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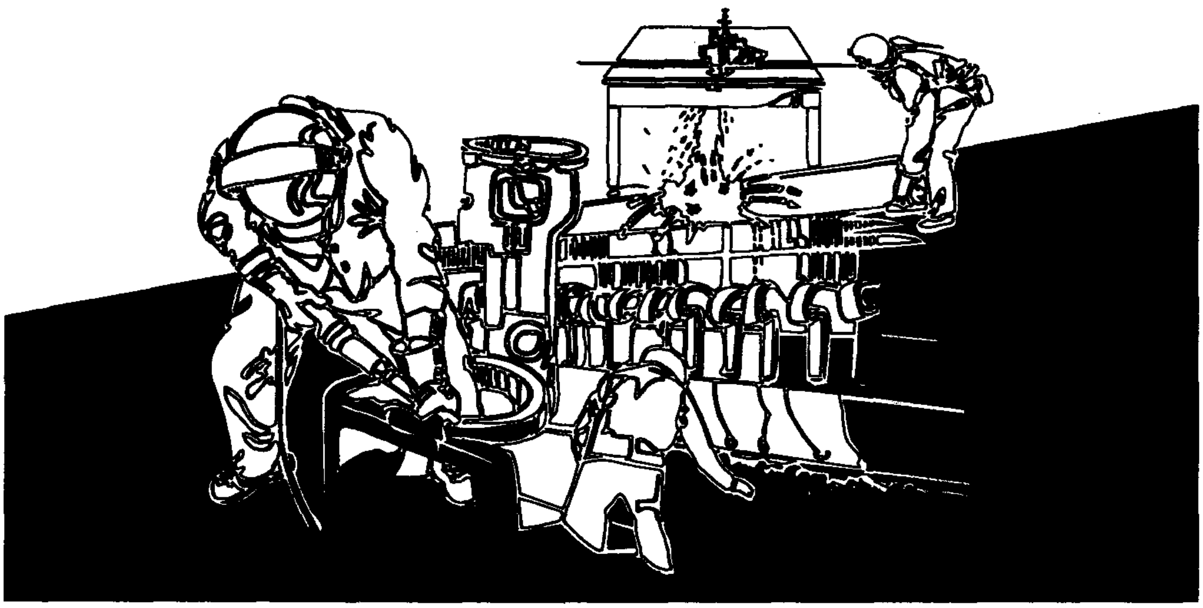
NIOSH HEALTH HAZARD EVALUATION REPORT

HETA 95-0273-2525
Advanced Occupational Health Services, Inc.
Elizabethtown, Kentucky

Gregory A. Burr, C.I.H.



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also 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.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Gregory A. Burr, C.I.H., of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing by Ellen E. Blythe.

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Health Hazard Evaluation Report 95–0273–2525
Advanced Occupational Health Services, Inc.
Elizabethtown, Kentucky
August 1995

Gregory A. Burr, C.I.H.

SUMMARY

On June 9, 1995, the National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation (HHE) request from Advanced Occupational Health Services, Inc. (AOHS), a firm headquartered in Elizabethtown, Kentucky. Four AOHS employees at a satellite office in Leitchfield, Kentucky, were concerned with the adequacy of the existing ventilation system and the possible presence of chemical contaminants off–gassing from the carpeting and floor tiles. The building was completed and first occupied in January 1995.

During a survey conducted at the Leitchfield office on June 15, 1995, real–time carbon dioxide (CO_2) measurements were obtained using a portable infrared CO_2 indicator, and temperature and relative humidity (RH) measurements were collected using a thermoanemometer. Carbotrap® 300 stainless steel thermal desorption (TD) tubes were used to collect air samples at locations within the office and outside the building. Based on the qualitative TD results, charcoal tube air samples (collected side–by–side with the TD samples) were analyzed for the following organic compounds: ethanol, isopropanol, butyl Cellosolve™ (ethylene glycol monobutyl ether), and limonene.

The CO_2 concentrations, which gradually increased during the work day and exceeded 1,000 parts per million (ppm) throughout the facility, were remarkably high considering the sparsely populated work area (less than seven employees per 1000 ft^2). This suggests that the AOHS office was not receiving adequate amounts of outside air. Temperatures fluctuated greatly, ranging from 66 → 78°F. This range of temperatures is not within the summer comfort guidelines recommended by the American Society of Heating, Refrigerating, and Air–Conditioning Engineers (ASHRAE) of 73 → 79°F. The RH levels ranged from 38 → 50%, within the ASHRAE guidelines. The TD air samples revealed the presence of isopropanol, ethanol, isobutane, propane, butyl Cellosolve, and a variety of aliphatic hydrocarbons. Only ethanol (ranging up to 2.2 ppm) and isopropanol (ranging up to 1.4 ppm) were present in quantifiable amounts. All of these concentrations are far below any applicable occupational exposure criteria.

NIOSH investigators have determined that although little (if any) outside air is being introduced into the AOHS office areas by the ventilation system, exposure to organic chemical contaminants in the air were minimal and did not constitute an occupational health hazard. Recommendations have been made to increase the amount of outside air introduced into the building, to extend the exhausts from the two bathrooms to outside the building, and to provide an exhaust system for the darkroom used for developing X–ray photographs.

Keywords: SIC 8049 (Offices and Clinics of Health Practitioners, Not Elsewhere Classified), carbon dioxide, temperature, relative humidity, ventilation, total volatile organic compounds, IEQ, IAQ

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Introduction

On June 9, 1995, the National Institute for Occupational Safety and Health (NIOSH) received a request for health hazard evaluation (HHE) from an administrator at Advanced Occupational Health Services, Inc. (AOHS), a firm which is headquartered in Elizabethtown, Kentucky. This HHE request, however, involved employee concerns about the indoor environmental quality (IEQ) at an AOHS satellite office located in Leitchfield, Kentucky. The Leitchfield clinic, with a staff of approximately four, provides occupational health services (such as drug screening, audiometric examinations, X-rays, vision tests) for surrounding industry. Some of the employees at the Leitchfield office were concerned with the adequacy of the existing ventilation system and the possible presence of chemical contaminants off-gassing from the carpeting and floor tiles which were installed when the building was completed and first occupied in January 1995. NIOSH investigators visited the Leitchfield office June 15, 1995.

Background

As shown in Figure 1, the Leitchfield AOHS office occupies approximately 3,000 $ft.^2$ in a single-story, metal prefabricated building which was completed in January 1995. Other tenants in the building include a hair salon, a physical therapy center, and a health club. With the exception of the physical therapy center, all tenants have ventilation systems which are separate from the heating, ventilation and air-conditioning (HVAC) unit dedicated to the AOHS office and physical therapy center.

A staff of three to four people occupy the AOHS office from approximately 8:00 a.m. to 5:00 p.m. Monday through Friday. The physical therapy unit, located at the rear of the AOHS center, has a staff of one or two. (No patients were seen on June 15, 1995.) Genesis Urgent Treatment, a company affiliated with AOHS, has a similarly sized staff which uses the AOHS office space during the evening hours (6:00 p.m. to 10:00 p.m.). While the AOHS center provides occupational medicine services (such as pre-placement exams, drug screening, workers compensation injury and illness treatment) and treats patients by appointment only, Genesis Urgent Treatment accepts "walk-in" patients.

The NIOSH evaluation on June 15, 1995, included measurements of carbon dioxide (CO_2), temperature, and relative humidity (RH) throughout the AOHS work day. In addition, general area air samples were collected using thermal desorption tubes and charcoal sorbent tubes to identify and quantitate any volatile organic compounds (VOCs) which may be present in the office space.

Evaluation Criteria

Indoor Environmental Quality

The symptoms reported by building occupants have been diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats, and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[1,2] Among these factors are imprecisely defined characteristics of HVAC systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise.[3,4,5,6] Reports are not conclusive as to whether increases of outdoor air above currently recommended amounts (≥ 15 cubic feet per minute of outside air per person

[CFM OA/person]) are beneficial.[6] However, rates lower than these amounts appear to increase the rates of complaints and symptoms in some studies.[7] Design, maintenance, and operation of HVAC systems are critical to their proper functioning and provision of healthy and thermally comfortable indoor environments. Indoor environmental pollutants can arise from either outdoor or indoor sources.[8]

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition.[9] Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints.[10,11] Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors.

Problems that NIOSH investigators have found in the non-industrial indoor environment have included poor air quality due to ventilation system deficiencies, overcrowding, volatile organic chemicals from office furnishings, machines, structural components of the building and contents, tobacco smoke, microbiological contamination, and outside air pollutants; comfort problems due to improper temperature and RH conditions, poor lighting, and unacceptable noise levels; adverse ergonomic conditions; and job-related psychosocial stressors. In most cases, however, no cause of the reported health effects could be determined.

Standards specifically for the non-industrial indoor environment do not exist. NIOSH, the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have published regulatory standards or recommended limits for occupational exposures.[12,13,14] With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines.[15,16] The ACGIH has also developed a manual of guidelines for approaching investigations of building-related symptoms that might be caused by airborne living organisms or their effluents.[17]

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. In ASHRAE's most recently published ventilation standard, 62-1989, Ventilation for Acceptable Indoor Air Quality, a supply rate of CFM OA/person for office spaces is recommended.[16]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 parts per million [ppm]). Carbon dioxide concentration is used as an indicator of the adequacy of outside air supplied to occupied areas.[a] When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected and other indoor contaminants may also be increased. NIOSH has stated that a level of 800 ppm should trigger inspection of ventilation system operation.[18]

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[a] The usefulness of CO_2 as an indicator of ventilation effectiveness is reduced in areas with low occupant density (less than seven employees per 1,000 ft^2.) This was the situation at AOHS on June 15, 1995.

Temperature and Relative Humidity

Temperature and RH measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort in an indoor environment. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.[15] Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The American National Standards Institute (ANSI)/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[15] Assuming slow air movement and 50% RH, the operative temperatures recommended by ASHRAE range from 68-74oF in the winter, and from 73–79oF in the summer. In separate documents, ASHRAE also recommends that RH be maintained between 30 and 60% RH.[15,16]

Total Volatile Organic Compounds

Total volatile organic compounds (TVOCs) describe a large class of chemicals which are organic (i.e., containing carbon) and have a sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. These compounds are emitted in varying concentrations from numerous indoor sources including, but not limited to, carpeting, fabrics, adhesives, solvents, paints, cleaners, waxes, cigarettes, and combustion sources. Studies have measured wide ranges of TVOC concentrations in indoor air as well as differences in the mixtures of chemicals which are present. Research also suggests that the irritant potency of these TVOC mixtures can vary. While in some instances it may be useful to identify some of the individual chemicals which may be present, TVOCs have been used in an attempt to predict certain types of health effects.[19] The use of this TVOC indicator, however, has never been standardized. Neither NIOSH nor OSHA currently have specific exposure criteria for VOC mixtures in the nonindustrial environment. Considering the difficulty in interpreting TVOC measurements, caution should be used in attempting to associate health effects (including non–specific sensory irritation) with specific TVOC levels.

ENVIRONMENTAL METHODS

Carbon Dioxide

Real–time CO_2 measurements were obtained using a Gastech Model RI-411A, Portable CO_2 Indicator. This portable, battery–operated instrument monitors CO_2 via non-dispersive infrared absorption with a range of 0-4975 ppm, and a sensitivity of 25 ppm. Instrument calibration was performed prior to use with a known concentration of CO_2 span gas (800 ppm).

Temperature and Relative Humidity

Real-time temperature and RH measurements were conducted using a TSI battery–operated Model 8360 Velocicalc® Plus Air Velocity meter. The TSI meter is capable of directly measuring dry bulb temperature and RH, ranging from –4 to 140oF, and 0 to 95% RH.

Volatile Organic Compounds

Thermal Desorption Method

Since concentrations of VOCs in non–industrial settings are typically low, Carbotrap® 300 stainless steel thermal desorption (TD) tubes, configured for the Tekmar® 5010 thermal desorber system, were used to collect air samples at three locations within the AOHS office (the Nurses Station, the Break Room, and the Staff Office). One TD sample was collected outside the building for a comparison to background concentrations. Each TD tube contained three beds of sorbent materials: (1) a front layer of Carbotrap C; (2) a middle layer of Carbotrap; and (3) a back section of Carbosieve S-III. The samples were analyzed using the Tekmar thermal desorber interfaced directly to a gas chromatograph and a mass selective detector. Each sample tube was desorbed at 400°C for ten minutes. Known concentrations of several common solvents were prepared and analyzed with this sample set to estimate concentrations.

Gas Chromatography/Flame Ionization Detector Method

While the extremely sensitive TD method can identify VOCs present in the parts per billion range, it does not indicate the *quantity* of these chemicals. To quantitate the airborne levels of the VOCs, air samples were collected at four office locations using activated charcoal as the sorbent material.

Based on the qualitative TD results, the charcoal tube air samples were prepared and analyzed for the following organic compounds using a combination of NIOSH Sampling and Analytical Methods Nos. 1400 and 1500: ethanol, isopropanol, butyl Cellosolve™ (ethylene glycol monobutyl ether), and limonene. The front and back sections of the charcoal tubes were desorbed separately in 1 milliliter of carbon disulfide containing 1% of 2-butanol. Following the desorption period, each sample was analyzed by gas chromatography equipped with a flame ionization detector (GC/FID) using a 30 meter Rtx-35 fused silica capillary column (0.53 millimeter interior diameter, 3 micrometer film). Separation of the analytes was achieved using a 35°C ramped at 8°C/minute to 200°C temperature program. Using the splitless injection technique, 1 microliter sample volumes were analyzed.

RESULTS

Carbon Dioxide Concentrations

As shown in Figure 2, CO_2 levels on June 15, 1995, gradually increased during the work day and generally exceeded 1,000 ppm throughout the facility. These CO_2 levels suggest that the AOHS office may not be receiving adequate amounts of outside air.

Temperature and Relative Humidity Levels

Temperature and RH levels were measured throughout the work day on June 15, 1995. Since several adjustments to the thermostat were made by employees during the work day, the recorded indoor temperature levels fluctuated greatly, ranging from 66 → 78°F. This range of temperatures is not within the ASHRAE summer comfort guideline of 73 → 79°F. The RH levels ranged from 38 → 50%, within the ASHRAE guidelines. The temperature and RH outside the building ranged from 74 → 88°F and 46 → 59% RH, respectively.

Volatile Organic Compounds

The qualitative analysis of the thermal desorption air samples revealed the presence of a variety of chemicals, including isopropanol, ethanol, isobutane, and propane, limonene, butyl cellosolve, acetone, siloxane, toluene, butane, xylene, ketones, pinene, and a variety of aliphatic hydrocarbons. A copy of the reconstructed total ion chromatogram for these samples is provided as Figure 3.

Based on these qualitative TD results, the following compounds were selected for quantitation from the charcoal tube air samples: ethanol, isopropanol, butyl Cellosolve, and limonene. As shown in Table 1, only ethanol (ranging up to 2.2 ppm) and isopropanol (ranging up to 1.4 ppm) were present in quantifiable amounts. All of these concentrations are well below any applicable occupational exposure criteria.

Ventilation Assessment

The inspection of the HVAC system was limited to a visual examination of the supply and return air ducts located in ceiling plenum. (The plenum is the interior space above the suspended ceiling and below the roof.) Supply air is provided to four-way ceiling diffusers located in all of the offices and labs (see Figure 1 for locations) via insulated flexible duct which branches off from either of two main metal trunk lines. These main trunk lines connect to the exterior HVAC package unit located on a metal platform approximately 10 feet off the ground at the rear of the building.[b] Two larger-diameter flexible ducts are used for returning air, connecting two perforated ceiling panels (approximately 2 ft^2 X 2 ft^2) located at the rear of the AOHS office to the air handling system. These observations were in agreement with the ventilation system design plans furnished to NIOSH by the AOHS office in Elizabethtown, Kentucky. There was no information on these design plans to indicate that outside air was being furnished to the AOHS office by the existing ventilation system.

[b] Because of the height that the HVAC unit was located off of the ground, it was not possible to examine its interior to check the condition of the air filters and the position of the outside air damper.

Discussion and Conclusions

The CO_2 concentrations measured in the AOHS office areas were remarkably high considering that it is a sparsely populated work area (less than seven employees per 1000 ft^2). More surprising were the higher-than-expected CO_2 concentrations at the beginning of the work day (7:40 to 7:50 a.m.), which averaged approximately 750 ppm. With the office empty overnight, combined with a very low occupant density, CO_2 concentrations would have been expected to be slightly above ambient concentrations.

These unusually high CO_2 concentrations suggest that little outside air is being introduced into the AOHS office areas by the ventilation system. The ventilation design plans for this office did not indicate whether outside air was being introduced into the building by the ventilation system.

During this evaluation it was observed that the darkroom (used for developing X-ray photographs) was not provided with a ventilation exhaust system. Such a system would reduce the migration of chemical odors associated with the development process to the surrounding offices. In addition to installing a ventilation system for this area, the door to the darkroom should remain closed during X-ray development.

Recommendations

1. The exhausts from the two bathrooms adjacent to the Nurses' Station should be vented outside the building. Currently the bathroom vents terminate in the plenum above the suspended ceiling.

2. The darkroom (used for developing X–ray photographs) should be provided with an exhaust system (to the outside) to reduce the migration of chemical odors associated with the development process to the surrounding offices. Since the darkroom is close to the rear exterior wall (approximately six feet), the installation of such an exhaust system should be neither difficult nor expensive. In addition, the door to the darkroom should remain closed during X–ray development.

3. Based on the unexpectedly high CO_2 concentrations (considering the low occupant density), the amount of outside air provided by the HVAC system should be measured. Based on these elevated CO_2 concentrations, it appears unlikely that the ventilation system supplying the Leitchfield was operating in accordance with ASHRAE's most recently published ventilation standard, 62-1989, Ventilation for Acceptable Indoor Air Quality on the day of this evaluation. A supply rate of 20 CFM OA/person for office spaces is recommended.

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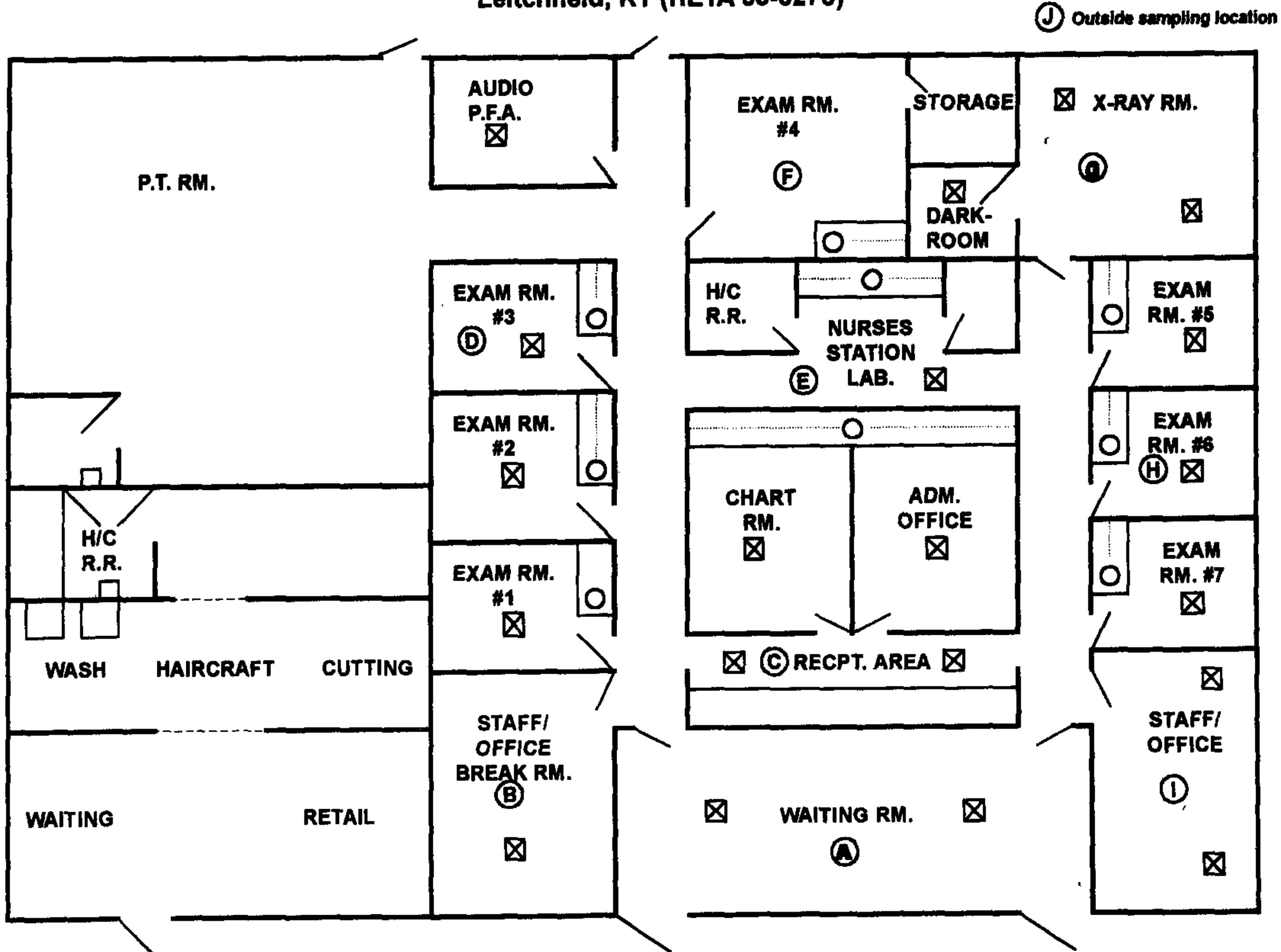
Table 1
Concentrations of Selected Volatile Organic Compounds
Advanced Occupational Health Services, Inc., Leitchfield, KY
HETA 95–0273
Sampling Performed on June 15, 1995

Sample Number	Sampling Location	Concentration, parts per million			
		Ethanol	Isopropanol	Ethylene glycol monobutyl ether‡	Limonene
GB - 1	Office Location J	1.2	1.2	ND	ND
GB - 2	Outside	ND	ND	ND	ND
GB - 3	Darkroom Area	1.7	1.4	ND	ND
GB - 4	Nurse's Station	1.7	1.1	ND	ND
GB - 5	X-Ray Room	2.2	1.2	ND	ND
Minimum Detectable Concentration (assuming a 40 liter air sample)		0.02	0.02	0.08	0.03
Minimum Quantifiable Concentration (assuming a 40 liter air sample)		0.05	0.06	0.3	0.11
Evaluation Criteria ***(expressed in parts per million)***					
NIOSH REL		1000 TWA	400 TWA; 500 STEL	5 TWA (Skin)	None
OSHA PEL		1000 TWA	400 TWA; 500 STEL	50 TWA (Skin)	None
ACGIH TLV		1000 TWA	400 TWA; 500 STEL	25 TWA (Skin)	None

Comments:
REL = Recommended Exposure Limit
TLV = Threshold Limit Value
TWA = Time weighted average
Skin = Potential for skin absorption
PEL = Permissible Exposure Limit
ND = Not Detectable
STEL = Short–term exposure limit
‡ = Also known as Butyl Cellosolve™

Figure 1
Floor Plan and Sampling Locations
Advanced Occupational Health Services
Leitchfield, KY (HETA 95-0273)



Legend:
The circled letters indicate sampling locations (see Figure 2 for carbon dioxide results).
The ⊠ represent location of supply air diffusers. Return air diffusers were located in the Nurse's Station Lab and near Exam Room #4.

Figure 2

Carbon Dioxide Concentrations
Advanced Occupational Health Services
Leitchfield, KY (HETA 95-0273)
Sampling Date: June 15, 1995

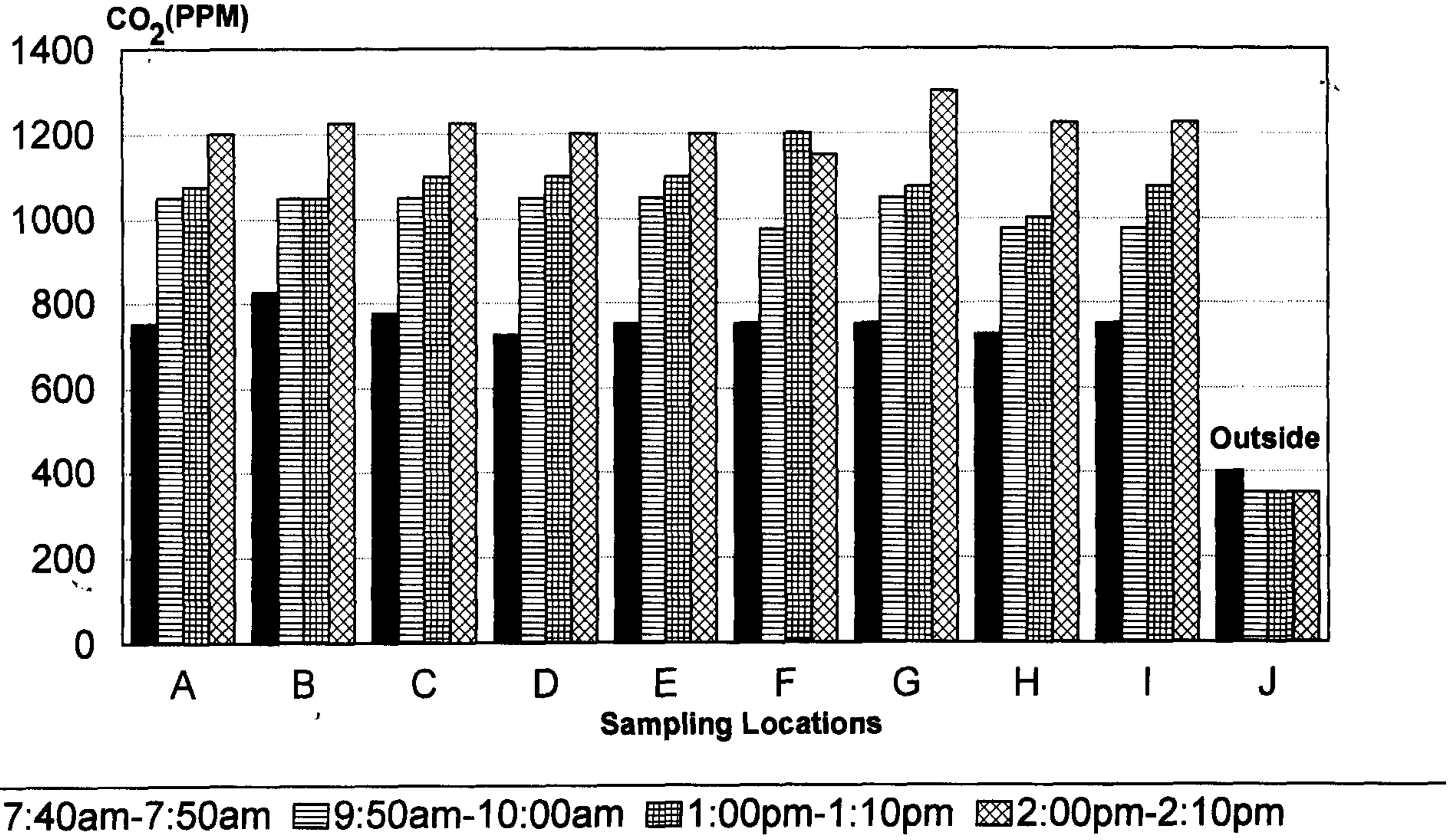
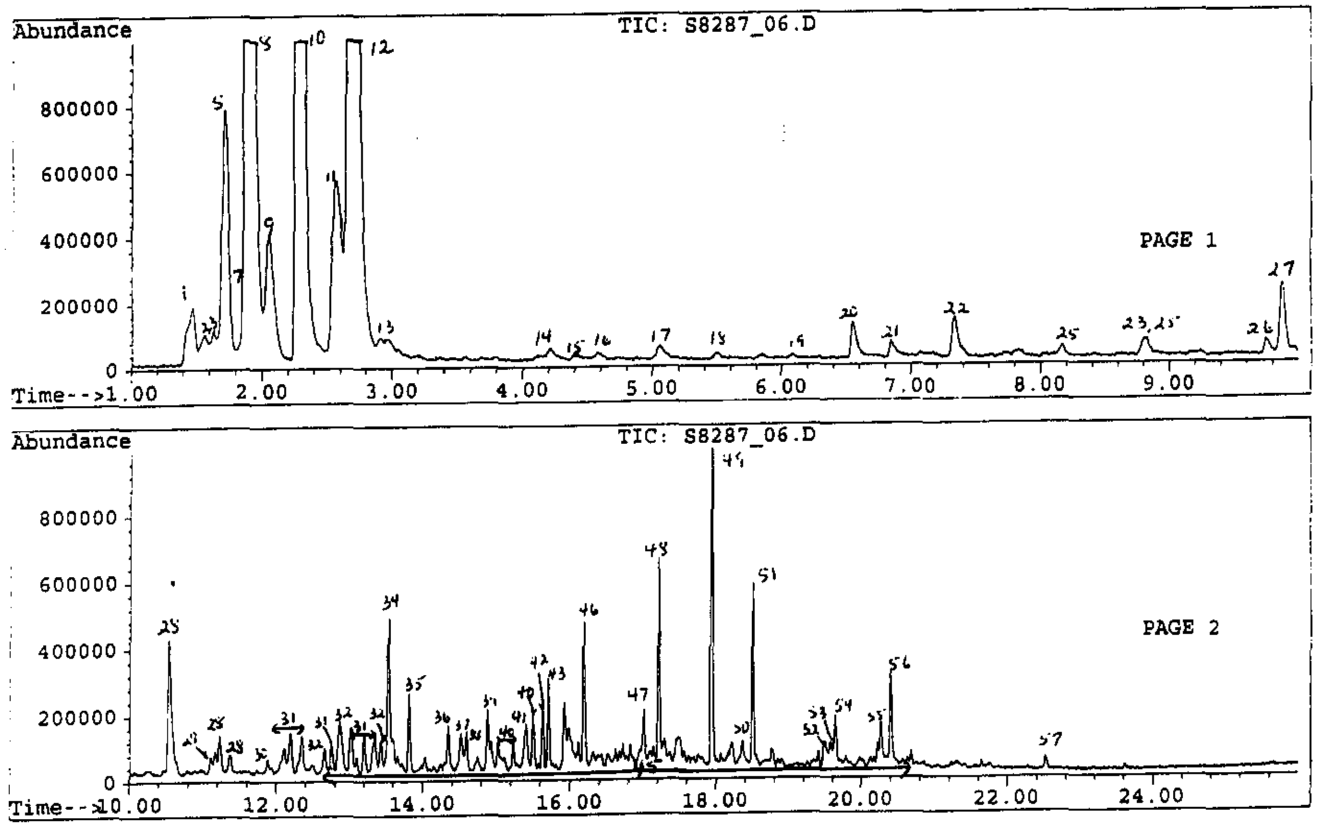


Figure 3
Reconstructed Chromatograms from Thermal Desorption Air Samples
Office Location J*
Advanced Occupational Health Services
Leitchfield, KY (HETA 95–0273)
Sampling Date: June 15, 1995



* See Figure 1

Figure 3 (continued)
Reconstructed Chromatograms from Thermal Desorption Air Samples
Nurses' Station
Advanced Occupational Health Services
Leitchfield, KY (HETA 95-0273)
Sampling Date: June 15, 1995

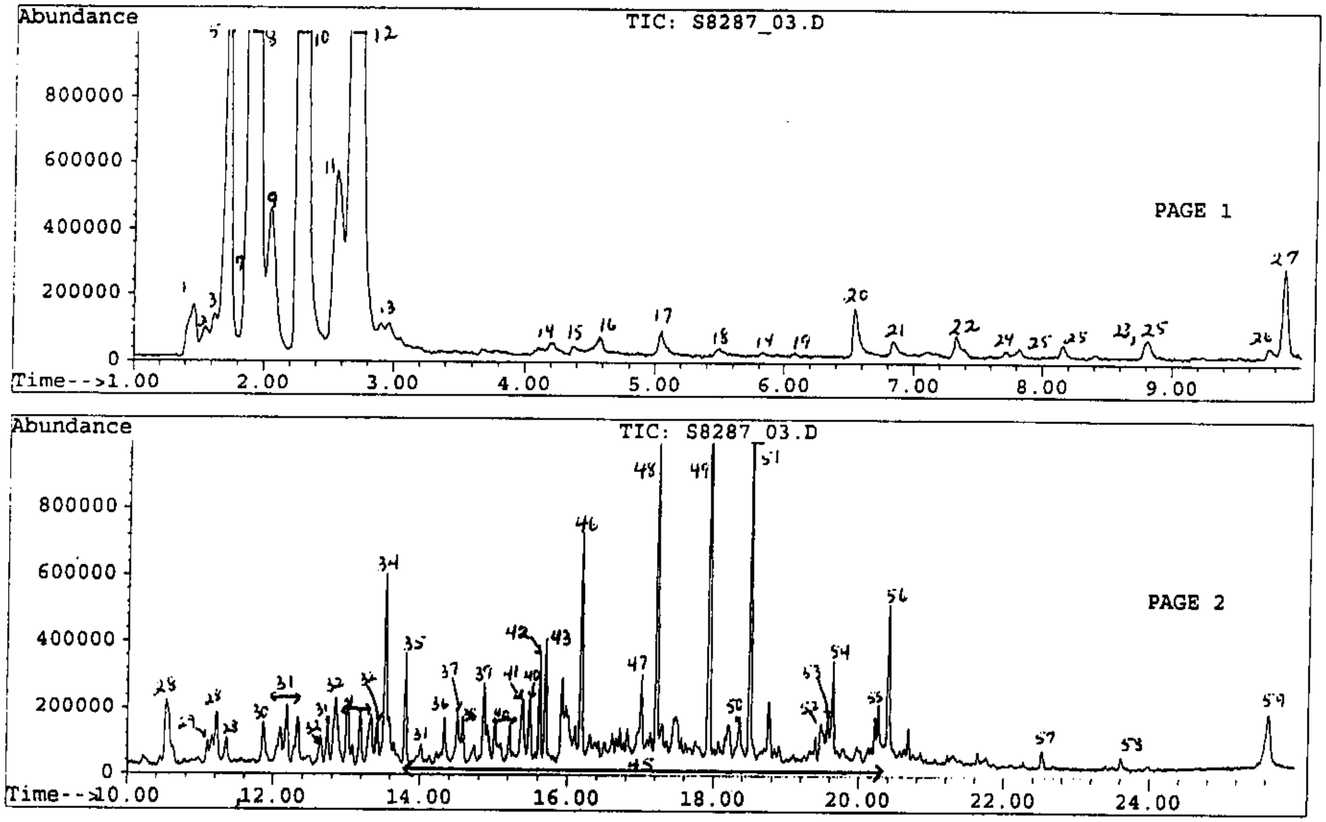


Figure 3 (continued)
Reconstructed Chromatograms from Thermal Desorption Air Samples
Outside Building (Background)
Advanced Occupational Health Services
Leitchfield, KY (HETA 95–0273)
Sampling Date: June 15, 1995

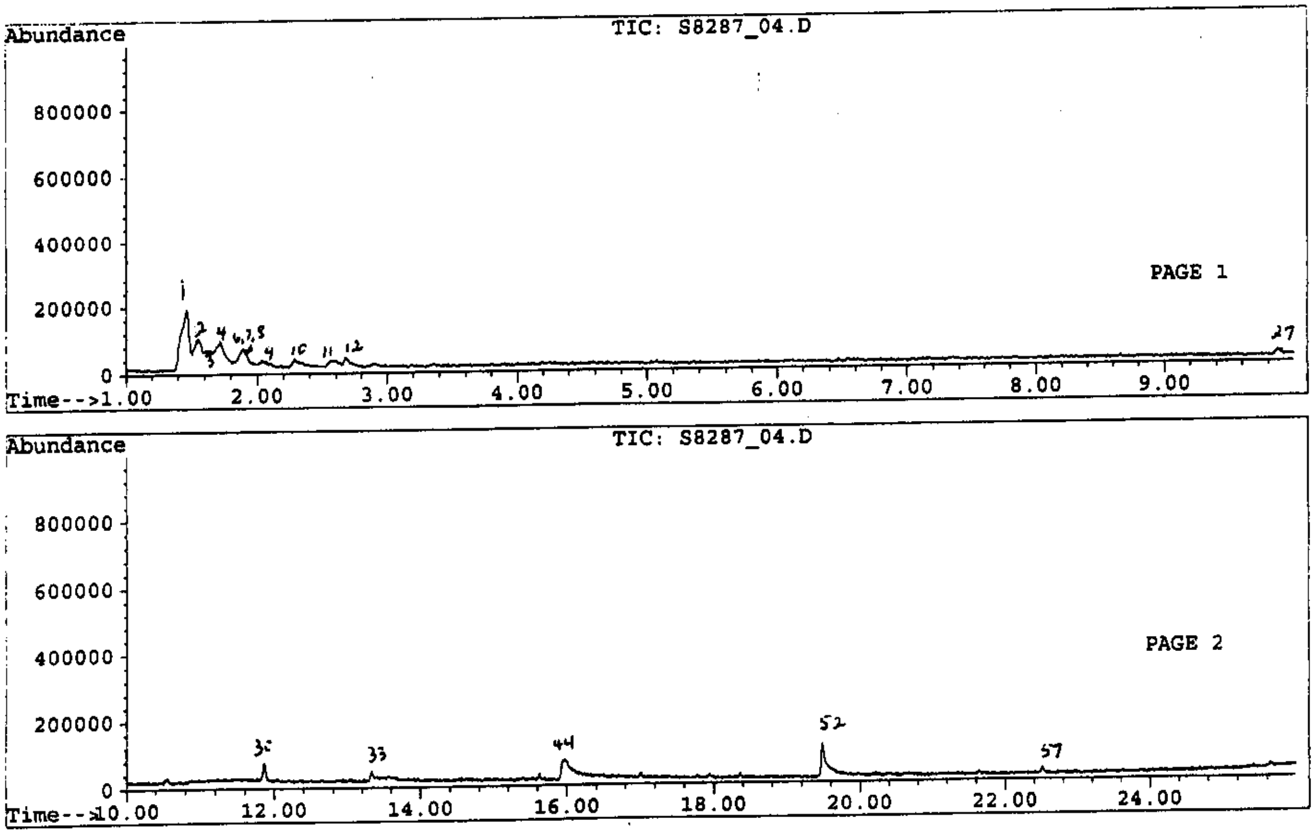


Figure 3 (continued)
Reconstructed Chromatograms from Thermal Desorption Air Samples
Employee Break Room
Advanced Occupational Health Services
Leitchfield, KY (HETA 95–0273)
Sampling Date: June 15, 1995

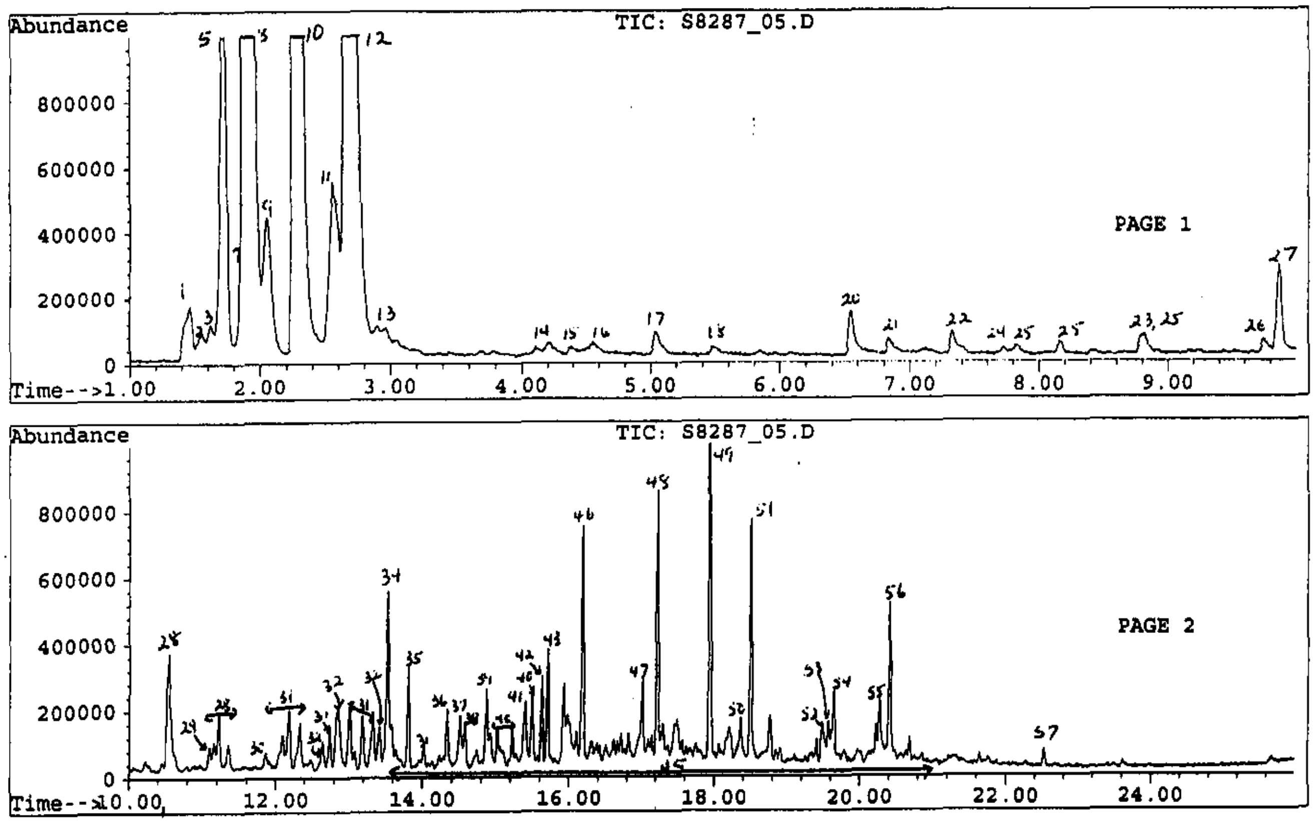


Figure 3 (continued)
Thermal Desorption Tubes
Chromatogram Peak Identification
Advanced Occupational Health Services
Leitchfield, KY (HETA 95–0273)
Sampling Date: June 15, 1995

1) Air*
2) CO_2*
3) Formaldehyde
4) SO_2
5) Propane
6) Methanol
7) Acetaldehyde
8) Isobutane
9) Butane
10) Ethanol
11) Acetone
12) Isopropanol
13) C_5H_{12}/C_5H_8 aliphatics
14) C_6H_{14}/C_6H_{12} aliphatics
15) Methyl ethyl ketone (MEK)
16) Acetic acid
17) Ethyl acetate/hexane
18) Tetrahydrofuran (THF)
19) 1,1,1-Trichloroethane
20) Butanol/isopropyl acetate/ benzene (trace)
21) 1-Methoxy-2-propanol
22) Pentanal (valeraldehyde)
23) Methyl isobutyl ketone (MIBK)
24) Trichloroethylene
25) C_7H_{16}/C_7H_{14} aliphatics
26) 1-Pentanol
27) Toluene
28) C_8H_{18}/C_8H_{16} aliphatics
29) n-Butyl acetate
30) Hexamethylcyclotrisiloxane*
31) C_9H_{18}/C_9H_{20} aliphatics
32) Ethyl benzene/xylene isomers
33) Cellosolve acetate*
34) Butyl cellosolve (2-butoxy ethanol)
35) Nonane
36) 1-Butoxy-2-propanol
37) Benzaldehyde
38) Pinene
39) C_9H_{12} alkyl benzene plus trace phenol
40) C_9H_{12} alkyl benzenes
41) Octanal
42) Octamethylcyclotetrasiloxane
43) Decane
44) Ethyl hexanol*
45) C_{10}-C_{13} aliphatics/C_9-C_{10} alkyl benzenes
46) Limonene
47) Nonanal
48) Undecane
49) Decamethylcyclopentasiloxane
50) Naphthalene/decanal
51) Dodecane
52) Phthalic anhydride*
53) Glycerol triacetate?
54) Tridecane
55) $C_{12}H_{24}O_3$, M.W.216 ester (Propanoic acid, 2-methyl-3-hydroxy-2,4-4-trimethylpentyl ester?)
56) $C_{12}H_{24}O_3$, M.W.216 ester (Propanoic acid, 2-methyl-2,2-dimethyl-1-(2-hydroxy-1-methyl-ethyl)propyl ester?)
57) $C_{18}H_{38}O_2$, M.W.286 ester (propanoic acid, 2-methyl-,1-(1,1-dimethyl)-2-methyl-1,3-propanediyl ester?)
58) M.W.210, diethyl biphenyl
59) Bis(2-ethylhexyl)phthalate

*Also present in system blank or on media/field blanks.