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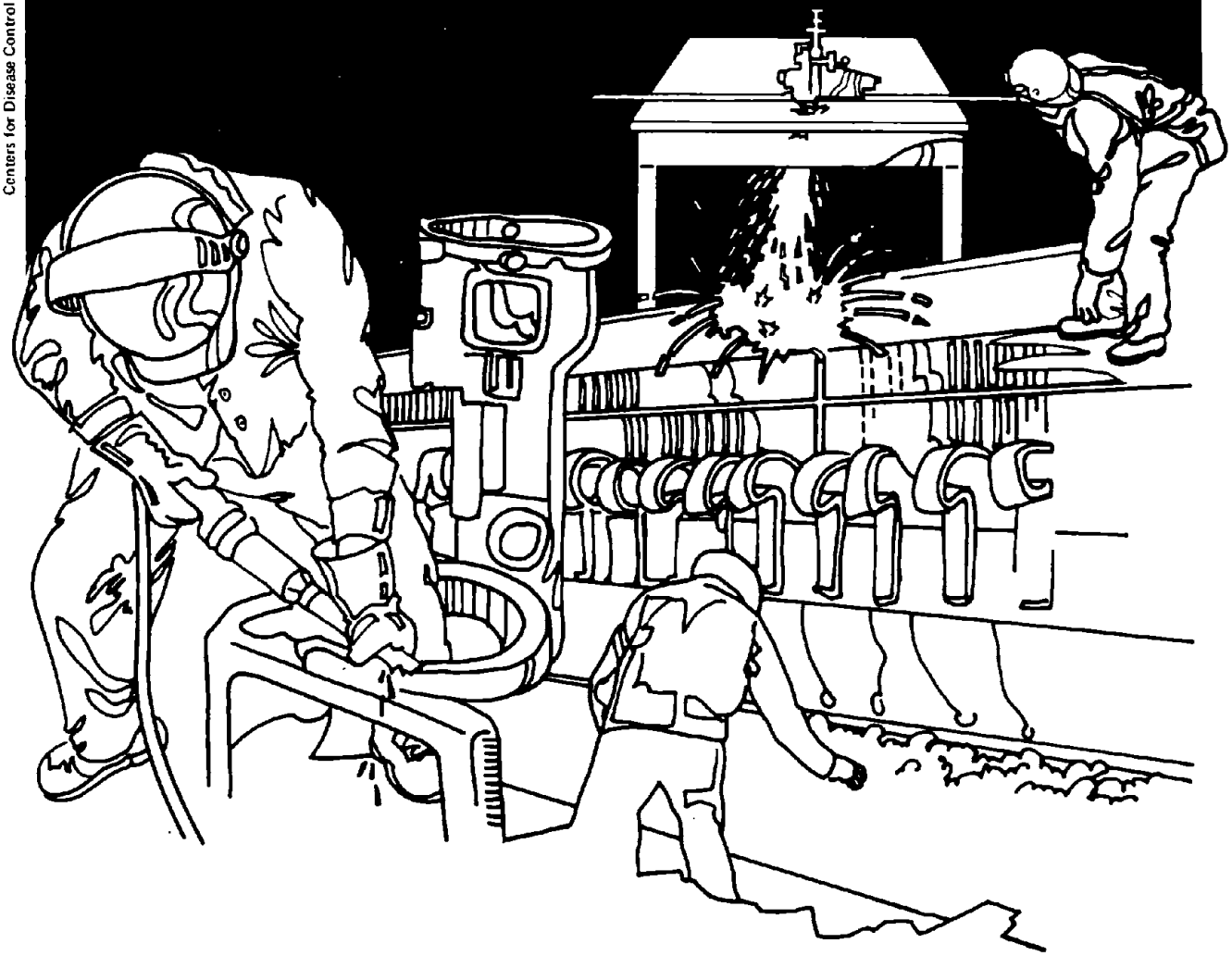

Health Hazard Evaluation Report

TA 78-058-864
TEXAS BOOT COMPANY
HARTSVILLE, TENNESSEE

REGION-4

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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16. Abstract (Limit 200 words)
Environmental and personal samples were analyzed for benzene (71432), cellosolve (110805), n-butyl-acetate (123864), methyl-ethyl-ketone (78933), isopropyl-alcohol (67630), and petroleum-naphtha (8030306), at the Texas Boot Company (SIC-3149) in Hartsville, Tennessee, during August and October, 1978 to ascertain the causes of an epidemic by the Tennessee Division of Occupational Safety and Health on behalf of approximately 501 employees. Medical interviews and psychological tests were administered to the workers. On personal sample for benzene and on for petroleum-naphtha exceeded the respective OSHA standards of 3.2 and 350 milligrams per cubic meter. All other exposures were within acceptable limits. Most reported medical symptoms were consistent with the hyperventilation syndrome which usually results from anxiety. The psychological evaluation suggested a relationship between life and job stresses and symptom outbreak. The greatest source of stress appeared to involve the physical aspects of pressure and unwanted overtime, and were consistent with previous reports of mass illness with apparent psychogenic components. Review of the epidemic suggested that the outbreak was precipitated by the odor of mercaptans when a new tank was added to the gas lines. Other contributing factors included other unfamiliar odors and organic solvents vapors, noise, crowding, poor illumination, inadequate ventilation, air pollution, improper work practices, media publicity, and possibly job and familial stress. The authors conclude that the epidemic of dizziness, nausea, and fainting at this facility was due to the environmental and pdychological factors. They recommend the exercise of good personal hygiene, the development of a health and safety program, and control measures to minimize adverse chemical exposure.

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TA 78-058-864
APRIL, 1981
TEXAS BOOT COMPANY
HARTSVILLE, TENNESSEE

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I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request from the Tennessee Division of Occupational Safety and Health for technical assistance in evaluating an ongoing epidemic of dizziness, nausea, and fainting among employees of the Texas Boot Company located in Hartsville, Tennessee. The epidemic was in its second week at the time the request was received on August 22, 1978.

On August 24 and 25, 1978, NIOSH conducted the initial evaluation of the plant including environmental, medical, and behavioral disciplines. By the end of this visit the epidemic had subsided. A preliminary report was made on September 1, 1978. Follow-up environmental studies were done on October 16-17, 1978.

Most employee exposures to benzene, cellosolve, n-butyl acetate, methyl ethyl ketone, isopropyl alcohol, naphtha distillates/refined petroleum solvent, 1,1,1-trichloroethane, and toluene were below occupational exposure criteria. One personal sample on the first visit showed 15 mg/M^3 benzene (criteria 3.2 mg/M^3) and 354 mg/M^3 of petroleum naphtha (C_6-C_9) (criteria 350 mg/M^3). On the follow-up visit only three personal samples exceeded criteria, all in the Welt or Welt-Lasting Departments--one benzene 3.3 mg/M^3 (criteria 3.2 mg/M^3) and toluene 476 mg/M^3 (criteria 375 mg/M^3). The other two samples were a toluene at 407 mg/M^3 and a petroluem naphtha at 367 mg/M^3 (criteria 350 mg/M^3).

Medically the majority of symptoms were consistent with the hyperventilation syndrome which is usually the result of anxiety, although there were individual cases where other or additional factors were important.

The behavioral evaluation suggested a relationship between life and job stresses and symptom outbreak. Those individuals experiencing the greatest frequency of symptoms were also likely to report experiencing greater levels of boredom, dissatisfaction with promotion and job mobility potential, and dissatisfaction with managerial style. The greatest source of stress appeared to involve the physical aspects of pressure and unwanted overtime. These findings are in general agreement with previous reports of mass illness having an apparent psychogenic component.

Review of the epidemic suggests the outbreak of symptoms was precipitated by the odor of mercaptans when a new tank was added to the gas lines by the local gas company. Other contributing factors included other unfamiliar odors and organic solvent vapors, noise, crowding, poor illumination, inadequate ventilation, unseasonably high ambient air pollution, improper work practices, media publicity, and possibly job and familial stress.

NIOSH has determined on the basis of review of chronology of events and of environmental, medical, and behavioral study results that the epidemic of dizziness, nausea, and fainting among Texas Boot employees was due to environmental and behavioral factors combining to produce a mass illness. Recommendations to improve the environment and prevent future problems from becoming mass outbreaks are presented on page 16-18.

KEYWORDS: SIC 3149 (Leather and Leather Products/Footwear, Except Rubber, Not Elsewhere Classified), benzene, butyl ketone, butyl acetate, cellosolve, isopropyl alcohol, methyl ethyl ketone, toluene, 1,1,1-trichloroethane, petroleum naphtha, illumination, noise hyperventilation syndrome, mass psychogenic illness.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request from the Tennessee Division of Occupational Safety and Health for technical assistance in evaluating an ongoing epidemic of dizziness, nausea, and fainting among employees of the Texas Boot Company located in Hartsville, Tennessee. The epidemic was in its second week at the time the request was received on August 22, 1978.

On August 24-25, 1978, NIOSH conducted the initial evaluation of the plant. An opening conference was held with a management representative and background information concerning the outbreak, facility, processes, and employee demography was obtained. A walk-through of the facility was then performed and the processes evaluated. (See Figure I for facility layout.) Representatives from Tennessee "OSHA", National Weather Service, the local hospital, and the gas company were contacted for information. A preliminary report with interim findings and recommendations was sent to management on September 1, 1978, along with health and safety information publications. Follow-up environmental studies were done October 16-17, 1978. On October 25, 1978, additional information concerning barrier creams was sent to management.

As the company acted on initial suggestions promptly and the epidemic had ended by the end of the initial visit, this report will deal primarily with what appears to have caused this outbreak and what steps might be taken to reduce the likelihood of a repeat outbreak.

III. BACKGROUND

A. Facility Description

The Texas Boot Company is a subsidiary of the U.S. Shoe Company, Cincinnati, Ohio, involved in the manufacture of leather boots. The facility is approximately 14 years old and occupies 50,000-60,000 square feet. (See Figure I) The facility is heated with electric heaters suspended from the ceiling and cooled by four recirculating air conditioners and eight fresh air, air conditioning units. Besides the main work area, the facility contains office areas, a chemical storage room, a repair shop, storage areas, and a vending machine area.

The facility employed 487 hourly and 14 salaried personnel. Routine production hours were 7:00 a.m. to 3:45 p.m. for nearly all employees, although about 10 employees worked a second shift. In the weeks prior to the illness outbreak employees had been asked to clock in early, to take a shortened lunch break, and to work an hour overtime to meet high production demands.

B. Process Description

Processed rolls of leather are received at the plant and are cut into various sized sheets in the leather storage department. The sheets are taken to the two cutting lines of the cutting department

where patterns for the upper portion of the boots are mechanically stamped out. The pieces include straps, vamps, underlay, linings, counter pockets, etc. The parts then go to the five prefit lines where they are assembled and the linings are attached with a latex cement to the upper portion of the boot. The tasks include: perforate, topstitch, stickmark, lace, fold quarters, skive, pipe, line vamps, stitch straps, etc. The pieces proceed to the fitting department's seven lines where they are sewn together. (The fancy stitching for boot top designs is also sewn in this area by automatic sewing machines.) The boot top, at this point, is inside out, so next it is "reversed" so that the outside is out. The boot top goes to the lasting injection department where it is secured to the "last" (a wooden foot mold) to hold the boot's bottom shape. Other tasks include: insole tack, insert and trim counters, counter pockets, press vamps, etc. From here some children's boots go to injection moldings where the entire sole and bottom are "cast" to the boot held in a metal injection mold. The injection molder uses polyvinylchloride (PVC) plastic pellets which are melted and injected into the mold. The men's and women's boots proceed to the welt-lasting department. Here the leather is softened in toluene and box toes are heat pressed; the leather is then conditioned in hot water. The bottoms are tacked to the last, and thermo cement is machine applied to the toes, heels, and sides to seat the boot bottom. The boot then receives its first inspection before continuing on. The remainder of the welt-lasting and the welt departments staple, stitch, and cement the insoles, soles, and bottoms to the boot, attach the straps and heels. The final boot assembly takes place in the bottoming department, and trimming, repair, and antiquing are also performed at this stage. The "last" is then pulled and the boot proceeds to the finishing area for heel renailing, trimming, scouring, burnishing, ink edging, bottom washing, buffing, rubber sole cleaning, and cracked heel repairing. The packing department reinspects, trims soles, cements in heel pads, top washes, lacquer sprays, antiques, repairs, sprays the final shine coat, flames threads, and packs the boots for shipment. Throughout the process there are numerous cements, adhesives, latexes, glues, etc. The grinders and buffers contain local exhaust ventilation. Also at the recommendation of NIOSH, additional local exhaust ventilation has been put into place at the lacquer spraying booths and at the boxtoe and antique stations, which were moved across from each other.

C. Chronology of Events

On August 14, 1978, at about 10:00 a.m., employees in the Welt and Welt-Lasting departments complained of a gas odor. Four female employees from welting and one female from welt-lasting became ill with symptoms of nausea, dizziness and lightheadedness and were sent to the hospital where they were kept overnight for observation. As a precaution, plant management decided to turn off the gas at the meter and contacted both the gas company and the state "OSHA" offices. The gas company reported that a fresh tank of mercaptan odorant had been added to the natural gas in the area and other local business and home owners had also reported smelling strong gas odors that day. The gas company checked for gas with a

combustible gas meter but found nothing. The odor complaints persisted and the plant shut down at about 2:30 p.m. (It was reported that on the 14th, the first two cases of illness seen at the hospital were not from the Texas Boot Company evacuees.)

On Tuesday morning, August 15, 1978, the plant reopened and by 8:30 a.m. it was reclosed due to numerous worker complaints of odors, burning smells, and throat irritation. Twentyfour employees were taken to the hospital with symptoms of nausea, dizziness, etc. This time the employees were from five different departments with pre-fitting having the highest incidence. Industrial hygienists from State "OSHA' and gas company inspectors were on hand and found no measurable natural gas on the combustible gas meter instrument. There were some solvent vapors in the workroom air, but were considered below any toxic levels, based on indicator tube measurements taken for - toluene <200 parts per million (ppm), methyl ethyl ketone (MEK)* <500 ppm, carbon monoxide (CO) <5ppm, and ammonia <10 ppm, and hydrogen sulfide (H_2S) and vinyl chloride not detected. Personal samples for organics indicated even lower exposures - toluene 190 ppm and MEK 14 ppm.

On Wednesday, August 16, 1978, the plant reopened and between 7:00 a.m. and 10:00 a.m. eleven employees reported ill. The Company had heating, ventilation, and air conditioning experts examine the systems. The condenser and compressors were thoroughly cleaned and new filters were installed. A gas leak was found under the driveway so the gas was also shut off at the street.

On Thursday, August 17, 1978, the insurance carrier had industrial hygienists present and by Noon sixteen employees reported illness with symptoms previously described. However, no environmental toxins were found in sufficient concentrations to account for the illnesses.

Friday, August 18, was uneventful with only one employee reporting an illness. The plant was closed as usual on Saturday and Sunday. Throughout the week described above, no illness was reported among employees who worked on second shift.

Over the weekend the outbreak at Texas Boot received some television coverage, which continued during the second week.

On Monday morning, August 21, nine employees became ill with symptoms of nausea, dizziness, dry mouth, and faint feelings. At 4:00 p.m. at the close of work the air conditioners were turned off, all fans were turned on, and the doors were opened to "air out" the plant overnight. (The plant normally operates only the recirculating air conditioners and not the exhaust fans.)

* The indicator tubes for MEK are not specific and other organics may interfere; thus, actual concentrations were unknown.

On Tuesday morning, August 22, the recirculating air conditioners were not initially turned on. Six employees became ill. The State's sampling data indicated that toluene was 100 ppm, MEK 10 ppm, and CO 5 ppm. The ventilation was returned to the usual operating conditions.

On August 23, ten more employees became ill and odor complaints continued. The odors were said to be sporadic and smelled of sewage gas.

On August 24, the NIOSH investigators arrived at the plant and met with management. The chronology of events were discussed and information concerning employee demography, raw materials, facility and process descriptions, etc., was obtained. A walk-through of the process was conducted. State OSHA, gas company inspectors, the National Weather Service, Air Pollution Control Administration, and plumbing and ventilation contractors were all contacted for relevant information. On August 24 and 25, approximately 22 more employees became ill. The NIOSH physician and/or physician's assistant attended to some of the employees and documented symptoms and complaints. The complaints of sewage odors continued sporadically.

On August 25, the NIOSH investigators had the air conditioner condensers, but not the fans, turned off for approximately 1/2 hour, (0800-0830). Within this time period the organic vapor analyzer showed that total airborne organics increased to over 1,000+ ppm in certain areas, although the temperature only increased approximately 5°F. Two workers became temporarily ill in one of these areas although by then the condensers had been turned back on and cooling had begun. The investigators recommended that the units be adjusted to maximum fresh air intake (the units were set for 25 percent fresh air initially), the loading dock doors be opened, all unnecessary solvent sources be cleared out of the area, and all exhaust fans turned on. This was done; however, approximately one-third to one-half of the employees were allowed to go home at 11:00-11:30, primarily from one of the areas with high exposures. Within a couple hours of ventilating the area the odor of solvents was appreciably lessened. Indicator tube samples taken during the episode for toluene indicated <200 ppm (average 133) and MEK <100 ppm. A check of all drains revealed that some had dry water traps thus allowing sewage odors to escape. Water was added to the traps.

Telephone contact with the plant on August 28 confirmed there was no further illness.

Additional related history showed there had been a chemical incident in Waverly, Tennessee, some week earlier which had received media coverage.

IV. METHODS AND MATERIALS

A. Environmental Sampling

During the August 24th and 25th episodes, environmental samples were obtained utilizing both direct reading instruments and personal sampling devices. General area and personal samples were obtained utilizing battery operated sampling pumps and solid adsorbent media tubes containing either activated charcoal or silica gel at airflows of 1.0 and 0.2 liters per minute (lpm). The personal exposure samples were obtained by clipping the sampling media tubes to the workers' collars to simulate their breathing zones. Direct readings were obtained with Drager* indicator tubes and an Organic Vapor Analyzer (OVA).

A re-evaluation was conducted on October 16 and 17, 1978, to assess exposures after ventilation modification had been performed.

B. Environmental Sample Analysis

The environmental and bulk samples were analyzed by gas chromotography (GC) and mass spectrometry (MS). The solid adsorbent media tubes were desorbed with 1 milliliter (ml) carbon disulfide (CS_2) and aliquots were injected into the GC/MS instrumentation.[2-5]

C. Medical and Behavioral Evaluation

Medical evaluation consisted of interviews with a limited number of affected employees by either the NIOSH physician or physician's assistant, evaluation of employees becoming ill on the day of the initial NIOSH visit, discussion with the physician at the local hospital who had cared for the majority of workers receiving medical attention during this episode, review of medical records of some of the workers receiving treatment, and a review of the questionnaires obtained for the Behavioral Evaluation.

On August 24, 1978, the Company identified a work force of 514. NIOSH behavioral scientists distributed a total of 380 questionnaires (74 percent of work force) of which 229 were returned and 213 could be grouped by department. See Table I for a detailed breakdown. In all, returned questionnaires covered 41 percent of the work force. The proportion of workers returning questionnaires was approximately equal for both sexes.

The questionnaire covered demographic, domestic, socioeconomic, occupational and psychologic factors, as well as general health factors and epidemiologic information describing the illness outbreak.

V. EVALUATION CRITERIA

A. Environmental

The following occupational exposure criteria were used in evaluating the environmental contaminants found at the time of the survey: (1) National Institute for Occupational Safety and Health (NIOSH), Recommended Criteria for Occupational Exposures, (2) American Conference of Governmental Industrial Hygienists (ACGIH), Threshold Limit Values (TLV) for Substances and Physical Agents in the Workroom Environment and Supporting Documentation, and (3) U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1910.1000, Tables 21, 22, and 23). The criteria are listed on the bottom of each Table, numbers V-VII, under the respective columns of the contaminant identified. (It should be noted that some substances do not have any occupational exposure criteria.) These criteria are designed to protect most workers for an eight to ten hour day, forty-hour week, during a normal working lifetime. However, there are numerous factors that may influence an individual's response to a particular substance, such as age, sex, health status, smoking, and alcohol habits, etc. Also, these criteria are based on single substance airborne exposures; thus, effects from exposures via other routes of entry and to combinations of substances may be additive or synergistic when the substances elicit similar physiological responses.

B. Toxicity Data

Discussion of the health effects of every substance identified in this study is beyond the scope of the medical evaluation. Included in the Reference Section, however, are sources which can be consulted for health effects information on the substances not discussed here. It should be noted that some of the identified substances have little, if any, health effects noted in the scientific literature.

1. Organic Solvents (benzene, cellosolve, n-butyl acetate, methyl ethyl ketone, isopropyl alcohol, naphta distillates/refined petroleum solvent, 1,1,1-trichloroethane, and toluene). All the organic solvents cause some degree of narcosis, with the effects being additive. Mild effects may only show up as a headache or mild drowsiness or weakness. More marked effects may resemble being "drunk". Marked intoxication can lead to unconsciousness and death. Prolonged or repeated skin contact can lead to a dermatitis because of the defatting action of the solvent. In addition, many organic solvents can be absorbed to a greater or lesser extent through the skin, thereby lowering the tolerance to exposure to the fumes.

   In addition to these systemic and dermal effects, the vapors of most organic solvents are to some degree irritating to the eyes, nose, and/or throat. Some in high doses can cause liver or kidney damage. Excessive benzene exposure can cause an aplastic anemia and possibly lead to leukemia. Cellosolve has been shown to be teratogenic and cause testicular atrophy in rodents. Because it is not as irritating as some solvents and is readily absorbed through the skin, particular care should be given to avoid undue skin contact.

2. Ammonia[6] and Latex[7] Adhesives. Ammonia vapors are irritating to eyes, nose, throat, and lungs. On regular exposure a person develops some tolerance to these effects. At high concentrations these effects can be serious. Ill effects from the latex is due to the ammonia in the solution and should be minimal.

3. Mercaptans[8] have a very strong, unpleasant odor leading to their use as an odorant in natural gas. Only very low levels are needed to allow gas leaks to be noticeable by the odor. At levels likely to be encountered from the gas line the strong, offensive smell may cause headaches and nausea. Much higher levels would be necessary before any other ill effects could be produced. (For example, the odor threshold of ethyl mercaptan is 0.00026 ppm, the environmental criteria (ACGIH) is 0.5 ppm.)

4. Sewer Gas[9] is an indefinite mixture of gases formed from the decomposition of organic matter in an oxygen poor atmosphere along with any interaction with a variety of chemicals which may be dumped into the sewer. Usual constitutents are carbon dioxide (at levels above normal atmospheric levels), carbon monoxide, methane, and hydrogen sulfide. Besides having an offensive odor, the fumes can irritate the eyes. Unless one works in the sewer it is unlikely that a person would develop any health problem from casual exposures to sewer gas.

   To prevent sewer gas from entering buildings, floor drains, as well as drains from sinks and toilets, have a trap (the under the sink) which retains sufficient water to prevent any gas from backing up the pipe. If all the water evaporates through lack of use, sewer gas can flow back up the drain any time the air pressure in the sewer rises (as when a nearby toilet is flushed).

C. Behavioral Criteria

In addition to the previously described information contained in the behavioral questionnaire, three standardized psychological instruments were used. These were:

1) The Eysenck Personality Inventory. This instrument measures a number of psychological dimensions which are predictive of conformity or contagion reactions.[10]

2) The Work Environment Scale.[11] This scale measures worker satisfaction with ten distinct facets of the psychosocial work environment.

3) The Mini-Mult of the MMPI.[12] Three of the subscales of this instrument were used. These were:

   a) The Hypochondriasis Scale - measures the extent to which the individual somatisizes psychological stress (has physical symptoms).

b) The Hysteria Scale - measures the extent to which the individual manifests those behaviors which are characteristic of clinical hysteria (e.g., dependency, dramatization).

c) The Depression Scale - measures the extent to which the individual feels isolated and dejected.

A detailed description of the components of the questionnaire and the rationale for their inclusion is available elsewhere.[13-17]

VI. RESULTS AND DISCUSSION

A. Environmental

The NIOSH investigators found that on August 14 the gas company had added a new tank of mercaptan to their gas and that odor complaints had been received from other areas of the community. Also, the attending physician indicated that the first two cases on August 14 were not from the Texas Boot Company. The initial cases from Texas Boot came from an area of the plant where gas jets are used and an increase in the odorant in the gas could expect to be noticed. The gas company checked for leaks and, although none were found, the gas was shut off at the meter.

However, it is very likely that the mercaptan odorant continued to be a problem during the first week because it was not until two days later that the gas was turned off at the street when it was found that there were leaks under the paved driveway immediately behind the plant. Odiferous gas would be expected to leak out on the sides of the driveway, particularly along the gas pipe. It would enter the air at the gas meter. The gas meter is right beside the back door used by most of the workers.

The gas supply would not have been a factor the second week because it was still shut off at the street.

Additional existing conditions which may have contributed to precipitating or continuing the outbreak were: three floor drains were found with dry traps, thus allowing sewer gas to back up into the facility intermittently; lack of local exhaust ventilation for specific jobs which generated airborne contaminants; crowding of aisles and work areas with racks of boots and materials; and above normal air pollution for the Hartsville area. The evaluation also revealed the chemical storage room to be inadequately ventilated and that work practices and usage of personal protective equipment were poor to nonexistent. Although many employees used open pans of solvents and lacquers with soaked sponges, barrier creams or impervious gloves were not used. The potential skin absorption of substances may reduce one's tolerance to airborne exposures.

Table II gives the results of direct total organic vapor readings. There were numerous airborne organic compounds. The solvents used also contained benzene as a contaminant which is the most toxic of the substances identified.

Tables III, IV, and V contain the results of the personal exposure data. The results should be considered as the minimum concentrations present because there may be competitive binding and differential desorption rates for the numerous compounds in the solid media tubes. Most exposures were well below the existing single substance exposure criteria, but some jobs did create overexposures. The additive and/or synergistic effects from combined exposures to all of the substances may well have been excessive. The total exposures may have been even higher since some of the substances are absorbed through direct skin contact and many employees were inadequately protected for handling solvent rags, sponges, etc. There was a lack of barrier creams, impervious gloves and aprons, as well as very little knowledge on the part of the employees as to how to safely work with solvents. The jobs which create the overexposures are primarily box toe, heel and insole gluing, and welt cementing. These, however, were not the areas with the highest incidence of illness. The new ventilation in the box toe, antiquing, and lacquer spray areas were functioning adequately (over 100 feet per minute (fpm) face velocity for the spray booths and 900 fpm at the one-inch face of the slots at the antique position), but due to the work practices, limited work space, and hood design, some exposures were still too high.

Indicator tube measurements for ammonia taken in the breathing zone of top wash employees ranged from 20-30 ppm. This was high enough that employees in the area complained of eye and throat irritation. The local exhaust at this location was measured at about 35-50 fpm which was inadequate. The local exhaust at the ink edging station was also inadequate. There was no exhaust ventilation at the heel pad and insole gluing stations. Measurements were made for illumination and noise levels throughout the facility (Tables VI, VII). As the results indicate, there are areas with excessive noise and many areas of improperly located or maintained lighting.

Overall it appears that although there were some excessive exposures most are low enough that the illness outbreaks cannot be totally attributed to airborne contaminant exposures. This is particularly clear in that the groups most affected were in the areas of the lowest airborne concentrations. There are numerous environmental parameters that could contribute to causing the outbreaks. They include: unfamiliar odors, solvent exposures, poor air circulation, noise, crowded work areas, improper lighting, and general lack of safe work practices/awareness. These type conditions have been documented to contribute to similar problems in other operations.[13,14,15]

B. Medical

The most reliable accounting of the date and size of the outbreak of illness appears to be the accounting of visits to the doctor (with some admissions) obtained from the Company records. Hospitalizations tended to be early in the week each week. Also of

note is that the initial cases came from Departments 13 and 17 (Lasting-Welt and Welting) whereas the bulk of the cases came from Departments 05 and 07 (Prefitting and Fitting). (See Table VIII.) These latter are also the Departments with most of the repeat visits. (See Table IX.) It is certainly suggestive that the mercaptan in the gas supply was a major factor during the first week because the initial cases were in an area where gas jets were in use; the bulk of cases occurred during the next three days, allowing about one day's lag time for the odorant to seep out of the ground by the back door and one day's lag time for it to dissipate after the gas was finally shut off away from the plant.

Discussions with the examining physicians showed that the complaints of nausea, dizziness, and lightheadedness were not associated with any specific findings or disease. Initial cases were admitted for observation, but no specific diagnoses were made.

A better detailing of symptoms was obtained from the questionnaires.

Of those responding to the questionnaire, 83 percent of the 36 in Department 05-Prefitting reported some symptoms, whereas only 57 percent of the 99 in Departments 07-Fitting, 13-Lasting Welting, and 17-Welting, reported some symptoms and only 35 percent of 63 in other departments reported symptoms. Where there were enough men and women in the same department for comparison, there did not appear to be a difference between the two.

When looking at symptoms by department other than symptoms reported by only a few workers, the only symptoms for which there are appreciable differences between departments are the same ones which showed an appreciable difference between the sexes. As the distribution of workers by sex is not uniform, it is very likely that the differences are related to the different sex ratios between departments rather than other differences which might exist.

Those seeing a doctor (whether admitted or not) showed a greater incidence of dry mouth, tightness in the chest, a bad taste in the mouth, chest pain, a tingling feeling, numbness, and having passed out. (See Table X.) A complaint of inability to catch one's breath was much more characteristic of those admitted to the hospital than of the others. This last symptom did not appear related to department.

In summary, there were no symptoms uniquely characteristic of any particular department on an overall basis. Women were more likely to have seen a doctor and were more likely to have complained of several non-specific symptoms including inability to catch one's breath, a symptom which was found in a larger proportion of those being admitted. Admission to the hospital also appeared to be more likely for those whose illness started early in the week.

The majority of symptoms are consistent with the hyperventilation syndrome described in Beeson and McDermott, Textbook of Medicine.[18]

> The hyperventilation syndrome is one of the most frequent causes of impaired consciousness, usually producing "faintness" and "lightheadedness" without actual [fainting]. It is almost always a manifestation of acute anxiety. At the onset of an attack, the patient may complain of tightness of the chest and a feeling of suffocation. He may not be aware of overbreathing but usually recalls excessive deep sighing. Later, a sense of unreality develops, accompanied by feelings of apprehension and sometimes panic. Symptoms relating to the heart and gastrointestinal tract often appear. These consist of palpitations or pounding of the heart, [heaviness of the chest], fullness in the throat, and discomfort [in the pit of the stomach]. The syndrome may last for as long as half an hour or more and may recur several times a day. Sensations of "numbness" and "coldness" of the hands, feet and [area around the mouth] often develop, and in prolonged attacks tetany with [spasm of the hands and feet] may be noted.

The effect of hyperventilation[19] (breathing more deeply and/or rapidly than necessary for bodily needs) is to blow off more carbon dioxide than the body is producing. This upsets the acid-base balance in the blood. If the hyperventilation continues for any length of time, the kidneys will excrete increased amounts of bicarbonate and retain a corresponding increased amount of chloride.

The few laboratory findings which showed changes in serum electrolytes were consistent with a respiratory alkalosis (a slight decrease in serum bicarbonate level and slight rise in serum chloride level) as can be caused by hyperventilation.

Although the hyperventilation syndrome is descriptive of most of the acute symptoms, there were individual cases where other or additional factors were also important. One case of pulmonary infarction led to a much more prolonged illness than was characteristic of most of the cases. Also in one case personnally observed, the major problem appeared to be mild intoxication due to overexposure to the solvents. Some workers showed skin problems consistent with hand exposure to solvents.

C. Behavioral

1. Findings

For purposes of data analysis the questionnaire results for the demographic and epidemiological information are presented in statistical summary form. The individual job stress items and

psychological scale data were analyzed by computing Kendall correlation coefficients between each of these dimensions or variables and the number of reported symptoms. For purposes of interpretation, the higher the absolute value of the Kendall Coefficient (γ), the stronger the relationship between that variable and symptom severity (as measured by number of symptoms).

a. Demographic Factors

Of the 380 workers given questionnaires, 229 returned completed questionnaires for a response rate of 60 percent. (A 25 percent return is considered the minimally acceptable return rate for this type of study.) Of these, 33 percent were male and 67 percent were female. The majority had a high school education and had worked for Texas Boot for an average of four years, one month.

b. Symptoms

Twenty-five symptoms, identified in the literature as often characteristic of mass psychogenic illness, were presented on the questionnaire. Each respondent was requested to check which, if any, of the symptoms he/she experienced during the outbreak.

Of the 229 respondents, 121 (53 percent) reported experiencing at least one or more symptoms. The five most prevalent symptoms were: headache (41 percent), sleepiness (28 percent), dry mouth (28 percent), weakness (25 percent), and dizziness (22 percent).

The distribution of symptoms was related to respondent sex ($\gamma = .17$, $\rho < .001$) and parental status ($\gamma = .17$, $\rho < .05$). Thus, those most likely to report symptoms were female workers with teenage children.

c. Psychological Stress Measures

The data indicated a consistent pattern of relationships between perceived stress and symptom frequency. In general, the more stress an individual reported experiencing as a result of job and life-related conditions, the greater the number of symptoms. More specifically, the following results were obtained:

(1) Length of time on the job was negatively related to symptom frequency ($\gamma = -.11$, $\rho < .01$). The less experienced workers reported the highest frequency of symptoms.

(2) Boredom was related to symptom frequency as indicated by the fact that:

(a) Those workers experiencing job dissatisfaction arising from perceived underutilization of talents and abilities reported higher frequencies of symptoms (γ = .12, ρ< .01).

(b) Those workers expressing dissatisfaction from repeating the same activities over and over reported greater frequencies of symptoms (γ = .11, ρ< .01).

(3) There was a relationship between symptom frequency and dissatisfaction with organizational factors. Thus, those workers expressing the greatest number of symptoms expressed dissatisfaction with their salaries (γ = .11, ρ< .01), the disciplinary system (γ = .11, ρ< .02), the system for evaluating individual performance (γ = .17, ρ< .001), and the system of promotion (γ = .17, ρ< .001).

(4) Work scheduling and unwanted overtime showed a strong relationship with symptom frequency.

(a) Workers most dissatisfied with their working hours (γ = .14, ρ< .01) and with unwanted overtime (γ = .11, ρ< .01) expressed the greatest number of symptoms.

(b) Those individuals working the most overtime reported the most symptoms (γ = .11, ρ< .01).

(5) Work or production pressure also showed a strong relationship to symptom frequency. Thus, the workers reporting the greatest number of symptoms reported feelings of:

(a) Having too much work to do (γ = .14, ρ< .02).

(b) Being pushed to get the work done (γ = .13, ρ< .01).

(c) Having to rush to keep up the workpace (γ = .14, ρ< .01).

Work pace or pressure was also implicated by responses to the Work Environment Scale which revealed a relationship between work pressure and symptom frequency (γ = .18, ρ< .01).

(6) Dissatisfaction with managerial style was related to symptom frequency as indicated by the fact that those individuals reporting the greatest number of symptoms reported the greatest degree of dissatisfaction with the amount of recognition they received from their supervisors (γ = .20, ρ< .001) and the amount of freedom they were given to make jobrelated decisions (γ = .20, ρ< .001).

(7) Finally, physical aspects of the work environment were identified as bothersome by those workers reporting more symptoms. More specifically, symptom frequency was related to complaints of noise ($\gamma = .10$, $p < .02$), bothersome odors ($\gamma = .37$, $p < .01$), dust ($\gamma = .16$, $p < .001$), poor lighting ($\gamma = .12$, $p < .01$), temperature variations ($\gamma = .14$, $p < .01$), and crowding ($\gamma = .17$, $p < .01$). Similarly, the Physical Comfort subscale of the Work Environment Scale indicated that the affected workers were less comfortable about the physical aspects of the plant than were the nonaffected workers ($\gamma = .11$, $p < .01$).

d. Social Patterns

There was a tendency for those workers expressing more symptoms to report greater dissatisfaction with the extent to which their working hours interfered with a wide range of family activities. Thus, symptom frequency was related to dissatisfaction with the amount of free time for shopping ($\gamma = .20$, $p < .001$), housework ($\gamma = .19$, $p < .001$), and interacting with the children ($\gamma = .12$, $p < .03$).

e. General Health Factors

There was no relationship between symptom frequency and pre-existing (i.e., pre-outbreak) health status. Similarly, symptom frequency was independent of medication usage. These data would seem to suggest that the individuals reporting symptoms at the time of the illness outbreak had not been in poor health prior to the outbreak.

f. Psychological Scales

Responses to the standardized psychological scales included in the questionnaire protocol indicated significant correlation between:

(1) Symptom frequency and impulsivity ($\gamma = .14$, $p < .01$) as measured by the Eysenck Personality Inventory.

(2) Symptom frequency and Hypochondriasis ($\gamma = .16$, $p < .001$), and Depression ($\gamma = .11$, $p < .01$) as measured by the mini-Mult of the MMPI.

2. Discussion

The findings of the behavioral investigation suggest a relationship between life and job stresses and symptom outbreaks. Those individuals experiencing the greatest frequency of symptoms were also likely to report experiencing greater levels of boredom, dissatisfaction with promotion and job mobility potential, and dissatisfaction with managerial style. The greatest source of stress appeared to involve the physical aspects of pressure, and unwanted overtime. The latter appeared to be especially stressful in that the time spent in unwanted overtime apparently interfered with personal and domestic responsibilities.

The findings of the present investigation are in general agreement with previous reports of mass illness having an apparent psychogenic component.[10-17, 20-21] These studies have suggested that stress-induced behavioral contagion affects primarily workers engaged in a predominantly routine task who are collectively experiencing considerable job stress resulting in the expression of subjective somatic complaints (e.g., headaches, nausea, chills, etc.). The actual outbreak of illness is usually triggered by a physical stimulus (e.g., an odor, a bug bite, etc.) which is perceived by one or more workers and which is believed to be the source of their experienced discomfort. As the rumor begins to spread that workers are becoming ill because of a physical hazard in the workplace, the overall anxiety may affect other workers, resulting in contagion of symptoms throughout the workforce.

VII. CONCLUSIONS/RECOMMENDATIONS

A. Conclusions

Based on the environmental-medical-behavioral findings of this study it appears that the outbreak of illness among Texas Boot employees was due to environmental and behavioral factors combining to produce a mass illness. The contributing factors included: gas odorant smells, poor ventilation, unusually high air pollution, solvent exposures, noise, below optimal illumination, crowding, job and familial stress, and publicity. A few employees were affected by airborne contaminants and developed physical signs and symptoms. These employees were in turn observed by other employees experiencing strange odors and stress, who responded to the situation in a similar manner. The situation then developed into a "contagion reaction" and precipitated additional cases. Intermixed with the major outbreak were a few illnesses or overexposures leading to disability of variable duration.

B. Recommendations

The following recommendations were offered to help improve the health and safety of the working environment at Texas Boot Company.

1. Employees should exercise strict personal hygiene and good work practices. Management should train each employee in the proper work practices to safely and efficiently do their required work.

2. Management is encouraged to develop a health and safety program with the employees having input. A committee with members of management and labor could work together on developing the programs and correcting problems and complaints. Employees with dermatitis should be sent to a dermatologist for evaluation and treatment.

3. Impervious gloves, arm guantlets, and aprons should be provided to all employees working with glues, solvents, lacquer sprays, hand washing boots, etc. There should be a variety of glove types available so that every employee can find a type suitable to them. The gloves should be thin and allow for manual dexterity.

   The protective clothing should be cleaned and maintained by the company and provided to the employees daily. Clean cotton liners should be provided daily to wear under the impervious gloves, if so desired, to help keep the skin dry. Some types of barrier creams should also be provided but their proper use must be stressed and taught. Also, all employees who work with stains, dyes, inks, solvents, glues, lacquers, etc., should receive clean coveralls or smocks daily to help maintain personal hygiene.

4. Local exhaust ventilation should be installed at all tables where glues, solvents, lacquers, stains, etc. are used. It may be more practical to consolidate some operations to certain areas, thereby reducing the number of local exhaust systems. A competent ventilation expert should be consulted prior to initiating any major modifications. Also, the new exhaust systems for the spray booths should have noise arrestors installed or the fan speed reduced to decrease the vibratory noise. The filters must also be changed regularly to insure proper airflows. The new slot ventilation at the box toe-antique area should be modified so that it more adequately captures vapors at the source of generation. (See Reference 22.)

5. All exhaust stacks should be at least 10-15 feet above the roof to prevent recirculating the exhaust to air intakes.

6. Ear plugs should be provided to employees who operate excessively loud equipment. Hearing tests for those employees should also be provided on an annual basis.

7. All sewing machine task lights should be kept operational to help reduce eyestrain. Also, when relocating equipment the available light should be considered so that the equipment is properly located so that sufficient light is available for the tasks to be performed.

8. All floor drains should be checked periodically to make sure the traps are water sealed. Any floor drains not in use should be capped with removable caps.

9. A lunchroom area should be provided that is clean and quiet.

10. Management was encouraged to implement its plan to provide First Aid and CPR training to qualified personnel. Also, consideration should be given for reinstitution of a pre-employment medical examination.

11. The chemical storage room requires local exhaust ventilation and the wiring must be explosion proof. The fan should automatically turn on when the door is opened.

12. The aisles should be kept clear to facilitate egress, particularly if there were an emergency.

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Copies of this report have been sent to:

1. Texas Boot Company.
2. Tennessee Occupational Safety and Health Administration.
3. U.S. Department of Labor/OSHA - Region IV.
4. NIOSH - Region IV.
5. Tennessee Department of Public Health.
5. State Designated Agency.

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

TABLE I

Workforce by Department and Sex

Texas Boot Company
Hartsville, Tennessee

Department	Company Records 08-24-78 Women	Men	Total	Returned Questionnaires Which Could Be Grouped by Department Women	Men	Total	Percent of Total Workforce
01 Cutting	15	16	31	12	10	22	71
05 Prefitting	95	1	96	35	1	36	38
07 Fitting	81	7	88	37	1	38	43
11 Lasting-Injection	5	19	24	1	10	11	46
13 Lasting-Welt	25	35	60	17	15	32	53
17 Welting	28	25	53	16	13	29	55
19 Bottoming	7	17	24	5	6	11	46
23 Finishing	11	23	34	4	7	11	32
25 Packing	57	5	62	15	0	15	24
Other	6	36	42	2	6	8	19
Total	330	184	514	144	69	213	41
Percent by Sex	64	36		68	32		

TABLE II

Results of On-Site Total Organic Vapor Readings*

Texas Boot Company
Hartsville, Tennessee

August 25, 1978

Time	Location	Results (ppm)[1]
0750	Office	1
0751	Cutting	2-6
0758	Chemical Storage	1000+
0800	Prefit	7-20
0805	Fitting	20-210 500 peak
0816	Lasting Injection	200-300
0820	Bottoming	500-750
0818	Injection Mold	100-150
0820	Heel Tack	200-300
0822	Edge Trim	100-150
0824	Edge Ink	100
0830	Sole Finish Grind	250-300
0832-0900	Toe Box	300-500-1000+

[1] parts per million

* Measured with an Organic Vapor Analyzer calibrated against methane. Indicates approximate concentration of total organic vapors for air.

TABLE III

Results of Air Sampling for Organic Vapors

Texas Boot Company
Hartsville, Tennessee

August 24-25, 1978

Environmental Conditions: Indoors, Temperature 69 - 82°F, R.H. 63 - 72 percent, 0800 - 1600 Hour

Sample No.	Description	Results (mg/M^3)* Benzene	Butyl Ketone[1]	Butyl Acetate	Cellosolve[2]	IPA[3]	MEK[4]	Toluene	TCE[5]	Hydrocarbons (C_6-C_9)
CT-8	Personal Sample (P.S.) Prefit Underlay	1.1	--	--	--	N.D.**	17	40	17	84
CT-9	P.S. Welt Close Fitting	N.D.	--	--	--	N.D.	16	30	16	76
CT-10	P.S. Antiquing	1.3	--	--	37.5[2]	319	81	210	N.D.	151
CT-11	P.S. Top Spray	2.2	--	--	--	13	12	144	7.8	103
CT-31	P.S. Production Supervisor Packing Dept.	0.7	14	--	--	N.D.	300	71	1.4	54
CT-33	P.S. Lacquer Spray	1.4	--	<3.6	--	22	43	79	9.3	74
CT-34	P.S. Thermo Heel Seating	N.D.	--	<4.6	--	15	9.1	20	10	14
CT-35	P.S. Box Toe	15	--	--	--	N.D.	N.D.	286	6.4	354
CT-031	Leather Area	N.D.	--	--	--	8.3	11	17	16	116
CT-36	P.S. Finishing	N.D.	--	--	--	N.D.	N.D.	17	21	31
CT-37	P.S. Spray Antique Booths	1.4	--	--	--	N.D.	N.D.	91	11	114
CT-38	P.S. Antique Brushing	N.D.	--	--	--	110	35	15	N.D.	12
CT-40	P.S. Sheep Skin Cutter	N.D.	--	<2.2	--	N.D.	7.2	17	7.2	29
CT-41	P.S. Prefit Underlay	N.D.	--	--	--	N.D.	9.5	8.1	8.1	30
CT-42	P.S. Prefit Sew Counter Pockets	N.D.	--	--	--	N.D.	N.D.	5.5	2.7	13
CT-43	P.S. Vamping	N.D.	--	--	--	N.D.	7.5	14	N.D.	35
CT-44	P.S. Bar Tack	N.D.	--	--	--	N.D.	5.9	8.6	6.4	23
CT-45[6]	P.S. Fitting Dept. Service Girl	N.D.	--	--	--	N.D.	N.D.	19	9.1	45
CT-46[6]	P.S. Toe Lasting	N.D.	--	--	--	N.D.	N.D.	N.D.	N.D.	N.D.
Occupational Exposure Criteria (References 23-31)										
NIOSH		3.2[7]	--	--	--	984	590	375[7]	1910	350
OSHA		3.2[7]	--	710	740[7]	980	590	750[7]	1900	2000
ACGIH		30[7]	--	710	370[7]	980	590	375[7]	1900	1350

* Approximate milligrams of substance per cubic meter air
** Not Detected
1 Molecular weight 142 - Estimated concentration.
2 2-ethoxy ethanol - There were also some unidentifiables.
3 Isopropyl alcohol - Concentration estimated, based on H_2O - CS_2 extraction - The limit of quantification for these samples was 0.1 mg/sample.
4 Methyl ethyl ketone - Concentration estimated, based on H_2O - CS_2 extraction - The limit of quantification for these samples was 0.1 mg/sample.
5 1,1,1-trichloroethane
6 Pump failed.
7 Substance known to be absorbed through intact skin.

TABLE IV

Results of Air Sampling for Organic Vapors

Texas Boot Company
Hartsville, Tennessee

October 16, 1978

Environmental Conditions: Indoors, 70°F, 40 percent R.H., 0800 HR.

Sample No.	Time	Description	Results (mg/M^3)* Benzene	Cellosolve	NBA[1]	MEK[2]	IPA[3]	Nap[4]	TCE[5]	Tol[6]
CT-1	0707-1537	Personal Sample (P.S.) Top Spray - Packing Dept.	0.91	N.D.**	9.0	N.D.**	N.D.	115	N.D.	59
CT-2	0706-1529	P.S. Lacquer Spray - Packing Department	0.50	N.D.	15	N.D.	90	105	5.0	80
CT-3	0705-1115***	P.S. Top Wash - Packing Department	N.D.	N.D.	29	N.D.	N.D.	114	186	29
CT-4	0711-1126***	P.S. Hand Antique - Finishing Department	N.D.	55	N.D.	N.D.	N.D.	255	N.D.	45
CT-5	0712-1535	P.S. Box Toe - Welt Lasting Department	3.3	38	4.8	N.D.	N.D.	243	N.D.	476
CT-6	0724-1525	P.S. Inking - Finishing Department	0.30	N.D.	9.5	N.D.	N.D.	52	N.D.	12
CT-7	0725-1532***	P.S. Ink Design - Prefit Department	0.43	N.D.	6.1	N.D.	N.D.	21	N.D.	13
CT-8	0730-1524	P.S. Counter Pockets - Prefit Department	N.D.	N.D.	N.D.	N.D.	N.D.	87	N.D.	13
CT-9	0731-1523	P.S. Sewing - Fitting Department	0.71	N.D.	7.1	N.D.	N.D.	50	N.D.	25
CT-10	0726-1526	P.S. Edge Inking - Finishing Department	0.77	N.D.	N.D.	N.D.	N.D.	142	N.D.	123
CT-11****	0747-1533	P.S. Cement Welt - Welt Department	1.3	N.D.	6.7	N.D.	N.D.	367	20	80
CT-12	0745-1528	P.S. Toe Lasting - Injection Lasting Department	N.D.	N.D.	N.D.	N.D.	N.D.	26	N.D.	7.4
* approximate milligrams per cubic meter air										
** Not Detected, the limit of detection for these samples was			0.01	0.2	0.1	0.4	0.5	0.1	0.1	0.1
*** pump failed										
**** minimum concentration present due to possible break through on backup section of tube										
Environmental Criteria (References 23-31)										
OSHA			3.2[7]	740[7]	710	590	980	2000	1900	750[7]
NIOSH			3.2	---	---	590	984	350	1910	375[7]
ACGIH			30	370[7]	710	590	980	1350	1900	375[7]

1 n-butyl acetate
2 methyl ethyl ketone
3 isopropyl alcohol
4 naptha distillates - refined petroleum solvents
5 1,1,1-trichloroethane
6 toluene
7 substance known to be absorbed through intact skin

TABLE V

Results of Air Sampling for Organic Vapors

Texas Boot Company
Hartsville, Tennessee

October 17, 1978

Environmental Conditions: Indoors, 66°F, 40-45 percent R.H., 0830 HR.

Sample No.	Time	Description	Results (mg/M^3)* Benzene	Cellosolve	NBA[1]	MEK[2]	IPA[3]	Nap[4]	TCE[5]	Tol[6]
CT-13***	0713-1523	Personal Sample (P.S.) Glue Insoles - Welt Lasting Department	1.8	N.D.**	7.4	93	N.D.	259	15	407
CT-15****	0716-1532	P.S. Box Toe - Welt Lasting Department	1.2	N.D.	8.0	N.D.	N.D.	96	N.D.	12
CT-16	0732-1524	P.S. Pull Over - Thermo Plastic - Welt Lasting Department	0.95	N.D.	9.5	N.D.	N.D.	167	9.5	71
CT-17****	0725-1528	P.S. Lacquer Spray - Packing Department	N.D.	N.D.	N.D.	N.D.	N.D.	21	N.D.	6.1
CT-18	0710-1525	P.S. Repair - Bottoming Department	0.33	N.D.	N.D.	39	N.D.	23	N.D.	12
CT-19	0709-1526	P.S. Top Wash - Packing Department	0.56	N.D.	11	N.D.	100	61	100	28
CT-20	0724-1536	P.S. Spray Lacquer - Packing Department	0.45	N.D.	14	N.D.	27	45	14	45
CT-21	0735-1531	P.S. Antiquing - Finishing Department	0.91	27	9.1	N.D.	55	50	N.D.	36
CT-22	0728-1530	P.S. Clean Bottoms - Final Inspection - Packing Department	0.67	N.D.	6.7	N.D.	N.D.	327	10.	197
CT-23	0750-1538	General Area - Leather Storage	N.D.	N.D.	11	N.D.	N.D.	17	N.D.	17
CT-24****	0830-1245	P.S. Injection Molder Operator	0.54	N.D.	5.4	11	N.D.	8.1	N.D.	8.1
* approximate milligrams per cubic meter air										
** Not Detected, the limit of detection for these samples was			0.01	0.2	0.1	0.4	0.5	0.1	0.1	0.1
*** pump failed										
**** minimum concentration present due to possible break through on backup section of tube										
Environmental Criteria (References 23-31)										
OSHA			3.2[7]	740[7]	710	590	980	2000	1900	750[7]
NIOSH			3.2[7]	---	---	590	984	350	1910	375[7]
ACGIH			30	370[7]	710	590	980	1350	1900	375[7]

1 n-butyl acetate
2 methyl ethyl ketone
3 isopropyl alcohol
4 naptha distillates - refined petroleum solvents
5 1,1,1-trichloroethane
6 toluene
7 substance known to be absorbed through intact skin

TABLE VI

Illumination Measurements

Texas Boot Company
Hartsville, Tennessee

October 17, 1978

Location Description	Illumination Foot Candles at Task Level
Office - clerk's desk	40
Office - center of room under lights	90
Leather cutting	150
Inking in finishing area	100
Prefit sewing row 6	100
Prefit sewing row 6 aisles	50 - 70
Prefit sewing row 8	100 - 200
Prefit sewing row 8 aisles	30 - 60
Fitting sewing machine without task light	50 - 70
Fitting sewing machine with task light	110
Fitting sewing machines with 2 task lights	200
Bottom welt	50 - 80
Buffing	50 - 60
Buffing under light	70 - 100
Injection No. 1 molder	50 - 70 background
Injection No. 1 molder	110 - 170
Injection No. 2 molder	50 - 100
Edge trim	38 - 50 background
Edge trim	70 - 80
Heel scour	90 - 100
Heel trim	50 - 60
Crimper	20 - 40
Sole tack	20 - 40
Hand antique	20 - 30
Packing	40 - 80
Top spray	70 - 100
Spray lacquer	150 - 200
Top wash	150 - 200

Environmental Criteria (Reference 32)

General Background, minimum (should provide at least one-tenth of the illumination on any task)	20
Office: Reading high-contrast or well-printed material and tasks not involving critical or prolonged seeing.	30 to 100
Regular office work, reading good reproductions, reading or transcribing handwriting in hard pencil or on poor paper, active filing, index references, mail sorting.	

TABLE VI (continued)

Illumination Measurements

Texas Boot Company
Hartsville, Tennessee

October 17, 1978

Location Description	Illumination Foot Candles at Task Level
Environmental Criteria (continued)	
Shoe Manufacturing - Leather	
Cutting and stitching	
Cutting tables	300*
Marking, buttonholing, skiving, sorting, vamping, counting	300*
Stitching, dark materials	300*
Making and finishing, nailers, sole layers, welt beaters and scarfers, trimmers, welters, lasters edge setters, sluggers, randers, wheelers, treers, cleaning, spraying, buffing, polishing, embossing	200

* Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the recommended luminance ratios. (Background at least 10 percent of total light.) These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion, color, and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

TABLE VII

Noise Measurements

Texas Boot Company
Hartsville, Tennessee

October 16, 1978

Location	dBA* Before Production	dBA* During Production
Office	45-55	50-65
Cutting	60-65	74-86 96 peak
Prefit	65-75	78-85 90 peak
Fitting	65-70	70-85 90,95 peak, stappling
Fitting	65-70	70-85 100 peak
Tac lasting	65-70	80-85 94 peak
Cement welt	75-82	80-85
Heel base	60-70	80-85
Sole edge	60-70	80-85
Thermo heel	70-78	80-85 100 peak
Injection mold	80-85	80-85 100 peak compressed air release
Box toe - antique	60-70	75-85
Spray lacquer booths	60-65 exhaust fans off	88-94 exhaust fans on
Packing	55-65	70-75
Leather storage	50-55	72-86
Top wash	60-65	80-87
Lasting	73-76	80-85
Sole roughing	60-70	100-112 peak
Welt beater	65-75	85-90 105 peak
Inseam trimmer	65-95	85-96 100 peak
Inseam welt	65-75	80-87 105 peak
Side lasher	65-76	85-90 97 peak
Sole tack	60-70	75-85 100 peak

* Slow Response Scale

Environmental Criteria (References 24, 33, 34)

OSHA - 90 dBA for an eight hour time weighted averge (TWA) daily exposure
NIOSH - 85 dBA for an eight hour time weighted averge (TWA) daily exposure
ACGIH - 85 dBA for an eight hour time weighted averge (TWA) daily exposure

TABLE VIII

Observed and Expected Initial Visits to a Physician by Department
(based on Company records)

Texas Boot Company
Hartsville, Tennessee

Department	Physician Visit Observed	Physician Visit Expected	No Physician Visit Observed	No Physician Visit Expected	Total in Department
05 Prefitting	28	18.1	68	77.9	96
07 Fitting	28	16.6	60	71.4	88
13 Lasting-Welt	11	11.3	49	48.7	60
17 Welting	12	10.0	41	43.0	53
25 Packing	10	11.7	52	50.3	62
Other	8	29.3	147	125.7	155
Totals	97		417		514

X^2=36.2231(d.f.=5), p less than 0.005. This is a statistically significant difference.

Comparing Departments 05 and 07 to Departments 13, 17, and 25, the difference in number of visits is still statistically significant. X^2=5.8606(d.f.=1), p=0.017.

TABLE IX

Observed and Expected Repeat Visits to a Physician by Department

Department	Repeat Visit Observed	Repeat Visit Expected	No Repeat Visit Observed	No Repeat Visit Expected	Total Repeat Visits
05 Prefitting	5	2.9	23	25.1	28
07 Fitting	4	2.9	24	25.1	28
13 Lasting-Welt	0	1.1	11	9.9	11
17 Welting	0	1.2	12	10.8	12
25 Packing	0	1.0	10	9.0	10
Other	1	0.8	7	7.2	8
Totals	10		87		97

Fisher's Exact probability for Departments 05 and 07 compared to the rest is 0.028. This is statistically significant.

TABLE X

Percent of Each Symptom of Those with Symptoms by Department

Texas Boot Company
Hartsville, Tennessee

Symptom	05 Prefitting All Women		07 Fitting All Women		13 Lasting-Welt 11 Women 7 Men		17 Welting 11 Women 6 Men		25 Packing All Women		Other 8 Women 13 Men	
Total Number	(30)	Rank	(21)	Rank	(18)	Rank	(17)	Rank	(6)	Rank	(21)	Rank
1. Headache	87	1	81	1	83	1	88	1	50	2	67	1
2. Sleepiness	60	3	38	6	50	3	41	4	33	3	67	2
3. Dry Mouth	67	2	62	2	50	4	65	2	0	16	33	7
4. Weakness	47	6	29	9	50	5	53	3	17	8	57	3
5. Dizziness	20	12	43	5	56	2	41	5	33	4	52	4
6. Tightness in chest	50	5	48	3	33	8	35	9	17	9	38	6
7. Bad taste in mouth	53	4	48	4	33	9	41	6	33	5	29	10
8. Lightheadedness	23	10	38	7	44	6	41	7	67	1	48	5
9. Watery eyes	27	9	33	8	39	7	41	8	17	10	33	8
10. Chest pain	37	7	24	10	22	12	35	10	33	6	29	11
11. Nausea	33	8	24	11	17	14	24	13	17	11	33	9
12. Tingling feeling	23	11	24	12	28	10	18	16	0	17	24	12
13. Difficulty swallowing	20	13	24	13	28	11	18	17	0	18	5	20
14. Numbness	10	16	24	14	11	19	35	11	0	19	14	16
15. Blurred vision	10	17	14	17	6	20	29	12	17	12	24	13
16. Racing heart	13	15	19	15	17	15	24	14	0	20	14	17
17. Couldn't catch breath	17	14	10	19	17	16	18	18	17	13	0	21
18. Abdominal pain	10	18	10	20	17	17	18	19	0	21	14	18
19. Vomiting	0	21	19	16	17	18	6	22	33	7	10	19
20. Muscle soreness	0	22	10	21	6	21	24	15	17	14	19	14
21. Ringing in ears	3	19	10	22	22	13	18	20	17	15	0	22
22. Diarrhea	0	23	5	23	6	22	6	23	0	22	19	15
23. Passed out	3	20	14	18	6	23	6	24	0	23	0	23
24. Fever	0	24	5	24	6	24	18	21	0	24	0	24
		out of		out of		out of		out of		out of		out of
Percent of Department	83	(36)	55	(38)	56	(32)	59	(29)	40	(15)	33	(63)
Percent of Women in Department	86	(35)	57	(37)	65	(17)	69	(16)	40	(15)	33	(24)
Percent of Men in Department	0	(1)	0	(1)	47	(15)	46	(13)	--	--	33	(39)

FIGURE I

Facility Layout Sketch
Texas Boot Company
TA 78-58
August, 1978