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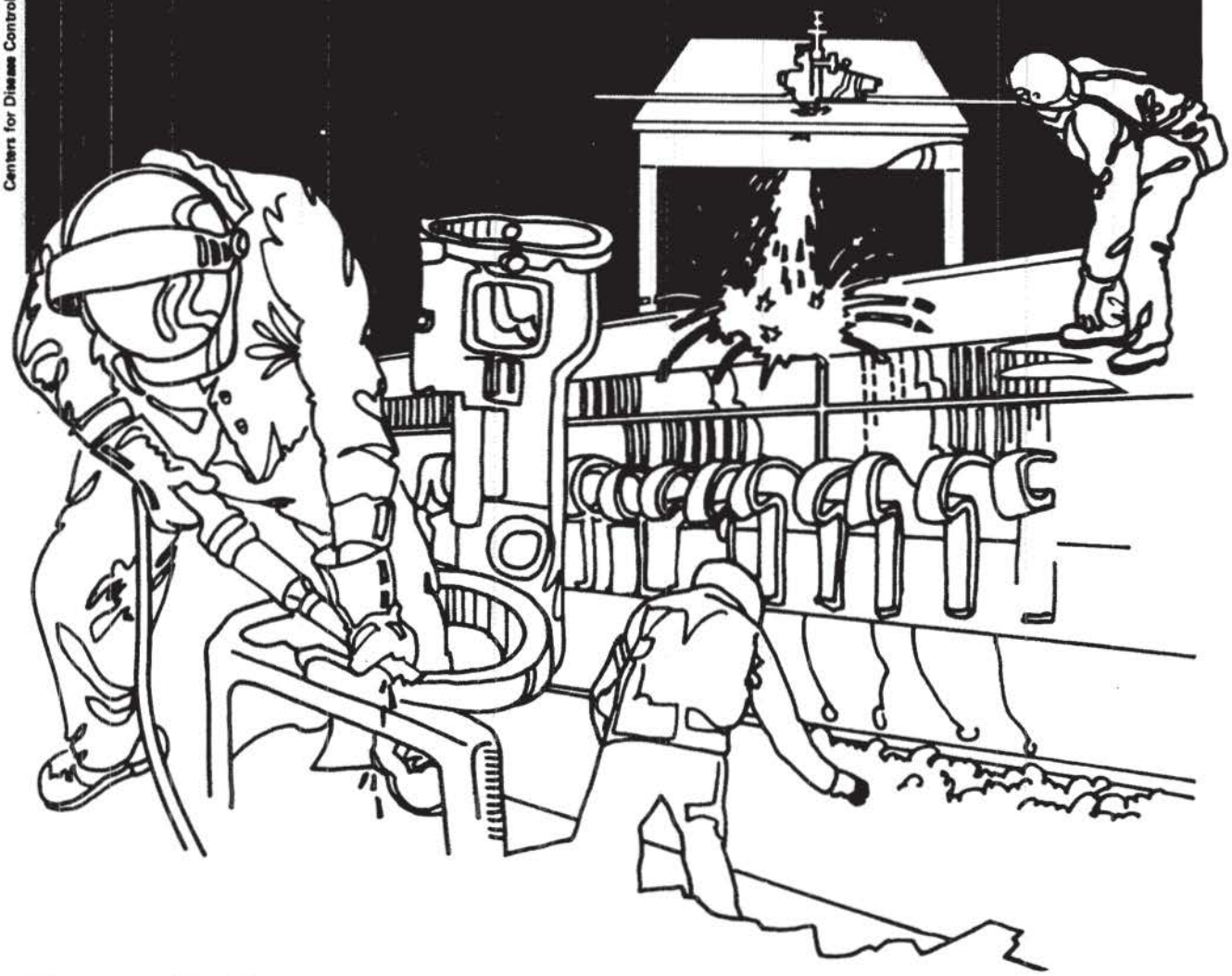

Health Hazard Evaluation Report

GHE 81-429-1299
APPALACHIAN LABORATORY FOR
OCCUPATIONAL SAFETY AND HEALTH
MORGANTOWN, WEST VIRGINIA

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.

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I. SUMMARY:

In August 1981 the National Institute for Occupational Safety and Health received a formal request for a health hazard evaluation concerning the work environment at the Appalachian Laboratory for Occupational Safety and Health (ALOSH), Morgantown, West Virginia. Some of the clerical employees of ALOSH had experienced throat irritation, eye strain and other symptoms while working at the facility.

An in-depth investigation was performed in October 1981 and included: environmental sampling and a survey of health complaints. The environmental evaluation concentrated on four major areas of concern: a search for any possible sources of gross chemical contamination; a review of the general ventilation; a study of temperature and humidity; and an evaluation of illumination levels. A health survey was carried out by using a multifaceted self-administered questionnaire.

Questionnaire data showed eye discomfort, headache, respiratory tract irritation and itching of skin to be the most common symptoms. Environmental assessment suggested that irritative symptoms could be related to improper ventilation, low relative humidity and fluorescent lighting. Female sex, contact lens use and use of video display terminals were significantly associated with work-related symptoms.

Based on these data it was determined that health complaints might be related to the environmental inadequacies noted. Recommendations for correcting these problems are contained in Section VII.

Key Words: SIC 249, office environment, energy conservation, eye irritation, low humidity, video display terminal.

II. INTRODUCTION:

In August 1981, NIOSH received an official request for a health hazard evaluation (HHE) from three employees of The Appalachian Laboratory for Occupational Safety and Health (ALOSH). This request was made because some of the clerical employees of ALOSH had experienced throat irritation, eye strain and other symptoms while working at the facility. Activities conducted at ALOSH include clerical and administrative work, testing and certification of personal protection and environmental monitoring equipment, and research involving occupational respiratory diseases and safety. Approximately 240 employees are involved in these activities.

III. BACKGROUND:

Construction of the ALOSH facility began in 1969 and the building was completed and ready for occupancy in 1972. The building consists of four stories with a total floor space of 92,000 square feet of which 25,000 square feet are laboratory space. An additional structure was built later to accommodate the Division of Safety Research (DSR). Separate ventilation systems serve the three sections of the ALOSH building. The first section is the front wing of the main building which includes the Division of Respiratory Disease Studies (DRDS), Office of Administration and Management Services (OAMS) and a part of the Division of Safety Research (DSR). The second section is the basic science laboratory and the third section houses the rest of the Division of Safety Research. These three sections receive their air supply from different sources. However, section one and section three are supplied by similar systems. The air is recirculated in these two systems. The second section does not recirculate the air.

IV. METHODS:

1. Environmental

The environmental evaluation concentrated on four major areas of concern: a search for any possible sources of gross chemical contamination; a review of the general ventilation; a study of temperature and humidity; and an evaluation of illumination levels. Also considered were the likelihood of microbial contamination and the possible adverse effects of smoking. Repeated consultation with the ALOSH facility engineer provided valuable information about heating, ventilation and air conditioning (HVAC) mechanisms; the history of past practices, problems and corrective actions; and actions to be taken in the future.

From the outset low relative humidity was thought to be a factor. Thus, continuous temperature and humidity readings were recorded by stationing a calibrated Weather Measure Model H-302 hygrothermograph in key locations for periods of a week or longer. Since illumination plays a key role in eye strain, illumination measurements were taken with a G.E. illumination meter and a cosine corrected Simpson model 408 illumination level meter. During our evaluation an independent study was being conducted that involved the determination of ambient airborne microbial levels within the main building. Samples were collected using Anderson Viable Cascade Impactors and four types of sampling media. Finally, the answers of questionnaire respondents to questions regarding smoking were considered in the overall evaluation of environmental conditions.

2. Medical

ALOSH work conditions were evaluated using a multi-faceted self-administered questionnaire. This survey instrument included questions concerning the employees' health, and job, as well as many aspect of the work environment. Employee participation in the questionnaire survey was voluntary.

Questionnaires were distributed to all the ALOSH employees on October 15, 1981, at about 9:00 a.m. The questionnaires were picked up at noon on the same day. This was to avoid communication bias. The employees who were absent on this particular day were contacted immediately after their return to the job and were requested to fill out the questionnaire.

3. Evaluation Criteria

Evaluation criteria were derived from a number of sources. For evaluation of the general ventilation system American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) recommendations as stated in the Trane Air Conditioning Manual were utilized.[3] Present day practice has replaced the older "air changes per hour" standards with a method that specifies a recommended volume of outdoor make-up air per occupant. This method recommends 20 cfm (cubic feet per minute) for each occupant in general office space in which some smoking occurs, a minimum volume of 5 cfm is acceptable if no one smokes.[1] ASHRAE does not specify a particular relative humidity; at 68°F, the lower comfort limit is approximately 50% relative humidity. Based on the ASHRAE graph and references cited elsewhere in this report it seems that during the winter heating months the relative humidity should be maintained at 40% as a minimum.

Illumination levels are recommended by the Illuminating Engineers Society of North America which, since 1979, no longer issues single-value illuminance recommendations. Instead it has gone to a complicated procedure involving the details to be seen, age of the worker, importance of speed and accuracy and the reflectance of the task. Far more useful are the levels recommended in Table A which were derived from the proceedings of a NIOSH illumination symposium published in 1975.

Health problems due to office environments cannot be successfully approached utilizing the exposure standards that currently exist. Workplace environmental standards are based on protection from a chronic disease such as cancer or an acute disease or symptom . They do not consider sensitization, subtle neurotoxicity or the chronic irritation that may result from a continuous low level exposure to a wide variety of chemicals or contaminants.

V. RESULTS:

A. Medical

The response rate to the self-administered questionnaire was 95% (229/240). Of the 229 employees who responded to the questionnaire, 77 complained of health problems which they felt were related to their work or to the environment at ALOSH. The prevalence rate of work or environmental related symptoms was 33.6 per 100.

Table I summarizes the most frequent symptoms reported by ALOSH employees. Eye irritation, headaches, backaches and nervous tension were the main symptoms thought to be caused by work or the environment at ALOSH.

Table II notes the prevalence of symptoms by sex and worksite for all workers. Female employees reported significantly more symptoms than male employees. Analysis of symptoms reported by sex and work site showed that this sex preference was observed in all three divisions. Female workers in the safety wing, however, were significantly more symptomatic than females in nonsafety wing buildings.

Table III shows the prevalence of symptoms by occupation of ALOSH employees. There was no significant difference in symptoms reported by different occupational groups at ALOSH.

Table IV shows the prevalence of symptoms by location of ALOSH employees. There was no significant difference in symptoms reported by different locations of ALOSH employees.

Table V shows alleged environmental problems reported by ALOSH employees. These data show ventilation (45%), heating (36%), cigarette smoke (34%), and fluorescent lighting (30%), were the main environmental factors thought to be responsible for causing ill health in the workforce. Table V also shows the mode of contact causing symptoms. The majority of the employees (53%) reported air being the major mode of contact causing symptoms.

Table VI shows the time required for symptoms to appear after employees started their work in the ALOSH facility. Twenty-three percent of the symptomatic employees did not specify time of onset of symptoms. The majority of the employees felt their symptoms improved after work, on weekends and when they were away on vacation.

Forty-six of 229 who responded to the questionnaire use video display terminals (VDT). Seventy-two percent of the VDT users are female (33/46). Fifty-two percent (24) of the video display terminal users complained of some symptoms (Table VII). Since female sex has previously been shown to be a risk for symptoms, VDT use was examined separately in female and male employees. As shown in Table VII, VDT use is an important determinant of symptoms independent of sex, i.e., it is strongly related to symptoms both in women and in men VDT users. Most of their symptoms were eye related (20/24).

Twenty-two percent (23/229) of the employees who reported symptoms use contact lenses. Most of the contact lense users are female (16/23). Seventy percent of the contact lens users (16) complained of discomfort while wearing contact lenses at the ALOSH building and 25% of the contact lens users said they could not wear contact lenses while at the ALOSH building (Table VII). Contact lens wearers reported more symptoms than the employees who did not use contact lenses ($P < 0.001$). Most of their symptoms were eye related (11/16). There was no difference in symptoms of male and female contact lense users.

In summary, questionnaire data showed the following:

1. Eye irritation, headache, backache and nervous tension were the main symptoms thought to be work related by respondents.

2. Fifty percent of the employees reporting symptoms reported onset of symptoms within two hours of entering the ALOSH facility, and eighty-three percent said their symptoms improve when they are away from the ALOSH facility.

3. Female employees reported significantly more symptoms than the male employees. This was true in all three building areas (main building, safety wing, labs).

4. Additional risk factors for symptoms were use of video display terminals and contact lense use.

5. Ventilation, heating, cigarette smoke and lighting were listed as main causes of symptoms by respondents. Questionnaire data, however, showed no symptom clustering by heating or ventilation system location. The questionnaires did not allow precise enough assessment of work area lighting or smoking to examine their relation to symptoms.

B. Environmental

Results of the environmental evaluation are summarized in Tables VIII and IX. Microbial levels were very low -- low enough to dispel any concern about microbial contamination.

Temperature and humidity readings were taken from October 9 to December 28, 1981. These results are summarized in Table VIII. Time weighted averages (TWA's) of relative humidity ranged from 20 to 38% over the periods sampled. Daily TWA's ranged from 11% to 60%. Two time frames are noteworthy. The period of October 9-20 in Room 120 of the Main Building is thought to be typical of conditions which prompted the HHE request since readings taken after October 20 reflect efforts made to improve conditions. The period around December 10 marks the onset of cold winter weather and thus is indicative of a "worst case" situation as noted in the table. The values marked with an asterick indicate "worst case" conditions in the Laboratory Wing and the Main Building. No air is recirculated in the Laboratory Wing. Due to the low temperatures the absolute humidity of the outside air is also low. When that air is heated to room temperature the relative humidity becomes very low. Since large volumes of make-up air are needed to replace the air which is continually exhausted through chemical fume hoods, large volumes of outside air must be rapidly heated to room temperature. This rapid heating and the lack of

recirculated air make it difficult to properly humidify the required volume of make-up air. Air is recirculated in the Main Building but a different problem exists here. Windows accounts for a large portion of the exterior walls in most offices. Due to the large differences in temperature between the interior side of the glass and the exterior, condensation and heavy frost form on the windows. To alleviate this problem, the relative humidity is lowered intentionally. On December 10 the hygrothermograph was moved at the suggestion of the facility engineer to record these effects in both wings.

Table IX contains the results of the illumination survey. Illumination levels in the lab appear to be sufficient for most of the work done there. Likewise illumination levels in the Safety Building seem quite adequate. In fact, Safety Building illumination levels were higher in rooms without windows than in rooms with windows despite the fact that the readings were taken on a sunny day. Many of the rooms with windows had the curtains closed to varying degrees. Since the weather was comfortably warm on the day of the survey, it is reasonable to assume that people in offices with windows had the drapes adjusted to control illumination rather than conserve heat. Rooms in the Safety Building have two sets of lights so that occupants can turn on all the lights or only half the lights. The illumination levels in Table IX were taken with both sets of lights on. However, many office workers prefer to work with only half the lights on. Thus illumination levels in the Safety Building appear to be quite adequate. However, a different situation exists in the Main Building. A pattern quickly became obvious as the survey progressed. Desks located away from the windows averaged 18 footcandles less illumination than those near the windows. As a rule, the supervisor had the desk nearest the window and the secretary occupied the desk away from the window. This arrangement placed the secretary in a good position to serve as a receptionist but did not afford her the degree of illumination needed for visually demanding tasks such as deciphering hand-written manuscripts while typing. In general, the secretary tends to have the more visually demanding tasks and the less desirable level of illumination. The entire lighting system at ALOSH consists of fluorescent lights.

Microbial sampling results appear in Table IX. Presently there are no environmental standards or guidelines for airborne microorganisms. Viable sampling techniques are still in the developmental stage. The sampling results that appear in the literature are difficult to interpret due to the lack of standardized procedures, variation in culture media, and differing methods of reporting results. With these difficulties in mind the values in Table IX are quite low when compared to ambient outdoor levels cited in the literature. Viable bacteria levels measured in downtown Cincinnati during the summer of 1969 ranged from 375 to 2490 viable bacterial particles per cubic meter. [13] A similar study in the Twin Cities from May and November 1967 reported an average of 58 viable counts per cubic foot which equals 2048 counts per cubic meter. [14] Results at ALOSH averaged 116 colony forming units per cubic meter (cfu/m^3) on Sunday and only 11 cfu/m^3 during the week. The higher count on Sunday may indicate some degree of build-up resulting from weekend energy corservation measures. However, any such build-up is still far below ambient urban levels and should not constitute a health problem.

VI. DISCUSSION:

Analysis of questionnaire data showed that symptoms were significantly correlated with female sex, VDT use and wearing of contact lenses. No clustering of symptoms by heating/ventilation system was found, and it was not possible to relate symptoms to smoking in employees' work areas. This does not diminish the well documented importance of this pollutant's adverse health consequences on nonsmokers where exercise of this habit is permitted. The environmental survey suggests several problem areas which should be addressed. Further discussion of these, as well as smoking and VDT use, follows.

A. Ventilation

In the typical office at ALOSH or elsewhere, ventilation and air quality are often worse around clerical workspaces, since clerical workers are usually located farthest from windows even when a window can be opened. And in many cases they are closest to and spend the most time using office machines which may emit a variety of chemical vapors. During our survey we noticed that most of the clerical/secretarial employees have their desks away from windows. Our environmental survey failed to detect any kind of high exposures above the recommended standards which might be responsible for the symptoms. As said earlier, workplace environmental standards are based on protection from a chronic disease such as cancer and acute disease or symptom. They do not consider sensitization, subtle neurotoxicity or the chronic irritation that may result from continuous low level exposure to a wide range of chemicals. Unpleasant working conditions, job satisfaction and stress may also contribute to the symptoms reported from office environment. There are methods to assess these problems but there is little NIOSH can do to address them.

Some obvious deficiencies in the ventilation systems at ALOSH are enumerated below:

1. Contaminated air from exhausts and several vents on the laboratory wing is often re-entrained in the building supply air. The main contributing factor is thought to be the stack heights. The American Conference on Governmental Industrial Hygienists (ACGIH) recommends similar stack heights to be roughly another 30% of the building height (1.3H) depending on terrain, building height, etc. [2] The ALOSH stacks do not all meet this criteria and some re-entrainment is evident.

2. Environmental effects such as inversion interact with a structure and its surrounding terrain in an often detrimental fashion. Inversions are particularly challenging to the ALOSH heating, ventilating and air conditioning (HVAC) systems when prevailing wind directions are adversely affected. Changes in the local geography can often enhance this challenge. Certain wind directions contribute to exhaust re-entrainment more than others.

3. Many HVAC control systems make economizing decisions after normally occupied hours which range from a slight cut back in fresh air intake to no air circulation at all. Even if the ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.)[3] recommended outdoor air requirements are resumed at the beginning of the work day, disagreeable odors remain from previous cigarette smoking and larger than normal concentrations of stale air are generally available until the normal control cycle provides several complete air changes.

4. Duplicating areas (xerox machines) at ALOSH are not in good locations for exhausting. There is a possibility that carbon black and other chemicals enter the office environment at ALOSH. However we did not measure any abnormal levels of various contaminants due to duplicating machines which could cause the symptoms.

5. Supply-air fan housing were generally rusty and coated with dirt and grease. The walls and floors were often no better. In the past there were no measures taken to clean this.

6. Ventilation fans are a contributor of particulate matter. The older the building the more deteriorated the fan surfaces become. This was a chronic problem at ALOSH particularly in the lab areas where quite often air quality can significantly effect test results. Particulate settling was more evident in the "clean" labs.

We consider these ventilation deficiencies may be contributing to the symptoms reported.

B. Temperature and Humidity Problems

Low humidity has been said to contribute to colds, a variety of respiratory problems, dry skin, and eye irritation especially for those who wear contract lenses.[10] In tests performed with identical heating and ventilating systems, increasing relative humidity produced significant reduction in winter respiratory illness.[11] It has been argued that the increased incidence of the common cold which typically accompanies the onset of winter weather is largely due to a lack of sufficient humidity. The argument reasons thusly. Viruses are responsible for the common cold. Viruses associated with coughs and sneezing remain viable for a long time in dry air. During the heating season the air in American homes is very dry (on the order of 13% relative humidity). These conditions of extreme dryness (10 percent points lower than average relative humidity in the Sahara Desert) contribute greatly to the increased frequency of the common cold that accompanies the heating season. The case for increased humidity is based on the fact that as the relative humidity increases viruses die more rapidly so that at 50% relative humidity nearly all are destroyed. Thus, by increasing the relative humidity indoors the occurance of the common cold can be greatly reduced.

An additional benefit is derived from increased humidity. By raising the relative humidity an acceptable level of comfort can be achieved at a lower temperature (see Table VIII). This is because as moisture evaporates from the skin, body heat is lost. In the summer this mechanism counteracts heat stress. In the winter, however, this has the effect of requiring an increase in room temperature to maintain a comfortable environment. As the relative humidity decreases, the rate of evaporative heat loss increases. The dry indoor conditions common during the heating season maximize evaporative heat loss. This process can be reversed, however, if the relative humidity is increased as indicated in Table VIII.

Thus, increasing the relative humidity toward the 50% level results in two benefits: it decreases the likelihood of spreading the common cold and it can save on heating costs. However, the aspect of low relative humidity most germane to this study is the obvious fact that it dries the eyes and when the eyes become too dry they itch, burn, and turn red. Thus, low relative humidity helps explain why the most frequently experienced symptom was "eyes, itching, burning, red" (see Table I).

The optimum relative humidity level is recommended to be 45 - 50%. The humidity control at ALOSH was very poor. The air supply system to the main building and laboratories recorded humidity in the range of 11 - 60%. The Time Weighted Average (TWA) was always below the optimum level (Table VIII). Surprisingly there was no humidity control at air supply system III which supplies the safety wing. The humidification system did exist for the safety wing but was never connected to the air handler until late October 1981.

C. Lighting

The entire lighting system at ALOSH consists of fluorescent lighting. Headaches, strained and burning eyes are common when prolonged close work is carried out under fluorescent lighting. Four main problems arise from the use of fluorescent lighting.[8]

(1) High intrinsic luminosity - This is a special problem if the source is unscreened.

(2) Linearity - This gives lighting a non-directional effect and minimizes shadows. Heavy shading leads to eyestrain as does its total absence because it removes one of the aids to judgment of distance.

(3) Tendency to flicker - This is a troublesome feature. Because it is minimized by the thermal inertia of the filament it is often not appreciated that tungsten lighting is actually varying as a result of the alternating supply. The flicker rate of fluorescent tubes is normally 100 cycles/second but their high luminosity raises the critical sensitivity to flicker to the conscious level, particularly in the young eyes with larger pupils. Furthermore, if there is a lack of symmetry in the electrodes, the flicker rate may be reduced to 50 cycles/second. This may be the reason why ageing tubes so frequently show this tendency.

Table A shows the recommended maximum lighting levels. Most ALOSH office work would fall in the 75 to 100 foot candle category while 50 to 75 foot candle seem appropriate to the majority of laboratories. Our survey showed the lighting levels at ALOSH were always below (Table IX) this recommended standard. Fluroscent lighting was partially responsible for the reported symptoms from the main building and the safety wing. Table B shows the relative visual task difficulty for common office tasks.

We consider ventilation, humidity and lighting as the major areas of concern at ALOSH. We could document the deficiencies in all these three areas where symptoms were reported.

In addition to these three problem areas there were aggravating factors such as cigarette smoking, video display terminal, and contact lenses.

1. Cigarette Smoke

Cigarette smoke in the office environment is a hazard to smokers and non-smokers alike. According to one environmental consultant, "The level of particulate matter in office buildings where smoking is allowed is 10 to 100 times higher than the allowable limits for outside air."[4] For clerical workers who spend all day sitting, the effects of smoking on health are magnified, since carbon monoxide from cigarettes stays in the bloodstream longer during low physical activity.[5] A recent epidemiological study concluded that long term exposure to smoke, limited to the work environment only (i.e., not at home) is deleterious to the non-smoker and significantly reduces small-airway function to the same extent as smoking one to ten cigarettes per day."[6] Cigarette smoke contains numerous potent carcinogens, including benzopyrene, affecting not only the lungs but many other organs. It also maximizes the effects of other indoor air pollutants because of the density and persistence of particulate matter released. We did not do any sampling for cigarette smoke.

2. Video Display Terminal (VDT)

In 1979-80, the NIOSH conducted a study of video display terminal operators at the request of a coalition of labor unions. Five worksites were examined, including newspaper offices and the clerical departments of Blue Shield in San Francisco. Eighty to ninety percent of the clerical VDT operators experienced eye strain or muscle strain. High levels of anxiety, depression and fatigue were reported by VDT users at all of the worksites.[7]

The NIOSH research team found that VDT operators in strictly clerical type operations showed higher stress ratings than any group of workers NIOSH had ever studied including air traffic controllers.

Conclusive information on the long-term effects of VDT use will take years to obtain and analyze, but the short-term effects are already well documented even though the causal mechanisms are not yet understood: eye strain; headaches; short-term loss of visual acuity and changes in color perception; back, neck and shoulder pain; fatigue; stomach aches and vomiting.[7]

VII. RECOMMENDATIONS:

Table C lists some sources of internal office contaminants and recommendations. Following are specific recommendations for ALOSH problems:

A. Ventilation

There is a need to look into the ventilation deficiencies at ALOSH facility.

1. Increase the stack height to meet the recommendation of ACGIH.

2. A study should be undertaken to evaluate the effects of different wind directions on exhaust re-entrainment.

3. A study to look into changes in office air quality when several complete air changes are abruptly made the first thing in the morning.

4. Washing of supply-air fans, floors and walls of fan house using a disinfecting procedure.

5. Sandblasting and painting of lab and office area fans and other fan housing hardware.

B. Lighting

1. A longitudinal study on ALOSH illuminance to improve inadequate lighting and comply with the Illuminating Engineering Society's recommended standards.

2. Ageing tubes should be replaced as soon as flicker is noticed.

C. Humidity Control

Humidity level should be maintained at optimum level.

D. Cigarette Smoking

Cigarette smoking cessation programs should be actively supported and provided to ALOSH employees. For the protection of the health of nonsmokers, cigarrette smoking should be expressly prohibited in offices and other work stations where nonsmokers are employed or which are utilized routinely by them. The right of nonsmokers to a smoke-free environment is increasingly being required and should strongly be supported. For smokers, specific building locations should be created where they may smoke. These should be clearly labeled and warning signs posted for nonsmokers.

E. Video Display Terminal

1. Work Station Design Features

Maximum possible flexibility should be designed into the work station so that it can be adapted to the individual operator. Specifically it would be desirable for the chair to have adjustable seat pan height, backrest height and tension. Similarly the keyboard height and screen height and position should be independently adjustable. The operator should also be able to adjust screen brightness and contrast.

2. Illumination

The lighting level should be approximately 500-700 lux depending upon the visual demands of other tasks performed in the same work area.

3. Glare Control

Direct and reflected glare should be limited through one or more of the following methods:

- -Screen hoods may be installed
- -Anti glare filters may be installed on the VDT screen
- -The terminals should be properly positioned with respect to windows and overhead lighting

4. Work Rest Regimens

Adequate rest periods and job rotation are the key to protecting the health and well-being of video-display terminal operators. The NIOSH recommends a 15-minute break per hour for visually intensive work and 15 minutes per two hours for continuous work at a VDT to reduce eyestrain and stress. [7]

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TABLE I

Work Related Symptoms
(Number of Employees with Symptoms = 77)

Most Frequent Symptoms	# employees	% employees
1. Eyes itching, burning, red	39	51%
2. Headache	35	45%
3. Nervous tension	28	36%
4. Backache	25	32%
5. Tiredness	23	30%
6. Neck strain	23	30%
7. Cold limbs	21	27%
8. Running eyes	16	21%

Prevalence rate of symptoms (77/229) x 100 = 33.6%

TABLE II

Prevalence of Symptoms by Sex of ALOSH Employees
(Number of ALOSH Employees Responding to Questionnaire = 229)

	Males	Females	Total
Symptoms	38	40	78 (34%)
No Symptoms	103	48	151 (66%)
Total	141 (62%)	88 (38%)	229 (100%)

Chi Square $X^2 = 7.45$, $p < 0.01$

Prevalence of Symptoms in Safety Wing by Sex
(Total Number of Safety Wing Employees Responding to Questionnaire = 35)

	Males	Females	Total
Symptoms	8	8	16 (46%)
No Symptoms	18	1	19 (54%)
Total	26 (74%)	9 (26%)	35 (100%)

Fisher Exact Test $p = 0.0063$ two tail

Prevalence of Symptoms in Nonsafety Wing Areas by Sex

	Male	Female	Total
Symptoms	30	32	62
No Symptoms	85	47	132
Total	115	79	194

Chi Square = 40.38, $p < 0.05$

Prevalence of Symptoms Among Women by Work Area

	Safety	NonSafety	Total
Symptoms	8	32	40
No Symptoms	1	47	48
Total	9	79	88

Fisher's Exact Test, $p = 0.005$

TABLE III

Prevalence of Symptoms by Occupation of ALOSH Employees
(Number of ALOSH Employees Responding to Questionnaire = 229)

	Clerical	Non-Clerical	Laboratory
Symptom	24	37	16
No Symptom	30	93	29
Total	54	130	45

	Clerical	Non-Clerical (Including Lab)	Total
Symptom	53	122	175
No Symptom	24	30	54
Total	77	152	229

$x^2 = 3.09 \quad p > 0.05$

	Clerical	Non-Clerical (Excluding Lab)	Total
Symptom	24	37	61
No Symptom	30	93	123
Total	54	130	184

$x^2 = 3.7 \quad p > 0.05$

	Office Workers	Lab Workers	Total
Symptom	61	16	77
No Symptom	123	29	152
Total	184	45	229

$x^2 = .01 \quad p > 0.5$

TABLE IV

Prevalence of Symptoms by Location of ALOSH Employee
(Number of ALOSH Employees Responding to Questionnaire = 229)

	Main Building	Safety Wing	Laboratories
Symptoms	45	16	16
No Symptoms	104	19	29
Total	149	35	45

	Main Building	Lab	Total
Symptoms	45	16	61
No Symptoms	104	29	133
Total	149	45	194

$x^2 = 0.24 \quad p>0.5$

	Main Building	Safety Wing	Total
Symptoms	45	16	61
No Symptoms	104	19	123
Total	149	35	184

$x^2 = 2.41 \quad p > 0.10$

	Safety Wing	Lab	Total
Symptoms	16	16	32
No Symptoms	19	29	48
Total	35	45	80

$x^2 = 0.04 \quad p > 0.5$

Table V

Number of Reported Environmental Problems by ALOSH Employees

Environmental Problem	No. of Employees	% of Employees
Ventilation	35	45%
Heating	28	36%
Cigarette Smoke	26	34%
Fluorescent Lighting	23	30%
Seating	20	26%
Dust	12	16%
Noise	7	9%
Decor	6	8%
Static Electricity	1	1%
Toilets	1	1%
General Hygiene	0	-

Mode of Contact Causing Symptoms
(Number of ALOSH Employees with Symptoms = 77)

Mode of Contact	No.of Employees	% of Employees
Air	41	53%
Direct	16	21%
Swallowing	0	-
Unspecified	20	26%

Table VI

Onset of Symptoms
(Number ALOSH Employees With Symptoms = 77)

Time	# of Symptomatic Employees	% of Symptomatic Employees
Within 1/2 hour	17	22%
1/2 to 2 hours	21	27%
2 - 4 hours	10	13%
4 - 8 hours	11	14%
Unspecified	18	23%

Improvement in Symptoms Outside ALOSH
(Number of ALOSH Employees with Symptoms = 77)

	No. of employees with improvement	% of employees with improvement
After work	64	83%
Weekends	68	88%
Vacation	68	88%

Table VII

Relationship of Symptoms and Use of Video Display Terminal (VDT)

	VDT Users	Non-VDT Users	Total
Symptoms	24	53	77
No Symptoms	22	130	152
Total	46	183	229

$X^2=7.86$, $p < 0.01$

Relationship of Symptoms and Use of VDT's Among Women

	VDT Use in Women		
	Yes	No	Total
Symptoms	20	20	40
No Symptoms	13	35	48
Total	33	55	88

$X^2 = 10.20$, $p < 0.01$

Relationship of Symptoms and Use of VDT's Among Men

	VDT Use in Men		
	Yes	No	Total
Symptoms	4	34	38
No Symptoms	9	94	103
Total	13	128	141

$X^2 = 41.08$, $p < 0.001$

Table VII (Con't)

Relationship of Symptoms and Contact Lense Use

	Use Contact Lens	Do Not Use Contact Lens	Total
Symptoms	16	65	81
No Symptoms	7	141	148
Total	23	206	229

$X^2=11.46$, $p<0.001$

Relationship of Symptoms and Contact Lense Use by Sex

	Male	Female	Total
Symptoms	5	11	16
No Symptoms	2	5	7
Total	7	16	23

Fisher's Exact Test $p > 0.05$

Table VIII

Temperature and Relative Humidity

Location	Dates	Temperature (°F)		Relative Humidity %	
		Range	TWA	Range	TWA
Lab Wing					
Room 289	12/4-10	72-76	75	11*-34	20
Safety Wing					
S-15	11/18-24	69-80	75	18-40	26
S-131	11/25-12/3	72-80	75	18-38	26
Main Building					
Room 120	10/9-20	71-76	75	22-39	31
	10/20-28	70-78	74	20-60	32
	10/28-11/6	71-78	74	32-52	38
	12/10-28	62-74	69	19*-44	27

*Worst case situation. Very cold weather.
289 is a lab and receives 100% outside air therefore low relative humidity.
120 is typical of need in Main Building to reduce condensation/frost on windows by lowering relative humidity.

Comfort Level as a Function of Temperature and Relative Humidity[12]

Relative Humidity Indoors (%)	Comfortable Temperature (°F)
10	76
20	74
30	72
40	70
50	68

Table IX

Illumination Levels

Location	Date	Illumination Levels in Footcandles					
		Range		Average			
Lab Wing	Jan. 19, '82	45 to 80		67			
Safety Bldg	May 6, '82	Rooms With Windows			Rooms Without Windows		
		Range		Average	Range		Average
		62-96		75	57-110		82
Main Bldg	Nov. 25, '81 Jan. 19, '82	Near Windows			Away from Windows		Elsewhere
		Range	Average		Range	Average	Range Average
		35-125	82		35-90	64	40-100 61

*Weather note.

Nov. 25 and Jan. 19 were gray, overcast days.
May 6 was a bright, sunny day.
Morgantown weather seems to be cloudy more than it is sunny.

Microbial Sampling Results

Mediam (agar)	Concentrations*							
	Sunday 3/21		Monday 3/22		Tuesday 3/23		Averages	
	11:48*	12:15	11:32	11:55	11:39	12:00	Sunday	Weekdays
Inhibitory Mold	173	152	11	14	7	7	163	10
Rose Bengal-Streptomycin	127	102	18	11	4	11	115	12
Sabourand Dextrose	187	159	18	18	4	14	173	14
Littman Oxgall	14	14	21	11	0	0	14	8
					All Media		116	11

* Concentrations in cfu/m^3 (colony forming units per cubic meter of sampled air)

** Times shown indicate the start of a 10-minute sampling period within the time frame of 11:30 am to 12:30 pm.

TABLE A

RECOMMENDED MAXIMUM LIGHTING LEVELS[15]

TASK OR AREA	Footcandle levels	How Measured
Hallways or corridors	10±5	Measured average, minimum 1 footcandle
Work and circulation areas surrounding work stations	30±5	Measured average
Normal office work such as reading and writing (on task only), store shelves and general display areas	50±10	Measured at work station
Prolonged office work which is somewhat difficult visually (on task only)	75±15	Measured at work station
Prolonged office work which is visually difficult and critical in nature (on task only	100±20	Measured at work station
Industrial tasks	ANSI-A11.1-1973*	As maximum

*American National Standards Institute A11.1-1973, June 1973 practice for industrial lighting.

TABLE B

RELATIVE VISUAL TASK DIFFICULTY FOR COMMON OFFICE TASKS[15]

Task Description	Visual Difficulty Rating
Large black object on white background	1
Book or magazine, printed matter, 8 point type and larger	2
Typed original	2
Ink Writing (script)	3
Newspaper Text	4
Shorthand Notes, Ink	4
Handwriting (Script) in No. 2 Pencil	5
Shorthand Notes, No. 3 Pencil	6
Washed-Out Copy From Copying Machine	7
Bookkeeping	8
Drafting	8
Telephone Directory	12
Typed Carbon, Fifth Copy	15

To use this table multiply the difficulty rating as shown in the table for each task performed at a given work place by a single worker times the number of decimal hours per day it is performed, for example, 3 hours, 15 minutes = 3.25 decimal hours. Add the products for each task if the sum is greater than 40, provide 75 footcandles on the work station. If the sum is greater than 60, provide 100 footcandles on the work station. Multiply the difficulty factor if operator is 50 years of age, as if he has uncorrectable eyesight problem.

TABLE C

SOURCES OF "INTERNAL" OFFICE CONTAMINANTS AND OFFICE WORKER ILLNESS[16]

MACHINES/MATERIALS	CHEMICALS/IRRITANTS	RECOMMENDATIONS
Photocopiers	Ozone Toner (carbon black binding agents) Noise (nuisance)	Move to open and/or well ventilated area
Spirit Duplicator	Methyl Alcohol (99%)	Local Exhaust
Telephone Facsimile Recorders	Butyl Methacrylate	Move away from workers desk to an open area
Blueprint Machines	Ammonia	Local Exhaust
Carbonless Paper	Formaldehyde	Good general ventilation, personal hygiene
Wall Insulation	Urea Formaldehyde	Boost ventilation, timing device - turn on ventilation early to clear air before workers come to work
Duct Insulation	Fibrous Glass Nuisance Dust 1 Respirable 2 Total Asbestos	Maintenance and good housekeeping
Video Display Terminals	Radiation Ultraviolet - UV Visible	Annual maintenance, check for radiation leaks at back of machine. Also, check print/background contrast and screen glare.
Cigarette Smoke	Carbon Monoxide Formaldehyde Oxides and Nitrogen Nitrosamine Particulates	Segregation of smoking and non-smoking areas - prohibition of smoking in offices and other areas which nonsmokers must frequent - posted warnings for nonsmokers in segregated smoking areas
Temperature/Humidity	General Discomford	Portable fans, humidifier in winter
Poor Illumination	Eye Strain, Headache	Install more lighting, or purchase desk lamps
Heat Pump Water Condensate	Infectious Agents Bacteria	Check for proper drainage Potassium permanganate
Fresh Air Intake Units	Fungal Viral	pills, check filters, clear bird roosts near air intake vents