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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HAZARD EVALUATION AND TECHNICAL ASSISTANCE
REPORT NO. TA 79-10

ENVIRONMENTAL PROTECTION AGENCY
BELTSVILLE AGRICULTURAL RESEARCH CENTER
BELTSVILLE, MARYLAND

JULY 1979

I. SUMMARY

On January 17 and 30, 1979, NIOSH Regional (III) Industrial Hygienist, Frank A. Lewis, conducted a walk-through and environmental survey for organic vapors in Lab Building 409 - EPA Beltsville Agricultural Research Center in Beltsville, Maryland. Personal air samples were taken to determine possible employee exposure to benzene, acetonitrile, tetrahydrofuran and 1,4 dioxane vapors and to evaluate laboratory hood performance.

It is the judgement of this Regional Industrial Hygienist that the employees in this laboratory would not be exposed to potentially toxic concentrations of these organic vapors. In fact, all of the samples taken were below the reliable analytical limit of detection for each substance (benzene = 0.02 mg, acetonitrile = 0.02 mg, tetrahydrofuran = 0.01 mg,and 1,4 dioxane = 0.01 mg).

This is well below the environmental criteria for each of these substances:

Benzene - 1 ppm (60 min. ceiling)/NIOSH; 10 ppm (8-hr.TWA)/ACGIH; 10 ppm (8-hr.TWA), 25 ppm (15 min. ceiling)/OSHA's current standard and 1 ppm (8-hr.TWA), 5 ppm (15 min. ceiling)/OSHA's proposed standard.

Acetonitrile - 40 ppm (8-hr.TWA), 60 ppm (15 min. STEL)/ACGIH; 40 ppm (8-hr.TWA)/OSHA.

Tetrahydrofuran - 200 ppm (8-hr.TWA), 250 (15 min. STEL)/ACGIH; 200 ppm (8-hr.TWA)/OSHA.

1,4-Dioxane - 1 ppm (30 min. ceiling)/NIOSH; 25 ppm (8-hr.TWA), 100 ppm (15 min. STEL) skin/ACGIH; 100 ppm (8-hr.TWA) skin/OSHA.

II. DISTRIBUTION AND AVAILABILITY OF REPORT

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(i) Director, NIOSH
(j) Director, DSHEFS
(k) William E. Shoemaker, NIOSH Regional Program Consultant, Region III
(l) Frank A. Lewis, NIOSH Regional Industrial Hygienist, Region III

III. INTRODUCTION

On December 18, 1978, NIOSH Region III, received a request from the OSHA Office of Federal Agency Programs for technical assistance concerning the EPA laboratory fume hoods and toxic materials storage area in Building 409. OSHA wanted NIOSH to resolve a long-standing EPA employee/union complaint concerning this facility at the Beltsville Agricultural Research Center.

NIOSH Regional Industrial Hygienist, Frank A. Lewis, met with EPA management officials, union representatives and a representative from the OSHA Office of Federal Agency Programs in order to resolve the occupational health problems (See Attachment I for listing). A walk-through survey and environmental sampling for organic vapors was conducted on January 17 and 30, 1979.

Eight-hour TWA and 15-minute ceiling value samples were taken in the breathing zone of two chemists working at lab hoods #1, #4, and #5 to determine exposure to benzene, acetonitrile, tetrahydrofuran and 1,4-dioxane vapors.

IV. TECHNICAL ASSISTANCE EVALUATION

A. Description - Conditions of Use

Building 409 is a pesticides residue laboratory which is utilized to validate analytical methods that have been developed to measure residues and set tolerances for pesticides. The building contains five air-supplied laboratory hoods, several lab benches and analytical apparatus and instrumentation. A make-up air system is incorporated into the laboratory ventilation system and consists of a perforated rectangular duct running the length of the lab to bring in laminarly diffused air of low velocity through outside fans. Two to three chemists may work in this area at any one time. Behind Building 409 is a free-standing chemical storage shack in which are stored various chemicals and solvents used in the laboratory (e.g. tetrahydrofuran, methanol, ethanol, pentane, hexane, petroleum ether, benzene, toluene, ethyl ether, ethyl acetate, acetonitrile, acetone, chloroform, and methylene chloride). Usage is dependent on what is required for a specific analytical method.

B. Evaluation Design

Personal air samples were taken in the breathing zone of the two chemists in Lab. 409. Both eight-hour time-weighted average samples (one morning and one afternoon sample) and ceiling-value samples were obtained for comparison to available environmental standards and criteria.

C. Evaluation Methods[1]

Organic vapors - four 8-hr. time-weighted average personal air samples and four ceiling-value personal air samples were collected on lot #107 activated charcoal tubes. Air was drawn through the charcoal tubes at a flow rate of 50cc/minute with Sipin Model SP-1 personal air sampling pumps.

All samples and blanks were analyzed by gas chromatography techniques. The results of these samples are presented in Table I.

D. Evaluation Criteria

1. Environmental Criteria
The following environmental standards or criteria were considered in this report:

Substance	NIOSH	ACGIH	OSHA
Benzene	1 ppm[2] (60 min. ceiling)	10 ppm (8-hr.TWA)[3]	10 ppm (8-hr.TWA)[4] 25 ppm (15 min. ceiling) 1 ppm (8-hr.TWA)[5]* 5 ppm (15 min. ceiling)*
Acetonitrile		40 ppm (8-hr.TWA)[3] 60 ppm (15 min. STEL**)	40 ppm (8-hr.TWA)[4]
Tetrahydrofuran		200 ppm (8-hr.TWA)[3] 250 ppm (15 min. STEL)	200 ppm (8-hr.TWA)[4]
1,4-Dioxane	1 ppm[6] (30 min. ceiling)	25 ppm (8-hr.TWA)[7] 100 ppm (15 min. STEL) (Skin)***	100 ppm (8-hr.TWA)[4] (Skin)***

*Proposed OSHA Standard - presently stayed in the courts.

**STEL = Short-Term Exposure Limit

***Skin = Refers to potential contribution to overall exposure through skin absorption, mucous membranes and eyes either by airborne or direct contact with the substance.

2. Toxicological Data[8,9,10]

Benzene - inhalation of the vapor or absorption of liquid through the skin upon acute exposure is characterized by an anesthetic action on the central nervous system; this consists of a preliminary stage of excitation, followed by depression and can lead to death due to respiratory failure. Chronic exposures may effect the blood-forming tissues causing various blood dyscrasias (e.g. aplastic anemia); benzene is now a recognized carcinogen of these tissues and has caused blood cancers generally known as leukemia. Signs and symptoms of acute and chronic toxicity may include headache, dizziness, fatigue, loss of appetite, irritability, nervousness, nosebleed and other areas of prolonged bleeding; various chromosomal aberrations have also been attributed to benzene exposures.

Acetonitrile - nitriles, in general, may have the same effect as hydrogen cyanide, but it comes on more slowly. Weakness, headaches, confusion, nausea and vomiting may occur at lower dosages. Respiration will begin to decrease and may cease if exposure has been extensive; cyanosis may present itself at this stage. Acetonitrile, in particular, may affect the thyroid gland adversely and in higher concentrations has a profound delayed effect - although it is considered to be much less toxic that other nitriles. It may also act as a primary irritant to the eye and skin and can be absorbed readily through the skin into the bloodstream.

Tetrahydrofuran - is irritating to the eyes and mucous membranes and produces a narcotic effect at higher concentrations; it has also been found to cause injury to the liver and kidneys in humans.

Dioxane, 1,4 - is a primary irritant to the skin and eyes and can be absorbed readily in toxic amounts through the skin. Dioxane vapor can be inhaled in amounts that may produce systemic injuries, primarily to the liver and kidneys. Symptoms of exposure are mucous membrane irritation, emaciation, cramps, narcosis, albuminuria and severe liver and kidney injury. Liver and nasal cancers induced in rats through large oral doses may point out the potential for dioxane as a human carcinogen.

V. RESULTS, DISCUSSION AND RECOMMENDATIONS[11]

In order to resolve this complaint in an orderly fashion it would be most expedient to answer each part related to alleged industrial hygiene problems directly:

1. "The vent-fume hoods do not draw a balanced 150 CFM as is necessary for a high hazardous-high toxic operation."

It is not necessary that laboratory fume hood draw at 150 CFM in order to be suitable for handling toxic materials. In fact, this may create a problem of turbulence due to the operator's position at the hood. Air flowing past the operator to the hood can become turbulent and bring about a back-flow of vapors into the operator's breathing zone. Ventilation studies have shown that 80 to 100 FPM (control velocity at the face of the hood) can provide desired worker protection if the flow is kept as laminar as possible and drafts in front of the hood are kept to a minimum (< 20 FPM). These drafts may be due to traffic flow and/or make-up air movement.

It is understood that only three out of five hoods are being utilized because of the deficiencies in the present make-up air system. This make-up air system is to be improved and the air-supplied auxiliary system placed back into operation which will further increase the effectiveness of the hood in and around the breathing zone. The NIOSH industrial hygienist's ventilation measurements show hood face velocity readings of: Hood #1 = 93 FPM; Hood #4 = 103 FPM; and Hood #5 - 113 FPM along with effective capture as observed by smoke tube tests (See Attachment II). These measurements and tests are comparable to those taken by EPA/CLV Inc. (Mr. Richard Chamberlain - Consultant), and the performance criteria written up by CLV/Chamberlain.

Eight-hour TWA and ceiling-value personal air samples were analyzed for benzene, acetonitrile, tetrahydrofuran and 1,4-dioxane and found to be below the reliable analytical limit of detection for each substance; this is well below the TWA 8-hr. and ceiling values for each of these chemicals.

Therefore, employees in Laboratory Building 409 would not be exposed to potentially toxic concentrations of these organic vapors; it would also appear that the lab hoods are performing effectively and that the lab hood performance criteria being utilized is valid.[12]

2. "The exhaust roof ventilations should be replaced with fans and stacks which are appropriate for lab hood exhaust."

It is good ventilation practice to install systems which are durable and easily maintained; also exhaust stacks should be above the wake boundary. More importantly, the exhaust and intake vents should not be located so that there will be any crossover of air contaminants back into the building. It is understood that it is the intention of the EPA to install a better fan and stack arrangement in the near future.

3. "Air replacement within laboratory should be at least six changes per hour."

The NIOSH industrial hygienist's ventilation measurements show that there are approximately 23 changes/hour in lab Building 409 (See Attachment III). However, it should be noted that the number of air changes/unit time is not a good basis for ventilation criteria where the control of toxic vapors is concerned - ventilation is dependent on the type of problem, not on the room size in which it occurs.

4. "Air conditioning in the laboratory does not work adequately."

Air conditioning is not normally used to control air contaminant exposures. This air conditioning problem is a comfort problem and only begins to enter the occupational health arena where heat stress may be a problem. On January 30, 1979, it was noted that it had been particularly warm in the lab and was attributed to a malfunction in the thermostat control. It is understood that the EPA will remedy this situation.

5. "High hazard storage building is not finished, approved, or accepted for use."

It is recommended an inventory be taken of all chemicals stored in this area. This listing, along with a material safety data sheet for each chemical, should be on file and be made readily available to management, union and employees.

6. "The plumbing should be checked for the presence of the right amount of vents and traps and for presence of a neutralizing tank which we believe is missing. Certification of compliance with the National Plumbing Code should be ascertained."

With regard to chemicals currently being used in the laboratory, the existing plumbing set-up would not present any occupational safety or health problems (e.g. chemical incompatibility, generation of highly toxic gases or explosive materials in sink, vent, or traps) to the worker.

VI. REFERENCES

1. NIOSH Manual of Sampling Data Sheets, 1977 Edition, U.S., HEW, PHS, CDC, NIOSH, March 1977.

2. NIOSH revised Recommendation for an Occupational Exposure Standard for Benzene, U.S., HEW, PHS, CDC, NIOSH, August 1976.

3. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1978, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

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5. Emergency Temporary Standard for Occupational Exposure to Benzene; Notice of Hearing, 29 CFR 1910, Occupational Safety and Health Standards, Federal Register, Vol. 42, No. 85, May 1977, DOL, OSHA.

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10. Industrial Toxicology, Hamilton and Hardy, Publishing Sciences Group, Inc., Third Edition, Massachusetts. 1974.

11. Industrial Ventilation, A Manual of Recommended Practice, 15th Edition, ACGIH, 1978.

12. Laboratory Fume Hood Standards, Recommended for the U.S. Environmental Protection Agency, R.I., Chamberlain and J.E. Leahy, January 1978.

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Acknowledgements

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Table I
Results of Personal Air Sampling for Organic Vapors
Laboratory Building 409 - Beltsville Agricultural Research Center
Environmental Protection Agency
Beltsville, Maryland

Organic Vapor	Sample Number	Sample Time (Minutes)	Location	Analysis (Total mg)
Benzene	EPA 8	5**	Hood #1	<0.02
Acetonitrile	EPA 1	147	Hood #1	<0.02
	EPA 7	107		<0.02
	EPA 4	10**		<0.02
Tetrahydrofuran	EPA 2	140	Hoods #4 & 5	<0.01
	EPA 3	9**		<0.01
Dioxane	EPA 5	3**		<0.01
	EPA 6	90		<0.01

*All samples and blanks were below the reliable analytical limit of detection, which is 0.02 mg for Benzene and Acetonitrile and 0.01 mg for Tetrahydrofuran and 1,4-Dioxane per charcoal tube.

**Ceiling values.

ATTACHMENT I

LISTING OF CONFERENCE ATTENDEES

Dr. Robert Jasper - Acting Director, EPA
Beltsville, Maryland

Adrian Burns - Chairman of Safety Committee, EPA
Beltsville, Maryland

Robert C. Magor - Director of Occupational Safety and Health, EPA
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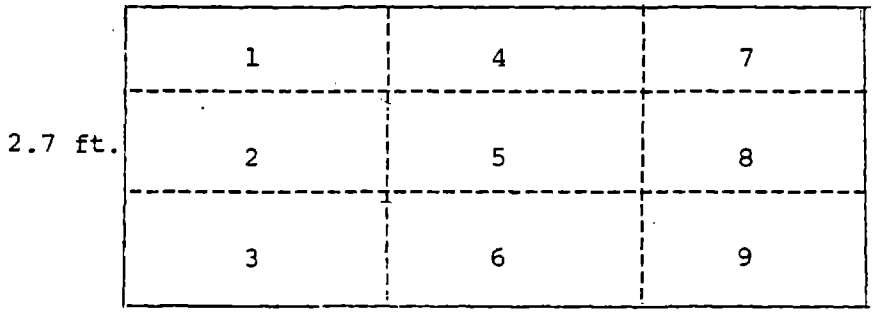
HOOD EVALUATION DATA

Environmental Protection Agency
Beltsville Agricultural Research Center
Beltsville, Maryland

Building No. 409
Pesticides Residue Laboratory:
To validate analytical methods developed to measure residues and set tolerances for pesticides.

SASH IN FULL OPEN POSITION
(Nine Quadrants - Center Measured in ft./min. with Alnor Senior Velometer)



5.1 ft.

Face Area (A) = (5.1)(2.7) = 13.8 ft.

Face Velocities (FPM) and Air Flow Rates (CFM)

	Hood #1	Hood #4	Hood #5
1	100	105	110
2	90	100	100
3	100	90	105
4	100	120	110
5	95	108	120
6	85	100	100
7	95	110	120
8	95	105	110
9	80	90	120
	*93	*103	*113
	**1283	**1421	**1559

*Average Face Velocity (FPM)
**Average Flow Rate (Q)
Q = Velocity x Area
(CFM)

ATTACHMENT III

AIR CHANGE EVALUATION DATA

Lab Building 409

Lab Dimensions = 42 ft. x 30 ft. x 9 ft.
Lab Volume = 11,340 $ft.^3$

Air Flow ($Q_{1,4,5}$) to hood with sash in full open position:

Hood #1	Hood #4	Hood #5
1283 CFM x 60 = 77004 CFH	1421 CFM x 60 = 85284 CFH	1559 CFM x 60 = 93564 CFH

Total Air Flow ($Q_1 + Q_4 + Q_5$) = 77004 + 85284 + 93564 = 255,852 CFH

Number of air changes/hour = total air flow/$_{\text{lab volume}}$

= 255,852 /$_{11,340}$ = 22.6

Air replacement ∿ 23 changes/hour

or

∿ 3 minutes/change

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15. Supplementary Notes
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16. Abstracts

ABSTRACT: Employee exposure to benzene (71432), acetonitrile (75058), tetrahydrofuran (109999) and 1,4-dioxane vapors (123911) was evaluated on January 17 and 30, 1979 at Lab Building 409 of the Environmental Protection Agency's Beltsville Agriculture Research Center in Beltsville, Maryland. The evaluation was prompted by a request from the OSHA Office of Federal Agency Programs resulting from employee and union complaints about laboratory fume hoods and toxic materials storage in the building. Breathing zone samples were collected on activated charcoal tubes. Eight-hour Time Weighted Average samples and ceiling value samples were obtained and compared to environmental standards and criteria. All samples were analyzed by gas chromatography. Results show that employee exposure was below the reliable analytical limit of detection. It is recommended that exhaust roof ventilation be replaced with fans and stacks appropriate for lab hood exhaust, air replacement wihin the laboratory be at least six changes per hour, and plumbing be checked for the presence of the required number of vents and traps.

17. Key

KEYWORDS: NIOSH-Publication, NIOSH-Author, NIOSH-Technical-Assistance-Report, TA-79-10, Research-and-development-laboratories, Hazards-unconfirmed, Toxic-substances, Exhaust-hoods, Organic-vapors, Air-sampling

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