silica gel tubes, filters and wipe samples in most cases will not be classified as hazardous materials.

e. When a restricted article is tendered for shipment, the customer is required to properly identify, classify, package, mark, label and certify all articles as specified in Title 49.

A Shipper's Certification and labels for restricted articles can be obtained from:

Label Master
6001 N. Clark St.
Chicago, ILL 60660
Tele. No. (312) 973-5100

f. Since all samples are subject to possible litigation, there has to be a chain and/or proof of custody of the samples from the field to the laboratory. The preferred form is the certified mail receipt. When samples are shipped by certified mail, they go first class (air mail).

The airline manager or his designated representative is the final authority in determining the acceptability of any restricted article. If a shipment is refused by a pilot and it goes by surface mail, the delivery time will be greatly extended.

g. If a restricted article cannot be shipped by certified mail to the laboratory, an alternate mode of transportation (e.g., Federal Express, Emery Air Express, United Parcel Service, etc.) can be used. A chain of custody for all samples must be obtained no matter what the mode of transportation.

G. Special Instructions for Silica.

1. Usually, respirable dust shall be collected for an evaluation of exposure to silica.

2. If the sample collected is nonrespirable, the laboratory must be so advised.

3. A sample weight and total air volume shall accompany all filter samples.

4. X-ray diffraction is the preferred analytical method used for most silica analyses, due to its sensitivity, minimum requirements for sample preparation and ability to identify polymorphs of free silica.

a. Quartz is identified by a major (primary) X-ray diffraction peak. Because other substances also have peaks at the same position, it is often necessary to confirm quartz by the presence of secondary and tertiary peaks.

b. Many times there is only enough quartz on a filter to identify the primary peak. This makes it important to submit a representative bulk to the laboratory. (This may require collecting several bulk samples at different locations.)

c. The amount of quartz in bulk samples will not be quantified unless specifically requested by the Industrial Hygienist. Results will be only semiquantitative as a accurate X-ray diffraction analysis cannot be provided for bulks.

d. When it is essential to know the silica content of a settled dust (rafter) sample or a manufacturer's bulk material, a gravimetric analysis should be requested.

5. Gravimetry and colorimetry analytical methods may be used when interfering materials are present.

6. In order of preference, bulk samples may be one of the following:

a. A high volume respirable filter sample.

b. A high volume filter sample.

c. A representative settled dust (rafter) sample.

d. A sample of the bulk material considered to be silica.

7. The type of bulk sample should be stated on the OSHA-91 and cross-referenced to the appropriate air sample.

8. Laboratory results are reported under one of three categories.

a. Percent quartz—where bulk samples are analyzed by the gravimetric method. (The gravimetric method does no differentiate between quartz and cristobalite.)

b. Nondetected—does not necessarily indicate the absence of quartz. For example, a sample weighing 100 micrograms would need to contain 5 percent quartz for any quartz to be detected if the reported detection limit is 5 micrograms. The Industrial Hygienist should evaluate the laboratory results to determine if adequate results are provided. If not, a longer sampling period may be required.

c. Unable to confirm the presence of quartz—if the amount of quartz in the sample was not sufficient to perform a reliable identification. In order to confirm the presence of quartz in excess of the PEL, one or more bulks should be submitted as described in paragraph G.6.

H. Special Instructions for Other Air Contaminants.

1. **Metals.** Where two or more of the following analytes are requested on the same filter, an inductively coupled plasma (ICP) analysis may be conducted. However, the Industrial Hygienist should specify the metals of interest in the event samples can not be analyzed by the ICP method. A computer print-out of the following ten analytes may be reported: cadmium, lead, chromium, copper, iron, nickel, manganese, antimony, vanadium and zinc. Other analytes may be reported as validation studies are completed.

2. (Reserved)

I. The Sampling and Analytical Techniques Table. This table lists the sampling and analytical techniques used by OSHA Compliance Officers in the assessment of employee exposures to potential health hazards. The table contains most of the substances covered by OSHA standards and regulations. (See Figure IX-5.) Changes and additions will be made as new technologies become available. This entire section should be utilized for all applications of this table. Abbreviations for this table may be found in Figure IX-6.

1. **Substance.** This column is an alphabetical listing of materials for which acceptable sampling and analytical methods are available. Only those substances requiring laboratory analysis or assistance are included in the table. A "skin" notation indicates a significant potential of the substance to cause additional exposure via dermal or mucous membrane routes. A "C" notation refer to a ceiling limit of exposure.

2. **Permissible Exposure Limit (PEL).** The PEL is given for the substances listed when there is an OSHA standard.

3. **Collection Method.** This column contains an abbreviated form of the recommended sampling method. Abbreviations are found at the end of the Appendix.

4. **Maximum Volume and Maximum Flow Rate.** Volumes listed are guidelines but should not be exceeded for solid sorbents. Flow rates are maximums and should not be exceeded. Lower flow rates may be used.

5. **Analytical Method.** This column contains an abbreviated form of the recommended analytical method. Abbreviations are found in Figure IX-6.

Figure IX-6

Abbreviations

AAS	atomic absorption spectroscopy
AAS-GF	atomic absorption spectroscopy-graphite furnace
Act. Char.	activated charcoal
Colori.	colorimetric
COP	ceiling or peak
EG	extraction-gravimetric
Fluoro.	fluorometric
Gravi.	gravimetric
GFF	glass fiber filter (without organic binder)
GLC	gas liquid chromatography
HPLC	high pressure liquid chromatography
IC	ion chromatography
ICP	inductively coupled plasma
ISE	ion specific electrode
LAPVC	low ash polyvinylchloride
MCEF	mixed cellulose ester filter
MFGB	midget fritted glass bubbler
MI	midger impinger
PC	particle count
PCM	phase contrast microscopy
Polaro.	polarographic
PVC	polyvinylchloride

TWA	time-weighted average
UV	ultra-violet spectrophotometer
XRD	X-ray diffraction
FH	fluoropore filter
AgM	silver membrane, glass fiber combination

6. Sampling and Analytical Error (SAE). The SAE is a measure of the precision and accuracy of the combined sampling and analytical process. It shall be applied by the Industrial Hygienist to sample results according to methods described in paragraph A.11, Chapter II. The values have been computed by multiplying the coefficient of variation for the total sampling and analytical procedure by 1.645, the appropriate statistical factor for one-sided 95 percent confidence intervals.

7. Reference. References are listed in Figure IX-7.

8. Method Class. Methods are classified as A, B, C, and D. See Figure IX-8.

Figure IX-8

Method Class

A. A sampling and analytical method which has been fully evaluated and successfully, collaboratively tested by a selected group of laboratories.

B. A sampling and analytical method which has been subjected to a thorough evaluation procedure and/or recommended by a government agency or a professional society.

C. A sampling and analytical method which has been partially evaluated.

D. A new or interim method.

9. Notes. The notes are defined in Figure IX-9. *These notes are very important since many sampling restrictions are given in this section.*

Figure IX-7

References

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5. *Analysis of Pesticide Residues in Human and Environmental Samples.* Pesticides and Toxic Substances Effects Laboratory, EPA, Research Triangle Park, N.C., 1974.

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10. King, J.R., Nevy, C.R., and Bowman, M.C.: "Trace Analysis of Diethylstilbestrol (DES) in Animan Chow by Parallel HighSpeed Liquid Chromatography, Electron-Capture Gas Chromatography, and Radioassays". *J. Chromatographic Science*15:14, 1977.

Figure IX-9

Notes

A. Standard size charcoal tubes containing 2 sections of 20 40 mesh activated charcoal, which is prepared from coconut shells. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg.

B. Submit as a separate sample.

C. Large size charcoal tubes containing 2 sections 20/40 mesh activated charcoal, which is prepared from coconut shells. The adsorbing section contains 400 mg of charcoal, the backup section 200 mg.

D. Standard size silica gel tubes containing 2 sections of 20 40 mesh silica gel. The adsorbing section contains 130 mg of charcoal, the backup section 65 mg.

E. Samples must be stored in an ice chest and analyzed within 48 hours. Contact SLCAL for information.

F. Use filter and no backup pad.

G. Field method; sample need not be submitted to the laboratory.

H. When standard is the same as for inert dust, noncompliance can be based on gross weight without analysis.

Figure IX-9 Continued

I. Samples may be collected up to an 8-hour period, if the filter is not overloaded.

J. If analysis or antimony and tin are desired, submit separate filters for each metal.

K. If nuisance dust is high, reduce air volume to 30 liters to avoid overloading the filter.

L. Analytical method does not distinguish between dust and fume.

M. When analysis of a compound is requested, an elemental analysis is performed and reported as the compound.

N. Organic material collected on the filter is ashed. The change in weight is reported as the analyte.

O. Collect a sample of the bulk substance and send to the laboratory in a separate mailing container at the time the air samples are submitted. Indicate on the sample sheet that a bulk sample has been submitted. For SiO_2, a high volume area or settled dust sample is preferred.

P. Samples must be collected on a PVC filter to avoid converting Cr^{+6} to Cr^{+3}.

Q. Any sample weight between 0.15 mg and 5.0 mg is acceptable (0.5 to 5.0 mg is preferred). If they are present in the work environment, the following major interferences should be noted: mica, graphite, zircon (zirconium silicate), talc, feldspar, potash, and iron carbide.

R. If present, sulfide should be listed as an interference. Particulate cyanide is collected on a filter, HCN is collected in an impinger.

S. Within 1 hour after the sample has been collected, transfer the filter to a clean screw cap vial.

T. If the relative humidity in the workplace is greater than 80% use a midget impinger with 15 ml of 0.1N H_2SO_4 at a flow rate of 1 lpm for 90 minutes.

U. If the gross weight sample yields a concentration below the standard for the air contaminant, do not submit the sample to the laboratory for analysis.

V. Hydrogen fluoride is collected in the 0.1N NaOH solution or on a Na_2CO_3 impregnated backup pad.

W. Samples should be submitted to the laboratory in Nalgene bottles.

X. Samples should be counted within 24 hours, preferably immediately. Information on the counting procedure may be obtained from Willard Dixon, FTS 588-5366.

Y. During and after sampling, the sample solution must be protected from light to prevent photodecomposition. This may be accomplished by wrapping the impinger and vial with aluminum foil or black tape. Send the samples to the laboratory immediately for analysis. Call the laboratory before beginning sampling.

Z. Within 1 hour after the sample has been collected, transfer the filter to a clean screw cap vial. Add 15 ml of acetic acid solution to the vial.

AA. The mercury vapor monitors are certified accurate for only 90 days.

BB. If present, other sodium compounds should be listed as an interference.

CC. Use 2 charcoal tubes in series, 1 large tube and 1 standard size tube as a backup.

DD. If a gravimetric analysis is not sufficient, submit the filter to the laboratory for analysis.

EE. For volatile arsenic compounds, sample with a MCEF 0.8 um filter followed by a midget impinger containing 10 ml of 0.1 N NaOH.

FF. After sampling, pour the impinger solution into one vial; place the filter in another vial containing isopropanol; place the backup pad in a third vial containing isopropanol.

GG. If a specific analysis is required, collect on a tared LAPVC filter. In this case, a separate filter is required.

HH. If particulate anions are present, a prefilter should be used.

II. Zinc ammonium chlorides and zinc oxide interfere with the analysis and should be reported when present.

JJ. Standard size tube containing 2 sections of 30/48 mesh deactivated Florisil. The adsorbing section contains 100 mg; the backup section contains 50 mg.

KK. Standard size tube containing 2 sections of 20/50 mesh XAD-2 resin. The adsorbing section contains 100 mg of resin; the backup section contains 50 mg.

LL. Standard size tube containing 2 sections of 20/40 mesh petroleum derived activated charcoal. The adsorbing section contains 100 mg of charcoal; the backup section contains 50 mg.

MM. Standard size tube containing 2 sections of 35/60 mesh Tenax GC. The adsorbing section contains 20 mg of Tenax GC; the backup section contains 20 mg of Tenax GC; the backup section contains 10 mg.

NN. Standard size tube containing 2 sections of 60/80 mesh pre-extracted Chromosorb 106. The adsorbing section contains 100 mg; the backup section contains 50 mg.

OO. Standard size tube containing 2 sections of 60/80 mesh pre-extracted chromosorb 104. The adsorbing section contains 100 mg; the backup section contains 50 mg.

PP. Samples must be refrigerated immediately and shipped on ice.

OSHA SAMPLING AND ANALYTICAL TECHNIQUES TABLE

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Acetaldehyde	200	360	MI 10 ml of 1% $NaHSO_3$	120 liters/1.0 lpm	GLC	0.15		D	
Acetic Acid	10	25	MI 10 ml of 0.1N $NaOH_3$	120 liters/1.0 lpm	GLC, IC	0.15	3	D	B
Acetic Anhydride	5	20	MFGB 10 ml of alkaline Hydroxyamine	120 liters/1.0 lpm	Colori.	0.15	1	B	B
Acetone	1000	2400	Activated Charcoal	2 liters/0.05 lpm	GLC	0.26	1	B	A,B
Acetonitrile	40	70	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	B,C
Acetylene Dicholoride (see 1,2-Dichloroethylene)									
Acetylene Tetrabromide	1	14	Silica Gel	120 liters/1.0 lpm	GLC	0.16	1	B	B,D
Acrolein	0.1	0.25	MFGB 15 ml of 1% $NaHSO_3$	120 liters/1.0 lpm	Colori.	0.30	1	B	E
Acrylamide - Skin		0.3	MI 15 ml H_2O	120 liters/1.0 lpm	HPLC	0.15	2	D	
Acrylonitrile Skin	STD 1910.1045		Activated Charcoal	20 liters/0.1 lpm	GLC	0.12	4	B	A,B
Aldrin - Skin		0.25	GFF + MI 15 ml of Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15	5	D	F
Allyl Alcohol - Skin	2	5	Activated Charcoal	10 liters/0.2 lpm	GLC	0.18	1	B	A,B

Substance	Permissible Exposure Limit (PEL) ppm.	mg/m3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Allyl Chloride	1	3	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Allyl Glycidyl Ether (AGE) - Skin	2	12	Tenax - GC	3 liters/0.2 lpm	GLC	0.10		D	
4-Aminobiphenyl	STD 1910.1011		15 ml Isopropanol	40 liters.1.0 lpm	HPLC		2	C	
2-Aminoethanol, (see Ethanolamine)									
Aluminum Oxide		15	LAPVC 5u	960 liters/2.0 lpm	Gravi. or AAS	0.15		B	B,H,I
2-Aminopyridine	0.5	2	MFCB 10 ml of 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
Ammonia	50	35	MI 10 ml of 0.1N H_2SO_4	120 liters/1.0 lpm	ISE or IC	0.23		C	
Ammonium Sulfamate (Amidol)		15	Tared PVC filter 5u	960 liters/2.0 lpm	Gravi.	0.10		D	G,H,I
n-Amyl Acetate	100	525	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
sec-Amyl Acetate	125	650	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Aniline-Skin	5	19	Silica Gel	20 liters/0.2 lpm	GLC	0.15		D	A
Antimony and compounds (as Sb)		0.5	MCEF 0.8 u	960 liters/2.0 lpm	AAS	0.12	1,2	B	I,J
ANTU		0.3	FH	960 liters/0.2 lpm	HPLC	0.25	1	B	
Arsenic and compounds (as As)	STD 1910.1018		MCEF 0.8 u	960 liters/2.0 lpm 2/	AAS-GF or Arsine	0.21	1,2	B	B,EE,I

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Arsine	0.05	0.2	Activated Charcoal	30 liters/0.2 lpm	AAS-GF or Arsine	0.09	1	B	A,B
Asbestos	STD 1910.1001		MCEF 0.8 u (Open face)	240 liters/2.0 lpm	PCM	0.25	1,2	B	B,K
Azinphos-Methyl Skin		0.2	MCEF 0.8u + MI 15 ml of Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15	1	B	
Barium, soluble compounds		0.5	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.09	1,2	B	B,I
p-Benzoquinone (see Quinone)									
Benzene-Skin	STD 1910.1028		Activated Charcoal	20 liters/0.2 lpm TWA 3/	GLC	0.18	2	B	A
Benzidine	STD 1910.1010		GFF + Silica Gel	20 liters/1.0 lpm	HPLC		2	C	
Benzoyl Peroxide		5	MI 10 ml of Dimethyl Phthalate	120 liters/1.0 lpm	HPLC	0.15		D	
Benzo-a-pyrene			AgM	960 liters/2.0 lpm	HPLC	0.33	2	B	A
Benzyl Chloride	1	5	Activated Charcoal	10 liters/0.2 lpm	GLC	0.16	1	B	B
Beryllium and compounds (as Be)	STD 1910.1000	2	MCEF 0.8 u	60 liters/2.0 lpm (CDP) 4/ 960 liters/2.0 lpm (TWA) 3/	AAS-GF	0.15	1,2	B	B,I
Biphenyl, (see Diphenyl)									

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Boron Oxide		15	Tared PVC filter 5u	960 liters/2.0 lpm	Gravi.	0.15		D	G,H,I
Bromine	Pending completion of new analytical method								
Bromoform-Skin	0.5	5	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Butadiene (1, 3-Butadiene)	1000	2200	Activated Charcoal	1 liter/0.05 lpm	GLC	0.10	1	B	A
Butanethiol, (see Butyl Mercaptan)									
2-Butanone (MEK)	200	590	Activated Charcoal	10 liters/0.2 lpm	GLC	0.31	1,2	B	A
2-Butoxyethanol - (Butyl Cellosolve) Skin	50	240	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15	1,2	B	A
Butyl Acetate	150	710	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1,2	B	A
sec-Butyl Acetate	200	950	Activated Charcoal	10 liters/0.2 lpm	GLC	0.08	1,2	B	A
tert-Butyl Acetate	200	950	Activated Charcoal	10 liters/0.2 lpm	GLC	0.08	1,2	B	A
Butyl Alcohol-Skin	100	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1,2	B	A
sec-Butyl Alcohol	150	450	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1,2	B	A
tert-Butyl Alcohol	100	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1,2	B	A
n-Butylamine Glycidyl Ether (BGE)	50	270	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Butyl Mercaptan	10	35	Chrom. 10N	1.5 liters/0.025 lpm	GLC	0.15		D	B,OO
p-tert-Butyl-toluene	10	60	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A
Cadmium dust (as Cd)	STD 1910.1000 Z-2		MCEF 0.8u	60 liters/2.0 lpm (COP) 4/ 960 liters/2.0 lpm (TWA) 3/	AAS AAS	0.12	1,2	B	L,I
Cadmium fume (as Cd)	STD 1910.1000 Z-2		MCEF 0.8u	60 liters/2.0 lpm (COP) 4/ 960 liters/2.0 lpm (TWA) 3/	AAS	0.12	1,2	B	L,I
Calcium Arsenate (as As)		1	MCEF 0.8u	960 liters/2.0 lpm	AAS-GF or Arsine	0.21	1 2	B	M,I M
Calcium Oxide		5	MCEF 0.8u	120 liters/2.0 lpm	AAS	0.11	1,2	B	M,I
Camphor		2	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Carbaryl (Sevin®)		5	Glass Fiber Filter	960 liters/2.0 lpm	HPLC	0.15		C	
Carbon Black		3.5	Tared LAPVC filter, 5u	960 liters/2.0 lpm	Gravi.	0.15	1,2	A	B,I,M
Carbon Disulfide-Skin	STD 1910.1000 Z-2		Activated Charcoal (2 tubes in series)	3 liter/0.1 lpm (COP) 4/ 6 liters/0.2 lpm (TWA) 3/	GLC	0.15	1	B	A,B
Carbon Tetrachloride-Skin	STD 1910.1000 Z-2		Activated Charcoal (2 tubes in series)	1.0 liters/0.1 lpm (COP) 4/ 15 liters/0.1 lpm (TWA) 3/	GLC	0.15	1	D	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Chlordane-Skin		0.5	Glass Fiber Filter	960 liters/2.0 lpm	GLC	0.15		C	
Chlorinated Camphene-Skin (Toxaphene)		0.5	MCEF 0.8 u	960 liters/2.0 lpm	GLC	0.12	1	B	O
Chlorinated Diphenyloxide		0.5	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.12	1	B	
C Chlorine	Pending completion of new analytical method.								
Chlorobenzene (monochlorobenzene)	75	350	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A
Chlorobromo-methane	200	1050	Activated Charcoal	5 liters/0.2 lpm	GLC	0.10	1	B	A
2-Chloro-1,3-butadiene, (see Chloroprene)									
Chlorodiphenyl (42 percent Chlorine)-Skin		1	Florisil	120 liters/1.0 lpm	GLC	0.15		C	O,JJ
Chlorodiphenyl (54 percent Chlorine)-Skin		0.5	Florisil	120 liters/1.0 lpm	GLC	0.11		C	O,JJ
1-Chloro, 2,3-epoxypropane, (see Epichlor-hydrin)									

INDUSTRIAL HYGIENE FOM

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
2-Chloroethanol, (see Ethylene Chlorohydrin)									
Chloroethylene, (see Vinyl Chloride)									
C Chloroform (Trichloro-methane)	50	240	Activated Charcoal	15 liters/1.0 lpm	GLC	0.10	1,2	B	A
bis, Chloromethyl ether	Pending completion of new analytical method								
Chloroprene (2-chloro-1,3-butadiene) Skin	25	90	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
Chromic acid and chromates (as Cr)		0.1	PVC 5u	960 liters/2.0 lpm	colori.	0.10	1,2	B	B,F,M
Chromium, soluble chromic, chromous salts (as Cr)		0.5	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.15	1,2	B	B

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Chromium, metal and insoluble salts (as Cr)		1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.15	1,2	B	M
Coal dust (respirable fraction less than 5% SiO_2; greater than 5% quartz use mass formula)		2.4	Tared, LAPVC 5u preceded by 10 mm cyclone	800 liters/1.7 lpm	XRD	0.26	1,2	B	U,DD
Coal Tar Pitch Volatiles (Benzene soluble fraction)		0.2	AgM	960 liters/2.0 lpm 2/	EG	0.21	1	B	B
Cobalt, metal fume and dust		0.1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.11	1	B	I
Coke Oven Emissions	STD 1910.1029		AgM	960 liters/2.0 lpm 2/	EG	0.21	1	B	B,I
Copper, dusts and mists (as Cu)		1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.12	1	B	L,I
Copper fume (as Cu)		0.1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.12	2	B	L,I
Cresol (all isomers)-Skin	5	22	Silica Gel or XI 10 ml 0.1N NaOH	20 liters/0.2 lpm 120 liters/1.0 lpm	GLC	0.12	1	B C	D

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Cristobalite	STD 1910.1000	2-3	Tared LAPVC, 5u preceded by 10 mm cyclone	800 liters/1.7 lpm 2/	XRD	0.24	1,2	B	B,O,Q
Cumene-Skin	50	245	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
Cyanide-Skin (as CN)		5	MCEF 0.8u e MI 10 ml 0.1 N NaOH	120 liters/0.2 lpm	ISE	0.17	1	B	A
Cyclohexane	300	1050	Activated Charcoal	5 liters/0.2 lpm	GLC	0.11	1	B	A
Cyclohexanol	50	200	Activated Charcoal	10 liters/0.2 lpm	GLC	0.13	1	B	A
Cyclohexene	300	1015	Activated Charcoal	5 liters/0.2 lpm	GLC	0.10	1	B	A
Cyclopentadiene	75	200	MI 15 ml Maleic Anhydride in Ethyl Acetate	50 liters/1.0 lpm	GLC	0.09	1	B	
2,4-D (2,4 Dichlorophenoxyacetic acid)		10	FH	960 liters/2.0 lpm	GLC	0.15	1	C	
DDT-Skin		1	Glass Fiber Filter	960 liters/2.0 lpm	GLC	0.10	1	B	C
DDVP-Skin		1	XAD	240 liters/1.0 lpm	GLC	0.15	1	C	KK
Demeton® (Systox) Skin		0.1	GFF + MI 15 ml Ethylene glycol	240 liters/1.0 lpm	GLC	0.15		C	

Substance	Permissible Exposure Limit (PEL) ppm.	mg/m3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Diacetone Alcohol (4-Hydroxy-4-methyl-2-pentanone)	50	240	Activated Charcoal	10 liters/0.2 lpm	GLC	0.17	1	B	A
1,2-Diaminoethane, (see Ethylene-diamine)									
Diazomethane	0.2	0.4	XAD-2	10 liters/0.2 lpm	GLC	0.14		C	EK
1,2-Dibromo-3-Chloropropane (DBCP)	STD 1910.1044		Activated Charcoal	10 liters/0.2 lpm (TWA) 2/ 3 liters/0.2 lpm (CEP) 2/	GLC	0.12	2	B	B,LL
Dibutyl Phosphate	1	5	FH	960 liters/0.2 lpm	GLC	0.09	1	B	
Dibutylphthalate		5	MCEF 0.8u	30 liters/1.0 lpm	GLC	0.10	1	B	
o-Dichloro-benzene	50	300	Activated Charcoal	3 liters/0.2 lpm	GLC	0.11	1,2	B	A
p-Dichloro-benzene	75	450	Activated Charcoal	3 liters/0.05 lpm	GLC	0.08	1	B	A
3,3 Dichloro-benzidine	STD 1910.1007		OFF + Silica Gel	200 liters/1.0 lpm	HPLC		2	C	
Dichlorodifluoro-methane (F-12)	1000	950	Activated Charcoal (2 tubes in series)	2 liters/0.05 lpm	GLC	0.20	1,2	B	B,C
1,1-Dichloroethane (Ethylene Dichloride) Skin	100	400	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
1,2-Dichloro-ethylene	200	790	Activated Charcoal	3 liters/0.2 lpm	GLC	0.09	1	B	A
C Dichloroethyl Ether-Skin	15	90	Activated Charcoal	15 liters/1.0 lpm	GLC	0.10	1	B	A
Dichloromono-fluoromethane (F-21)	1000	4200	Activated Charcoal (2 tubes in series)	2.0 liters/0.05 lpm	GLC	0.15			B,C
C 1,1-Dichloro-1-nitroethane	10	60	Activated Charcoal	15 liters/1.0 lpm	GLC	0.09	1	B	A
1,2-Dichloropropane (see Propylene Dichloride)									
Dichloromethane (see Methylene Chloride)									
Dichlorotetra-fluoroethane	1000	7000	Activated Charcoal (2 tubes in series)	2.0 liters/0.05 lpm	GLC	0.16	1	B	B,C
Dieldrin - Skin		0.25	Glass Fiber Filter	240 liters/2.0 lpm	GLC	0.15	1	C	S
Diethylamine	25	75	MI + 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
Diethylether (see Ethyl Ether)									
Diethylstibestrol			FH	960 liters/2.0 lpm	HPLC	0.15	10	B	

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Max. Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Difluorodibromo-methane (F-12-B2)	100	860	Activated Charcoal (2 tubes in series)	10 liters/0.2 lpm	GLC	0.15	1	B	A
Dihydroxybenzene, (see Hydroquinone)									
Diisobutyl Ketone	50	290	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Diisopropylamine - Skin	5	20	MI + 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
Dimethoxymethane, (see Methylal)									
Dimethyl Acetamide - Skin	10	35	MI + 10 ml 0.1N H_2SO_4	120 liters.1.0 lpm	GLC	0.15		D	
Dimethylamine	10	18	MI e 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
4, Dimethylaminoazo-benzene	STD 1910.1015		Glass Fiber Filter	50 liters/0.2 lpm	HPLC			C	
Dimethylaminobenzene, (see Xylidine)									
Dimethylaniline (N-dimethylaniline) - Skin	5	25	Activated Charcoal	10 liters/0.2 lpm	GLC	0.08	1	B	A
Dimethylbenzene, (see Xylene)									

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Max. Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Dimethyl 1,2-dibromo-2,2-dichloroethyl phosphate, (Dibrom)	3		MI 15 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15	1	B	
Dimethylformamide - Skin	10	30	Silica Gel	60 liters/1.0 lpm	GLC	0.09	1	B	D,T
2-6-Dimethylheptanone, (see Diisobutyl Ketone)									
Dimethylphthalate		5	MI 15 ml Isopropanol	90 liters/1.0 lpm	GLC	0.15		C	
Dimethyl Sulfate-Skin	1	5	Silica Gel	60 liters/1.0 lpm	GLC	0.15		D	D
Dinitrobenzene (all) isomers) - Skin		1	MCEF 0.8u e MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	HPLC	0.15		C	
Dinitrotoluene - Skin		1.5	MCEF 0.8u e MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	HPLC	0.15		C	
Dioxane (Diethylene Dioxide) - Skin	100	360	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
Diphenylmethane diisocyanate, (see Methylene Bisphenyl Isocyanate (MDI))									
Diphenyl	0.2	1	Tenax GC	30 liters/0.2 lpm	GLC	0.12	1	B	MH
Dipropylene Glycol Methyl Ether - Skin	100	600	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/m3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Di-sec, Octyl Phthalate (Di-2-Ethylhexyl-phthalate)		5	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.09	1	B	
Endrin-Skin		0.1	OFF + MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15		C	
Epichloro-hydrin-Skin	5	19	Activated Charcoal	20 liters/0.2 lpm	GLC	0.09	1	B	A,B
EPN-Skin		0.5	OFF + 10 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.10	1	B	S
1,2-Epoxypropane, (see Propylene oxide									
2,3,-Epoxy-1-propanol (see Glycidol)									
Ethanolamine	3	6	MI + 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15			D
2-Ethoxyethanol (Cellosolve)-Skin	200	740	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A,B

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Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
2-Ethoxyethyl-acetate (Cellosolve acetate)-Skin	100	540	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
Ethyl Acetate	400	1400	Activated Charcoal	5 liters/0.2 lpm	GLC	0.10	1,2	B	A
Ethyl Acrylate-Skin	25	100	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A
Ethyl Alcohol (Ethanol)	1000	1900	Activated Charcoal	1 liter/0.05 lpm	GLC	0.11	1	B	A
Ethylamine	10	18	NI + 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
Ethyl sec-Amyl Ketone (4 methyl-3-heptanone)	25	130	Activated Charcoal	10 liters/0.2 lpm	GLC	0.17	1	B	A
Ethyl Benzene	100	435	Activated Charcoal	10 liters/0.2 lpm	GLC	0.07	1	B	A
Ethyl Bromide	200	890	Activated Charcoal	5 liters/0.2 lpm	GLC	0.09	1	B	A
Ethyl Butyl Ketone (3-Heptanone)	50	230	Activated Charcoal	10 liters/0.2 lpm	GLC	0.14	1	B	A
Ethyl Chloride	1000	2600	Activated Charcoal (2 tubes in series)	1 liter/0.05 lpm	GLC	0.12	1	B	CC

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	Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
	Ethyl Ether	400	1200	Activated Charcoal	3 liters/0.2 lpm	GLC	0.08	1	B	A
	Ethyl Formate	100	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.13	1	B	A
	Ethyl Silicate	100	850	XAD-2	9 liters/0.05 lpm	GLC	0.09		C	KK
	Ethylene Chloro-hydrin-Skin	5	16	Activated Charcoal	20 liters/0.2 lpm	GLC	0.12	1	B	B,LL
	Ethylenediamine	10	25	MI + 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
	Ethylene Dibromide (1,2-Dibromo-emethane)	STD 1910.1000		Z-2	Activated Charcoal	1.0 liters/0.2 lpm (CEP)4/ 10 liters/0.2 lpm (TWA)3/	GLC	0.12	1	B	A
	Ethylene dichloride (1,2-Dichloroe-thane)	STD 1910.1000		Z-2	Activated Charcoal	1.0 liters/0.2 lpm (CEP)4/ 10 liters/0.2 lpm (TWA)3/	GLC	0.13	1	B	A
C	Ethylene, glycol dinitrate and/or Nitroglycerin - Skin	0.2	1	Tenax GC	480 liters/1.0 lpm	HPLC or GC	0.15		C	MM
	Ethylene glycol mono-methyl ether acetate, (see, Methyl cello-solve acetate)									

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Ethylene oxide	50	90	Activated Charcoal (2 tubes in series)	3 liters/0.05 lpm	GLC	0.15		C	A,B
Ethylidine Chloride (see 1,1-Dichloroethane)									
N-Ethylmorpholine - Skin	20	94	Silica Gel	10 liters/0.2 lpm	GLC	0.12	1	B	D,T
Ferbam		15	Glass Fiber Filter	960 liters/2.0 lpm	HPLC	0.15		C	I
Ferrovanadium dust		1	MCEF 0.8 u	960 liters/2.0 lpm	AAS	0.15	2	C	M,I
Fluoride (as F)		2.5	MCEF 0.8u	960 liters/2.0 lpm	ISE	0.15	2	B	I
Fluorotrichloro-methane (F-11)	1000	5600	Activated Charcoal (2 tubes in series)	1 liter/0.05 lpm	GLC	0.13	1	B	C
Formaldehyde	STD 1910.1000	Z-2	MFGB 15 ml 10% Methanol	30 liters/1.0 lpm (COP) 4/ 120 liters/1.0 lpm (TWA) 3/	Polaro.		11	D	W
Formic acid	5	9	CH_2Cl_2 + 10 ML 0.1N NaOH	120 liters/1.0 lpm	IC	0.15		C	
Furfural-Skin	5	20	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A,B
Furfuryl Alcohol-Skin	50	200	XAD-2	5 liters/0.05 lpm	GLC	0.12		B	KK

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Glycidol (2,3-Epoxyl-1 -phropanol)	50	150	Activated Charcoal	50 liters/1.0 lpm	GLC	0.13	1	B	A,B PP
Glycol monoethyl ether, (see 2-Ethoxyethanol)									
Graphite (synthetc)	15 mppcf		MI 15 ml 95% Ethyl Alcohol	84 liters/28 lpm	PC			B	X
Guthion (see Azinphos-methyl)									
Heptachlor - skin	0.5		GFF + MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15		C	
Heptane (n-Heptane)	500	2000	Activated Charcoal	5 liters/0.2 lpm	GLC	0.09	1,2	B	A
Hexachloroethane skin	1	10	Activated Charcoal	30 liters/0.2 lpm	GLC	0.20	1	B	A,B
Hexachoronaph-thalene-skin		0.2	MCEF 0.8 u	960 liters/2.0 lpm	GLC	0.11	1	B	B
Hexane (n-Hexane)	500	1800	Activated Charcoal	5 liters/0.2 lpm	GLC	0.10	1,2	B	A
2-Hexanone (MBK) skin	100	410	Activated Charcoal	10 liters/0.2 lpm	GLC	0.07	1,2	B	A

	Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
	Hexane (Methyl Isobutyl ketone) skin	100	410	Activated Charcoal	10 liters/0.2 lpm	GLC	0.16	1,2	B	A
	sec-Hexyl Acetate	50	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
	Hydrogen Bromide	3	10	MI 15 ml 0.01N NaOH	120 liters/1.0 lpm	ISE or IC	0.12	1		B,C
C	Hydrogen Chloride	5	7	MI 10 @ 0.0 N NaOH	15 liters/1.0 lpm (COF)	ISE or IC	0.39	2	C	H;
	Hydrogen Cyanide	10	11	MCEF 0.8u + MI 10 ml 0.1N NaOH	120 liters/1.0 lpm	ISE	0.17	2	B	R
	Hydrogen Fluoride	3-10		MCEF 0.8u @ MI 10 ml 0.0 in NaOH	30 liters/1.0 lpm (COF) 120 liters/1.0 lpm (TWA)	ISE	0.15		B	
	Hydrogen Peroxide (90%)	1	1,4	MFOB 10ml TI (SO_4 $9H_2O$	120 liters/1.0 lpm	Colori.	0.15		B	
	Hydrogen Sulfide	STD 1910.1000, Z-2		MI 10 ml alkaline CD So_4	2 liters/0.2 lpm	Colori.	0.20	1,2	B	I
	Hydroquinone			MCEF 0.8u	960 liters/2.0 lpm	HPLC	0.10	1	B	I,Z
C	Iodine	Pending completion of new analytical method								
	Iron Oxide (fume)		10	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.12	1,2	B	I,L
	Isoamyl Acetate	100	525	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Isobutyl Acetate	150	700	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Isobutyl Alcohol	100	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1,2	B	A
Isophorone	26	140	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10		C	LL
Isopropyl Acetate	250	950	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A
Isopropyl Alchol-skin	400	980	Activated Charcoal	3 liters/0.1 lpm	GLC	0.14	1	B	A
Isopropylamine	5	12	MFGB 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.11	1	B	A
Isopropy Ether	500	2100	Activated Charcoal	3 liters/0.05 lpm	GLC	0.09	1	B	A
Isopropyl Glycidyl Ether (IGE)	50	240	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A
Ketene	05	0.9	MFGB 10 ml alkaline hydroxylammonium chloride	60 liters/1.0 lpm	Colori.	0.11	1	B	I
Lead Arsenate		0.15	MCEF 0.8u	960 liters/2.0 lpm	AAS-GF or Arsine	0.21	1 2	B B	M,I M
Lead and its inorganic compounds	STD 1910.1025		MCEF 0.8u	960 liters/2.0 lpm	AAS	0.12	1,2	B	I
Lindane		0.5	GFF + MI 15 ml Ethylene glycol	90 liters/2.0 lpm	GLC	0.14	1	B	F

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Magnesium Oxide (fume)		15	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.10	1,2	B	I,L,M
Malthion skin		15	GFF + 10 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15	1	B	
Maleic Anhydride	0.25	1	FH + MI 15 ml Isopropanol	60 liters/1.0 lpm	HPLC	0.15		D	FF
C Manganese and compounds (as Mn)		5	MCEF 0.8u	30 liters/2.0 lpm	AAS	0.10	1,2	B	
Mercury-skin		0.1	Mercury Vapor Monitor						
Mesityl oxide	25	100	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Methoxychlor	15	10	GFF + MI ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15		B	
2-Methoxyethanol, (see Methyl cellosolve)									
Methyl Acetate	200	610	Activated Charcoal	5 liters/0.2 lpm	GLC	0.09	1	B	A
Methyl Acetylene (propyne)	1000	1650	Activated Charcoal (2 tubes in series)	2 liters/0.05 lpm	GLC	0.15		C	A
Methyl Acetylene-Propadiene mixture (MAPP)	1000	1800	Activated Charcoal	2 liters/0.05 lpm	GLC	0.10	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Methyl Acrylate skin	10	35	Activated Charcoal	5 liters/0.2 lpm	GLC	0.11	1	B	A
Methylal	1000	3100	Activated Charcoal	2 liters/0.05 lpm	GLC	0.10	1	B	A,B
Methyl Alcohol (Methanol) skin	200	260	Silica Gel or Distilled water	5 liters/0.2 lpm 120 liters/1.0 lpm	GLC	0.12	1	B	D
Methylamine	10	12	HI 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	D
Methyl Amyl Alcohol (see Methyl isobutyl carbinol)									
C Methyl Bromide skin	20	80	Activated Charcoal	3 liters/0.2 lpm	GLC	0.16	1	B	C,LL
Methyl Butyl Ketone (see 2-Hexanone)									
Methyl cello-solve (2-methoxy ethanol)- skin	25	80	Activated Charcoal	30 liters/0.2 lpm	GLC	0.11	1	B	A,B

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Methyl Cellosolve Acetate (Ethylene Glycol Monomethyl Ether Acetate) - skin	25	120	Activated Charcoal	20 liters/0.2 lpm	GLC	0.11	1	B	A,B
Methyl Chloroform	350	1900	Activated Charcoal	5 liters/0.2 lpm	GLC	0.11	1,2	B	A
Methyl Chloromethyl Ether									
Methylcyclohexane	500	2000	Activated Charcoal	5 liters/0.2 lpm	GLC	0.08	1	B	A
Methycyclo-hexanol	100	470	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A
O-Methylcycol hexanone skinm	100	460	XAD-2	3 liters/0.05 lpm	GLC	0.10		C	KK
4, 4 Methylene bis (2 Chloroaniline)	STD 1910.1005		glass fiber filter	300 liters/1.5 lpm	HPLC		2	C	
C Methylene Bisphenyl Isocyanate (MDI)	0.02	0.2	MI 10 ml Nitro regeant	15 liters/1.0 lpm	HPLC			C	
Methylene Chloride (Dichloromethane)	STD 1910.1000, Z-2		Activated Charcoal (2 tubes in series)	1 liter/0.2 lpm (CQP)4/ 2.0 liters/0.05 lpm (TWA)3/	GLC	0.15	1	B	A,B

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Methyl Ethyl Ketone (MEK), (see 2-Butanone)									
Methyl Formate	100	250	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A
Methyl Iodide skin	5	28	Activated Charcoal	50 liters/1.0 lpm	GLC	0.12	1	B	A,B
Methyl Isobutyl Carbinol skin	25	100	Activated Charcoal	10 liters/0.2 lpm	GLC	0.13	1	B	A
Methyl (n-amyl)	100	465	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A
Methyl Isobutyl Ketone (see Hexone)									
Methyl Methacrylate	100	410	Activated Charcoal	10 liters/0.2 lpm	GLC	0.21	1	B	A
Methyl Propyl Ketone (see 2-Pentanone)									
alpha Methyl Styrene	100	480	Activated Charcoal	3 liters/0.2 lpm	GLC	0.09	1	B	A
Molybdenum (insoluble compounds)		15	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.09	1,2	B	I
Molybdenum (soluble compounds)		5	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.15	1	B	

	Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
	Monomethyl Aniline skin	2	9	MI 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15	1	B	
C	Monomethyl Hydrazine	0.2	0.35	MI 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		C	
	Morpholine skin	20	70	MI 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.15		D	
	Naphtha (coal Tar)	10	50	Activated Charcoal	10 liters/0.2 lpm	GLC	0.08	1	B	A,O
	Naphthalene	10	50	Activated Charcoal	20 liters/0.2 lpm	GLC	0.09	1	B	A
	Nickel Carbonyl	0.001	0.007	MCEF 0.8u + MI 10 ml 3% HCl	240 liters/1.0 lpm	AAS-GF	0.15		C	M
	Nickel, metal and soluble compounds (as Ni)		1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.11	1,2	B	I
	alpha naphthylamine	*STD 1910.1004*		15 ml isopropyl alcohol	*20 liters/0.2 lpm*	*HPLC*		2	C	
	beta naphthylamine	STD 1910.1009		15 ml isopropyl	20 liters/0.2 lpm	HPLC		2	C	
	Nicotine skin		0.5	XAD-2	120 liters/1.0 lpm	GLC	0.11	1	B	B,KK
	Nitric Acid	2	5	MI 15 ml H_2SO_4	120 liters/1.0 lpm	IC	0.19		C	
	Nitrobenzene skin	1	5	Silica Gel	60 liters/1.0 lpm	HPLC	0.10		D	

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
p-Nitrochloro-Benzene-Skin		1	Silica Gel	60 liters/1.0 lpm	GLC	0.17	1	B	D
Nitroethane	100	310	XAD-2 (2 series) tubes in	1.5 liters/0.05 lpm	GLC	0.15		C	KK
C Nitrogen Dioxide	5	9	TEA-Molecular Sieve	1.0 liter/0.05 lpm	Colori.	0.15	1	D	
C Nitroglycerin Skin	0.2	2	Tenax GC	15 liters/1.0 lpm	HPLC or GC	0.17	1	B	MM
Nitromethane	100	250	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A
1-Nitropropane	25	90	Activated Charcoal	10 liters/0.2 lpm	GLC	0.15		C	A
2-Nitropropane	25	90	Chromosorb 106	3 liters/0.05 lpm	GLC	0.15		C	NN
Nitrotoluene Skin	5	30	Silica Gel	20 liters/0.2 lpm	GLC	0.10	1	B	D
Nitrotrichlorome-thane, (see Chloropicrin)									
Nuisance Dust		15	PVC 5.0u	960 liters/2.0 lpm	Gravi.	0.10	1	A	H,I,D,D
Octachloronaph-thalene-Skin		0.1	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.11	1	B	B

Substance	Permissible Exposure Limit (PEL) ppm.	mg/m3	Collection Method	Maximum Volume/ Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Octane	500	2350	Activated Charcoal	5 liters/0.1 lpm	GLC	0.10	1	B	A
Oil Mist, (mineral)		5	Tared PVC filter 5u	960 liters/2.0 lpm	Gravi. Fluoro.	0.14		C	0,I,U
Ozone	0.1	0.2	MI 10 ml 1% KI in 1N NaOH	120 liters/1.0 lpm	Colori.	0.13	1	B	I
Parathion Skin	0.1	CRF	Glass Fiber Filter	960 liters/2.0 lpm	GLC	0.12	1	B	S
Pentachloro-naphthalene Skin		0.5	GFF + MI 15 ml	270 liters/1.0 lpm	GLC	0.11	1	B	O
Pentachlorophenol Skin		0.5	Glass Fiber Filter	960 liters/2.0 lpm	HPLC	0.15		D	
Pentane	1000	2950	Activated Charcoal	2 liters/0.05 lpm	GLC	0.09	1	B	A
2-Pentanone	200	700	Activated Charcoal	10 liters/0.2 lpm	GLC	0.11	1	B	A
Perchloroethylene, (see Tetrachloro-ethylene)									
Petroleum distillates (Naphtha)	500	2000	Activated Charcoal	5 liters/0.2 lpm	GLC	0.08	1	B	A,O

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Phenol-Skin	5	19	MI 15 ml 0.1N NaOH	120 liters/1.0 lpm	GLC	0.12	1	B	
Phenyl Ether (vapor)	1	7	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
Phenyl Ether-Biphenyl mixture (vapor)	1	7	Silica Gel	10 liters/0.2 lpm	GLC	0.15	1	B	D
Phenylethylene, (see Styrene)									
Phenylglycidyl Ether (PGE)	10	60	Activated Charcoal	50 liters/1.0 lpm	GLC	0.09	1	B	A,B
Phosdrin (Mevinphos®) Skin		0.1	GFF + MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	GLC	0.15	1	B	
Phosphoric Acid		1	MCEF 0.8u	960 liters/2.0 lpm	IC	0.14		C	I
Phosphorus (Yellow)		0.1	Tenax GCu	10 liters/0.2 lpm	GLC	0.15	1	B	
Phthalic Anhydride	2	12	FH + MI 15 ml Isopropanol	60 liters/1.0 lpm	HPLC	0.15		D	FF
Platinum (soluble salts) as Pt		0.002	MCEF 0.8u	960 liters/s.0 lpm 2/	AAS-GF	0.11	1	B	B,I
n-Propyl Acetate	200	840	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE) 1/	Ref.	Method Class	Notes
Propyl Alcohol	200	500	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1,2	B	A
N-Propyl Nitrate	25	110	Activated Carcoal	50 liters/1.0 lpm	GLC	0.15		C	B,LL
Propylene Dichloride	75	350	Activated Charcoal	10 liters/0.2 lpm	GLC	0.07	1	B	A
Propylene Oxide	100	240	Activated Charcoal	5 liters/0.2 lpm	GLC	0.14	1	B	A
Propyne, (see Methyl-acetylene)									
Pyridine	5	15	Activated Charcoal	50 liters/1.0 lpm	GLC	0.10	1	B	A,B
Quartz (respirable)	STD 1910.1000, Z-3		Tared LAPWC 5u preceded by 10mm cyclone	800 liters/1.7 lpm 2/	XRD	0.24	1,2	B	O,Q
Quinone (p-Benzoquinone)	0.1	0.4	XAD-2	20 liters/0.2 lpm	HPLC	0.16		C	KK
RDX - Skin		1.5	Glass Fiber Filter	960 liters/2.0 lpm	HPLC	0.15		C	
Rhodium, (metal fume and dusts) as Rh		0.1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.13	1	B	I
Rhodium, (soluble salts) as Rh		0.001	MCEF 0.8u	960 liters/2.0 lpm 2/	AAS-GF	0.12	1	B	B
Rotenone (commercial)		5	MI 10 ml Ethylene Glycol	240 liters/1.0 lpm	HPLC	0.15		D	

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Selenium compounds (as Se)		0.2	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.15	1,2	B	
Silica (see Quartz)									
Silver (metal and soluble compounds) (as Ag)		0.01	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.19	1	B	I
Sodium Hydroxide		2	MCEF 0.8u	960 liters/2.0 lpm	AAS or IC	0.11		C	B,BB,I
Stoddard Sovent	500	2900	Activated Charcoal	5 liters/0.2 lpm	GLC	0.08	1	B	A,O
Styrene (Phenylethylene)	STD 1910.1000, Z-2		Activated Charcoal	1 liters/0.2 lpm (CDP)3/ 10 liters/0.2 lpm (TWA)2/	GLC	0.11	1,2	B	A
Sulfur Dioxide	5	13	MCEF 0.8u + NI 15 ml 0.3 M H_2O_2	120 liters/1.0 lpm	IC	0.14	2	B	H,N
Sulfuric Acid		1	MCEF 0.8u	480 liters/2.0 lpm	IC	0.14	1,2	B	B
Systox (see Demeton4) - Skin									
2,4,5T		10	Glass Fiber Filter	960 liters/2.0 lpm	GLC	0.15		C	
Talc, (total)	STD 1910.1000, Z-3		MI 10 ml Isopropanol	30 liters/2.8 lpm	PC	0.25		B	G

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M^3	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Talc (fibrous Tremolite)	STD 1910.1001		MCEF 0.8u (open face)	70 liters/2.0 lpm	PCM	0.25	1,2	B	B,K
Talc (fibrous non-Tremolite)	20 mppcf		MI 10 ml Isopropanol	30 liters/2.8 lpm	PC	0.25		B	G
Tantalum		5	MCEF 0.8u	960 liters/2.0 lpm	AAS-GF	0.15		C	
Tellurium		0.1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.09	1,2	B	
Telurium Hexafluoride (as Te)	0.02	0.2	Activated Charcoal	400 liters/1.0 lpm	AAS	0.09	1	C	A,M
C Terphenyls	1	9	MCEF 0.8u	30 liters/2.0 lpm	GLC	0.16	1	B	
1,1,1,2-Tetra-chloro-2,2-Difluoroethane	500	4170	Activated Charcoal	2 liters/0.05 lpm	GLC	0.12	1	B	A
1,1,2,2-Tetra-chloro-1,2-Difluoroethane	500	4170	Activated Charcoal	2 liters/0.05 lpm	GLC	0.09	1	B	A
1,1,2,2-Tetra-chloroethane Skin	5	35	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A,LL

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Tetrachloroethylene (Perchloroethylene) Skin	STD 1910.1000, Z-2		Activated Charcoal	1 liter/0.2 lpm (CGP)2/ 10 liters/0.2 lpm (TWA)3/	GLC	0.12	1,2	B	A
Tetrachloronaphthalene - Skin		2	GFF + MI 15 ml Isopropanol	90 liters/1.5 lpm	GLC	0.16	1	B	C,F
Tetraethyl-Lead (as Pb)-Skin		0.075	Activated Charcoal	240 liters/1.0 lpm	AAS	0.15		C	A
Tetrahydrofuran	200	590	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1,2	B	A
Tetramethyl lead (as Pb) Skin		0.075	Activated Charcoal	240 liters/1.0 lpm	AAS	0.15		C	A
Tetramethyl Succinonitrile Skin	0.5	3	Activated Charcoal	50 liters/1.0 lpm	GLC	0.12	1	B	A,B
Tetryl (2,4,6-Trinitrophenylmethylnitramine) - Skin		1.5	MCEF 0.8u	960 liters/2.0 lpm	Colori.	0.11	1	B	
Thallium (soluble coumpouds) as Tl Skin		0.1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.10	1,2	B	B
Thiram[H]		5	Glass Fiber Filter	960 liters/2.0 lpm	HPLC	0.15		C	
Tin (inorganic compounds except oxides) as Sn		2	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.15	1,2	B	B,I

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Titanium Dioxide		15	LAPWC 5u	960 liters/2.0 lpm	Gravi.	0.18	1,2	B	B,H
Toluene-Skin	STD 1910.1000, Z-2		Activated Charcoal	2 liters/0.2 lpm (COF)3/ 10 liters/0.2 lpm (TWA) 3	GLC	0.09	1,2	B	A
C Toluene-2,4-diisocyanate. (TDI)	0.02	0.14	10 ml Nitro Reagent	15 liters/1.0 lpm	HPLC			C	
o-Toluidine Skin	5	22	Silica Gel	50 liters/1.0 lpm	GLC	0.10	1	B	D,T
Toxaphene, (see Chlorinated camphene)									
Tributyl-phosphate	5	NOSF	NOSF 0.8u	960 liters/2.0 lpm	GLC	0.12	1	B	
1,1,1-Trichloro-ethane (see Methyl chloroform)									
1,1,2- Trichloro-ethane - Skin	10	45	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Trichloroethylene	STD 1910.1000, Z-2		Activated Charcoal	1.0 liters/0.2 lpm (COP)4/ 10 liters/0.2 lpm (TWA)3/	GLC	0.01	1,2		
Trichloromethane, (see Chloroform)									
Trichloronaphthalene Skin		5	GFF + MI 15 ml Isopropanol	120 liters/1.0 lpm	GLC	0.19	1	B	F
1,2,3-Trichloropropane	50	300	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A
1,1,2-Trichloro 1,2,2-trifluoroethane	1000	7600	Activated Charcoal	1.5 liters/0.05 lpm	GLC	0.12	1	B	A,B
Triethylamine	25	100	MFGB 10 ml 0.1N H_2SO_4	120 liters/1.0 lpm	GLC	0.11	1	B	
Trifluoromonobromo-methane	1000	6100	Activated Charcoal	1 liter/0.05 lpm	GLC	0.11	1	B	B,CC
2,4,6-Trinitrophenol, (see Picric acid)									
2,4,6-Trinitrophenyl-methylnitramine (see Tetryl)									
Trinitrotoluene (TNT)-Skin		1.5	FH + Tenax GC	120 liters/1.0 lpm	HPLC	0.15		D	

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M³	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Triorthoresyl Phosphate		0.1	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.14	1	B	
Triphenyl Phosphate		3	MCEF 0.8u	960 liters/2.0 lpm	GLC	0.11	1	B	
Turpentine	100	560	Activated Charcoal	10 liters/0.2 lpm	GLC	0.09	1	B	
C Vanadium, V_2O_5 dust		0.5	MCEF 0.8u	30 liters/2.0 lpmpm	AAS-QF	0.21		C	L
C Vanadium, V_2O_5 fume		0.1	MCEF 0.8u	30 liters/2.0 lpm	AAS-QF	0.21	1	B	L
Vinyl Benzene, (see Styrene)									
C Vinyl Chloride	STD 1910.1017		Activated Charcoal (2 tubes in series)	1 liters/0.05 lpm	GLC	0.15	1	B	A,B
Vinyloyanide, (see Acrylonitrile)									
Vinyl Toluene	100	480	Activated Charcoal	10 liters/0.2 lpm	GLC	0.10	1	B	A
Warfarin		0.1	FH	960 liters/2.0 lpm	HPLC	0.15		D	
Xylene (Xylol) Skin	100	435	Activated Charcoal	10 liters/0.2 lpm	GLC	0.12	1	B	A

Substance	Permissible Exposure Limit (PEL) ppm.	mg/M3	Collection Method	Maximum Volume Maximum Flow Rate	Analytical Method	Sampling and Analytical Error (SAE)1/	Ref.	Method Class	Notes
Pyridine - Skin	5	25	Silica Gel	20 liters/0.2 lpm	GLC	0.09	1	B	D,T
Yttrium		1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.09	1	B	B
Zinc Chloride (Fume)		1	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.11	1	B	I,M
Zinc Oxide (Fume)		5	LAPVC 5u	960 liters/2.0 lpm	XRD	0.11		B	L
Zirconium compounds (as Zr)		5	MCEF 0.8u	960 liters/2.0 lpm	AAS	0.09	1	B	B

1/ Factor includes the entire sampling and analytical process. Refer to Section A.11 of Chapter II of this manual for further explanation.

2/ Full shift sample required for analysis.

3/ TWA-Sample volume for a time-weighted average determination.

4/ CDF- Sample volume for a ceiling or peak determination.

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GUIDES AND REFERENCES

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