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 NO. 79-103-640

ST. CHARLES FURNITURE CORPORATION
WRIGHT CITY, MISSOURI 63390

DECEMBER 1979

I. SUMMARY

From May 2 1979 to May 24, 1979, sixty (60) of the two hundred (200) workers at the St. Charles Furniture Co., Wright City, Mo. developed one or more of a variety of symptoms including headache, tremor, nervousness, dizziness, confusion, chest tightness and rash. To evaluate the etiology of these symptoms, NIOSH conducted a health hazard evaluation with assistance from the Occupational Safety and Health Administration (OSHA) of operations in Building 49 of the St. Charles Furniture Co. during the period of May 25, 1979, through June 1, 1979. The evaluation methodology consisted of (a) medical interviews with 12 employees; (b) environmental sampling of known air contaminants; (c) laboratory analysis of samples; (d) literature review of chemicals known to be present in the work place with concentration on their physiological effects; and (e) inspection of the work place and personal observations; (f) review of medical records from local physicians; and (g) review of company absentee data and illness reports.

Results of the hazard evaluation indicate the following:

A. The onset of employee illness occurred on May 2-3, 1979, during operations consisting of dipping wooden dowels in a stain solution containing mostly toluene. These operations involved a probable toxic exposure to toluene, resulting in three of four workers who were involved in the dipping operations becoming ill. The determination of a probable toxic exposure of employees to toluene is based upon the medical symptomatology of the employees, previous evaluations of similar operations at other facilities, and calculations indicating that the health standard for exposure to toluene was probably exceeded during the dipping operations.

B. The initial May 3 incident heightened the awareness of employees within the plant regarding their work place environment and induced added stress in some employees. Various exposures and odors from usual processes as well as other contributing exposures such as carbon monoxide emanating from fork lift trucks, exposures from short term operations such as silk screening, and the odor of a gas leak and an overheated compressor also contributed to illnesses. It is felt that there was no one agent

to account for the physical illness in the weeks following the May 2-3 episode, but rather multiple agents and/or factors causing illness.

C. Results of long term environmental personal and/or area samples obtained during the survey showed levels of the main airborne contaminants (e.g.; isopropanol, toluene, mineral spirits, and n-butyl acetate) being well below appropriate Federal and other health standards. A few other comtaminants such as t-butyl-4-ethyl phenol and 2,6 di-t butyl-4 ethyl phenol were detected in trace quantities.

D. The maximum estimated 8 hour time weighted average (TWA) expsoure for carbon monoxide (CO) was 34 mg/M^3 (milligrams of substance per cubic meter of air) which is below the NIOSH recommended standard of 40 mg/M^3. However, levels of carbon monoxide ranged from 51-63 mg/M^3 with short term peaks up to 171 mg/M^3.

E. One personal sample for total nuisance particulates obtained from a saw operator was estimated for 8 hour TWA to be 11.2 mg/M^3 (milligrams of substance per cubic meter of air); this level is above the American Conference of Governmental Industrial Hygienists (ACGIH) recommended criteria of 10 mg/M^3 for total nuisance particulates.

II. DISTRIBUTIONS AND AVIALABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request to 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 Publication Office at the Cincinnati address.

Copies of this report have been sent to:

a) St. Charles Furniture Corporation
b) Authorized Representatives of the Amalgamated Clothing and Textile Worker's Union
c) U.S. Department of Labor - Region VII
d) NIOSH - Region VII

For the purpose of informing the approximately 120 "affected employees," the employer shall promptly "post" for a period of thirty calendar days, this Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION AND BACKGROUND

On May 24th, 1979, NIOSH received a telephone request from the St. Charles Furniture Company, Wright City, Mo., regarding continuing health problems experienced by workers. Approximately sixty (60) workers over the period May 2nd through May 24th complained of various symptoms including headache, tremors, nervousness, confusion and dizziness. Many workers were seen by local physicians in emergency rooms and private offices. Sixty (60) of the approximately two hundred (200) workers were absent from work due to health complaints on the day of the call (May 24th). (Twenty-five (25) workers were out earlier that week.) The problem began on May 2nd when three of the four workers performing a dip staining operation, which is carried out once or twice a year, experienced headache, nervousness, tremors, dizziness and confusion. In that process wooden dowels were dipped into an open, unhooded vessel containing staining solution, then lifted out and shaken dry. The stain reportedly smelled differently from those used in the past.

The next day, a small dipping operation was performed using the same walnut stain. Four workers became ill in an adjacent area (hardware). Over the subsequent three week individual and clusters of cases continued throughout Building 49.

A team of NIOSH investigators, which included an industrial hygienist, a nurse consultant and a physician, arrived at the plant at 9 AM on May 25th to find that two (2) workers had suffered syncopal attacks (fainted) in the few minutes preceding the team's arrival. First Aid was administered and the workers were taken to a nearby hospital by ambulance. A few minutes later the building was evacuated because of the smell of "gas," and then closed for the day.

The health hazard evaluation began with a walk around the facility by the industrial hygienist while interviews with workers were conducted by the medical personnel.

IV. HEALTH HAZARD EVALUATION

A. Description of Process

The St. Charles Furniture Corporation, a Division of National Home Products, has approximately 200 employees, 155 women and 45 men, involved in the fabrication or manufacturing of ready-to-assemble furniture. The request covered Building 49 which has approximately 120 employees involved in the day shift production operations. The on-line machining operation involves eight production lines. These lines consist of at least two or more of the following operations: double end-toner, laminator, groover, drill station, staining, cleaning, spray booth, roller coating, and off stacking. The off-line machining primarily involves the drilling and sawing of particleboard or wood to appropriate sizes and shapes. The butcher block line primarily involves gluing and assembly operations. The sample shop has the

capability (e.g.; sawing, drilling, spraying, staining, etc.) of making and assembling sample pieces of furniture for display purposes. The spray paint line consists of four walk-in spray booths and four ovens. The line is used on a limited basis only during the fabrication of specialty pieces of furniture fabricated a few times each year. One of the booths is also used for intermittent operations such as stain-dipping of small parts and a silk screen process for certain pieces of furniture. The hardware packing department packages the necessary hardware (e.g.; screws, bolts, nuts, etc.) for the assembly of the piece of furniture. The finished goods packing area consists of placing the various components (e.g.; sides, tops, legs, hardware, etc.) of the piece of furniture together in a cardboard box and sealing it. There is also a salvage or sawing operation which reclaims any salvageable pieces of particleboard and wood. Over 90 percent of the fabricated furniture involves particleboard which may be covered with a protective or decorative finish such as plastic laminated wood, which is glued to the particleboard. Operations at the St. Charles Furniture Corporation are typical of furniture manufacturing (e.g.; sawing, gluing, staining, cleaning, etc.) operations, except for the final assembly which is performed by the consumer.

B. Evaluation Progress and Methods

1. Progress

An initial NIOSH walk-through as well as an environmental-medical survey of operations in Building 49 was accomplished during the period of May 25, 1979, through June 1, 1979. The survey was accomplished by two NIOSH physicians, one NIOSH registered nurse, one NIOSH industrial hygienist, and two industrial hygienists representing the Occupational Safety and Health Administration (OSHA). An exit interview was held with appropriate representatives of union and management to discuss any preliminary observations and findings, and to answer any questions concerning this evaluation and subsequent reports. An interim report summarizing observations and preliminary findings was sent to management and union representatives on July 16, 1979. OSHA continued their inspections of facilities and other operations after the NIOSH team had completed this medical-environmental evaluation of operations in Building 49. OSHA's findings, with the exception of results for carbon monoxide, are not discussed in this report.

2. Environmental Design and Methods

Bulk samples of several products (e.g.; dip stains, adhesives, glues, sawdusts, etc.) used in Building 49 were obtained and submitted to the NIOSH laboratory in Cincinnati for analysis of possible contaminants which may produce some adverse symptomotology. The manufacturer of the various products were contacted to ascertain the specific chemicals in their products.

Air samples via personal and area sampling apparatus were used to assess the potential exposure of several production employees to various

contaminants. Four pre-wighted FWSB polyvinyl chloride filter samples in a two piece cassette were obtained for total dust by using an MSA pump at a sampling rate of 1.5 liters of air per minute (lpm). Eighteen charcoal tube samples were obtained for analysis of organic chemicals such as toluene, using a Sipin or MSA pump at 0.05 lpm to 0.6 lpm. These samples were submitted to the NIOSH laboratory in Cincinnati for gravimetric analysis of the filter samples and analysis of the charcoal tubes via gas chromatographic and mass spectrographic procedures contained in the NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 77-157, Cincinnati, Ohio, 1977. These analytical techniques are not only sensitive for the identification of most organic compounds but also allows the chemist to quantify the compounds identified. Draeger detector tubes and a continuous monitoring instrument were used for measuring carbon monoxide (CO) levels at appropriate locations. Draeger detector tubes were used to measure any potential exposure to formaldehyde. Formaldehyde was not detected and not considered further in this report.

Two 55 gallon containers with hardware parts had warning labels on the outside that they contained sodium cyanide. Smear samples of the containers and their contents were obtained and submitted to the NIOSH laboratory in Cincinnati for analysis of cyanide. No cyanide was detected on the smear samples. The shipper was contacted and stated that the 55 gallon barrels did not contain sodium cyanide and were mislabeled. Hence, sodium cyanide was not considered as a potential hazard and is not discussed further in this report.

3. Medical Design and Methods

NIOSH medical personnel interviewed plant employees including 12 persons who complained of illnesses during the month of May. These 12 persons were questioned regarding any pertinent past medical history, and any recent specific or non-specific symptoms (e.g.; nausea, headaches, etc.) which had occurred over the past month or so. Local physicians who had treated some of the sick employees were also contacted to obtain additional medical data.

Medical records from local physicians and emergency rooms were reviewed along with company illness reports. A day by day accounting of the total number of hours worked by the workforce was compiled by the company and used to graph an epidemic curve.

The medical investigation was based on characterizing the epidemic using epidemiological methods on existing data. Additional physical examinations and laboratory testing by NIOSH, beyond those carried out by local physicians was not performed because of the non-specific nature of the illnesses and the low expected yield.

C. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are: (a) NIOSH Criteria Documents with recommended standards

for occupational exposure; (b) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation; and (c) Federal Occupational Health Standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor (29 CRR 1910.1000). For the substances evaluated during this study, the primary environmental criteria considered most appropriate are:

TABLE OF ENVIRONMENTAL CRITERIA

SUBSTANCE	STANDARD OR GUIDE mg/M^3*
Mineral Spirits (e.g.; stoddard solvent, etc.)	350 (a)** (maximum concentration of 1,800 mg/M^3 for 15 minutes sampling period)
Toluene	375 (a,b)*** (750 mg/M^3 for 10 minutes sampling period)
n-Butyl Acetate	710 (b)
Isopropanol (Isopropyl Alcohol)	984 (a,b,c)
Carbon Monoxide	40 (a)
Total Nuisance Particulates (Dusts)	10 (b)

*Approximate milligrams (mg) of substance per cubic meter (M^3) of air sampled.

**Reference letters in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

***In case of a mixture of air contaminants particularly with organic solvents, the overall effects are considered as additive. An employer shall compute the equivalent exposure as follows:

$$*EM = \frac{C_1}{L_1} + \frac{C_2}{L_2} \ldots \frac{C_n}{L_n}$$

Where:

Em is the equivalent exposure for the mixture.
C is the concentration of a particular contaminant.
L is the exposure criteria for that contaminant.

*The value of Em shall not exceed unity or 1.

Occupational health exposure limits for individual substances are generally established at levels designed to protect workers occupationally exposed for an 8 hour per day, 40 hour per week basis over a normal working lifetime.

There are no criteria or health standards established for t-butyl-methoxy phenol and 2,6 di-t-butyl-4 ethyl phenol or a similar compound which was

detected in one bulk air sample as discussed in subsequent section of this report. This latter compound is similar to butylated hydroxytoluene (BHT).

2. Biological Criteria - Review of Literature

Biological criteria are based on the observable health effects of exposure to the work environment usually in reference to a biologically normal condition. Exposures include not only the breathing concentrations but also direct skin contact with solvents, cleaning agents, and other chemicals. Absorption via the skin of various chemicals as well as absorption via the gastrointestinal tract from hands contaminated with various chemicals are major areas of concern but areas where there is only limited data and information. General information on the major compounds considered in this evaluation are discussed below.

Mineral Spirits--There is a wide variety of refined petroleum products (e.g.; mineral spirits, stoddard solvent, naphthenic and paraffinic oils, toluene, ethyl benzene, etc.) which are used as additives and solvents in various formulations or products - the most common being mineral spirits and/or stoddard solvent which are relatively high boiling point petroleum oils. Repeated or prolonged contact with the skin may lead to a dermatitis. Solvents dissolve the natural protective oils from the skin resulting in a loss of skin hydration. This leads to redness, drying, and cracking of the skin. Once the skin barrier is broken, it is easily infected by common bacteria and also deeper penetration with subsequent absorption of chemicals through the affected skin areas. Persons with dry, senile, or senitive skin are particularly prone to solvent actions. The other major toxic effects from mineral spirits and other solvents are irritation of the skin, eyes, throat and nose, and the feeling of sleepiness, lightheadedness, headache, and possibly some incoordination from breathing excessive amounts of the vapors. These symptoms of the central nervous system may be intensified or first noted at the moment of entry into an uncontaminated atmosphere after a solvent (e.g.; mineral spirits, toluene, etc.) overexposure.

Toluene--Controlled exposure of human subjects to 750 mg/u^3 for eight hours produced mild fatigue, weakness, confusion, lacrimation, and paresthesias of the skin. At 2250 mg/u^3 for eight hours, other effects were euphoria headache, dizziness, dilated pupils, and nausea; at 3000 mg/u^3 for eight hours, symptoms were more pronounced, and after effects included nervousness, muscular fatigue, and insomnia persisting for several days. (Ref. 4)

n-Butyl Acetate--The effects of exposure at high concentrations consist of signs of irritations of the eyes, nose, and throat, followed by a slow and gradual onset of narcosis with slow recovery after exposure ceases. Anesthetic symptoms normally do not result in man from butyl acetate or levels of 94 to 1893 mg/M^3 in exposure of 2 to 3 hours duration. While butyl acetate may produce slight eye irritation in some people at 947 mg/M^3, it does not appear to produce the characteristic temporary corneal edema caused by butanol at such levels. No skin sensitization and only minor dryness of the skin has been noted.

Isopropanol (Isopropyl Alcohol)--Concentrations of 984 mg/M^3 cause mild irritation of the eyes, nose, and throat; ingestion or inhalation of high level may cause vomiting, headache, giddiness, and coma. The effects of isopropanol are similar to ethyl alcohol but considered as twice as toxic with the main symptomatic action being narcosis. Evidence indicates that a slight tolerance is acquired to the narcotic effects from isopropanol.

Carbon Monoxide--The symptoms of carbon monoxide poisoning include headache, nausea, vomiting, dizziness, drowsiness, mental confusion, hallucination and collapse. CO exerts its harmful effect by binding with the blood hemoglobin forming carboxyhemoglobin. As a result, the hemoglobin is no longer able to transport oxygen to the cells of the body, causing tissue hypoxia. The intensity of the symptoms is dependent on the percent of carboxyhemoglobin in the blood. Smokers usually have higher levels of carboxyhemoglobin than non-smokers (often 5 - 10 percent or more). The effect of carbon monoxide exposure on man is enhanced by many environmental factors such as heavy labor, high environmental temperatures, and altitudes above 2000 feet.

Nuisance Dusts or Particulates--Nuisance dusts have few adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert so that when inhaled the architecture of the alveoli remains intact, little or no scar tissue is formed, and any reaction provoked is potentially reversible. Excessive concentrations in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, and nose, and secondarily cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

t-Butyl-Methoxy Phenol or Butylated Hydroxyanisole (BHA); and 2,6, di-t-Butyl-4 Ethyl Phenol which is similar to Butylated Hydroxytoluene (BHT) differing only by an additional Methyl group--These compounds are used as an antioxidant in many applications as small amounts prevents the deterioration of a wide variety of materials, including fats, oils, glues (such as used in Building 49), waxes, and plastic films. They have been used as additives in foods and in waxes or plastic films for coating food wrappers or containers. Toxic concentrations have been absorbed into tissues of unanesthetized animals inducing signs of intoxication resembling those seen after absorption of a toxic dose of a parasympathetic drug resulting in salivation, a mild degree of miosis, (reduced size of pupils), unsteadiness, restlessness, diarrhea, and tremors. Large doses produce a gross disturbance of sodium, potassium, and water imbalance in the rabbit. Chronic toxicity studies using dogs and rats showed that these compounds are relatively innocuous. Direct skin contact may cause sensitization type of dermatitis, and practically no systemic toxicity. The reader is cautioned that studies of these compounds have not been extensive and there is a need for additional toxicity studies on them.

D. Evaluation Results and Discussion

1. Environmental Results and Discussion

Solutions of the walnut stain (as used and as received) were analyzed by gas chromatographic and mass spectographic analysis methods. Only one solvent peak was identified that being toluene. Hence, benzene or other contaminants (e.g. xylene, etc.) were not present in sufficient quantities to be identified and are not considered further in this report. Analysis of heated headspace samples from the hot melt waxes (used in packaging lines and laminator operations) showed that BHT, toluene, and C_{10}-C_{12} alkanes or mineral spirits were the major peaks in these samples. Alkanes were included as mineral spirits from a toxicity standpoint as far as this report is concerned as mineral spirits include alkanes as well as many other similar compounds. Tables I and II show the results of the area and personal air samples obtained during operations on May 31, 1979. In this regard, more contaminants were collected on the area samples (e.g.; around 200 liters of air sampled) than personal samples as the NIOSH investigators wanted to identify any potential airborne contaminants. The area samples were located in the immediate vicinity of the operation. There were sic area and 12 personal air samples obtained during the survey. The results of these samples are discussed below.

Samples Nos. A-21 and A-22 had the highest concentrations of organic compound with toluene and isopropanol as the major components with small amounts of alkanes (e.g.; included as mineral spirits) indicated. Two small late eluting peaks were observed on Sample A-21. The first peak appeared to be a compound with a molecular weight of 180 such as t-butyl-methoxy phenol. The second peak, the larger of the two, was a compound with a molecular weight of 234 such as 2,6, di-t-butyl-4-ethyl phenol which is similar to BHT. These two peaks were not present on any of the other area or personal air samples. Sample No. A-21 was obtained within a foot of the operation where the adhesive glue is applied in the laminating operation. Exposure of employees to airborne concentrations of compounds such as BHT and BHA is considered to be minimal or not toxic as the levels were not of such concentration to be quantified and not detectable in the other 17 area and personal samples. It is noted that glues, adhesives, and waxes may contain compounds such as BHT and BHA, and absorption of these compounds via direct skin contact is possible, particularly for those employees not wearing gloves when handling these materials. However, it is considered highly unlikely that absorption via direct skin contact of these compounds in amounts which would be considered as toxic when considering the actual operations and the potential for exposure via absorption.

All of the air sample results were well below (less than 10 percent) the environmental criteria of 984 mg/M^3 for isopropanol, 375 mg/M^3 for toluene, and 350 mg/M^3 for mineral spirits, and 710 mg/M^3 for n-butyl acetate as shown in Table I. Three of the samples indicated isopropanol

breakthrough on the backup section of the charcoal tube and the reported values for the samples are considered as minimum values for isopropanol. It is felt that the concentrations reported for these three samples are within a factor of two or three times the concentrations reported and well below the environmental criteria for isopronpanol. When considering concentrations of isopropanol as 3 times the concentration noted in Table I as well as the combined effects ($EM = \frac{C_1}{L_1} + \frac{C_2}{L_2} \cdots \frac{C_n}{L_n} = 1$) of all the organic compounds covered by this evaluation, employee exposure would be less than ^{15} ($Em = <0.15$) percent of the environmental critieria of EM = 1. Hence, employees were not exposed to airborne concentrations of organic compounds which were considered as toxic at the time of this evalaution.

Table II shows the results of air samples obtained for total nuisance dusts. One sample (maximum concentration of 11.2 mg/M^3) exceeded the environmental criteria of 10 mg/M^3 for total nuisance dust on an 8 hour time weighted average (TWA). This sample was obtained in the breathing zone of an operator receiving sawed particle boards from the double end-Toner saw prior to the laminator on Line 5. The result for the salvage saw operator was estimated as 8.2 mg/M^3 for total nuisance dusts which may be considered as somewhat excessive but not exceeding the environmental criteria. These plus a few other employees had visible sawdust on their hair and clothing.

On May 24, 1979, an instrument with a strip chart was used for continuously measuring carbon monoxide (CO) levels in the breathing zone of employees. The CO readings in the morning ranged from 51 to 63 mg/M^3 with short term peaks up to 171 mg/M^3. It was recommended that the propane powered forklift trucks be properly tuned and maintained. The average reading in the afternoon was 29 to 34 mg/M^3 of CO with short term peaks up to 51 mg/M^3 of CO. The 8 hour time weighted average (TWA) was estimated at 34 mg/M^3 of CO which is below the OSHA Federal Standard of 57 mg/M^3 for CO; but, this reading was only slightly below the NIOSH recommended standard of 40 mg/M^3 of CO for an 8 hour TWA. After tune-up of the propane forklift trucks, subsequent surveys with a continuous monitoring instrument plus Bendix and/or Drager detector tubes showed CO levels of ^{6} to ^{23} mg/M^3 with an average maximum estimated TWA of 11 mg/M^3. The survey did show the importance of proper maintenance and tuning of the forklift trucks.

A cursory ventilation survey was made of some operations using an Alnor, Jr. velometer and smoke tubes. All four walk-in hoods in the paint line had an average face air velocity of less than 150 feet of air per minute (fmp) and the hood in the sample area was 150 fpm. The exhaust from the hoods are at roof level (no stacks for discharge at higher elevations). A few vents were in the general vicinity of one of the roof air make up units. The hoods could provide for better ventilation for spraying operations by minor modifications to the hood (e.g.; lower the surface area openings, cleaning and changing the filters, etc.). The hoods for the spray operations on

production lines five and seven could be improved by providing a sliding front face which would increase the air flow and containment of the spray. Housekeeping and the periodic maintenance program did not appear adequate. Many of the different types of saws (e.g.; groover, double edger toner, etc.) were provided with enclosures or point of operation ventilation to collect sawdust. Most of their local exhaust systems had inadequate air flows and visual observations showed that several elephant trunks were not connected to the enclosure. There were holes in the elephant trunks and other inadequate maintenance of the ventilation system provided for the saws.

The investigators noted several instances (e.g.; cleaning of machines and clothes with compressed air; absence of appropriate protective clothing for this particular job, such as safety glasses or goggles, inadequate guards on saws, visual airborne sawdust particles with potential eye injury etc.) where general health and safety practices and engineering controls should be improved. Housekeeping (e.g.; open containers of solvent, piles of sawdust, etc.) in general was considered poor throughout the facilities. A silkscreening operation was observed being conducted one afternoon in front of one of the large walk-in spray booths. The operation provides for maximizing exposure of the employee as fumes from the operation was drawn through the employees breathing zone into the walk-in hood. This operation is limited to a few days during a year.

The plant heating system is by natural gas with a backup system of propane. Both systems have a mercaptan additive which gives an offensive odor if there are any leaks. The system was shut off during the month of May. A few employees said they had smelled an offensive odor previously and on May 25, 1979. The gas company sent three representatives to survey the plant for leaks and they also checked vents to the sanitary sewer system. No leaks of natural gas or propane were detected. A slow leak of propane was detected from a valve which did have an offensive odor in the very near vicinity of the tank, but was not considered to be a health hazard. The gas company felt the heating system was in excellent condition and the pipes still have pressure in them which indicated a very tight system. A follow-up survey by the team was made on May 29, 1979, using a MSA combustible gas indicator and no combustible gas was detected in the facility nor in the vents to the sanitary sewer and the plant drainage system in the back of the facility. A more in-depth evaluation of these systems was not warranted.

The original walnut dipping operation consisted of dipping wooded dowels into an open, unhooded metal container with several gallons of stain solution. These operations are conducted for a few days a year and were performed for 2 1/2 days during the first part of May 1979. The dipping operations were performed by three to four employees in front of one of the walk-in spray booths. Approximately 20,000 dowel rods were dipped in 2 1/2 days which consumed about 46 gallons of stain. Analysis of the stain (as noted in the first paragraph of this section) showed toluene

to be the main chemical. No air samples were obtained of the dipping; hence, no factual statement can be made concerning actual concentrations of toluene during this operation. However, based on the investigator's judgement and considering the amount of stain used over the 2 1/2 days, it is felt that employees in the immediate vicinity of the dipping operation were probably exposed to airborne concentrations of toluene at levels up to eight times the environmental criterion of 375 mg/M^3.

2. Medical Results and Discussion

An epidemic curve (graph 1) was drawn using worker absenteeism data supplied by the company (Table 3). The particular data requested, namely illness data for workers in Building 49 over the time period of interest was unavailable. The data supplied includes all full-time workers on the payroll, not on extended leave, and is a crude estimate of absenteeism in the entire plant. Records were unavailable to separate workers in Building 49 from the rest of the workforce. Also, no adjustment was possible using the data provided to account for workers who may have quit due to illness or had been fired, nor for the possible imposition of overtime on days with high absenteeism.

The background absenteeism level is usually between 9.4% and 18.4% percent. The data are not sensitive enough to detect small clusters of cases which may be masked by the background absentee level.

The graph suggests that an epidemic of absenteeism began during the week of May 21st and concluded after June 7th. A pronounced peak is seen on May 24th and 25th when 33% and 72.3% percent respectively, of the workforce was absent. The high level of 72.3% is an artifact of the crude data which reflects the evacuation and subsequent closing of the plant on May 25th. The 33% figure reached on May 24th is probably a more accurate depiction of the true percentage of workers absent due to illness during this peak period.

A review of the data obtained from medical records, insurance records, and interviews with workers and local physicians was used to characterize the illness. Workers experienced a wide variety of symptoms including headache, nervousness, tremor, dizziness, confusion, nausea, rash, throat irritation, chest tightness, fatigue, alternating crying and laughter. (Table 4) Symptoms were generally transient although some workers reported persistent symptoms and experienced repeated illnesses.

The onset of illness occurred on May 2nd and 3rd when three (3) of the four(4) persons performing a dip staining operation complained of dizziness, confusion, headache, nervousness, tremor, and alternating crying and laughter. Fresh air seemed to help relieve symptoms, however, the workers required medical attention and later re-experienced these symptoms when they again worked with the staining solution. Toluene was

shown to be the major solvent component of the stain and this episode, clustered in place and time, is consistent with a toluene intoxication.

Similar cases continued through May 7th, occurring in clusters, some were scattered and some linked by line-of sight. After May 7th, the incidence of new cases seemed to abate. However, clusters of cases again occurred on May 16-18 and again on May 24th. Some illnesses were associated with handling of the original dipped dowels by workers in the packing department while other illnesses were stated to be associated with unusual odors emanating from an overheated compressor or a "gas" leak. It was not possible to link all cases or clusters with a special exposure, process or area. A rough chronology of events is listed in Table 5.

A review of medical records revealed that laboratory tests were within normal limits except for one blood smear which revealed basophillic stippling and two (2) elevated blood carboxyhemoglobin levels which deserve follow-up.

Almost one-third of the workforce was affected (60/200) including 7 males and approximately 50 females. The attack rate was 7/45 or 16% for males and 50/155 or 32% for females.

The historical data gathered do not suggest that a toxic agent was solely responsible for the illnesses occurring after the May 2-3 cluster. Instead, the self-limited epidemic can be explained by the dynamics of a complex combination of exposures and factors as explained below.

V. CONCLUSIONS AND RECOMMENDATIONS

The initial illnesses resulting from the May 2-3 dipping operation are consistent with toluene intoxication. Environmental monitoring performed after May 2-3 failed to detect any chemical agent that, in and of itself, could explain the subsequent epidemic. Although an extensive industrial hygiene evaluation of the workplace was performed and failed to identify any chemical toxins capable of producing the observed symptoms, there is always a slight possibility that a contaminant present in the environment somehow escaped detection. Instead of looking for one causal agent, however, the self limited epidemic can better be explained by the dynamics of a complex combination of exposures and factors on the basis of available data.

Sample results show that at least one employee (there may be a few other in sawing operations) was exposed to concentrations of nuisance dust which exceeded the environmental criteria of 10.0 mg/M^3. Visual observations also indicated excessive airborne sawdust from some sawing operations.

Carbon monoxide levels were detected with short term peaks up to 171 mg/M^3 indicating improper maintenance of fork lift trucks. This finding may partially explain the two elevated blood carboxyhemoglobin levels.

Background exposures in the plant include noise, solvents, glues, waxes, etc., some of which were present in higher than necessary amounts due to poor housekeeping and maintenance policies and inadequacies in the ventilation system.

The initial illnesses on May 2-3 heightened the awareness of employees regarding their workplace environment. The anxiety caused by a fellow worker's illness, by new exposures such as those emanating from the dipping operation or from the overheated compressor or gas leak, and the presence of materials from the original dipping operation known to have been associated with health complaints all contributed to increased stress. Stress was also increased due to rotation of job tasks necessitated by high absenteeism, fear of illness, fear of loss of pay and the possible loss of employment. This increased stress is added to the stresses usually encountered in the workplace resulting from chemical and physical exposures as well as that component due to job dissatisfaction from the pressure to perform routine or repetitive tasks, the lack of autonomy (lack of control), and from organizational factors such as the pressure of production demands and poor communications between labor and management.

The May 2-3 episode may have acted as a trigger mechanism at which point the stress manifested itself in disease and resulted in the epidemic during the subsequent weeks. This conclusion must be taken as seriously as if a single chemical or biological agent was considered causal. The induced stress resulted in multiple illness including faintings which could have produced serious bodily harm in a workplace where the use of power machinery is routine.

Hence, in view of the above information, the following recommendations are made to provide for a healthier working environment with the emphasis placed on prevention of future occurrences.

1. An education program should be implemented so that employees are made aware of the toxicity and hazards, plus the proper precautions to be taken when handling materials used in operations covered by this evaluation. Good work practices and procedures should also be included in this program. Certain operations (e.g.; cleaning of sawdust collected, solvent cleaning, sawing, silk screening, etc.) should require additional protective clothing (e.g.; long-sleeved shirts, safety glasses, goggles, respirators, gloves, etc.) and/or engineering controls to preclude contamination of skin and eyes by dusts and/or solvent. Personal cleanliness and hygiene of employees (e.g.; washing hands, changing clothes, etc.) contamination control, and use of appropriate protective clothing

(e.g.; respirators, gloves, goggles, safety glasses, etc.) should be stressed. Material Safety Data Sheets on various chemicals used at the plant should be obtained and should be available to employees for their information. Eating should not be allowed in the production area of Building 49. The wearing of adequate protective clothing by employees should be enforced. However, protective equipment or administrative control measures should not be used in lieu of good engineering controls.

2. Engineering controls should be reviewed and evaluated and appropriate modifications should be made (e.g.; ventilation, enclosures, hoods, etc.) to assure that the controls are adequate, operational, and properly used. This evaluation should include periodic checking, cleaning and maintenance of equipment and engineering controls such as hoods. Improved engineering controls and maintenance programs would prevent airborne contamination and accumulation of dusts, mists and vapors. Maximum ventilation should be maintained to keep all exposures to a minimum.

3. An effort should be made to improve communications between management and labor. A health and safety committee made-up of both labor and management should actively work towards improving the workplace environment. Encouraging employee participation in decision making may begin to address the problem of job dissatisfaction.

4. The employer should improve general housekeeping in the plant. Specifically, clean-up and covering of paint, solvent, and glue containers, as well as, reduction of dust accumulation should be instituted. Containers with various chemicals should have tight fitting lids in place when not in use, and be appropriately marked with the content of the container. Also, open trays or cans of isopropanol and other solvents should not be allowed. Small or large liquid spray pump bottles or plunger cans could be used in lieu of open containers or trays. Piles of sawdust should not be allowed to accumulate where they may present a fire or other hazard.

5. Increased emphasis and improvement on safety items is needed. For instance, some saws were not adequately maintained, ventilated, or guarded; and containers of flammable materials should not be stored in wooden cabinets, but in cabinets approved for storage of flammable or combustible materials. Goggles should be worn for operations where airborne sawdust is a problem.

6. All portable propane tanks should be ckecked for leaks and proper maintenance.

7. All materials used in the original dipping process of wooden dowels on May 2, 1979, should be removed from this plant; or an adequate secured storage of such materials should be provided prior to appropriate disposal.

8. Adequate periodic tuning and maintenance should be provided for all forklift trucks to assure that there is no excessive exposure of employees to carbon monoxide. It is a good industrial hygiene practice to provide for appropriate periodic monitoring of carbon monoxide levels if levels exceed 50 percent of the current OSHA Health Standard.

9. The company should evaluate and modify the respiratory protection program to assure that it is in compliance with the requirements (e.g.; training, face fit, sanitation, etc.) described (outlined as 11 criteria for a "minimal acceptable program") in the Occupational Safety and Health Administration Standard, Title 29 of the Code of Federal Regulations, Part 1910, Section 134. Respirators should be provided for those employees who may be exposed to excessive nuisance dust concentrations during sawing operations. Note: Not all sawing operations generate excessive nuisance dust concentrations.

VI. REFERENCES

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VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared and Survey Conducted by:

Eugene Schwartz, M.D. M.P.H.
Medical Officer
Medical Section
Hazard Evaluations & Technical Assistance Branch
Cincinnati, Ohio

Raymond L. Hervin
NIOSH Regional Industrial Hygienist
Kansas City, Missouri

Environmental Evaluation Conducted By:

Raymond L. Hervin
NIOSH Regional Industrial Hygienist
Kansas City, Missouri

Bruce Moen
OSHA Area Industrial Hygienist
St. Louis, Missouri

Mark Banden
OSHA Industrial Hygienist
St. Louis, Missouri

Medical Evaluation Conducted By:

Eugene Schwartz, M.D., M.P.H.
Medical Officer
Medical Section
Hazard Evaluations & Technical Assistance Branch
Cincinnati, Ohio

Thomas Wilcox, M.D.
Medical Officer
Medical Section
Hazard Evaluations & Technical Assistance Branch
Cincinnati, Ohio

Linda Frederick, R.N.
Clinical Nurse
Medical Section
Hazard Evaluations & Technical Assistance Branch
Cincinnati, Ohio

Originating Office:

Jerome P. Flesch
Acting Chief
Hazard Evaluations & Technical Assistance Branch
Cincinnati, Ohio

Laboratory Analysis:

Ardith A. Grote
Research Chemist
Cincinnati, Ohio

Walter S. Kim
Research Chemist
Cincinnati, Ohio

John L. Holtz, Chief
Measurement Services Section
Cincinnati, Ohio

Report Typed By:

Linda R. Lear
Clerk-Typist
Medical Section
Hazard Evaluations & Technical
Assistance Branch
Cincinnati, Ohio

Table I

Concentrations of Organic Solvents of Area (A) and Personal (P) Samples Obtained During Normal Production Operations at the St. Charles Furniture Corporation, Wright City, Mo., on May 31, 1979 HHE 79-103

Job and/or Area Classification	Sample Number	Time of Sample	Isopranol mg/M^3*	Toluene mg/M^3*	Mineral Spirits mg/M^3*	n-Butyl Acetate mg/M^3*
Spray Booth Sample Shop	A-1	0735-1510	0.7	1.4	1.1	1.5
Laminator-Line #2	A-21	0813-1505	4.8**	5.3	1.2	ND***
Spray Booth-Line #7	A-22	0817-1520	6.1**	12.1	1.2	ND
Butcher Block Line	A-23	0822-1504	0.8	1.7	0.4	ND
Packaging Line	A-24	0830-1130	0.5	0.6	0.9	ND
Packaging Line	A-25	1240-1515	0.5	0.6	1.0	ND
Butcher Block Operator	P-3	0820-1506	1.3	1.9	1.2	ND
Off Stock Packing Line Operator	P-10	0704-1514	1.6	1.5	1.0	ND
Wipe Grooves Operator-Line #7	P-7	0710-1450	5.2	1.9	2.1	ND
Wipe Surface Operator-Line #7	P-5	0712-1451	6.0	2.2	2.3	ND
Stainer Operator-Line #3	P-12	0715-1517	4.8	2.3	2.0	ND
Laminator Operator-Line #3	P-4	0718-1458	3.9	2.6	1.1	ND
Stainer Operator-Line #2	P-11	0720-1500	14.1	4.7	3.3	ND
Laminator Operator-Line #2	P-2	0722-1520	3.9	7.9	2.1	ND
Laminator Operator-Line #6	P-6	0724-1453	2.4	2.4	1.0	ND
Surface Wiper Operator-Line #2	P-8	0728-1459	38.9**	4.7	3.2	ND
Supervisor-Sample Shop	P-9	0732-1511	0.5	2.3	5.3	4.0
Laminator Operator-Line #5 (also packing line)	P-18	0850-1522	4.6	3.7	1.3	ND
Environmental Criteria for 40-hour workweek			984	375	350	710

*mg/M^3--approximate milligrams of substance per cubic meter of air.

**--Some isopranol breakthrough was indicated on the backup section of the above three charcoal tubes. Hence, values reported may be taken as minimum amounts present since breakthrough may have occurred.

***--ND-none detected or value was less than the limit of detection of 0.05 mg per charcoal tube.

(1) Date	(2) Total Hours Worked (observed)	(3) Number of Employees (Active)	(4) X 3 hours Total person-hours	% Absent $\frac{4-2}{1}$ X 100%
5-29	1131 1/2	189	1512	25.2
5-30	1073 1/2	189	1512	29.0
5-31	1121 3/4	189	1512	25.8
6-1	1157 1/2	189	1512	23.4
6-4	1236	196	1568	21.2
6-5	1206 1/4	196	1568	23.1
6-6	1294 1/2	196	1568	17.4
6-7	1235 3/4	196	1568	21.2
6-8	1290	196	1568	17.7
6-11	1273 1/2	193	1544	17.5
6-12	1336 3/4	193	1544	13.4
6-13	1348	193	1544	12.7
6-14	1299 1/2	193	1544	15.8
6-15	1306 3/4	193	1544	15.4
6-18	1301 3/4	186	1488	12.5
6-19	1288 3/4	186	1488	13.4
6-20	1293	186	1488	13.1
6-21	1198 1/4	186	1488	19.5
6-22	1265 1/4	186	1488	15.0

Table III

(1) Date	(2) Total Hours Worked (observed)	(3) Number of Employees (Active)	(4) X 8 hours Total person-hours (expected)	% Absent $\frac{4-2}{1}$ X 100%
4-16	1436 1/2	205	1640	12.4
4-17	1486 1/2	205	1640	9.4
4-18	1458 3/4	205	1640	11.1
4-19	1480	205	1640	9.8
4-20	1486 1/4	205	1640	9.4
4-23	1331 3/4	201	1608	17.2
4-24	1364 1/4	201	1608	15.2
4-25	1345	201	1608	16.4
4-26	1312 3/4	201	1608	18.4
4-27	1313 3/4	201	1608	18.3
4-30	1288	192	1536	16.1
5-1	1267 1/2	192	1536	17.5
5-2	1245 1/2	192	1536	18.3
5-3	1240	192	1536	19.3
5-4	1277 1/4	192	1536	16.8
5-7	1287 1/2	194	1552	17.0
5-8	1325	194	1552	14.6
5-9	1262	194	1552	18.7
5-10	1341	194	1552	13.6
5-11	1348	194	1552	13.1
5-14	1340 1/2	196	1568	14.5
5-15	1342 3/4	196	1568	14.4
5-16	1315 3/4	196	1568	16.1
5-17	1359 3/4	196	1568	13.3
5-18	1319	196	1568	15.9
5-21	1336 1/4	191	1528	12.5
5-22	1236 1/4	191	1528	17.3
5-23	1218 1/2	191	1528	20.3
5-24	1024 1/2	191	1528	33.0
5-25	422 3/4	191	1528	72.3

Table V

Chronology of Events

Date	Activity
May 2	Dowels stained using new walnut dip - 3 workers ill.
May 3	Same process - 4 people in hardware department sent to doctor at 12 noon.
May 4	Bulk of dip stain material moved outside of building.
May 7	Dip staining completed between 8-9 a.m. on outside platform (1 employee from packing department sent to doctor).
May 8	1 person in hand-machine area ill.
May 9	Set of dowels packed.
May 14	3 employees sent to doctor. (1 packing area - 2 hand machine area)
May 16	7 workers ill including '4 original cases'. (1 cleaning department, 1 packing, 1 finishing-hardware)
May 17	OSHA contacted - Additional stain material removed.
	4 workers ill - (2 cleaning department, 2 hand machine)
May 18	OSHA arrives - 11 workers ill. (1 hand machining; 1 packing; 5 cleaning; 4 finishing and hardware)
May 22	Additional dowels packed - forklifts checked for CO. (1 ill in packing; 1 cleaning; 1 hand machining)
May 23	'Loaner' forklifts replace regular forklifts.
May 24	NIOSH called - 60 workers ill.
	7 workers in packing department ill.
May 25	NIOSH arrives. Workers in Building 49 evacuated and closed for remainder of day.
May 28	Memorial Day - Plant Closed.

Table IV

Frequency of Complaints May 2-24

Symptom	Number	Frequency	%
nervoucness-tremor	9	9/21	43%
headache	9	9/21	43%
dizziness-confusion	7	7/21	33%
rash	5	5/21	24%
nausea	5	5/21	24%
throat irritation	4	4/21	19%
chest tightness	4	4/21	19%
fatigue	4	4/21	19%
alternating laughing-crying	4	4/21	19%
fainting	3	3/21	14%
eye irritation	2	2/21	10%
burning on urination	2	2/21	10%
itch	2	2/21	10%
chest pain	1	1/21	5%
cough	1	1/21	5%
fuzzy hearing	1	1/21	5%
blurry vision	1	1/21	5%
dry mouth	1	1/21	5%

Data compiled by reviewing records on 21 workers.

Table II

Concentrations of Total Nuisance Particulates Obtained From Personal Samples During Sawing Operations at St. Charles Furniture Corporation, Wright City, Mo., on May 31, 1979 HHE 79-103

Job Classifications	Sample Number	Time of Sample	Total Nuisance Particulates mg/M^3*	Estimated 8 Hour Time-Weighted Average Exposure-Total Nuisance Particulates mg/M^3
DE Operator-Line #3	3339	0808-1456	0.8	0.7
Salvage Saw Operator	3343	0811-1502	9.6	8.7
V. Groover Operator	3346	0824-0954	0.2	(Not considered a valid sample-insufficient time)
Saw Operator (before laminator-Line #5)	2258	0910-1456	15.6	11.2

Environmental Criteria for 40 hour workweek----------10.0

*mg/M^3-- approximate milligrams of substance per cubic meter of air.

St. Charles Furniture Company
Wright City, Mo.

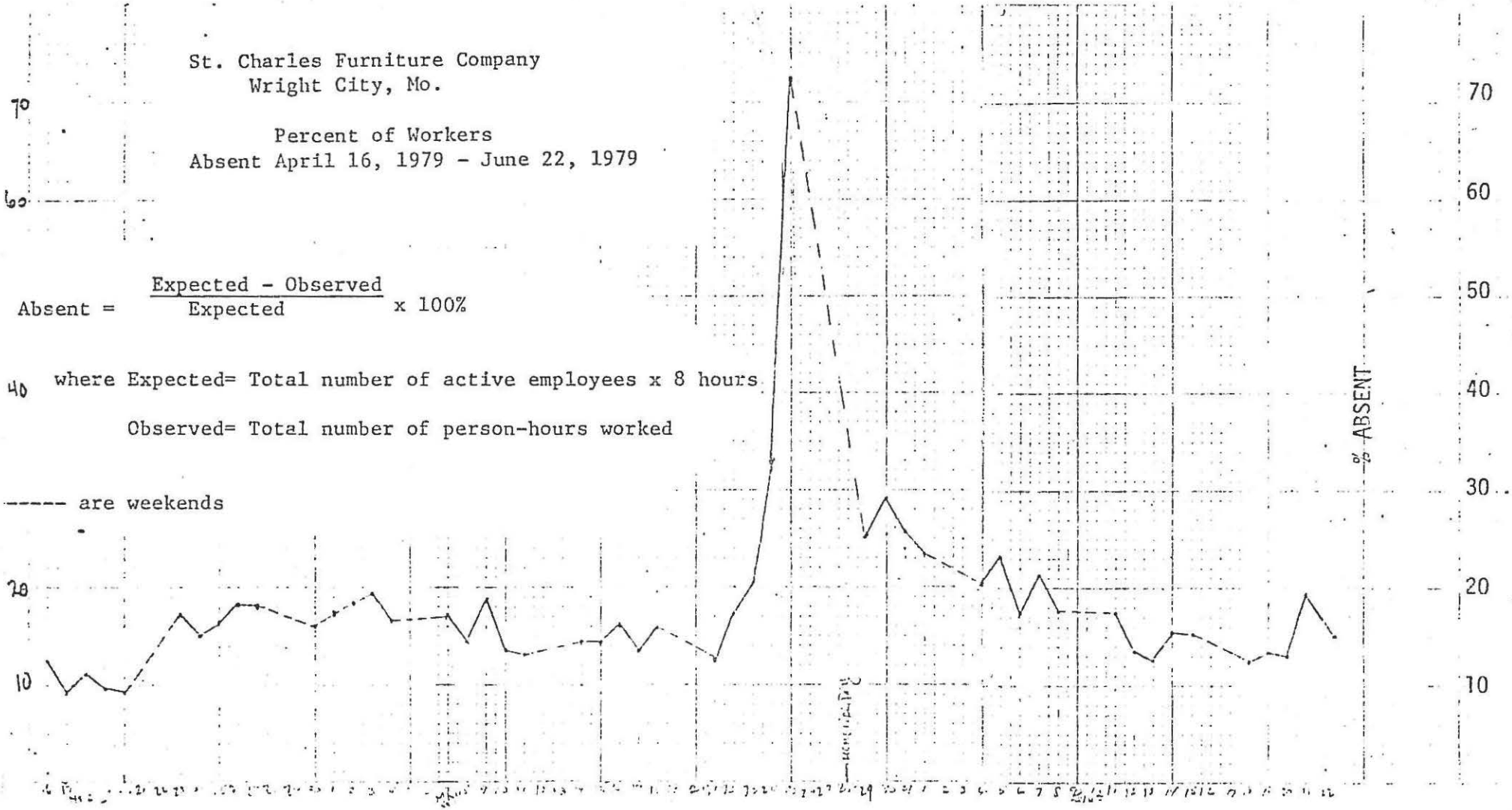
Percent of Workers
Absent April 16, 1979 - June 22, 1979

$$\text{Absent} = \frac{\text{Expected} - \text{Observed}}{\text{Expected}} \times 100\%$$

where Expected= Total number of active employees x 8 hours

Observed= Total number of person-hours worked

----- are weekends



Graph 1