

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT HE 78-116-557

COMMONWEALTH TRADING COMPANY
STOUGHTON, MASSACHUSETTS

JANUARY 1979

I. TOXICITY DETERMINATION

Employees of Commonwealth Trading Company were not exposed to a health hazard from chemical exposure during the survey (August 16-17, 1978). Formaldehyde concentrations approached but did not exceed the NIOSH recommended exposure criteria of 1 ppm (part per million) based on a 30 minute sampling period. However, levels of formaldehyde normally expected to be observed by odor were detected. Whether or not employees were exposed to irritating levels of chemical substances during the episodes of mass illness can only be speculation. A possible explanation for the episodes of mass illness is that these detectable levels of formaldehyde served as the "triggering mechanism" which precipitated the large numbers of employees reporting ill.

From information gathered in employee medical interviews concerning the episodes of mass illness, it is NIOSH's opinion that symptoms of irritation described by employees may have been due to formaldehyde exposure. Other symptoms described could have been of psychogenic origin.

From a behavioral factors approach, it can be concluded that, in the absence of any other identifiable toxic substance, the pattern of results obtained from a detailed human factors questionnaire is indicative of stress-induced mass psychogenic illness. Affected workers exhibited elevated job and life stress and more frequent health complaints (more frequent feelings of physical discomfort, pressure, less autonomy) than non-affected workers. Also, affected workers reported a strange or irritating odor and concomitant vague symptomology more frequently than non-affected workers.

It is important to remember that the judgement of mass psychogenic illness or occupational hysteria is often a diagnosis by exclusion. That is, it is a conclusion reached when certain stress related conditions are present and when other chemical and physical possibilities have been eliminated as a possible cause. In this case, NIOSH investigators were asked to evaluate an environment and determine whether or not its condition

could have caused the problems experienced by workers in the past. Since one cannot expertly relate present conditions to past symptomatology, the overall conclusion can certainly be questioned. However, it is NIOSH's conclusion that episodes of mass psychogenic illness were experienced in the past and that the probable triggering mechanism was low levels of formaldehyde vapor escaping from permanent press clothing. It is also NIOSH's conclusion that individual employees experiencing irritation of the eyes and breathing passages may have been exposed to levels of formaldehyde which could actually produce such irritation. The literature cited in this report indicates that people can experience irritation at formaldehyde exposure levels below 1 ppm.

Recommendations are presented which will hopefully prevent such episodes from occurring again.

II. DISTRIBUTION AND AVAILABILITY

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

Copies of this report have been sent to:

- a. Commonwealth Trading Company
- b. Local 313, International Ladies Garment Workers Union
- c. U.S. Department of Labor, OSHA, Region I
- d. NIOSH, Region I

For the purpose of informing the approximately 225 affected employees, copies of the report shall be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

III. INTRODUCTION

Section 20 (a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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.

NIOSH received such a request from the employer to evaluate the potential for employee exposure to formaldehyde or other toxic substances in the workplace.

Since approximately April, 1978, employees reported having work-associated symptoms (primarily headache, nausea, tiredness, weakness, etc.) Most of these individual occurrences were not brought to the attention of management. In mid-April an unusual number of employees reported ill at one time, thus prompting the management to contact a private consulting firm and the State of Massachusetts, Division of Occupational Hygiene, to evaluate the warehouse for toxic substances and review the ventilation requirements. The Occupational Safety and Health Administration was also consulted, however, none of the organizations were able to determine a cause for the outbreak. On June 21, 1978, four female and two male employees became ill, complaining of puffy eyes, headache, dizziness, sore throat, faintness, nausea, shortness of breath, and eye irritation. All affected employees were sent to the hospital for tests and the remaining employees sent home. Subsequently, management filed a request for a Health Hazard Evaluation with the NIOSH, Region I, program consultant.

IV. HEALTH HAZARD EVALUATION

A. Description of Facilities/Operation

Commonwealth Trading Company, a subsidiary of Zayre Corporation, is a distribution center for female clothing. The warehouse occupies 110,000 square feet and employs approximately 325 workers, 80 percent of whom are female. There are 250 first shift workers (150 in the warehouse and 100 in the offices) and 75 second shift workers (all warehouse).

The warehouse operations consist of the following stepwise process: Clothing is received from the manufacturer (over 400 manufacturers supply Commonwealth Trading) either in boxes or hanging racks and brought into the warehouse through 10 shipping and receiving doors. The shipment is forklifted from the receiving area to the "T" area, where it is unpacked and placed on hangers and placed in the conveyor system. Clothing is manually pushed through the conveyor system to the temporary storage area "A". In the "B" & "C" areas, the clothing is arranged by size and ticketed. The stamping of tickets is done in an adjacent area. The ticketed garments are then moved to the upper floor where they are further arranged by size, color, etc. If not needed for immediate shipment, the garments are placed in holding area "Y". When ready for distribution to retail stores, the selected clothing is conveyed back to the first level, coded for distribution and boxed. First shift is primarily concerned with the receiving aspects of the operation; second shift concentrates on packing and shipping to retail outlets.

The warehouse area is ventilated by a centrally located, 86,000 cubic feet per minute (cfm) intake rooftop fan and by whatever air exchange that takes place when the shipping and receiving doors are open. There are no windows in the warehouse. There are also four 10,000 cfm exhaust fans located along one side of the roof to help relieve the positive pressure buildup. The warehouse is not air conditioned and is heated by a city gas-fired furnace. Figure I shows the general layout of the building and the ventilation system. In addition, after the first episode, management rented and installed 12 pedestal fans to help eliminate areas of stagnant air.

B. Evaluation Design and Methods

Since other consulting groups had previously investigated the problem and had not been able to identify any causal agent, it was decided that NIOSH would consider the problem from three approaches - environmental, medical and behavioral.

1. Environmental

Many of the symptoms presented by the employees suggested exposure to an irritant chemical. Since many durable press clothing manufacturers utilize formaldehyde to instill this quality in clothing and the symptomatology paralleled low level formaldehyde exposure, it was judged that formaldehyde was a possible causative agent. Therefore, personal 30 minute "ceiling concentration" samples and longer term personal breathing zone samples were taken for formaldehyde.

Employee complaints centered in three areas of the warehouse - the "T" area, the aisle area between "B" and "C" area and the Ticket area; and were associated with certain brands of clothing (Outlander, India Imports, Organically Grown), none of which were being handled at the time of the investigation. Personal and area samples were taken in these three areas. In order to determine if significant concentrations of formaldehyde could build up in a package from the manufacturer, an unopened box of India Imports was obtained and a hole large enough to withdraw an air sample was made. This sample was analyzed for formaldehyde. Formaldehyde sampling was performed by two methods - an impinging solution (20 milliliters of 1 percent Sodium Bisulfite) and a personal sampling pump calibrated to draw ambient air at 1.0 liter per minute (lpm); and a specially treated charcoal tube for formaldehyde vapors connected to a personal sampling pump calibrated to sample ambient air at 0.2 lpm. Analysis was performed by spectrophotometric methods (P&CAM #125).¹

Since the presence of formaldehyde was only suspected, general area samples for qualitative identification of organic atmospheric contaminants were obtained. Regular charcoal sampling media and 0.2 lpm sampling pumps were used. Analysis was by gas-liquid chromatography (P&CAM #127).¹

2. Medical

Detailed, private interviews were conducted by the medical officer with four employees identified as having been affected in either the April or June outbreak. Informal interviews were conducted with numerous other employees at their work stations.

3. Behavioral

A detailed questionnaire was distributed to 210 employees covering both shifts. This questionnaire was specifically designed for investigations where there is no apparent environmental condition that could be related to documented health effects and where conditions predisposing to stress induced mass psychogenic illness might prevail. In addition to socio-

demographic (age, sex, level of education, marital and parental status, etc.) and epidemiological information (date and time of illness, symptomatology, location of workplace at the time of the onset of illness, etc.), the questionnaire contained items designed to measure perceived job stress along a variety of dimensions (unwanted overtime, role ambiguity, job boredom, role conflict, etc.). Four standardized personality/psychodiagnostic instruments were also included in the survey protocol. These were:

1. The Work Environment Scale² - This scale measures ten dimensions of social climate of the workplace which are believed to be predictive of worker satisfaction or adjustment. These are: 1) Involvement - extent to which workers are enthusiastic or committed to their jobs; 2) Peer Cohesion - the extent to which workers are mutually supportive; 3) Staff Support - the extent to which management is perceived as supportive by the workers; 4) Autonomy - the extent to which workers feel self-sufficient and independent; 5) Task Orientation - the extent to which the climate emphasizes productivity and efficiency; 6) Work Pressure - the extent to which workers perceive pressure to produce; 7) Clarity - the extent to which workers know what is expected of them in the performance of their jobs; 8) Control - the extent to which management imposes rules and regulations on the workers; 9) Innovation - the extent to which variety and new approaches are emphasized in the workplace; and 10) Physical Comfort - the extent to which the physical surroundings contribute to a pleasant work environment.

2. Abbreviated Internal-External Control Scale³ - This is an 11-item scale designed to measure the extent to which an individual attributes causation for his experience to internal vs external sources. For example, it was felt that individuals experiencing vague, psychosomatic symptoms might attribute them to internal factors (stress, anxiety, fatigue) or external factors (a gas leak, a virus, etc.).

3. The Eysenck Personality Inventory (EPI)⁴ - This scale measures personality in terms of two pervasive, independent dimensions: extroversion-introversion and neuroticism-stability. There is some evidence to indicate that clinically diagnosed hysterics score lower on the extroversion scale than normals.

4. The Mini-Mult of the MMPI⁵ - This is a factor-analytically derived scale of the Minnesota Multiphasic Personality Inventory. Three subscales from this instrument were included in the present survey protocol. These were:

a) The Hysteria Scale - Measures the extent to which the individual exhibits behavioral patterns characteristic of the hysteria-prone personality: excitability, emotional instability, self dramatization.

b) The Hypochondriasis Scale - Measures the extent to which the individual somaticizes emotional or psychogenic strain or tension.

c) The Depression Scale - Measures the extent to which the individual experiences feelings of dejection, hopelessness, worthlessness, etc.

C. Evaluation Criteria

In this study three sources of criteria were used to evaluate a worker's exposure to toxic chemicals in an occupational setting. These exposure limits are derived from existing human and animal data, and industrial experience, and represent values to which it is believed that nearly all workers may be exposed for an 8-10 hour day, 40 hour work week, over a working lifetime with no adverse effect. However, due to variations in individual susceptibility, a small percentage of workers may experience effects at levels at or below the recommended exposure limit; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by development of an occupational illness.

The three sources of criteria for this study are: 1) Criteria for a Recommended Standard⁶ by the National Institute for Occupational Safety and Health; 2) Occupational Safety and Health Standards for General Industry⁷ by the Department of Labor's Occupational Safety and Health Administration; and 3) Threshold Limit Values (TLVs) and their supporting documentation⁸ by the American Conference of Governmental Industrial Hygienists.

Since initial screening of the environment indicated formaldehyde to be the only chemical with toxic exposure potential, the toxicological summary will be confined to formaldehyde.

Formaldehyde is an intense irritant of the upper respiratory passages. For this reason, systemic poisoning is unlikely since workers would be compelled to leave the exposure area before levels sufficient to cause systemic poisoning were reached. Formaldehyde also irritates the eyes, causing a burning, stinging sensation with consequent tearing.

There are several studies reported in the literature concerning occupational exposure to formaldehyde, with some being analogous to this situation. Bourne and Seferian⁹ reported that customers and employees were affected by 0.13-0.45 ppm formaldehyde, reporting stinging eyes, headaches and throat irritation. Shipkovitz¹⁰ studied eight textile plants and found that an average formaldehyde concentration of 0.68 ppm was causing irritation of mucous membranes, heavy tearing, wheezing, excessive thirst and disturbed sleep in employees. The California Department of Public Health¹¹ also studied a textile factory which manufactured "permanent press" clothing and found eye and upper respiratory tract irritation from exposures ranging from 0.9 to 2.7 ppm. Additionally, many studies - Shipkovitz¹⁰, California Department of Public Health¹¹, Sim and Pattie¹², Kerfoot and Mooney¹³, - have uncovered evidence that the irritant effects of low level formaldehyde exposure may cease due to "olfactory adaptation" or "acclimatization". However, this adaptation is transient since irritation returns following periods of nonexposure. Elkins^{14,15} reported that workers may develop a tolerance to formaldehyde irritation; on the other hand, Henderson and Haggard¹⁶ reported that people may become more susceptible on repeated exposure.

Various studies have reported the odor threshold for formaldehyde. Patty¹⁷ indicates an odor threshold below 1 ppm, which is consistent with Bourne, et al⁹, Shipkovitz¹⁰, Reinhalt¹⁸, Melekhina¹⁹, and Leonardos, et al²⁰.

NIOSH has recommended that employee exposure be limited to 1 ppm formaldehyde as measured by a 30 minute sampling period; i.e. any 30 minute exposure during the working day should not exceed 1 ppm. The ACGIH recommends a 2 ppm limit or ceiling value but does not indicate a time period. The OSHA standard is an 8-hour time weighted average of 3 ppm, with a 30 minute ceiling of 5 ppm.

NIOSH's recommended workplace standard is designed to protect all but the sensitized worker from adverse health effects associated with formaldehyde exposure. People who have become sensitized to formaldehyde should not be exposed.

V. RESULTS AND CONCLUSIONS

A. Environmental

Seven personal breathing zone samples were taken for formaldehyde; all were below the NIOSH recommended criteria of 1 ppm. General area samples for formaldehyde were also below this limit. See Table I for environmental data. Samples taken for detection of any organic substances failed to reveal the presence of any substances at the 50 microgram limit of detection. Analysis of swipe samples for formaldehyde taken from a worker's hands and from two articles of clothing merchandise did not detect formaldehyde at the 50 microgram level. It can be concluded that employees were not exposed to levels of formaldehyde above recommended criteria during the days sampled. However, levels above the "action level" of 0.5 ppm for formaldehyde were measured. The "action level" is the level of employee exposure, when reached, that requires that measures be taken to reduce this exposure. These steps may include employee exposure monitoring and/or engineering control. Also, as indicated in previously cited literature, some levels were recorded that have caused irritation symptoms in workers.

The roof-mounted ventilation system is not adequately moving air throughout the warehouse. With the intake and exhaust fans located in the ceiling and the racks of hanging clothes on the upper level acting as a barrier to air exchange with the lower level, much of the outside make-up air is being channeled back out via the 4 exhaust fans. The contention that there is little air exchange on the lower level may be supported by the proportion of affected employees on the lower level versus the upper level. Air moved by the large pedestal fans located throughout the warehouse is also being channeled by the rows of hanging clothing. In aisles where there is no fan directed, the air becomes stale and odors from hanging clothes are noticeable. This was reported by some employees and noted by NIOSH investigators.

B. Medical

Based on private medical interviews with 4 employees identified by the union representative as having been affected during either the April or June outbreak, and informal discussions with numerous other employees at their work stations, the following information was revealed:

1. Common symptoms included eye and upper respiratory tract irritation, unusual fatigue, lightheadedness (dizziness), headache, and nausea. Symptoms characteristic of the hyperventilation syndrome were generally not reported.
2. Besides the two "epidemic" cases in April and June, there were other individual incidents not reported to management; this indicates a routine or continuing problem. The major outbreaks seemed to coincide with the handling of certain brands of clothing which seemed to be stronger smelling than other brands handled.
3. Some employees indicated that their symptoms coincided with stale air conditions in the warehouse.
4. Several employees expressed dissatisfaction with the relatively impersonal, unfriendly atmosphere of the new larger building. None reported any substantial change in the work itself.
5. Most affected employees were on first shift, and were located throughout the warehouse.

From the above, it is concluded that the irritative symptoms are compatible with the known effects of formaldehyde exposure.

C. Behavioral Factors Evaluation

A total of 210 questionnaires were distributed to employees; 141 were returned, representing a response rate of 67 percent, which is 63 percent of the total warehouse population.

The questionnaire data was analyzed by correlating the work environment, job stress, and personality measures with the number of symptoms reported (as an indication of severity). The correlation test used was the Pearson product moment coefficient (r). This test measures the degree to which there is a linear relationship between two measures. Thus the larger the value of the correlation coefficient (r), the stronger the relationship between measures. The probability, p , that the correlation or relationship between the measures occurred just by chance is also indicated. The smaller the value for p the lower the possibility the correlation occurred by chance.

1. Demographic Factors

The 141 respondents represented 86 females (60 percent) and 55 males (40 percent) from the warehouse population who had worked for the company for less than 1 year (median = 11 months). Fifty-eight percent worked the day shift and 27 percent worked the afternoon or evening shift. The remaining 15 percent worked either the night shift, rotated on shifts periodically, or did not respond to this item. The median age of the sample was 21.4 years with a range of 16-61 years. Eighty-five percent of the sample were white and 69 percent reported having at least some high school education. Fifty-nine percent were single, 34 percent married and 7 percent either separated or divorced. A majority of the respondents reported having no children (60 percent).

Nearly half of the respondents (46 percent) reported earning less than \$3,000.00 per year with 79 percent earning less than \$7,000.00 per year. Over half (61 percent) reported using all or most of their income in the support of the family but only 24 percent provided the major portion of the annual income of the family. For this sample, either the father (38 percent) or the spouse (25 percent) were reported as being the "chief breadwinner" of the family.

This data should be interpreted in light of the fact that management policy allows employees to determine their own schedules with respect to number of hours per day, days per week and time of day for reporting to work.

2. Symptoms

The questionnaire contained 25 symptoms which were selected from the literature as characteristic of mass psychogenic illness. The respondents were instructed to check which, if any, of the symptoms they experienced during the outbreak at the plant either in April 1978 or June 1978; there were relatively few respondents in the sample who indicated during which illness outbreak they experienced symptoms to permit an analysis of symptom distribution for each occurrence. Thus, in the remainder of this report, the two outbreaks are treated as a single illness event. Of the 141 respondents to the survey, 72 (51 percent) reported experiencing at least one symptom during the outbreaks. Table II presents the 25 symptoms in rank-ordered format in terms of frequency. The five most prevalent symptoms were headache (32.6 percent), lightheadedness (29.8 percent), sleepiness (25.5 percent) dry mouth (24.1 percent) and dizziness (21.2 percent). Examination of the most prevalent symptoms reveals a pattern which is remarkably similar to other evaluations of this type among diverse industrial groups²⁰. This concordance is discussed in more detail later in this report.

Table III presents the distribution of workers according to the number of symptoms reported in the survey. For purposes of this report, the number of symptoms reported is used as an index of symptom severity and as a criteria in the classification of workers as "affected" by the

illness outbreak or "unaffected". "Affected" workers indicated one or more symptoms; "unaffected" workers indicated zero symptoms. There is considerable variance regarding the number of symptoms reported as seen in Table III. The mean number of symptoms reported for affected workers was 4.83 and the mean number of days ill for affected workers was 4.16 days. A majority of affected individuals were ill for a duration of 1-3 days.

3. Job Stress Factors

There were a number of work related factors which correlated significantly with symptom frequency. These are listed below:

a) Workers who reported having to push hard to get the work done had the highest number of symptoms during the illness outbreak ($r=.22$, $p<.006$).

b) Those individuals experiencing more symptoms reported being less concerned about receiving a reprimand or complaint from their supervisor ($r=-.15$, $p<.04$).

c) There were very strong relationships between symptom occurrence and perceived uncomfortable physical characteristics at the workplace. Symptom severity was related to the frequency of loud persistent noises ($r=.22$, $p<.006$), irritating smells ($r=.50$, $p<.00001$), dust in the plant ($r=.38$, $p<.00001$), and uncomfortable temperature variations ($r=.20$, $p<.009$).

d) Three of the 10 subscales of the Work Environment Scale were significantly related to symptom frequency. These were:

1) Autonomy ($r=-.20$, $p<.01$) - The less the individuals are encouraged to be self-sufficient and make their own decisions, the more symptoms were experienced.

2) Control ($r=-.18$, $p<.02$) - Individuals with more symptoms perceived management as using rules or pressures to keep workers under control.

3) Physical Comfort ($r=-.18$, $p<.02$) - Workers who perceived the workplace as physically uncomfortable experienced more symptoms during the illness outbreak.

4. Health Status

The data revealed a pattern of relationships between number of symptoms and health variables. These were:

a) General ($r=.13$, $p<.07$) - There appeared to be a trend for workers who experienced more symptoms to report their health as poorer.

b) Absenteeism ($r=.37$, $p<.00001$) - Workers with a higher number of symptoms took significantly more sick leave days during an average month.

c) Medication Use - Employees who experienced more symptoms during the outbreak reported more frequent use of aspirin or headache medication ($r=.28$, $p<.0006$) and cough, cold, or sinus medication ($r=.17$, $p<.03$).

d) Affected workers reported being bothered more frequently during an average month by frequent or severe headaches ($r=.14$, $p<.05$) and spells of exhaustion or fatigue ($r=.16$, $p<.03$).

e) Affected workers were more likely to see a physician if they had been feeling poorly for a few days ($r=.18$, $p<.02$) or if they had a temperature of about 100° F ($r=.15$, $p<.05$).

f) There was a significant relationship between number of symptoms and feelings of being tired or sleepy after completing work ($r=.22$, $p<.005$) and a trend toward feeling tired or sleepy at work in affected workers ($r=.13$, $p<.06$).

g) There was no correlation or trend between symptom severity and consulting a physician about the illness. Other than those taken to the hospital emergency room via ambulance at the company's request, only 3 affected workers (2%) were treated by a physician for their symptoms.

5. Personal, Family and Social Factors

There was a positive relationship between symptom frequency and several personal, family and social factors. Compared to nonaffecteds, affected workers:

a) were primarily female (73 percent)

b) were less satisfied with the personal appearance code at the plant ($r=.22$, $p<.03$)

c) reported more frequently witnessing others becoming ill at the plant ($r=.38$, $p<.00001$) and provided more names of co-workers who had become ill ($r=.47$, $p<.00001$) during the illness event.

There were no significant correlations between symptom frequency and age, educational level, annual income, number of children, length of time with present employer, marital status, and ethnic background.

6. Personality Factors

Of the personality measures used in the survey, only two subscales correlated significantly with affected status. These were:

a) Hypochondriasis ($r=.15$, $p<.04$), which measures the tendency in workers to express stress or strain in somatic or bodily symptoms.

b) Hysteria ($r=.21$, $p<.007$), which measures the degree to which an individual exhibits excitability, emotional insecurity, and self-dramatization.

7. Interviews with Affected Workers

A total of 13 affected workers were interviewed at the plant by the behavioral factors personnel. A number of common observations were made based on interviews with affected workers. For example, affected workers reported symptoms of headache, sleepiness, dryness of the mouth, bad taste in mouth, and unpleasant odor in the workplace. These results fit with the questionnaire results presented earlier. Affected workers described the atmosphere at the current plant in Stoughton, Massachusetts as being less friendly than the former facility in Avon, Massachusetts.

Affected workers reported feelings of isolation from fellow workers due to the larger size of the new facility and poorer circulation of air in the new plant. Supervisors were viewed as "pushing harder" since the move to the new facility and some workers were upset at the increase in security in the form of video monitors in the plant and the required use of security badges by all personnel.

A frequent complaint was that the plant was too hot which was exacerbated by the poor ventilation system (as perceived by the workers). This situation was not relieved by opening the dock doors.

8. Attitudes Toward the Outbreak

Eighty-two percent of the respondents reported being fully recovered from the illness (April and June outbreaks) at the time of the NIOSH investigation. A majority of the respondents (53 percent) did not know if the illness could have been prevented, with 43 percent answering in the affirmative. Forty-five percent of the respondents felt that a danger still existed in the plant while 47 percent were unsure of whether the problem had been adequately taken care of. The sample was nearly evenly split (49 percent vs 51 percent) concerning whether there had been any recent changes at the workplace such as a change in operation or a new ventilating system. Affected workers, more so than non-affected workers, felt the illness events could have been prevented ($r=.21$, $p<.009$) and felt that a danger still existed in the plant ($r=.22$, $p<.007$).

9. Discussion

The findings of the behavioral factors evaluation indicate that workers who were affected during the illness outbreaks showed a pattern of elevated job and life stress and more frequent health complaints relative to non-affected workers. Specific factors in this pattern include more frequent feelings of physical discomfort, heavy production pressure and less autonomy at the workplace.

Higher absenteeism, poorer overall health, and more frequent headaches, feelings of fatigue and medication use were seen in affected individuals. Such workers witnessed others becoming ill more frequently than did non-affecteds, a finding suggestive of psychogenic illness. Affected workers also reported a strange or irritating odor in the workplace more frequently than did non-affected workers.

D. Summary

The environmental aspect of this hazard evaluation was not able to document the presence of an unsuspected chemical substance or the presence of hazardous levels of formaldehyde. However, formaldehyde was found and conceivably could have caused the irritation described by the workers. The strange odors or smells detected by some employees could also be attributed to these levels of formaldehyde. The medical opinion tends to bear this out. The behavioral factors analysis reveals a pattern of results which is indicative of stress-induced mass psychogenic illness.²²⁻²⁴ Such an illness outbreak develops suddenly and spreads contagiously, typically affecting a workforce engaged in short-cycle, repetitive and usually boring jobs. Whether this is because women tend to predominate this type of job or whether the predisposing socio-economic stresses preferentially affect women, has not been determined. The outbreak is usually triggered by an external event e.g., a strange odor, and spreads rapidly through the plant as others are observed to be affected or as word of someone becoming ill circulates. The specific symptoms may vary across cases but typically are vague and non-specific and include headache, lightheadedness, dizziness, weakness and dry mouth. Such outbreaks have occurred in a variety of organizational settings but all appear to have the above factors in common. In isolation, the results of the present study would only point toward the illness having a psychogenic factor. Combined with previous investigations of this type, however, the common findings more clearly indicate the importance of the psychogenic nature of the illness.

This conclusion in no manner implies that the affected employees were not ill. The workers were sick and the symptoms were real. The same logic applies to the fact that there is often a strong psychological or stress component in the etiology of a peptic ulcer, but this does not minimize the seriousness of the condition. Moreover, the present results do not suggest an abnormal group of workers at this plant. On the contrary, previous investigations of mass psychogenic illness have characterized the illness as occurring in a psychologically normal work force which is temporarily experiencing high levels of stress.²⁰ Those workers who became affected by the illness did not show consistent personality traits which distinguish them from non-affecteds. Although affected workers showed stronger tendencies toward hypochondriasis and hysteria on one personality test, it is clear that work environment and job stress factors are much stronger predictors of symptom severity than are measures of personality traits.

VI. RECOMMENDATIONS

Since levels of formaldehyde are at or above the action level of 0.5 ppm, engineering control should be implemented and work practices changed so that the chance of employee exposure to formaldehyde concentrations in excess of 1 ppm is reduced.

The following recommendations are based on the following premises:

- Number of symptoms (severity of illness) was significantly correlated with stale or "bad" ventilation conditions in the warehouse,
- Outbreaks of illness coincided with the handling of certain brands of clothing,
- People can become sensitized to formaldehyde.

1. Figure II²³ contains examples of poor and good intake/exhaust locations. Although the Commonwealth Trading design is not among them, it is our opinion that it would rank in the poor category. The following are options to improving the present system.

a) Relocate the four exhaust fans on the walls, preferably as low as possible and one to a wall to eliminate air channeling from intake to exhaust.

b) Install duct work from the intake fan to the various locations in the warehouse so that the intake air can be more evenly distributed. Duct work should be provided to both levels. Figure III²⁴ is an example of this approach.

c) Install duct work from the exhaust fans to the problem areas - T area, ticket area, and isle area between "B" & "C".

2. Reduce the temperature difference between the office area and warehouse area on hot days. Breaks and lunch in a cool area intensifies employee perceptions of heat and discomfort when returning to work stations.

3. Some workers stated that leaving the shipping doors open helped alleviate discomfort; others stated that conditions seemed to get worse. All things being equal, it is probably better to leave the shipping doors open when ever possible on hot days.

4. Identify the brands of clothing which characteristically have strong odors associated with them. Position pedestal fans around the clothing when employees must work with them. This may be impossible in storage areas such as "B" and "C" but it is certainly possible in the T area.

5. Allow employees who seem to experience problems with strong smelling clothing to perform other jobs while this type of clothing is being processed.

6. If possible, allow boxes suspected of containing strong smelling clothing to stand partially opened in a well ventilated area prior to processing to reduce employee exposure to formaldehyde. (See 1-C.)

7. Some employees expressed concern over the cleanliness of the warehouse. Periodic wet mopping or vacuuming should be done to reduce dustiness.

8. Do not allow sensitized employees to become exposed to formaldehyde.

VII. REFERENCES

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Table I

Airborne Formaldehyde Concentrations

Commonwealth Trading Company
Stoughton, Massachusetts

August 16-17, 1978

HE 78-116

<u>Job Description/Location</u>	<u>Type Sample</u>	<u>Sample Time (min)</u>	<u>Collection Method</u>	<u>Formaldehyde Concentration (ppm)</u>
Machine Operator, ticket area	personal	35	charcoal tube	.57
Machine Operator, ticket area	personal	35	impinger	.37
Clothes Hanger, "T" area, #12 line	personal	37	charcoal tube	.73
Clothes Hanger, "T" area, #12 line	personal	37	impinger	.51
Mobile Worker, "T" area	personal	41	charcoal tube	.33
Mobile Worker, "T" area	personal	41	impinger	.20
Supervisor, B & C area	personal	32	charcoal tube	.41
Supervisor, "T" area	personal	32	charcoal tube	.16
Supervisor, "T" area	personal	32	impinger	.34
Clothes Hanger, "T" area, #12 line	personal	32	charcoal tube	.33
Clothes Hanger, "T" area, #12 line	personal	32	impinger	.11 (½ sample lost)
Clothes Hanger, "T" area, #15 line	personal	32	charcoal tube	.57
Clothes Hanger, "T" area, #15 line	personal	32	impinger	.41
Beeba's #5523 being unpacked, "T" area, #15 line	area	164	impinger	.08
"T" area, #13 line	area	340	charcoal tube	.08
"T" area, #13 line	area	340	impinger	.19
Between Aisle, B & C area	area	341	charcoal tube	.05
Between Aisle, B & C area	area	341	impinger	.19
Ticket area	area	340	charcoal tube	.04
Ticket area	area	340	impinger	.18
Sample taken in box-LouBella #5764	box	306	charcoal tube	.16
Sample taken in box-LouBella #5764	box	306	impinger	.15
Recommended Limit				1.0

Table II

Frequency and Percentage of Workers Reporting
Each Symptom (Sample Size = 141)

Commonwealth Trading Company
Stoughton, Massachusetts

August 16-17, 1978

HE 78-116

Symptom	No. Affected Workers with symptom	% of Total respondent sample (N=141)
Headache	46	32.6%
Lightheadedness	42	29.8%
Sleepiness	36	25.5%
Dry Mouth	34	24.1%
Dizziness	30	21.2%
Watery Eyes	24	17.0%
Weakness	21	14.9%
Nausea	20	14.2%
Bad Taste in Mouth	15	10.6%
Difficulty Swallowing	15	10.6%
Couldn't Catch Breath	11	7.8%
Tightness in Chest	8	5.7%
Tingling Feeling	7	5.0%
Muscle Soreness	7	5.0%
Racing Heart	6	4.3%
Blurred Vision	5	3.5%
Fever	5	3.5%
Numbness	4	2.8%
Vomiting	3	2.1%
Ringing in Ears	3	2.1%
Chest Pain	2	1.4%
Diarrhea	2	1.4%
Passed Out	1	0.7%
Abdominal Pain	1	0.7%
Convulsions	0	0.0%

Table III

The Distribution of Workers in Terms of the Number of
Symptoms Reported in the Survey

Commonwealth Trading Company
Stoughton, Massachusetts

August 16-17, 1978

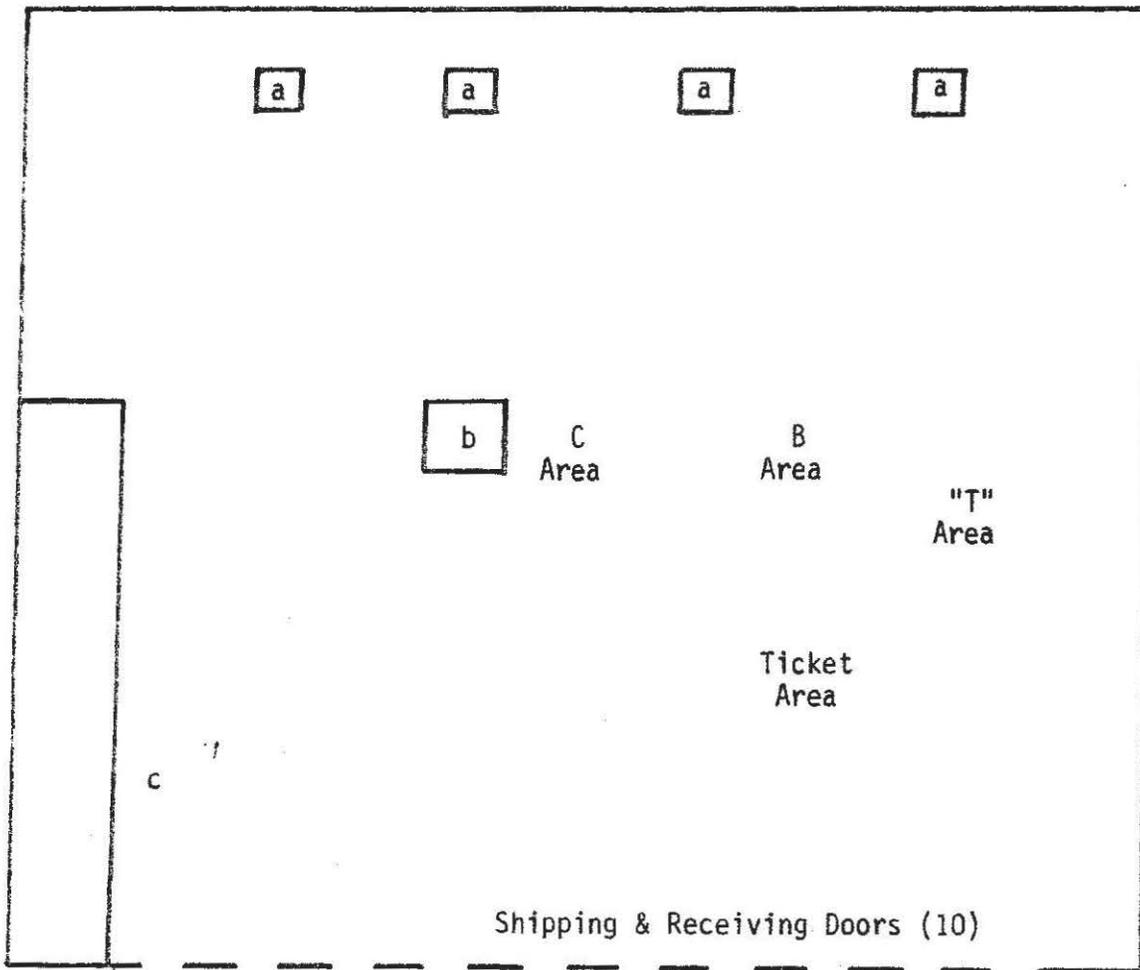
HE 78-116

<u>No. Symptoms Reported</u>	<u>No. Workers</u>	<u>% Total Sample(N=141)</u>
0	69	49%
1	4	3%
2	10	7%
3	14	10%
4	9	6%
5	9	6%
6	9	6%
7	7	5%
8	2	1%
9	3	2%
10	3	2%
11	0	0%
12	1	1%
13	<u>1</u>	<u>1%</u>
	141	100%

Figure I
Schematic of Warehouse
Commonwealth Trading Company
Stoughton, Massachusetts

August 16-17, 1978

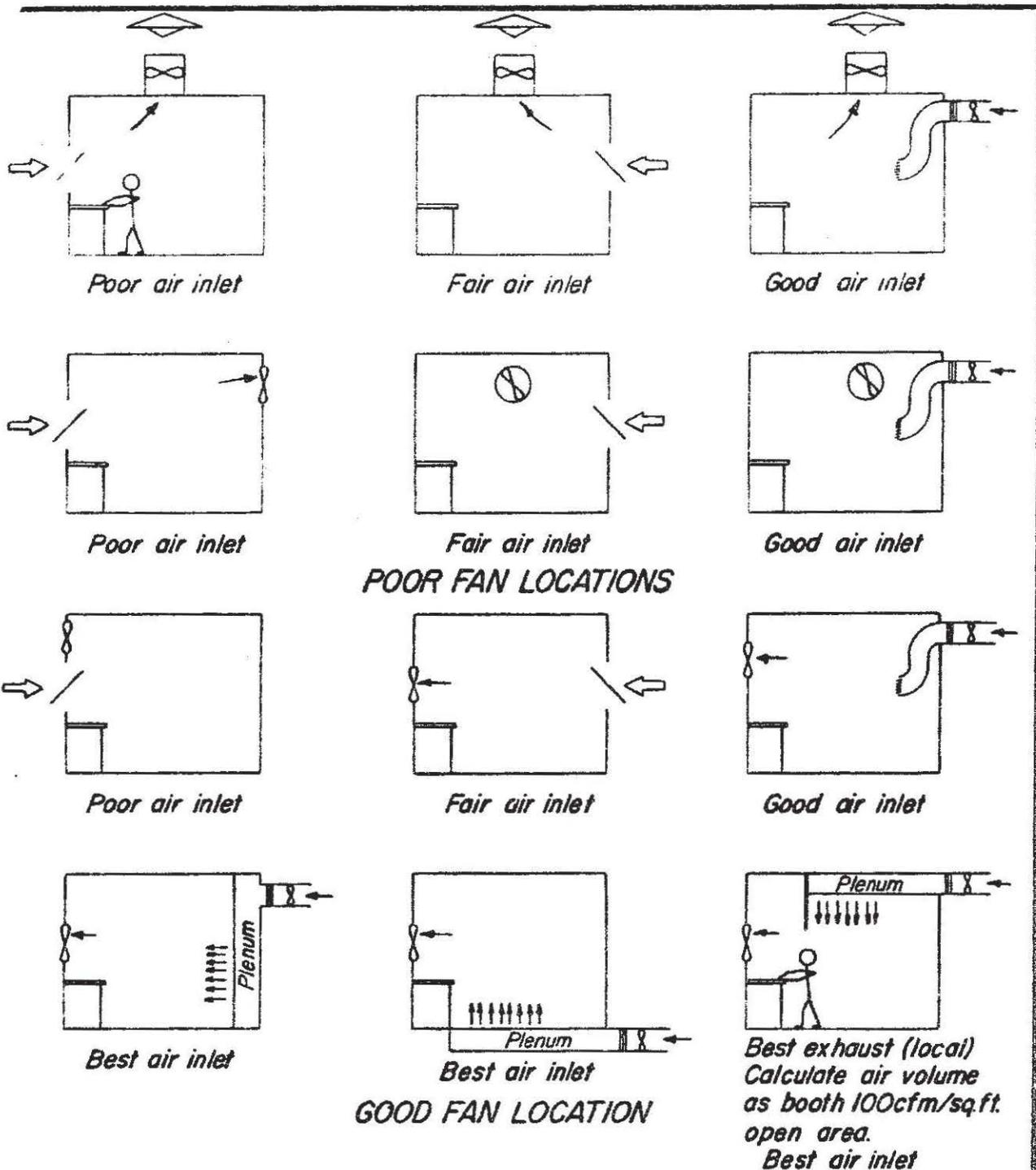
HE 78-116



- a. 4 - 10,000 CFM ceiling installed exhaust fans
- b. 1 - 86,000 CFM ceiling installed intake fan
- c. Grided area indicates extent of 2nd level only
- d. "Y" area is above "C" area on second level

Figure II

DILUTION VENTILATION



Note:
 Inlet air requires tempering
 during winter months.
 See Section 7.

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PRINCIPLES OF DILUTION VENTILATION

DATE 1-66

Fig. 2-1

Figure III

9-2

HEATING AND COOLING FOR MAN IN INDUSTRY

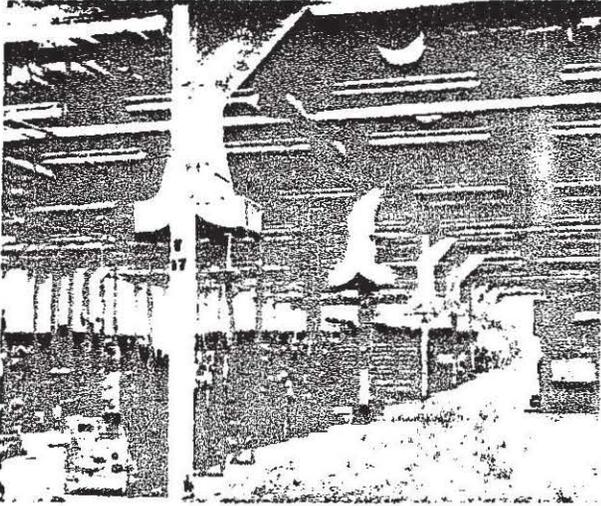


Fig. 9-1. Open manufacturing area. Outlet drops at columns are provided with the directional grilles shown in Fig. 9-7. The outlets, located 10 ft above the floor, are operable from the floor by a chain. Air can be deflected up or down as desired. System provides makeup, heating, and summer relief.

Fig. 9-2. Open manufacturing area. The outlets, shown in Fig. 9-21, are located at the columns, are 8 ft above the floor, and are provided with a slip joint to permit rotation by pole from the floor. The grilles are of the standard double deflection type. The individual vanes must be set by hand. Directional grilles similar to Fig. 9-7, not available at the time of this installation, would have improved the versatility.

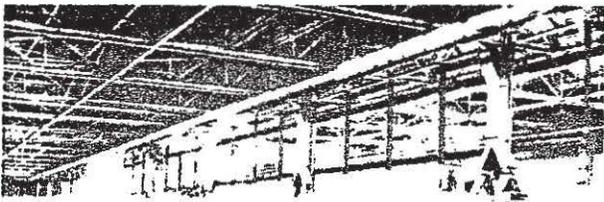
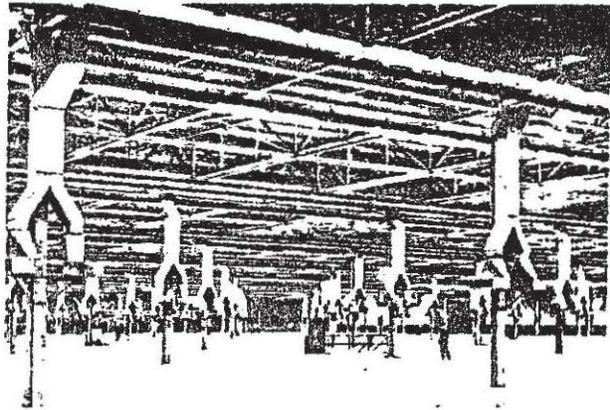


Fig. 9-3. Same area as Fig. 9-2, under smoke test to demonstrate how the supply air is delivered at low level for effective ventilation in the work zone. With such systems the work zone will be within several degrees of the supply air temperature.