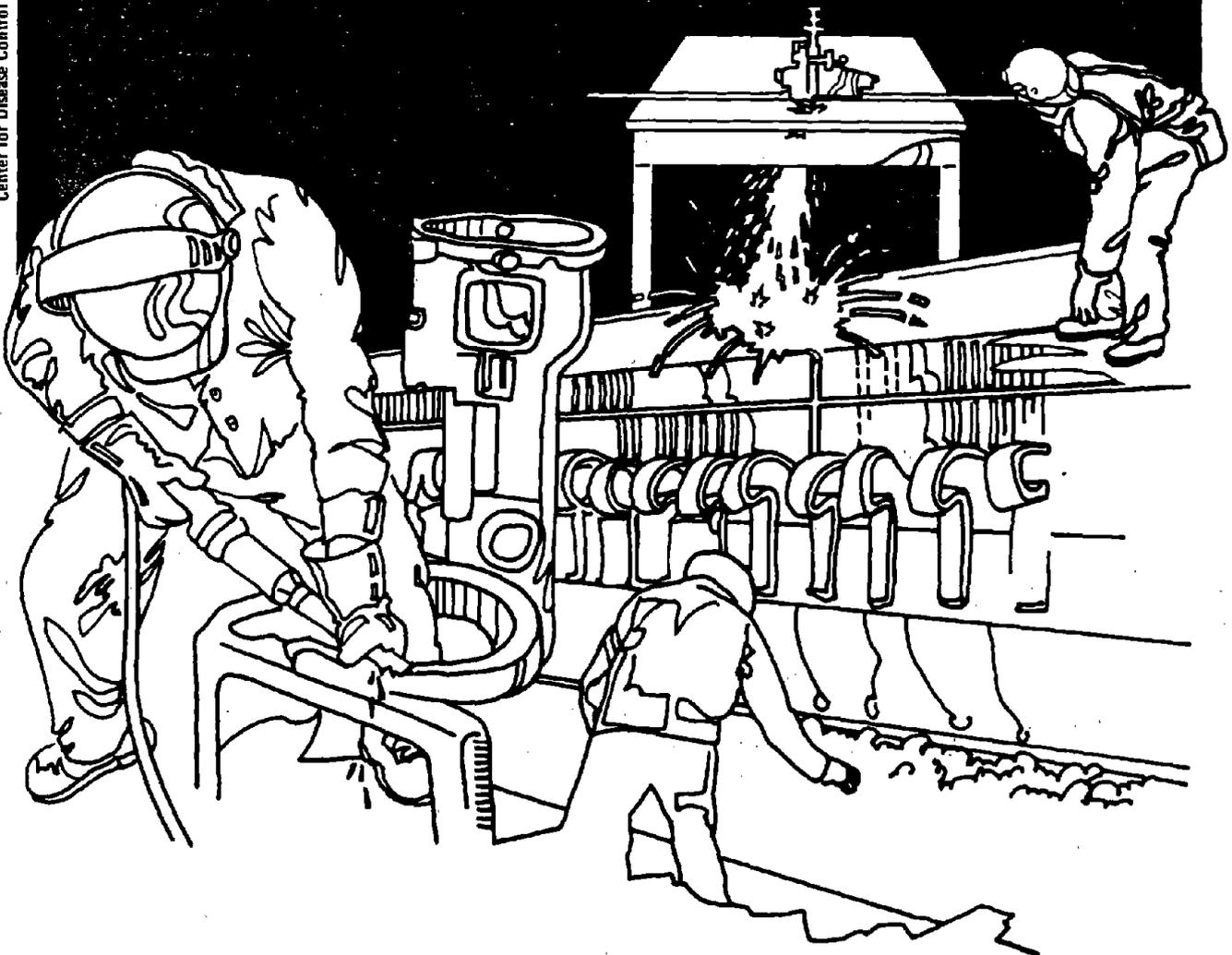


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NIOSH



Technical Assistance Report

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PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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6. Abstract (Limit: 200 words)

Exposure to harmful emissions from an office recorder were investigated on July 16 and 17 in a Congressman's office (SIC-9160) in Washington, D.C. The Congressman requested technical assistance for the evaluation. The office staff consisted of four females and two males who reported respiratory discomfort, eye irritation, and the presence of disagreeable odors. Air samples were collected from the locations near the operating recorder. The ventilation system was evaluated, and the personnel were interviewed. Ventilation around the equipment was inadequate. The odor was caused by approximately a 0.4 parts per million of n-butyl-methacrylate (97881). No carcinogens were identified and carbon-monoxide (630080) concentrations were stable. The authors conclude that poor ventilation was responsible for the irritations reported by the office employees. They recommended relocation of the equipment and placement of a suitable health warning in the recorder paper supply boxes.

7. Document Analysis a. Descriptors

TA-80-67-754, Hazards-confirmed, Health-surveys, Work-environment, Air-contaminants, Chemical-exposure, Toxic-response, Industrial-processes, Control-methods, Ventilation-system, Warning-systems

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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NIOSH INVESTIGATORS:
Richard Gorman, IH

SUMMARY

In April 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from Congressman Cavanaugh to evaluate exposure of his staff to emissions from a Qwip Systems, Model 1200 Facsimile Recorder at his office in Washington, D.C. Respiratory discomfort, eye irritation and obnoxious odors were the primary complaints, and there was also a concern that the emissions may contain substances that have carcinogenic potential. NIOSH responded to this request by reviewing emission studies provided by the manufacturer and conducting a field survey on July 16 and 17. Resulting data indicated that the odor was probably the result of the presence of low concentrations (≤ 0.4 ppm) of n-butyl-methacrylate. Other substances identified in bulk air samples were not detectable in exposure samples but may have contributed (additive effects) along with the n-butyl-methacrylate, to occasional respiratory discomfort (dryness in the throat) in two of the five employees.

The Qwip unit was found to generate small particles in concentration ranges of 0.11-0.19 mg/M³ in the immediate vicinity of the unit. These particulates were probably responsible for the eye irritation and cloudy vision experienced by the two employees who wore contact lenses. They were not found to contain a benzene soluble fraction or detectable amounts of five polynuclear aromatic hydrocarbons (PNAH's) - benzo(a)anthracene, chrysene, pyrene, benzo(a)pyrene, and flouoranthene. There were no substances detected that have been associated with carcinogenicity in animals or humans. Carbon monoxide levels were stable at 5 ppm and not appreciably affected by the operation of the Qwip unit.

Exposure to the emissions of the Qwip Facsimile Recorder, as evaluated during this investigation, would not be expected to cause a health hazard; however, respiratory discomfort, eye irritation and the presence of a disagreeable odor were experienced due to the placement and use of the unit in a poorly ventilated corner of the office. More significant respiratory problems may result from operation of this equipment in a non-ventilated or very poorly ventilated area due to expected increases in airborne concentrations of the n-butyl-methacrylate and other thermal decomposition products of the paper.

Employee complaints were resolved by relocating the unit to a better ventilated area of the office as recommended by the NIOSH investigator at the time of the field survey. The manufacturer has been aware of the situation and has arranged to have a health notice included in each box of paper (see Appendix B). There is also an ongoing research effort to obtain a replacement paper.

KEYWORDS: SIC 9160 (Federal Government), Qwip Facsimile Recorder, Electro-sensitive Paper, Electro-thermal Printing, n-Butyl-Methacrylate, Polynuclear-Aromatic-Hydrocarbons.

INTRODUCTION

Workers on Congressman Cavanaugh's office staff in Washington, D.C. have experienced respiratory discomfort, eye irritation and an obnoxious odor during the operation of a Qwip, Model 1200, Facsimile Recorder which was installed in May, 1979. The symptoms are temporary and have been associated with the use of this unit in the "receive" mode. Normal run time is 1 1/2 to 3 hours per workday. There are six employees (4 female, 2 male) in the office.

The Occupational Safety and Health Administration (OSHA), Office of Carcinogen Identification and Classification, Washington, D.C. was contacted in September 1979 concerning this matter. Information that OSHA subsequently received from the manufacturer indicated that there may be a health problem under conditions of poor ventilation and advised that either NIOSH or the local OSHA field office be contacted to investigate.

NIOSH received a request for technical assistance in April 1980 to evaluate the potential acute and chronic health effects, including carcinogenic effects, associated with exposure to the emissions from the Qwip unit.

EVALUATION

Initial efforts were directed at determining what information was already known concerning the emission characteristics of this equipment. No published reports of emission studies on this type of equipment were found. Requests were sent to both Exxon and the Fitchburg Paper Company (paper supplier) for information on emission studies and chemical components of the electrosensitive paper used. The reports of three emission studies and a listing of the chemical components of the paper were received and reviewed. Due to the highly competitive nature of this type of telecommunications system, NIOSH was requested to treat much of the information provided as proprietary.

Based on review of this information, and considering the concerns and symptoms of the exposed employees, a sampling protocol was developed and conducted at the Congressman's office on July 17, 1980.

A. Description of Operation and Use of the Qwip Telecopier

The Qwip recorder, manufactured by Qwip Systems, a Division of Exxon Enterprises Incorporated, can send or receive words and images from any telephone connected to it. The unit evaluated was primarily used to receive information from the Congressman's home state. The system consists of a telephone acoustic coupler and transceiver main frame (22 1/8" X 6 1/4" X 8") and weighs 16 pounds. The NDR Electrosensitive Paper, supplied by the Fitchburg Paper Company, is a multilayer paper designed with an electrically conductive surface and an optically contrasting sublayer. A stylus rests on the surface of the NDR paper which is attached to a rotating drum. An electrical potential produced at the tip of the stylus in response to a transmitted image causes vaporization of the top layer leaving the sublayer exposed forming letters or images. The time required to receive one page is six minutes. This electrothermal printing results in the release of the emissions of concern. Back layers of the paper serve as support layers and are not involved in the generation of emissions.

The recorder is located in the main office (15' X 27' X 11') of the Congressman's suite, see Figure 1. The transmission process is started when a telephone call is received from the sender indicating that a page is ready to be transmitted. The person on the receiving end ensures the selector switch is in the receive position, loads a piece of NDR paper, relays that they are ready to receive and places the telephone receiver in the coupling device. An alarm sounds after 6 minutes signaling that the transmission is completed. The paper is removed at each station and the process is repeated for as many pages as necessary. Generally 7 to 21 pages are received per work day.

B. Methods

The field study consisted of employee interviews, evaluation of the ventilation system and area air sampling.

Each of the five employees present in the main office was interviewed to determine the nature and extent of symptoms which they associated with operation of the Qwip Recorder. One person was not at work on the day of the survey.

All air inlets and exhausts affecting the main office environment were located, and general flow patterns were observed using a smoke tube technique. The air conditioning architect for the Capitol was contacted for more specific information on the environmental system.

Area air sampling was accomplished at three locations in the main office (location A, B and C, see Figure 1). Location A was at the center and approximately two inches above the slit in the plastic cover of the Qwip unit. Location B was 10 feet in front and 4 feet higher than the unit (on top of a book case). Location C was two feet behind and one foot above the unit.

Total particulates were collected on Millipore M-5 PVC filters (preweighted). Glass fiber/silver membrane filters were used to test for benzene solubles and specific PNAH's. Two charcoal tubes were used at each location to collect organic vapors. One of the charcoal tubes was used to identify organic substances and the other to quantify these substances. Porous - aromatic - polymer (PAP) tubes were used as a back-up to quantitate n-butyl-methacrylate levels. Carbon monoxide (CO) levels were obtained with a CO Ecolizer equipped with a strip chart recorder. Further information on sampling and analytical methods are presented in Appendix A. Twenty-one pages (maximum number normally received in one day) were received on the day of the survey. This was arranged so that the air sampling effort would monitor a maximum use situation. All sampling apparatus was operated only during those times when the telecopier was operating. There were two continuous run times - 9:40 am to 11:12 am and 3:27 pm to 4:30 pm. Total run time was 2 hours and 35 minutes.

RESULTS AND DISCUSSION

All of the five employees interviewed complained of the presence of an obnoxious odor during the time when the Qwip unit is operating. Three of these five had no other complaints. The other two complained of eye irritation (both wore contact lenses) and a dryness in the throat. The eye irritation was not a problem when the Qwip unit was not being used or when the contact lenses were not worn. Occasionally vision through the contact lenses became "foggy". Clear vision was restored once the lenses were removed and cleaned.

Environmental conditions in the office were centrally controlled. There were three inlets (approximately 24 inches from the ceiling in the main office) and two exhausts that handle the entire suite. These are annotated on Figure 1. The flow patterns (observed using a smoke tube technique) indicate that the area where the Qwip unit was located is not well ventilated. Air that entered the room at the inlets tended to bypass this corner of the room on its way to the exhaust points.

Air sampling results for July 17, 1980 are presented in Table 1. The only detectable organic emission was n-butyl-methacrylate. A concentration of 0.4 ppm was obtained at location A. This value was the average of the level found using the charcoal tube method (0.6) and the level using the PAP tubes (0.2). The fact that n-butyl-methacrylate odor can be detected when airborne concentrations may not be detectable is explained by the fact that methacrylates have low odor threshold. For example, one study(1) found the absolute odor threshold for methyl methacrylate to be 0.05 ppm. No value was listed for n-butyl-methacrylate.

Total particulates at location A and C were 0.19 and 0.11 mg/M³ respectively for the period of time sampled. The process by which the particles are generated is similar to welding in that a solid material is vaporized at the point where the stylus rests on the NDR paper and condensed in the atmosphere forming fume particles.

Carbon monoxide levels remained constant at 5 ppm throughout the day indicating that operation of the Qwip unit had negligible effect on the CO concentrations in the office.

A potential exposure not evaluated in the studies received from Exxon was carbon black and PNAH's. Since the depth to which the NDR paper was penetrated was not known, there was a potential for generation of carbon black particles if the sublayer was being vaporized to any extent. There was no detectable amount of a benzene-soluble fraction in the particulate samples collected and no detectable levels of the five PNAH's evaluated.

Toxicology:

Comments are directed to n-butyl-methacrylate and total particulates. Other substances were identified or looked for in the emission studies provided by Exxon; however, airborne concentrations of all but n-butyl-methacrylate were below detectable levels in this study.

n-butyl-methacrylate:

There are no exposure criteria for n-butyl-methacrylate. Only two references (2)(3) were found in the literature related to the toxicology of this substance. Both were animal studies. Deichmann (2) exposed rabbits, guinea pigs and rats to chamber concentration of 500-860 ppm of n-butyl-methacrylate for 8 hours. Animals exposed to this concentration showed temporary irritation of the mucous membranes, malaise (uneasiness) and accelerated respiration. Deichmann also determined an LD₅₀ for oral administration to be approximately 8 mg/kg for the rabbits tested. The simple determination of LD₅₀ provides an initial comparative index for the location of the compound in the overall spectrum of toxic potency. Mir, et al (3) studied the activity of n-butyl-methacrylate on isolated rabbit hearts in concentrations of 1:1000, 1:10,000 and 1:100,000 (v/v) and found a reduced heart rate and force of contraction.

Methyl-methacrylate, a similarly structured molecule, has a recommended Threshold Limit Value (TLV) of 100 ppm (5). This level is considered sufficiently low, by the American Conference of Governmental Industrial Hygienists, to protect against discomfort from irritation and, reportedly, well below the level giving rise to any systemic effects (6). Part of the documentation for the TLV came from the study done by Deichman (2).

This is very little toxicological data available for n-butyl-methacrylate. The oral LD₅₀ value (8 mg/kg) suggested that it is relatively non-toxic (4). The inhalation study by Deichmann (2) indicate the n-butyl-methacrylate irritates mucous membrane and the work done by Spealman et al (7) on methyl-methacrylate suggests that n-butyl-methacrylate may have cutaneous sensitization potential.

Particulates:

The degree of hazard associated with exposure to airborne particles depends on the chemical nature of the dust as well as the concentration and particle size distribution. The studies provided by Exxon characterized the particles generated. All substances in the particulate emission would be well below their respective exposure criteria based on the fact that the highest total dust concentration was 0.19 mg/M³. Considering the chemical makeup of the particulate emission and the method of generation, the welding fume standard of 5 mg/M³, not otherwise classified, would appear to offer adequate protection. However, a particulate concentration of 5 mg/M³ would not be compatible with the requirements of a comfortable office environment. A better method would be to maintain particulate levels as low as possible.

CONCLUSION

Results of the air sampling indicated that the probable cause of the disagreeable odor was n-butyl-methacrylate, a thermal decomposition product of the acrylic resin used in the top layer of the NDR electro-sensitive paper. This substances may have also been responsible for the occasional episodes of respiratory discomfort. It is difficult to say this with any degree of certainty since there are other emission products which were identified by Exxon in their laboratory but not present in high enough concentrations to be detectable in the office environment that may have contributed.

The particulates generated by the Qwip unit were likely getting trapped behind the contact lenses and sticking to both surfaces, thus causing eye irritation and cloudy vision.

There were no known or suspected carcinogens detected. However, literature searches failed to turn up any studies where n-butyl-methacrylate was evaluated in this regard.

The disagreeable odor and potential health effects, such as respiratory discomfort, have prompted Exxon to include a health notice with the electro-sensitive paper (Appendix B). In addition, Exxon has an ongoing research effort to reduce emissions from the paper.

VI. RECOMMENDATION

The recommendation to move the unit to one of the two locations (see Figure 1) identified during the field survey was accomplished since the survey. Recent contact by telephone with a member of the staff verified that there is no respiratory discomfort or eye irritation and that the odor has been significantly reduced.

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VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22151. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. The Honorable John J. Cavanaugh, Washington, DC.
2. Department of Labor, Washington, DC.
3. EPA, Chemical Hazard Identification Branch, Washington, D.C.
4. NIOSH, Region III
5. Sharon Morris, NIOSH, Rockville

Table I
Air Sampling Results (1)
TA 80-67

July 17, 1980

Substance	Samples - Location A (2)			Samples - Location B			Samples - Location C			Lower Detectable Limit
	Rate	Vol.	Concen.	Rate	Vol.	Concen.	Rate	Vol.	Concen.	
n-butyl-methacrylate	(3) 274 cc/min (4) 200 cc/min	42.5ℓ 32.2ℓ	0.6 ppm 0.2 ppm	260 cc/min 200 cc/min	40.3ℓ 31.6ℓ	<0.1 ppm <.05 ppm	303 cc/min 200 cc/min	47.0ℓ 31.8ℓ	<0.1 ppm <.05 ppm	0.01 mg/sample 0.01 mg/sample
total particulates	9.0 ℓ/min	1.4 M ³	0.19 mg/M ³	-	-	-	8.9 ℓ/min	1.4 M ³	0.11 mg/M ³	0.01 mg/sample
benzene solubles	9.1 ℓ/min	1.4 M ³	<0.01 mg/M ³	-	-	-	9.0 ℓ/min	1.4 M ³	<0.01 mg/ℓ	0.02 mg/sample
carbon monoxide (5)	-	-	5 ppm	-	-	5 ppm	-	-	5 ppm	1.0 ppm
PNAH's										
B(a)P	9.0 ℓ/min	1.4 M ³	N.D. (6)	-	-	-	9 ℓ/min	1.4 M ³	N.D.	0.04 µg/sample
chrysene	9.0 ℓ/min	1.4 M ³	N.D.	-	-	-	9 ℓ/min	1.4 M ³	N.D.	0.12 µg/sample
pyrene	9.0 ℓ/min	1.4 M ³	N.D.	-	-	-	9 ℓ/min	1.4 M ³	N.D.	0.12 µg/sample
B(a)A	9.0 ℓ/min	1.4 M ³	N.D.	-	-	-	9 ℓ/min	1.4 M ³	N.D.	0.04 µg/sample
fluoranthene	9.0 ℓ/min	1.4 M ³	N.D.	-	-	-	9 ℓ/min	1.4 M ³	N.D.	0.08 µg/sample

(1) Results are time-weighted-averages for the period of time sampled (2 hours 35 minutes).

(2) Location A - At center and 2" above slit in cover; Location B - 10' in front and 4' higher than ϕ wip unit.

Location C - 2' behind and 1' above telecopier.

(3) Charcoal tubes used to collect sample.

(4) PAP tubes used to collect sample.

(5) Continuous recording using CO Ecolizer with strip chart recorder.

(6) ND - Not Detectable

APPENDIX A

SAMPLING AND ANALYTICAL METHODS

Organic Vapors

Organic vapors were collected on small charcoal tubes (100 mg. front section, 50 mg back section) at a sampling rate of 200 to 300 cc/min. (actual sampling rate is provided on Table 1 for each sample) using battery powered pumps. A total of six samples were collected. Three were submitted for qualitative identification using a GC/MS technique and three were submitted for quantification of substances identified in the GC/MS work up.

All of the samples were desorbed with 1 ml of carbon disulfide and analyzed by gas chromatography (FID) using a 20 foot, 10%, SP-1000 column. The quantitative analysis was done in accordance with NIOSH Method No. P&CAM 127.

n-Butyl-methacrylate

There is no standard NIOSH analytical method for n-butyl-methacrylate. Since there was a potential for instability on the charcoal tube porous-aromatic polymer tubes were used as a backup sampling method. These samples were analyzed by gas chromatography according to NIOSH Method S-43 with minor modifications. The front and back sections of each sample were separately desorbed with 1 ml of carbon disulfide containing 1 ul/ml of benzene as internal standard. The analysis was performed using a Hewlett-Packard 5731A gas chromatograph equipped with a FID. A 20' by 1/8" stainless steel column packed with 10% SP-1000 on 80/100 mesh Supelcoport was used under isothermal conditions at an oven temperature of 150°C. A total of 3 samples were collected.

Particulate

Airborne particulate concentrations were obtained using Millipore M-5 filters at a flow rate of 8-9 lpm using a gast vacuum pump (electrically operated). The high flow rates were used because concentrations were expected to be low. Particulate weights were determined by weighing the samples plus the filters on an electrobalance and subtracting the previously determined tare weights of the filters. The tare and gross weighings were done in duplicate. The instrumental precision of weighings is 0.01 mg.

Benzene Solubles and PNAH's

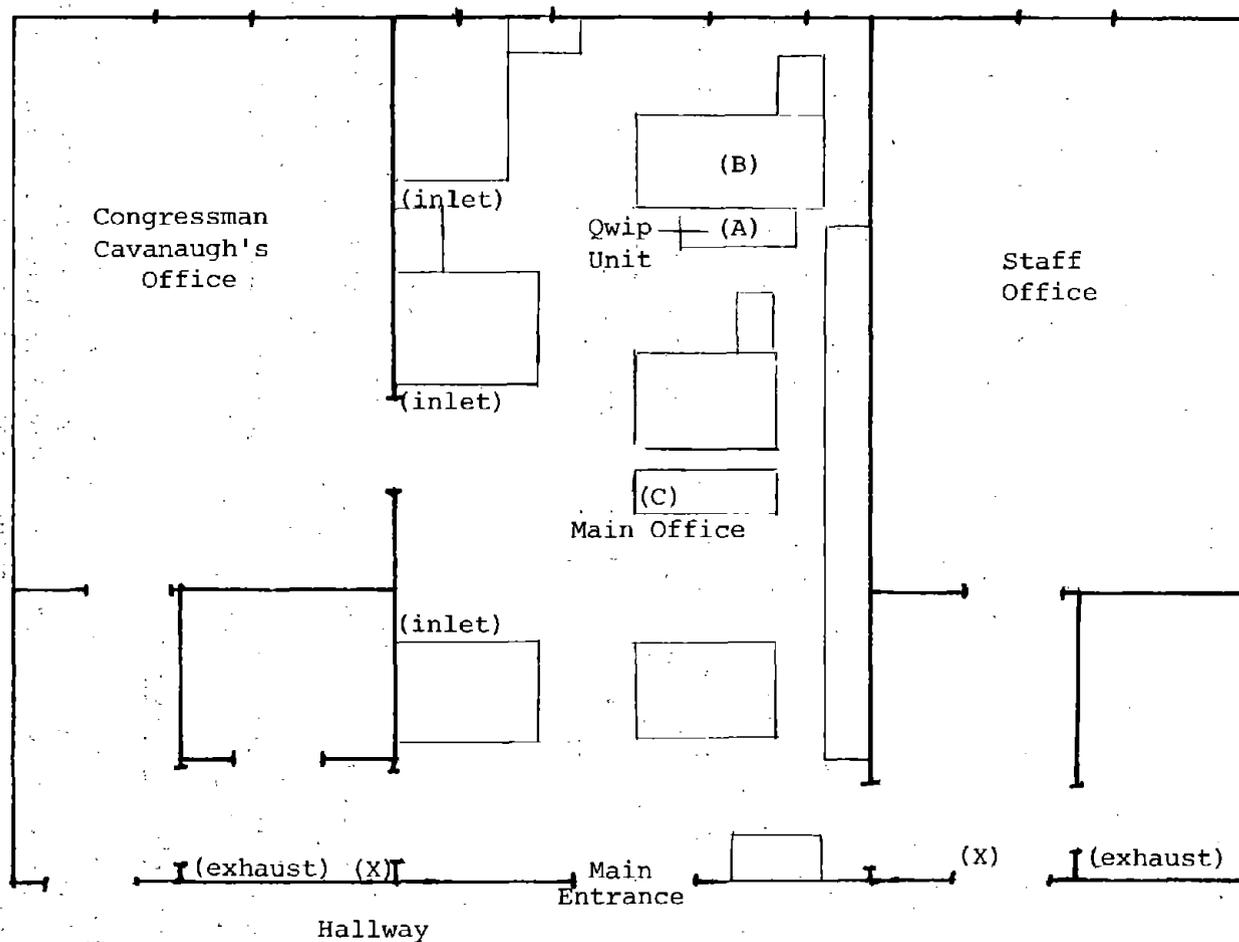
Glass fiber/silver membrane filters were used to collect air samples at the rate of 9 lpm for determination of benzene soluble fractions in the particulate emissions. Samples were placed in screw-cap vials with 5 ml of benzene and sonified for 15 minutes. The extract was filtered through a 0.45 microm silver membrane filter and collected in an evaporation tube. Each sample was extracted one additional time with 2 ml of benzene and filtered into the same evaporation tube. The extract was concentrated to 1 ml under a stream of dried nitrogen at 40°C. One-half ml of each sample was transferred into a tared teflon cup and evaporated to dryness in a vacuum oven at 40°C. The Teflon cups were again weighed and the difference recorded, the weight gain of the cup being one-half the total benzene solubles per sample. The reported results are blank corrected.

FIGURE 1

Sketch of Congressman Cavanaugh's Suite
Washington, D.C.

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A,B,C: Sampling locations

(inlet): Conditioned air enters main office

(exhaust): Exhausts air from entire suite

(X): Recommended location for Qwip unit

The benzene extract for each sample was analyzed by high pressure liquid chromatography utilizing a Waters Associates HPLC System equipped with a Vydac 201 TP column. Analytical procedures involved the application of a methanol/water/acetonitrile solvent gradient. Detection was accomplished by measuring the UV absorbance at wavelengths of 280 nm and 365 nm. Retention times were obtained from known standards of each analyte. PNA compounds in the samples were identified by HPLC retention time. Quantitation is accomplished by comparison of peak areas.

Carbon Monoxide

An CO Ecolizer equipped with a strip chart recorder was used to continuously record airborne concentrations of CO. The system was pre-calibrated at the site with a 25 ppm CO span gas.

FACSIMILE RECORDING PAPER

The recording paper contained in this box has been developed specifically for use on QWIP facsimile transceivers (except QWIP 1000 Series). It is specially designed by QWIP SYSTEMS to provide a pleasant odor during the recording process. The paper can also be used in other manufacturers' facsimile equipment utilizing the same electro-sensitive recording process as QWIP transceivers.

PRODUCT SPECIFICATION

Type:	Electrosensitive	Temperature:	Operational: 50°F-140°F Storage: -40°F-140°F
Size:	8½" x 11"		
Weight:	55 - 66 lbs.	Humidity:	Operational: 20%-80% RH Storage: (when packaged) 1% - 99% RH
Caliper:	3.7 - 4.3 mils		
Brightness:	.08 - .13 MacBeth	Packaged:	250 Sheets
Coating:	Titanium dioxide		
Gray Scale:	8 shades		

IMPORTANT:

It is recommended that equipment using electro-sensitive recording processes be operated in well-ventilated areas. Persons with known skin and/or respiratory sensitivities are advised to avoid the immediate vicinity of the machine during recording.