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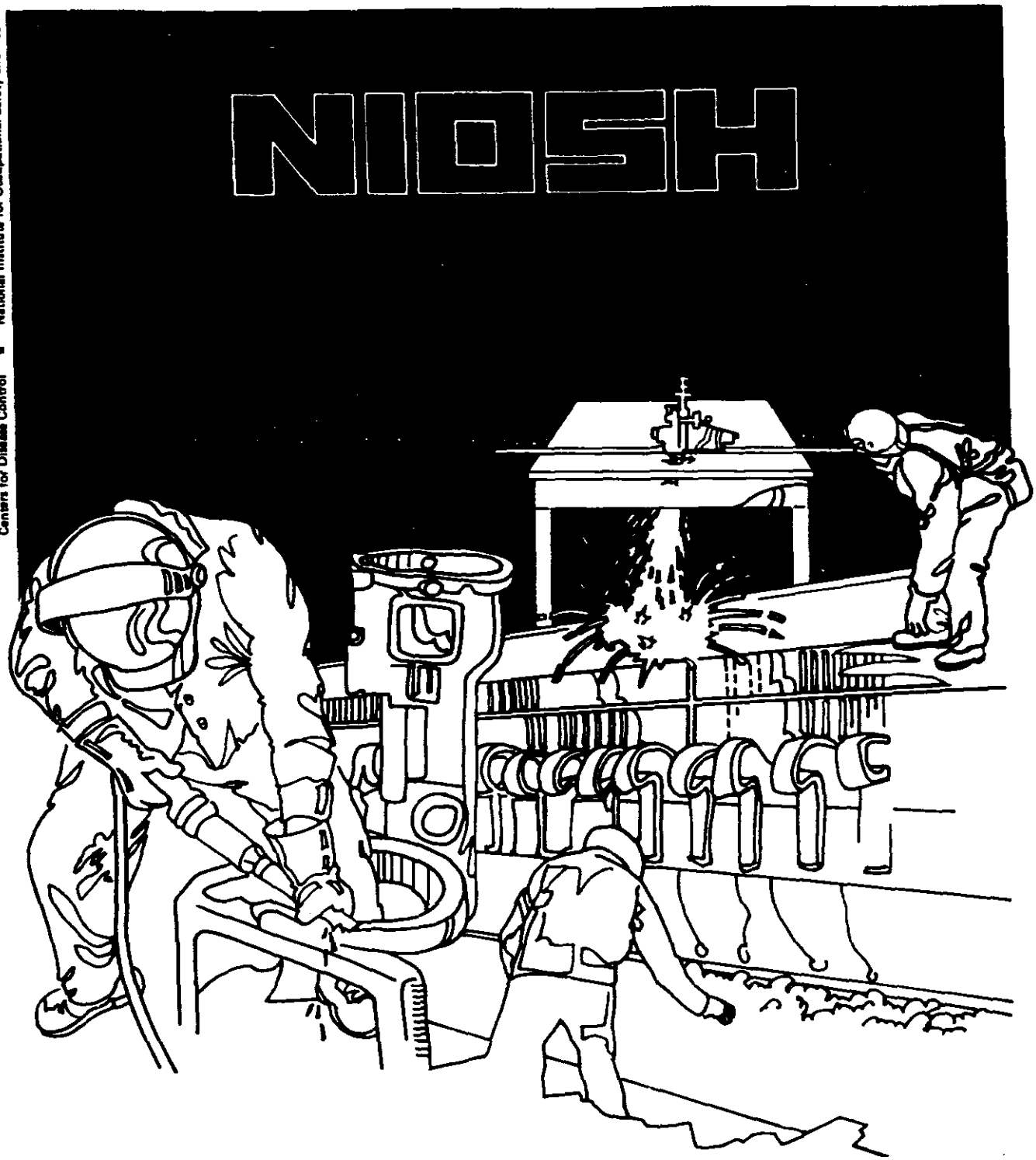

Health Hazard Evaluation Report

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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 or 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.

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I. SUMMARY

On March 12, 1987, employees from the Clarksburg Publishing Company (CPC) requested the National Institute for Occupational Safety and Health (NIOSH) to investigate work-associated complaints of headache, sinus trouble, nasal irritation, blurred vision, dizziness, diarrhea, memory loss, muscle weakness/cramping, nausea, confusion, and chills. These symptoms were reported among employees in the CPC Exponet Telegram Building (ETB) in Clarksburg, West Virginia.

In April 1987, NIOSH investigators conducted a walk-through evaluation; a screening questionnaire was distributed by mail to all ETB employees in May 1987, to assess the nature and frequency of the health/comfort complaints. An environmental survey was done in May 1987 to assess indoor air quality (IAQ). Sampling was done for a number of air contaminants/environmental conditions including: carbon dioxide; carbon monoxide; formaldehyde; organic vapors; and temperature/relative humidity. Evaluation of the building and its ventilation system were also done. Medical telephone interviews were done to investigate any building related health problems; medical records were requested and reviewed for one employee.

Forty-six percent (46%) of the approximate 124 employees in the ETB completed the questionnaire survey; survey results indicated the most prevalent complaints were discomfort/irritation from cigarette smoke, headache, uncomfortable temperatures, chemical odors, frequent colds, and other complaints. One former ETB employee interviewed by telephone had additional symptoms as described in the first paragraph for which she sought medical treatment.

Airborne gas and vapor concentrations measured inside the ETB were below the existing permissible exposure limits and exposure guidelines of The Occupational Safety and Health Administration (OSHA), The American Conference of Governmental Industrial Hygienists (ACGIH), The American Society for Heating Refrigerating and Air-Conditioning Engineers (ASHRAE), and NIOSH. The design and operation of the building's heating, ventilation, and air-conditioning systems were suboptimal. Some building occupants do not receive adequate outside air supply by ASHRAE standards.

On the basis of the data obtained during this evaluation, the symptoms reported by this group of workers can most likely be explained by areas of substandard ventilation in conjunction with low level indoor pollutants (e.g. tobacco smoke or organic vapors). Recommendations for prevention of these types of problems in the ETB are presented in section IX of this report.

KEYWORDS: SIC 9441 Office-buildings, Indoor Air Pollution, Tight Building Syndrome, Ventilation

II. INTRODUCTION

On March 12, 1987, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a health hazard evaluation request from employees at the Clarksburg Publishing Company's Exponet Telegram Building (ETB) in Clarksburg, West Virginia. The request cited complaints of headaches, sinus trouble, nasal irritation, blurred vision, dizziness, diarrhea, memory loss, muscle weakness/cramping, nausea, confusion, and chills related to the work environment. Formaldehyde and carbon monoxide exposures were identified in the HHE request as potential causes of these symptoms along with exposures to other unidentified chemicals. A preliminary walk-through evaluation was done on April 16, 1987, to become familiar with the building and building activities/operations. On May 1, 1987, a standardized questionnaire on indoor air quality (IAQ) was mailed to all building employees. Following an evaluation of the questionnaire results, NIOSH investigators conducted an industrial hygiene survey at the ETB on May 28, 1987. Telephone interviews were done to collect medical information from workers reporting building related health problems.

III. BACKGROUND

The Exponet Telegram Building (ETB) is a brick/concrete structure built during the 1920's. It is located on Hewes Avenue in downtown Clarksburg, West Virginia. The ETB has three active floors: basement; first; and second. Approximately 124 employees occupy the building over two shifts. These employees are involved in the production of the local newspaper, The Clarksburg Telegram. In addition to normal office activities, the building contains a printing press, a photography/developing department, a photoengraving plate department, and a small print (job) shop. The second floor contains the business offices, the composing room, and photoengraving operations. (See Figure 1). There is also a dental laboratory on the second floor separate from Clarksburg Publishing Company. The first floor is largely an office area including classified and display advertising departments, a circulation department, and a news (editorial) room. The first floor also contains photography/developing rooms and a job shop were small printing jobs are done. The basement area contains the press room (where the paper is printed), the mail room, a paper loading driveway, and storage areas. Quite a number of chemicals are used in the building including: inks; solvents; developers; glues; and cleaning agents. Smoking is permitted in office areas without restriction.

IV. METHODS

A. Indoor Air Quality Questionnaire

On May 1, 1987, a one-page, self-administered questionnaire (Table I) was distributed to all building employees in order to assess the nature, frequency, and demographics of reported health complaints in the ETB. Employees were asked to complete the questionnaire and return it by mail in a stamped envelope provided with each questionnaire. The questionnaire data were analyzed and used to help direct this evaluation.

B. Environmental

An industrial hygiene evaluation of the ETB was done to identify potential indoor air pollution problems related to the health/comfort complaints. This evaluation was done during two separate site visits in April and May 1987. This industrial hygiene evaluation included physical and chemical assessments of building conditions and indoor air quality (IAQ). The selection of environmental analytes for this evaluation was based on (1) chemicals listed on the HHE request form; (2) information gathered from building employees through conversation and the IAQ questionnaire; and (3) NIOSH experience from IAQ evaluations in other office buildings. Almost all employee health complaints were reported by office workers on the first floor, consequently, our evaluation efforts were centered on this floor.

Physical aspects involved evaluation of office areas for problem conditions including mold growth, flooding/water incursions, or other physical problems. Temperature and relative humidity measurements were taken and an evaluation of the ventilation system was done. First floor ventilation system flow rates were measured with a pitot tube and inclined manometer.[1]

Airborne sampling for several chemicals/substances was also done to assess the indoor air quality; these included carbon dioxide, carbon monoxide, formaldehyde, and organic gases/vapors.

Formaldehyde samples were taken with a midget impinger operated at 1 liter per minute (lpm). A sodium bisulfite collection media was used. Full shift samples were collected. The samples were analyzed by spectrophotometry. This method has a LOD of about 0.001 ppm for an 8 hour sample.[2]

Carbon dioxide, carbon monoxide, and formaldehyde were sampled using direct reading indicator tubes. These short term samples were collected over a time period of about 4 minutes.[3] These indicator tube samples use colormetric methods where the length of a color change in the sampling tube is a measure of airborne gas concentration.

Bulk organic gas/vapor samples were collected on activated charcoal media at a sampling rate of 200 milliliters per minute. Full shift, area samples were taken and analyzed qualitatively for organic compounds by gas chromatography.[2] Organic gas/vapor samples were collected on activated charcoal media at a sampling rate of 100 milliliters per minute. Full shift, area samples were taken and analyzed by gas chromatography to quantify the major organic compounds identified in the bulk charcoal tube samples.[2]

C. Medical

A NIOSH medical officer reviewed the health complaints provided on the IAQ questionnaire form. Telephone interviews were conducted with three of the ETB employees complaining of work related medical illness. Personal medical records were obtained and reviewed for the one ETB employee who sought medical evaluation and treatment.

V. EVALUATION CRITERIA

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria consist of exposure levels for substances and conditions to which most workers can be exposed day after day for a working lifetime without adverse health effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure.

Several sources of evaluation criteria exist and are commonly used by NIOSH investigators to assess occupational exposures. These include:

1. The U.S. Department of Labor (OSHA Federal Occupational Health Standards; permissible exposure limits (PEL's);[4]

2. The American Conference of Governmental Industrial Hygienist (ACGIH) Threshold Limit (Exposure) Values (TLV's);[5]

3. NIOSH criteria documents and recommendations. (Recommended exposure limits.)

These criteria have been derived from industrial experience, from human and animal studies, and when possible, from a combination of the three. Consequently, due to differences in scientific interpretation of these data, there is some variability in exposure recommendations for certain substances. Additionally, OSHA considers economic feasibility in establishing occupational exposure standards; NIOSH and ACGIH place less emphasis on economic feasibility in development of their criteria.

The exposure criteria described below are reported as time-weighted average (TWA) exposure recommendations (averaged over the full work shift); short term exposure limits (STEL) recommendations for a 10-15 minute exposure period; and ceiling levels (C) not to be exceeded for any amount of time. These exposure criteria and standards are commonly reported as parts contaminant per million parts air (ppm), or milligrams of contaminant per cubic meter of air (mg/m^3). Occupational criteria for the contaminants evaluated in this study are as follows:

Substance	NIOSH (REC.)	ACGIH (TLV)	OSHA (PEL)
Carbon Dioxide	10,000 ppm	5,000 ppm	5,000 ppm
Carbon Monoxide	35 ppm	50 ppm	50 ppm
Formaldehyde[1]	LFL	1 ppm	3 ppm

[1]Considered a potential human carcinogen by NIOSH and ACGIH.
- These standards/exposure levels refer to time-weighted averages (TWA) unless otherwise specified as short term exposure limits (STEL), or ceiling values (C).
-ppm - Parts contaminant per million parts air.
-mg/m^3 - Milligrams contaminant per cubic meter of air.
LFL - Lowest feasible limit.

Some research suggests that industrial exposure criteria may be inappropriate for evaluating IAQ problems in office buildings.(6,7,8) The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) is one organization with environmental criteria designated to maintain acceptable IAQ in office building environments. They define acceptable IAQ as, "air in which there are no known contaminants at harmful concentrations and with which a substantial majority (usually 80%) of the people exposed do not express dissatisfaction."(6) ASHRAE recommends that outdoor air acceptable for ventilation (without treatment) meet the requirements established by the U. S. Environmental Protection Agency in the National Ambient Air Quality Standards and Additional Ambient Air Quality Guidelines.(6) These ASHRAE criteria for the contaminants evaluated in this study would include:

	level	time
Carbon Dioxide	-	-
Carbon Monoxide	35 ppm	1 hr
Formaldehyde	0.1 ppm	ceiling

ppm - Parts per million parts air.
mg/m^3 - Milligrams per cubic meter of air.

ASHRAE also recommends criteria[1] for indoor temperatures and ventilation rates for office buildings as detailed below:

Temp./Relative Humidity		Air Changes Per Hour	Minimum Outdoor Air
Winter	Summer		5 cu. ft. per min. (CFM)/person (non-smoking)
70-74°F	74-78°	4 to 10	
20-30% RH	40-50% RH		20 CFM/person (smoking)

[1]ASHRAE is in the process of revising their recommendations on minimum outside air requirements for office buildings; however, the revisions are not in final print.

Carbon dioxide (CO_2) concentrations in indoor air are often used as an indirect measure of a buildings capability to dilute indoor generated odors and irritants. The following CO_2 criteria have been used to assess IAQ in office environments:[9,10]

Carbon Dioxide (ppm)	Comments
Less than 600	Adequate outside air intake
600 - 800	There may be occasional complaints, particularly if the air temperature rises
800 - 1000	Complaints more prevalent
>1000	Insufficient make-up air, complaints are general

VI. RESULTS

A. Indoor Air Quality Questionnaire

Questionnaires were received from 57 of the approximately 124 current ETB employees for a response rate of 46 percent(%) (Table I). Approximately 16% of the employees who completed a questionnaire (9 employees) reported experiencing discomfort believed to be work related. Of these, most of the complaints were from office areas on the first floor; one complaint of discomfort was from the basement. Approximately 5% of the employees reported work related medical illness. All of these medical complaints were from first floor office areas.

The most prevalent complaint of ETB employees was discomfort/irritation related to cigarette smoke in the building (10% or 6 employee complaints). Other prevalent symptoms/complaints from the IAQ questionnaire included uncomfortable temperatures (5%), frequent colds (5%), headache (3.5%), and chemical odors (3.5%).

B. Environmental

Building evaluation:
Some building ceiling tiles had stains; however, there was no evidence of water damage to carpets or office materials in these areas. There were no areas of obvious, visible mold growth in the office areas or on office ceiling tiles. Ceiling tiles near the ventilation supplies in some areas were dirty with accumulated particles.

Temperature and Relative Humidity:
Nineteen temperature and relative humidity measurements were taken at the ETB in April and May (Table II). Indoor temperatures ranged from a low of 68 degrees fahrenheit (°F) to a high of 77° F, and relative humidity ranged from a low of 30% to a high of 59%.

Building Ventilation System Evaluation:
The ETB is not a modern air-tight building, the windows open; however, employees are requested to keep windows closed. Consequently, the heating, ventilation, and air-conditioning systems (HVAC) are the primary source for outside air supply to building occupants. The ETB is served by five separate ventilation systems. The second floor is served by two of the systems while, the first floor has three systems. The basement areas have steam heat radiators but no ventilation systems.

The three ventilation systems that serve the first floor are different in respect to size and ventilation capabilities. These systems have heating and air-conditioning (cooling) capabilities. Heating is provided by a

boiler located in the basement; cooling is accomplished by individual compressors. Only one of the first floor ventilation systems (system 1) has outside air intake capability; this system serves all first floor office areas except the news room and the classified advertising room. The outside air intake for this ventilation system is operated pneumatically based on ambient conditions; the outside air intake was closed during our evaluation on 5/28/87.

The supply air from HVAC #1 is delivered to office areas through ceiling supply terminals; return air for this system is drawn through a ceiling grill located in the main hall outside the job shop. Volumetric air flow readings for system #1 measured during the 5/28/87 survey were 4180 cubic feet per minute (CFM). The design flow rate for this system is 8960 CFM. Some duct work for this system contained fiberglass lining within the duct.

Standing water with biological growth was observed in the water collection tray below the cooling coils in HVAC system #1. The drain for this water collection tray appeared to be blocked with HVAC dirt/materials.

HVAC system #2 provided tempered air supply to the news room and classified advertising room through ceiling supply air terminals. Ceiling return air grills were used in these areas. This system provided no outside air supply to building occupants working in these office areas. The water collection tray below the cooling coils in this system was wet and draining freely; it was free of obvious biological growth.

A third HVAC system was used on the first floor for the computer room (in addition to HVAC system #1) to help provide more precise environmental control for computer equipment. This HVAC system has no outside air intake.

Airborne Gases/Vapors:
Formaldehyde impinger samples (3) taken inside the ETB had an airborne concentration of 0.003 parts per million parts air by volume (ppm). The ambient formaldehyde concentration measured outside the ETB had a concentration of 0.002 ppm (Table III). These formaldehyde concentrations were to low to be detected with the short term detector tube samples taken in the building.

Carbon Dioxide (CO_2) measurements from short term, area detector tube samples taken within the ETB ranged from 600 ppm to 900 ppm (Table IV). The 15 building samples had a mean of 773 ppm and a standard deviation (STD) of 84. The three ambient CO_2 samples taken outside the ETB had a mean of 350 ppm and a STD of 87. Carbon dioxide concentrations from first floor office areas served by HVAC system #1 (with outside air intake) had a mean concentration of 718 ppm; while, those 1st floor office areas served by HVAC system #2 (no outside air intake) had a mean CO_2 concentration of 818 ppm (Table V).

Carbon monoxide readings taken in the basement loading area during loading operations were all below detectable levels (LOD< 1 ppm). During newspaper loading, all automobile engines were turned off.

Bulk airborne samples taken for qualitative identification of organic gases and vapors contained a number of compounds including isoproponal, various 6 carbon (C6) alkanes including n-hexane, alkyl substituted napthas, C9-12 aliphatic hydrocarbons, limoneue, cellosolve, toluene, and other unresolved hydrocarbons. Based on the analytical results for these three bulk samples, the charcoal tube samples were analyzed for n-hexane, cyclohexane, cellosolve, toluene, n-octane, n-nonane, n-decane, n-undecane, n-dodecane,limonene, and total hydrocarbons. Of these organic compounds, only n-hexane was detected in building air at quantifiable levels (Table VI). Building n-hexane concentrations ranged from below detectable levels (LOD) in the mail room and press room to a high of 5.5 ppm in the first floor job shop. (The LOD for n-hexane is 0.02 mg/sample or, depending on sample volume, about 0.1 ppm). The first floor office areas had n-hexane concentrations between 1 and 2 ppm. N-hexane was not detected in the ambient sample. Total hydrocarbon vapor concentrations in air ranged from nondetectable levels (LOD of approximately 0.5 mg/m^3) in the mail room to a high of 88 mg/m^3 in the job shop. The ambient total hydrocarbon concentration was 5.3.$mg/m.^3$

C. Medical

Three employees interviewed regarding medical complaints believed to be work related are described below:

Employee #1 is female. Her symptoms first began in April/May, 1986 and were described as sinus infection, sinus drainage, nasal stuffiness, and headache. These symptoms reportly became worse over the next several months and additional symptoms were reported including general malaise for 1-2 days/week, blurred vision, dizziness, memory loss, muscle weakness, confusion, nausea, cramping, diarrhea, chills, double vision. From April to October 1986, she took prescription medications including antibiotics, decongestants, muscle relaxants, and anti-anxiety medications. On the first of October, 1986, she went on sick leave and consulted an allergist on October 7th. Upon return to work at the ETB (October 9), all symptoms reportedly reoccurred 10 minutes after entering the building.

On October 10th, arterial blood gas analysis was done to measure carboxyhemoglobin levels for carbon monoxide exposure; carboxyhemoglobin levels were reported as "quite high" by this employee; however, she did not supply us with the test results and we were unable to obtain these test results independently.

On October 14th, she returned to her allergist for sensitivity testing for formaldehyde. NIOSH investigators received correspondence from the

allergist indicating that this employee is extremely sensitive to formaldehyde; however, the allergist reports that an end point to this test could not be reached. The tests with this chemical were reported to produce symptoms very similar to those she experienced at work. This employee has not worked in the ETB since October 1986. In February/March 1987, she was still experiencing symptoms although they were reported as less severe than those while working in the ETB.

In April 1987, this employee had a spontaneous pneumothorax and had a chest tube inserted. She reported that her doctor indicated the pneumothorax may have been related to some chemical exposure. However, she had not worked in the ETB since October 1986.

Employee #2 is female. She complained of frontal headaches 2-3 days a week, dizziness, fatigue, and occasional blurred vision. These symptoms were first reported to occur after she began work in the ETB. She has missed work on several occasions due to these symptoms, but has never seen a physician for these symptoms.

Employee #3 is female. She complained of frequent sinus trouble and states that her sinuses are frequently infected. She also reports frequent headaches after about one hour in the ETB office where she does most of her work. The headache does not reportedly occur in other ETB offices and subsides after leaving her office.

VII. DISCUSSION

Among the health/comfort complaints of ETB employees, discomfort/irritation from smoking, uncomfortable temperatures, frequent colds, headaches, sinus problems, fatigue, and dizziness were the most prevalent from medical interviews and from the IAQ questionnaires. The IAQ questionnaire response rate for this survey (46%) is low. Sixteen percent of the employees completing questionnaires reported experiencing work related discomfort; while, approximately 5% of the respondents reported work related medical illness. Almost all of the health/comfort complaints occurred among first floor office workers. One of these workers had medical complaints more severe than the other workers for which she sought medical treatment. Her symptoms were described as sinus infection/drainage, nasal stuffiness, headache, general malaise, blurred vision, dizziness, memory loss, muscle aches, weakness, confusion, nausea, cramping, chills, diarrhea, and double vision.

Many of the health/comfort complaints of ETB employees have been commonly reported in airtight, multi-story buildings with central HVAC systems. In most instances, the reported symptoms can not be attributed to any specific environmental substance/exposure; hence the term 'tight building syndrome' has been used to describe these types of reported health/comfort problems.[7,9-11] Traditional industrial hygiene methods are often

insensitive to these type of health/comfort problems reported in the office environment. This is consistent with the results of our evaluation. The etiology of the health/comfort complaints at the ETB can not be directly attributed to overexposure to any particular environmental agent. None of the NIOSH industrial hygiene sampling results from the ETB exceeded existing OSHA PEL's or the exposure guidelines of NIOSH and ACGIH. Most of the environmental analytes sampled at ETB were substantially below these evaluation criteria. Carbon monoxide and formaldehyde were both cited on the HHE request form as potential causes of the reported symptoms among ETB employees. Carbon monoxide was not detected in the ETB while formaldehyde concentrations were not substantially different from ambient levels and 1000 times lower than the existing OSHA exposure standard.(4)

Reduced ventilation rates, inadequate outside air supply, or altered air distribution are commonly associated with the 'tight building syndrome' problems.(7,9-10) It is well-recognized that fresh outside air must be added to closed-circuit building ventilation systems, in adequate amounts, to provide sufficient oxygen for respiration and to dilute the numerous low-level contaminants generated in occupied spaces. ASHRAE recommends a minimum of 5 cubic feet per minute (CFM) of outside air per occupant in a building where smoking is prohibited; to compensate for increased indoor air pollution from smoking, ASHRAE recommends a minimum of 20 CFM outside air per occupant in a building where tobacco smoking occurs.(7) The reduction in outside air intake, or distribution, can result in occupant discomfort and complaints similar to many of those reported at ETB.(7,9-12)

Cigarette smoke is a major contributor to indoor air pollution and its components can cause many of the major complaints reported by ETB building occupants such as eye, nose, or throat irritation.(7,14) Cigarette smoke contains over four thousand chemicals, many of which are noxious irritants and/or carcinogens or co-carcinogens. Numerous scientific studies have shown a strong relationship between cigarette smoke and respiratory tract disease, heart disease, and cancer. Evidence is mounting for a relationship of cigarette smoke and these diseases in exposed non-smokers as well as smokers.(7,14)

Carbon dioxide (CO_2) concentrations are often used as a marker for adequate outside air intake and distribution. (CO_2 is generated in an office environment through human respiration, tobacco smoke, combustion processes, etc.) As the CO_2 concentrations increase above the normal ambient levels (approximately 330 ppm in non-polluted locations) there is evidence of reduced outside air intake. Increased CO_2 levels indicate insufficient outside air intake (with increased air recirculation) and have been associated with increased discomfort/complaints. Carbon dioxide concentrations in the 600-1000 ppm range are associated with occupant complaints. Carbon dioxide concentrations above 1000 ppm are associated

with insufficient make-up air and widespread complaints.[9,10] Short term carbon dioxide concentrations measured in the ETB during the NIOSH surveys ranged from 600 ppm to 925 ppm with a mean concentration of 773 ppm. CO_2 samples taken outside had a mean concentration of 350 ppm. Consequently, CO_2 concentrations measured inside the ETB indicate some deficiency in outside air intake. Carbon dioxide concentrations from those first floor office areas served by the HVAC system #2, with no outside air intake (news room and classified advertising) were higher than those measurements taken from other office areas.

As discussed earlier, the ETB is not a modern, air-tight building. It was built during the 1920's. The building windows do open, but building employees are requested to keep the windows closed. Consequently, the HVAC is the primary source of outside supply air for building occupants. Only one of the three HVAC systems serving the first floor of the ETB has outside air intake capability. The outside air intake louvers for this system are controlled pneumatically, based on ambient temperature. On the day of our evaluation (5/28/87), the outside air intake for this system was closed. HVAC system #2 (serving the first floor news room and classified advertising department) has no outside air intake. Consequently, on the day of our evaluation, the first floor office areas would not meet ASHRAE recommended outside air intake for a building where tobacco smoking is permitted (20 CFM/person).[6] The numerous chemical agents used in this building (as contrasted to other office settings) increase the need for adequate outside air intake and distribution throughout office areas. Additionally, the return air grill for HVAC system #1, located in the hallway outside the job shop, facilitates distribution of organic vapors generated from the job shop throughout other first floor office areas (Figure 1). Based on the organic vapor sampling results, the job shop is a major source of organic vapor release into the ETB.

Other building areas are served by HVAC systems with no outside air intake. These include the Business Office on the second floor and all basement areas.

VIII. CONCLUSIONS

1. Most workers in the ETB report symptoms consistent with those commonly described as "tight building syndrome." These types of complaints, including eye irritation, stuffiness, tiredness, headache, nausea, muscle aches, upper respiratory tract irritation, and others are commonly associated with inadequate ventilation, in conjunction with low level indoor pollutants (e.g. tobacco smoke, organic vapors, etc.)[7,9-11]

2. One ETB employee reported medical symptoms more severe than the other workers for which she sought medical treatment. Due to variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels that are below existing health standards or exposure guidelines.

3. None of the gases/vapors sampled during the industrial hygiene survey exceeded the OSHA PEL's, ACGIH TLV's, NIOSH criteria, or ASHRAE standards.

4. Some of the temperature measurements taken at the ETB were below the ASHRAE recommended levels; while, some of the relative humidity measurements exceeded ASHRAE recommendations.

5. The design and operation of the building ventilation systems is suboptimal:

   - During our evaluation, first floor office occupants were not supplied with adequate amounts of outside air. Carbon dioxide concentrations were in a concentration range that has been associated with IAQ complaints in other offices.[9,10] Some building HVAC systems have no outside air intake; others were operating with outside air intakes closed during our evaluation. Considering the chemicals used in this building for printing and other operations, adequate outside air intake and distribution is needed to prevent any related odors/irritation.

   - The return air grill for HVAC system #1 on the first floor is located outside the job shop - a major source for the release of low level organic vapors. Grills in the entrance door to the job shop allow the ink/solvent vapors from this area to escape, enter the return air grill for HVAC system #1, and become distributed throughout other first floor areas.

   - The drain for the condensate pan below the cooling coils in HVAC system #1 was blocked and contained water/biological materials.

   - The fiberglass insulation inside some of the ductwork in this building (e.g. HVAC system #1) provides a substrate for accumulation of dirt/moisture and subsequent growth of fungi and bacteria.

IX. RECOMMENDATIONS

1. Rebalance (adjust) the building HVAC systems to ensure they meet ASHRAE standards for outside air intake and distribution, indoor temperature, and relative humidity. ASHRAE recommends a minimum outside air supply of 20 CFM/person in a building where smoking is permitted; however, considering chemical use in this building, increased outside air intake would be recommended in excess of the minimum ASHRAE recommendations.[6]

2. Establish a mechanism (protocol) for routine maintenance of the ventilation system to ensure ASHRAE's ventilation standards are maintained.

3. The air from the first floor job shop should not be recirculated in the HVAC system #1 (or directly) to other building areas. This could be accomplished by removing the return air grills in the entrance door to the job shop and exhausting the (return) air from the job shop area to the building's exterior (away from any HVAC outside air intake).

4. Duckwork with internal fiberglass lining should be replaced.

5. The HVAC drain pans and cooling coils should be inspected at least monthly during the summer (cooling) season to prevent blockage, water stagnation, and the excessive biological growth. HVAC drain pans should drain freely without obstruction. Cleaning with detergents or biocides should be done periodically as needed; however, care should be taken to prevent the aerosolization of these substances into the HVAC system and occupied spaces.[13]

6. Consideration should be given to developing a no (or restricted) smoking policy in the ETB. Based on the evidence concerning cigarette smoke and its many health consequences, coupled with our survey findings including symptomatic complaints of irritation, it seems prudent to consider a smoking ban as a positive step toward improving air quality and related health/comfort in the ETB.

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For the purpose of informing affected employees, copies of this report should be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I
INDOOR AIR QUALITY QUESTIONNAIRE RESULTS
EXPONET TELEGRAM BUILDING
MHETA 87-193

RESPONSE: 57 - (46%)

SEX: Male (51%)
Female (49%)

BY FLOOR: Basement: 14%
First: 65%
Second: 14%

Questions	Responses (%)		
	Yes	No	No Response
Do you currently smoke tobacco products?	37	61	2
Are tobacco products smoked at your work area?	77	19	4
Have you experienced any significant discomfort related to your current work environment?	16	82	2
Have you changed your usual work activities because of this discomfort?	11	89	0
Have you changed your usual work location because of this discomfort?	11	87	0
Have you requested a change because of this discomfort?	67	43	0
Have you had a medical illness which you suspect is related to your current work environment?	5	95	0
Have you missed work because of this illness?	67	33	0
Have you seen a doctor for this illness?	67	33	0
Have you been treated for this illness?	33	67	0
Have you noticed a hazardous condition in your current work environment?	9	91	0
Have you changed your usual work activities because of this hazardous condition?	20	60	20
Have you changed your usual work location because of this hazardous condition?	20	60	20
Have you requested a change because of this hazardous condition?	80	20	0

TABLE I (con't)
INDOOR AIR QUALITY QUESTIONNAIRE RESULTS
EXPONET TELEGRAM BUILDING
MHETA 87-193

Symptoms	Percent (%)
Frequent Colds	5.0
Headaches	3.5
Difficulty Concentrating	2.0
Eye Irritation	2.0
Nausea/Vomiting	2.0
Runny Nose	2.0
Stuffy Nose	2.0

Problem Conditions	Percent (%)
Smoking Odors/Irritation	10.0
Uncomfortable Temperatures	5.0
Chemical Odors	3.5
Too Dusty	2.0

TABLE II
TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS
EXPONET TELEGRAM BUILDING
MHETA 87-193

TIME	DATE	LOCATION	TEMPERATURE (°F)	RELATIVE HUMIDITY (%)
1050	4/16/87	Loading Area	68	30
1114	4/16/87	News Room	69	59
1133	4/16/87	Classified	75	34
1143	4/16/87	Display	76	32
1146	4/16/87	Ambient	58	58
1442	4/16/87	Circulation	73	36
1450	4/16/87	Display	76	32
1457	4/16/87	News Room	69	44
1506	4/16/87	Classified	73	36
1008	5/28/87	Display	75	44
1018	5/28/87	News Room	75	44
1022	5/28/87	News Room	75	50
1050	5/28/87	Ambient	77	70
1055	5/28/87	Classified	70	44
1426	5/28/87	Classified	72	49
1434	5/28/87	Display	77	45
1441	5/28/87	News Room	72	45
1448	5/28/87	Circulation	77	45
1501	5/28/87	Ambient	89	43

ASHRAE Comfort Guidelines

	Winter	Summer
- Temperature	70-74°F	74-78°F
- Relative Humidity	20-30%	40-50%

ASHRAE - American Society for Heating Refrigerating and Air-Conditioning Engineers

TABLE III
FORMALDEHYDE CONCENTRATIONS IN AIR
EXPONET TELEGRAM BUILDING
MHETA 87-193

SAMPLE	LOCATION	DATE	CONCENTRATION (PPM)
1	Newsroom	5/28/87	0.003
2	Display	5/28/87	0.003
3	Circulation	5/28/87	0.003
4	Ambient	5/28/87	0.002

Health Standards/Guidelines

NIOSH Recommendation - LFL
ACGIH (TWA) Recommendation - 1 ppm
OSHA (TWA) Standard - 3 ppm
ASHRAE Recommendation - 0.1 ppm (C)

ppm - Parts Per Million Parts Air by Volume
OSHA - Occupational Safety and Health Administration
ACGIH - American Conference of Governmental Industrial Hygienist
ASHRAE - American Society for Heating, Refrigerating, and Air-Conditioning Engineers
TWA - Time Weighted Average
C - Ceiling Exposure Level
LFL - Lowest Feasible Limit

TABLE IV
CARBON DIOXIDE CONCENTRATIONS IN AIR
EXPONET TELEGRAM BUILDING
MHETA 87-193

LOCATION[1]	DATE	TIME	CONCENTRATION (PPM)
Ambient	4/16/87	11:46	250
Circulation	4/16/87	14:42	600
Display	4/16/87	14:50	650
News Room	4/16/87	14:57	750
Classified	4/16/87	15:06	750
Business Office	4/16/87	16:10	850
Display	4/16/87	16:22	750
News Room	4/16/87	16:27	800
Display	5/28/87	10:08	750
News Room	5/28/87	10:18	900
Circulation	5/28/87	10:38	800
Ambient	5/28/87	10:50	400
Classified	5/28/87	10:55	800
Classified	5/28/87	14:26	925
Display	5/28/87	14:34	750
News Room	5/28/87	14:41	800
Circulation	5/28/87	14:48	725
Ambient	5/28/87	15:01	400

Health Standards/Guidelines

NIOSH (TWA) - 10,000 ppm
ACGIH (TWA) - 5,000 ppm
OSHA (TWA) - 5,000 ppm

ppm - Parts Per Million Parts Air by Volume
ACGIH - American Conference of Governmental Industrial Hygienist
OSHA - Occupational Safety and Health Administration
TWA - Time Weighted Average

TABLE V
CARBON DIOXIDE CONCENTRATIONS BY LOCATION
FIRST FLOOR OFFICE AREAS
EXPONET TELEGRAM BUILDING
MHETA 87-193

CONCENTRATIONS IN PPM

LOCATION	SAMPLES	MEAN	STD	RANGE LOW	RANGE HIGH
HVAC System #1 Areas-Outside Air Intake	7	718	69	600	800
HVAC System #2 Areas-No Outside Air Intake	7	818	69	750	925
Ambient	3	350	87	250	400

ppm - Parts Per Million Parts Air
STD - Standard Deviation

TABLE VI
ORGANIC VAPOR CONCENTRATIONS IN AIR
EXPONET TELEGRAM BUILDING
MHETA 87-193

SAMPLE	DATE	LOCATION	CONCENTRATION N-HEXANE (PPM)	TOTAL HYDROCARBONS (mg/m^3)
B	5/28/87	News Room	1.6	29.5
C	5/28/87	News Room	1.3	23
D	5/28/87	Ambient	ND	5.3
F	5/28/87	Circulation	1.2	20
G	5/28/87	Display	1.5	25
H	5/28/87	Job Shop	5.5	88
K	5/28/87	Press Room	ND	11
N	5/28/87	Mail Room	ND	ND
		Health Standards/Guidelines		
		NIOSH Recommendation (TWA)	100	None
		ACGIH Recommendation (TWA)	50	None
		OSHA Recommendation (TWA)	500	None

ppm - Parts Per Million Parts Air by Volume
mg/m^3 - Milligrams Per Cubic Meter of Air
ACGIH - American Conference of Governmental Industrial Hygienist
OSHA - Occupational Safety and Health Administration