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I. SUMMARY

On February 19, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a joint management/labor request to evaluate an outbreak of sudden illness which occurred that day among workers at the Rotorex facility in Walkersville, Maryland.

NIOSH investigators began the evaluation at Rotorex on February 20. The NIOSH evaluation continued through February 26, after the plant had been operating without incident for two days. During the NIOSH evaluation: pertinent medical records were reviewed and several employees were interviewed; industrial hygiene measurements were made and previous data collected by Maryland Occupational Safety and Health and a company consultant were reviewed; and a questionnaire was developed and distributed to employees on the first and second shifts. Meetings were held daily with management, labor and other investigators to discuss the progress of the NIOSH evaluation.

Chronologically, on January 29, a regulator valve on a plant boiler malfunctioned and an explosion occurred damaging the northwest corner of the building. No one was injured. The plant was closed for several days until a temporary boiler could be set up and the plant was determined to be structurally safe. On the first day the plant returned to full operations, February 3, ten employees became ill with symptoms that included headache, nausea, dizziness, and chest pain. Blood testing for carbon monoxide (CO) was done on 8 of the 10 affected employees and five were found to have elevated carboxyhemoglobin (CO-Hb) levels. Between February 4 and 18, 15 employees were seen by the plant nurse for similar complaints, but all returned to work. Testing for CO-Hb from one of two laboratories consistently reported elevated levels. However, it was later confirmed that CO-Hb test results reported by this laboratory were inaccurate.

On February 19, a second outbreak of illness occurred and 18 workers were seen at the local hospital. Most were transferred by ambulance (leaving by stretcher through the plant). Testing for exposure to CO, trichloroethylene (TCE), fluorocarbons, and methylene chloride was negative in all 18 persons. In addition, plant-wide direct monitoring for CO did not find elevated levels. A questionnaire was administered to all workers on February 25. The results identified that workers in the pump assembly area had a relative risk (RR) for illness of 2.44 compared to other workers in the plant on February 3. On February 19 however, the RR for illness of employees entering the pump assembly area was only 1.06 that of other workers.

It was concluded after review of all medical and environmental data, that the illness of February 3, was due to the toxic effects of CO exposure complicated by exposure to TCE. The illness of February 19, however, is believed to represent a collective anxiety reaction. The combination of the boiler explosion, misleading blood tests, and the previous toxic exposures of February 3, led to plant-wide anxiety that precipitated the acute illness of February 19.

The illness occurring on February 3, 1986, was due to the toxic effects of CO exposure complicated by exposure to TCE. The illness occurring on February 19, however, is believed to represent a collective anxiety reaction. The combination of the boiler explosion on January 29, toxic exposures on February 3, and the misleading follow-up blood test results between February 4 and 18, led to plant-wide anxiety that precipitated the evacuation of employees and shutdown of the plant on February 19. Recommendations to help prevent recurrences are presented in Section VIII of this report.

Keywords: SIC 3580 (Refrigeration and Service Industry Machinery), carbon monoxide, carboxyhemoglobin, trichloroethylene, collective anxiety

II. INTRODUCTION

On February 19, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from Rotorex and Local 133, of the International Union of Electronic, Electrical, Technical, Salaried and Machine Workers (IUE), to evaluate an outbreak of sudden illness among workers at the Rotorex facility in Walkersville, Maryland.

On February 19, an outbreak of sudden illness affecting 18 workers occurred which precipitated the request for NIOSH involvement. Since this had occurred previously on February 3, production in the plant was stopped pending further evaluation. On February 20, two NIOSH investigators, a physician and an industrial hygienist, arrived at Rotorex to begin the NIOSH evaluation. On February 21, a third NIOSH investigator, an epidemiologist, arrived to assist the ongoing evaluation. The NIOSH evaluation continued through the morning of February 26, after the plant had been operating without incident for two days of production.

During the NIOSH evaluation: pertinent medical records were reviewed and several employees were interviewed, including management and labor officials and the plant nurse; industrial hygiene measurements were made and previous data collected by Maryland Occupational Safety and Health (MOSH) and a company consultant were reviewed; and an employee questionnaire was developed and distributed to employees on the first and second shifts. At least one meeting was held each day with management, labor and other investigators to discuss the progress of the NIOSH evaluation. An interim letter dated April 8, to both management and labor representatives summarized the findings of our investigation and provided medical and industrial hygiene recommendations.

III. BACKGROUND

Rotorex manufactures small rotary compressors for room and recreational vehicle air conditioners and is a subsidiary of the Fedders Corporation. The Rotorex facility in Walkersville, Maryland, was built in the early 1970's and has approximately 225,000 ft^2 under roof. At the time of our evaluation, about 350 employees worked at the plant. Of these, about 265 were hourly production workers and 80 were salaried employees. There were two production shifts operating at Rotorex with the first shift being the larger having about 280 employees.

Internal compressor parts such as cylinders, shafts, rollers, and vanes are machined to specifications using a variety of machine tools such as grinders, drills, broaches, and lathes. Compressor cases and caps are fabricated in a number of manufacturing steps including cutting, stamping, forming, and welding. The compressor components are heat treated, lubricated, and degreased as necessary and then assembled. Welding, brazing, and soldering operations are used as appropriate during compressor assembly. The assembled compressors are then painted, tested, packaged, and placed in the warehouse, pending shipment to the customer.

Materials are moved throughout the plant as necessary during the compressor manufacturing process by conveyor belt, utility cart and propane gas-powered forklifts. A floor plan of the plant is presented in Figure 1.

IV. EVALUATION DESIGN

A. Environmental

The environmental evaluation included a thorough initial walk-through survey of the facility while the plant was not in production to identify sources of carbon monoxide (CO) and other potential hazards. Follow-up walk-through surveys were conducted on both shifts after the plant resumed production to measure CO and to observe manufacturing processes, chemical use, and facility ventilation.

CO was measured using an MSA MiniCOT direct-reading CO monitor that was periodically calibrated during use. Local exhaust and general building ventilation was evaluated using smoke tubes.

Discussions were held with representatives from MOSH and the industrial hygiene consultant hired by the company who had previously been in the plant collecting samples. MOSH collected samples for CO, phosgene, trichloroethylene (TCE), methylene chloride, Freon 11T, and Freon 22T. The consultant collected samples for CO, TCE, iron oxide fume, oxides of nitrogen, freon 11, butyl cellosolve, oxygen, and combustable gasses. All of these sample results were reviewed.

B. Medical

The medical evaluation included: (1) interviews with selected employees; (2) review of company-maintained employee medical records of all employees evaluated by the plant nurse between February 3 and 20; (3) review of physician interviews and community hospital or clinic records on all Rotorex employees evaluated between February 3 and 20; (4) interviews with the company medical staff and local emergency medical personnel; and (5) submission of a control blood sample to determine the accuracy of carboxyhemoglobin (CO-Hb) analysis of two laboratories.

C. Epidemiology

A questionnaire (Appendix A) was developed by NIOSH staff on February 24, and administered to all Rotorex employees present at work the next day. The purpose was to identify other cases of illness besides those referred to the hospital and to document the distribution of illness by work area on February 3 and February 19. Data collected included: (1) demographics; (2) plant conditions; (3) a symptom survey; (4) work area; and (5) the perception of safety conditions and the occurrence of illness among fellow workers.

The survey instrument was administered on the second day of plant operation following shutdown February 19. Groups of workers were assembled in a single large room, and given instructions pertaining to the questionnaire. Completed questionnaires were reviewed by NIOSH personnel in the presence of the worker to correct mistakes and clarify some of the responses.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage of workers may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH criteria documents and recommendations; (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's); and (3) the U.S. Department of Labor (OSHA) general industry standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used. The NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in the report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA, where there are recognized toxic effects from high dosage short-term exposures. Recommended TWA's for the substances studies are described in the following paragraphs.

A. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas, slightly lighter than air. It is produced whenever incomplete combustion of carbon-containing compounds occurs. The combination of incomplete combustion and inadequate venting often results in overexposure. [1]

The danger of this gas derives from its affinity for the hemoglobin of red blood cells, which is 300 times that of oxygen. The hazard of exposure to CO is compounded by the insidiousness with which high concentrations of CO-Hb can be attained without marked symptoms.[2] Symptoms exhibited are related to the level of CO-Hb in the blood, as shown in Table 1.

Intermittent exposures are not cumulative in effect and, in general, symptoms occur more acutely with higher concentrations of CO.[2] The OSHA standard for CO is 50 ppm averaged over an 8-hour work shift.[3] The ACGIH TLV for CO is also 50 ppm.[4] NIOSH recommends a 35 ppm TWA concentration for up to an 8-hour work shift, 40-hour work week, with a ceiling level of 200 ppm.[5] ACGIH also has proposed a biological exposure index (BEI) of <8% CO-Hb in blood at the end of a workshift.[4]

A few other compounds are known to act in a manner similar to CO and increase the CO-Hb level in blood. Methylene chloride is the most notable example of these compounds; it is a widely-used solvent.

B. Trichloroethylene

Trichloroethylene (TCE) is a central nervous system depressant. Effects include drowsiness, dizziness, disturbances of vision, impairment of the senses of smell and touch, tremor, impaired coordination, anxiety, confusion, and loss of consciousness. Other effects of TCE include vomiting, abdominal cramps, cardiac arrhythmias, and respiratory tract irritation. Skin contact can cause irritation and blisters. Liver and kidney damage have resulted from drinking TCE. It is possible that such damage may also result from the repeated breathing of air contaminated with excessive levels of TCE. [1]

TCE reduces tolerance to alcoholic beverages. Some individuals who have been exposed to TCE experience "degreaser's flush" after consuming alcohol. This apparently harmless condition lasts only a few hours, and consists of red areas of skin on the face, neck, shoulders, and back. [6]

The OSHA standard for TCE is 100 ppm as an 8-hour TWA with an acceptable ceiling concentration of 200 ppm. A maximum peak of 300 ppm is allowed for no more than 5 minutes in any 2-hour period. [3] The ACGIH TLV for TCE is 50 ppm for an 8-hour TWA. [4]

TCE has also been shown to cause liver cancer in rodents. In light of the potential risks of human exposure in the work environment, NIOSH recommends that TCE be handled as a potential carcinogen and that exposures be controlled to the fullest extent possible. For a correctly operating heated degreaser, airborne TCE concentrations should be less that 25 ppm. [7]

Biological monitoring of TCE exposure may involve determination of concentrations of TCE in exhaled air or determination of concentrations of TCE or its metabolites in urine. Several investigators have found that urine concentrations of total trichlorocompounds offers an approximate guide to exposure. Urine trichloroethanol concentrations in a specimen collected just before the start of the next work period should not exceed 300 mg/L in persons exposed to 100 ppm of TCE daily. [8] In addition, ACGIH has proposed a BEI of 100 mg/L trichloroacetic acid in urine at the end of a workweek. [4]

VI. RESULTS AND DISCUSSION

A. Chronology of Events

On January 29, 1986, a regulator valve on the fuel line to the plant boiler apparently malfunctioned and an explosion occurred damaging the northwest corner of the building. The explosion occurred during second shift when most of the 44 employees at the plant were on break in a second floor lunchroom. No one was injured.

The plant was closed from January 29 to January 31 while a temporary, portable boiler system was installed and the building was determined to be structurally sound. Although a reduced staff was on site February 1 and 2, the first day of full operations was not until February 3. Between 8:35 a.m. and 12:30 p.m. of that day, 8 employees became ill and were evacuated from the plant by ambulance. Their symptoms included headache, dizziness, disorientation, eye and throat irritation, nausea, vomiting, shortness of breath, and chest pain. All were evaluated at Frederick Memorial Hospital for a presumed toxic inhalation. Later the same day, two other self-referred employees were also seen. By early afternoon, first shift production was stopped and second shift workers were sent home as they reported for work.

MOSH and an industrial hygiene consultant hired by the company began their investigations after production stopped on February 3. Direct-reading measurements for CO were made throughout the plant but none exceeded the OSHA standard, ACGIH TLV, or the NIOSH recommended standard. No measurements for CO exposure were made during the morning when the illnesses occurred. In addition, the Baron Blakeslee degreaser, which uses TCE, was reported by workers to emit strong solvent odors at the time of employee illness. Further investigation indicated that the degreaser probably malfunctioned because the level of liquid TCE had fallen below the manufacturer's recommendation for operation. Employees noted that compressor parts exited the system wet and passed along the conveyor line into the pump assembly area where the liquid solvent vaporized. The degreaser was removed from operation on February 3, pending repair, except for a brief period two days later when it was restarted in order to simulate conditions at the time of employee illness. Measurements taken by the company consultant in the pump assembly room near the conveyor line entry point 2 hours after startup of the system for this simulation, found the TCE concentration in the air to be 224 ppm.

Sources of CO identified by MOSH and the company consultant were the propane forklifts, open flames in the welding and brazing operations, and the portable boiler. Two of the seven forklifts were found to emit relatively excessive amounts of CO in their exhaust plumes and were taken out of service pending repair prior to resuming production.

Full production began again on the first shift of February 4. Between February 4 and 18, 15 employees were seen in the plant clinic for complaints that included headache, eye and throat irritation, nausea, fatigue and muscle aches. All were treated for their symptoms and returned to work except for one employee who was referred. This employee and eleven others were seen in local medical facilities with complaints of headache, dizziness, and malaise or sought further medical evaluation and testing because of their concern about possible exposure to "toxic fumes" at work.

Between February 4 and February 18, there was legitimate concern and wide-spread belief throughout the plant (due in part to inaccurate blood test results) that "toxic exposures" were continuing after February 3. Local physicians contacted company officials, the plant nurse, or individual employees in an effort to ascertain the nature of any possible ongoing toxic exposure or to arrange follow-up evaluations.

On February 19, between 9 a.m. and 11 a.m., 18 workers became ill with symptoms similar to those experienced on February 3. Most were triaged from the single room plant clinic where ill workers could be found sitting or lying on the floor, examining table, or on stretchers. Two workers lost consciousness for a brief period. Fifteen workers were eventually transferred by ambulance to Frederick Memorial Hospital with emergency medical technicians carrying stretchers through the plant production areas as they exited the facility. Most received oxygen before or during transfer. Four workers were later self-referred and requested a medical evaluation. Production at the plant was then stopped and NIOSH was called.

During the February 19 occurrence, MOSH was in the plant to follow-up their previous work and conducted plant wide monitoring for CO. No CO levels in excess of the OSHA standard , ACGIH TLV, or the NIOSH recommended standard were found.

Since no methylene chloride was used at the plant, the NIOSH environmental effort focused on sources of CO which could have caused the elevated CO-Hb levels in those symptomatic employees on February 3. The portable boiler was an outside source that was installed after the explosion and, therefore, represented the only possible "new" source of CO. The top of the flue stack of this boiler was below the roof line of the plant which could have allowed flue gas to reenter the plant during certain weather conditions. Based on a NIOSH recommendation, this flue stack was raised about 30% above the roof line prior to the plant resuming production.

Other sources of CO included the forklifts, heat treat operations, welding and brazing operations, and gas-fired make-up air systems. Six of the forklifts were checked for CO emissions. Two of these were found to have relatively excessive emissions and were removed from service pending repair. The drivers of the remaining forklifts were instructed on good operating practices to minimize CO emission when they returned to work.

Additionally, NIOSH investigators concurred with the decision to not operate the Baron Blakeslee degreaser until it was repaired and its initial operation could be checked by the company's industrial hygiene consultant.

Production began again with the first shift on February 24, 1986. An employee meeting with NIOSH, Rotorex, IUE local and international, and MOSH representatives was held at the beginning of the first and second shifts that day. The findings of the NIOSH investigation were presented and questions were answered.

B. Environmental Results

After the plant resumed production on February 24, follow-up walk-through surveys were conducted on both production shifts. Continuous CO measurements indicated concentrations ranging from 5 to 20 ppm; well below the OSHA standard, ACGIH TLV, and NIOSH recommended standard. Additionally, a bulk sample of a welding curtain was obtained and analyzed for asbestos content by polarized light microscopy. It was found to contain approximately 30% chrysotile asbestos.

Observations suggested several other potential problems that should be evaluated further. These include the general plant ventilation, welding and brazing operations, oil mist, bacteria in the central coolant, Freon 11T used for degreasing, noise, and plant safety. Specific recommendations based on these observations are made in the Recommendations Section of this report.

C. Medical Results

Clinic records from Frederick Medical Center, emergency room and inpatient medical records from Frederick Memorial Hospital, and inpatient medical records from City Hospital, Martinsburg, West Virginia, were reviewed on all Rotorex employees seen between February 1 and 21. A frequency distribution of those employees presenting for hospital or clinic evaluation over this time period is presented in Figure 2. The most frequently reported symptoms were headache, dizziness, disorientation, eye and throat irritation, nausea, vomiting, and shortness of breath. Treatment consisted of monitoring vital signs, administering oxygen, and an occasional precautionary intervenous line.

Two employees were hospitalized, one for five days after the first episode of acute illness and the other for seven days after the second episode. Arterial blood gases, CO-Hb levels, smoking histories and a record of oxygen therapy, obtained at the hospital on February 3 and 19, are summarized in Table 2.

CO-Hb levels were drawn on 8 of 10 employees evaluated during the first episode of illness at Frederick Memorial Hospital. No other toxicologic screening was done. CO-Hb among the non-smokers were none detected, 4.9%, 13.3%, and 13.9% (Table 2). The smokers had CO-Hb levels of 5.0%, 13.8%, 14.4%,

and 14.8%. Thus, two of four non-smokers and three of four smokers tested had elevated CO-Hb levels (>8%). All were treated and released. One employee was later admitted to City Hospital in Martinsburg, West Virginia, and remained hospitalized for six days. Six of these eight employees were referred for further evaluation to the University of Maryland Hyperbaric Center in Baltimore, Maryland and seen on February 5. Repeat testing for CO-Hb was done and results ranged between 1.2 to 1.7% in the non-smokers to between 5.8 to 6.9% in smokers. A psychometric testing battery was reported to be abnormal in 3 of the 6 tested. Those employees with abnormal psychometric test results and one other with persisting symptoms compatible with CO poisoning were treated with hyperbaric oxygen therapy (46 minutes at 2.8 atmospheres). After therapy, 3 were reported to have improved psychometric test results while another employee had subjective improvement in symptoms.

CO-Hb levels may be affected by a delay in drawing the sample or the administration of oxygen. Normally the half-life of carbon monoxide is 4 to 5 hours. However, if 100% oxygen is administered and no further exposure occurs, the half-life is reduced to 80 minutes. [9] Those employees who were transferred by ambulance received 4 to 6 liters per minute of oxygen by mask and this would be expected to have decreased the CO-Hb levels. In addition, there was a delay of 30 to 120 minutes from the time of exposure in the plant to testing. As a result, CO-Hb levels at the time of exposure may well have been 20 to 50% higher than those levels recorded.

During the second episode of illness on February 19, 16 of 18 employees were tested for elevated CO-Hb levels. Levels, determined at Frederick Memorial Hospital, ranged from none detected to 6.1%. None were considered elevated. Additional toxicologic screening for TCE, fluorocarbons, and methylene chloride was negative in all 13 samples tested at National Medical Service in Willow Grove, Pennsylvania. Later testing for CO-Hb at this lab confirmed the reliability of CO-Hb results obtained at Frederick Memorial Hospital. A respiratory alkalosis (PH >7.4, PCO_2 <30mmHg) was present in 3 of 8 (37.5%) employees tested during the first episode of illness and 8 of 15 (53.3%) tested during the second episode (Table 1). Acute respiratory alkalosis is a condition most commonly resulting from hyperventilation, often associated with anxiety.

Between February 4 and 18, 15 employees were seen in the plant clinic for complaints that included headache, eye and throat irritation, nausea, fatigue and muscle aches. All were treated for their symptoms and returned to work except for one employee who was referred to a local physician. This employee and eleven others (self-referred) were seen in local medical facilities for complaints of headache, dizziness, malaise or sought further medical evaluation and testing because of concern about possible exposure to "toxic fumes."

Elevated CO-Hb levels (from 13.7 to 20%) were reported in all five blood samples drawn between February 4 and February 18 and tested at one of two laboratories which did follow-up testing. Two additional samples tested by the same laboratory on February 21 (two days after the plant was closed) were also found to be elevated with CO-Hb levels of 16 and 20%. Between February 4 and 18, blood samples tested at Frederick Memorial Hospital were not elevated. It was felt that CO-Hb test results from the first laboratory might be inaccurate and a control sample was submitted by NIOSH to both laboratories on February 21. A wide discrepancy between the CO-Hb test results was found. The clinical laboratory director at the lab that had previously reported elevated CO-Hb levels was notified, and his preliminary investigation confirmed the impression that the lab test method was in error. The clinic physicians were advised of the probable lab error and notified those employees previously tested.

D. Epidemiology Results

On February 25, the second day of operation following shutdown on February 19, an employee questionnaire was administered to all first and second shift employees. A total of 325 employees completed questionnaires, 279 first shift workers and 46 second shift workers. All second shift workers were later excluded from analysis since plant shutdown on February 3 and February 19 prohibited their working on either day. Another 8 questionnaires were excluded because the employee did not work February 3 and February 19 (new hire or vacation) or did not complete the questionnaire. The total number of questionnaires included in these analyses was 271.

The average age of the Rotorex workforce was 33.1 ± 12.0 years. Employees ranged in age from 18 to 62 years with a median of 30 years. Sixty-seven percent were male and 33% female. As a group, almost 30% of the employees had not finished high school, 42% were high school graduates, 21% had some college or vocational training, and 7.7% were college graduates.

Medical evaluation of workers seen at Frederick Memorial Hospital suggested that an exposure to CO had occurred on February 3, but not February 19. The epidemiologic evaluation focused on differences in the plant on these two days which could explain the occurrence of employee illness.

Plant Conditions

Workers were asked to recall conditions in the plant on February 3 and February 19. The list of these conditions and the number of employees reporting them appears as Table 3. The presence of each condition was reported by a greater number of workers on February 3 than on February 19. These differences were statistically significant for the perceived presence of chemical exposures (X^2=4.38, $p<0.05$); odors of gasoline or diesel fumes (X^2=8.97, $p<0.01$); and visible haze, mist, or fog (X^2=7.75, $p<0.01$). Thus, there may have existed a noticeable difference in the presence of these conditions on the two days.

Symptoms

The prevalence of symptoms reported by employees is given in Table 4. Headache was the most prevalent symptom, on both February 3 and 19, with greater than 20% of the workforce so reporting. Other common symptoms reported included sleepiness, sore throat, lightheadedness, nausea, and weakness. The percentage of symptomatic employees on the two days was similar for each symptom. Since there existed no specific pattern of symptoms among the employees, and all of the symptoms were compatible with CO intoxication, the case definition used included headache plus a varied number of additional symptoms. Headache was included since it is an early symptom of CO intoxication. However, headache is not a symptom which is specific for CO intoxication, as employees reported headaches to be a consequence of their normal working day. The use of additional symptoms was made in an attempt to separate common headaches from those associated with exposure on February 3 or February 19. It was also believed that the number of symptoms experienced by an individual may correlate with the individual's degree of exposure. Thus, individuals with many symptoms may have been more heavily exposed than workers with fewer symptoms.

Work Area

Two salaried Rotorex employees, who did not work in the production area of the plant and did not smoke cigarettes, were seen at Frederick Memorial Hospital on February 3 with elevated CO-Hb levels. Both had entered the pump assembly room and were exposed to TCE vapor from the malfunctioning Baron Blakeslee degreaser. Neither reported contact with other chemical exposures or plant processes on that day. The degreaser was not in operation from February 4 through February 19, except for a few hours February 5 when a simulation was made as previously described. NIOSH investigators believed the episode of illness on February 3 may have been complicated by exposure to TCE from the malfunctioning degreaser. Illness on February 19, however, could not have been so explained.

To test this hypothesis, employees were asked to estimate the time spent in the pump assembly room (PAROOM) on the two days. Workers who could not remember if they had entered the PAROOM were excluded. Eighty-seven of 240 and 72 of 245 employees entered the PAROOM on February 3 and February 19, respectively. Table 5 gives the percentage of ill workers by exposure in the PAROOM and the odds associated with illness for both days. On February 3, entry in the PAROOM was associated with illness. The relative odds ranged from 1.39 to 3.40. The odds of illness given exposure increased as the case definition became more restrictive. In other words, the strength of the association increased as the number of symptoms increased. No association between illness and entry into the PAROOM was observed on February 19.

If an association is causal, one would expect the strength of the association to increase with increasing duration of exposure. Categories of duration by minutes inside the PAROOM were used to explore this relationship. The categories included the unexposed, those exposed from 1 to 60 minutes, and those exposed from 61 to 390 minutes. Workers who could not remember how long they were exposed were excluded. The results are given in Table 6. On February 3, illness was associated with duration of exposure, those in the PAROOM for more than 1 hour had the greatest risk of illness. The association between illness and entry into the PAROOM increased as the number of symptoms used to define a case increased. Thus, workers with more symptoms were more likely to have entered the PAROOM and to have remained longer than other workers. In contrast, duration of exposure in the PAROOM was not associated with illness on February 19.

Other Factors

More than 50% of the workers indicated they smoked cigarettes. Of 269 respondents, 49.5% did not smoke, 11.8% smoked approximately 1/2 pack per day, 31.7% smoked about 1 pack per day, and

6.3% smoked 2 or more packs per day. Smoking was not associated with illness on either February 3 or February 19.

Forklifts had been identified as sources of CO in the plant. Table 3 indicated that 20% of the workers on February 3, and 18.2% on February 19, recalled an idling forklift in their work area. However, no association between exposure to an idling forklift and illness was found on either day.

On both days, women were more likely to have symptoms of illness than men. The average age of the workers with a headache plus 3 or more other symptoms was 30 years compared to 34.3 years for other workers on February 3. The difference between these averages was not statistically significant. Similarly, on February 19, ill workers were slightly younger on average, 31.2 years, than their counterparts, 34.1 years. Once again, the difference was not statistically significant.

On February 19, women were twice as likely as men to become ill, regardless of whether they entered the PAROOM or not. In contrast, on February 3, women entering the PAROOM were almost four times as likely to become ill as men entering the PAROOM (O.R.=3.87). Illness among unexposed workers on February 3 did not vary significantly by the sex of the employee (O.R.=1.25). Women, therefore, appear to have been more susceptible to illness than men on both days. However, on February 3, this observation was limited to women entering the PAROOM where TCE vapor from the malfunctioning degreaser was believed to have contributed to the illness. On February 19, when no exposure was identified in the PAROOM, the increased risk of illness among women appears to have been plantwide.

These findings support our hypothesis that illness was the result of toxic exposures on February 3, and a collective anxiety reaction on February 19.

The phenomenon of collective anxiety reactions has typically been reported in plants with a largely female, high school-educated workforce doing routine, repetitive work.[10,11] Such a condition exists at the Rotorex facility. It should be emphasized that the association of sex and educational level with collective anxiety phenomena does not necessarily imply that these are causative factors. Little is known about the epidemiology of collective anxiety reactions. Women without higher education are likely to find employment in stressful, low-paying, highly routine jobs, and this may explain, in part, why collective anxiety reactions are usually associated with unskilled or semi-skilled female work forces.

VII. CONCLUSIONS

We conclude that the illness of February 3, was due to the toxic effects of CO exposure complicated by exposure to TCE. The illness of February 19, however, is believed to represent a collective anxiety reaction. The combination of the boiler explosion on January 29, toxic exposures on February 3, and the misleading follow-up blood test results between February 4 and February 18, led to plant-wide anxiety that precipitated the acute illness experienced on February 19, resulting in the evacuation of employees and shutdown of the plant.

The conclusion that the illness of February 19 is due to collective anxiety does not mean that it is not "real". The term refers to illness in which the primary cause is psychological stress, arising from the occupational and/or general social environment, rather than from environmental chemical, physical, or infectious agents or metabolic abnormalities. The occurrence of a collective anxiety reaction does not imply a psychiatric disorder. It can represent normal psychophysiological responses to a stressful environment.

VIII. RECOMMENDATIONS

At a closing conference held on February 26, and in a letter to the company and union dated April 8, the

following medical and industrial hygiene recommendations resulting from the NIOSH evaluation were made. These are repeated here.

A. Medical Recommendations

1. Form a joint management and union Health and Safety Committee that meets on a regular basis. Clearly defined and prioritized health and safety issues identified by this committee should be disseminated widely throughout the plant. Every employee should feel they have timely access to this committee to address any real or perceived health or safety concern.

2. Select management representation for the Health and Safety Committee based on expertise in health and safety issues or a commitment to develop such expertise. Union representation should be selected by members using the same criteria.

3. Make medical and industrial hygiene technical assistance available to assist the Health and Safety Committee to address technical aspects of priority issues they have identified. Management should follow through on these issues to guarantee their resolution.

4. Define the role of local company contract medical personnel. There should be active participation of these medical personnel when appropriate on the Health and Safety Committee. A mechanism should be established by the committee to quickly alert committee representatives when medical evaluations or blood testing suggests that an occupational related illness may be present.

5. Ensure that medical evaluations and triaging decisions of the plant nurse or local contract medical personnel be conducted independent of management.

6. Discourage cigarette smoking on the job.

7. Conduct periodic fire drills and plant evacuation planning.

B. Industrial Hygiene Recommendations

The industrial hygiene recommendations concerning CO sources and the TCE degreaser have already been discussed in the Results and Discussion Section. The following are the other recommendations resulting from the NIOSH environmental evaluation:

1. Evaluate the overall ventilation of the plant, especially with regard to make-up air. The apparent negative pressure of the plant relative to the outside suggests that more make-up air is needed. Until this can be done and long-term solution developed, running the wall fans and partially opening exterior doors (while not compromising comfort) will increase the general dilution ventilation and is a good interim control measure.

2. Evaluate the generation of ozone and heavy metals (such as cadmium, copper and zinc) at welding and brazing operations. Those operations taking place near the TCE degreaser should also be checked for phosgene (a breakdown product of TCE in the presence of a high-temperature open flame).

3. Evaluate the airborne concentration of oil mist in the machining area. The haze which forms in those areas is apparently an oil mist, not a coolant haze.

4. Begin a weekly bacterial check of the central coolant. This can most logically be done by the manufacturer's representative. Manufacturer's guidelines for bacterial levels should be followed to prevent odor problems and the loss of coolant effectiveness.

5. Evaluate the use of Freon 11T for degreasing parts in open cans, especially in the pump assembly area. Where this is not necessary, the use of open cans should be discontinued. Where its use is necessary, wire baskets should be used for dipping parts to minimize direct skin contact with the liquid.

6. Evaluate worker noise exposure, especially in the machining and stamping operations.

7. The welding curtain was found to contain about 30 percent chrysotile asbestos. It should be replaced with a non-asbestos welding curtain.

8. Conduct a thorough safety evaluation of the plant. Several items of note that need particular attention are:

   . Properly securing compressed gas cylinders.
   . Proper floor mats or grates to prevent slips and falls.
   . Proper machine guarding.
   . Proper eyewash facilities.
   . Proper electrical lockout procedures.
   . Proper machine cleaning and maintenance.
   . Proper use of approved respirators, if required.
   . Proper work practices.
   . Presence of gas leaks.
   . Smoking at work stations.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Rotorex
2. International Union of Electronic, Electrical, Technical Salaried and Machine Workers, Local 133
3. NIOSH, Region III
4. OSHA, Region III

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

Table 1

Principal Symptoms Correlating With Exposure to Carbon Monoxide*

Atmospheric carbon monoxide concentration (ppm)	Carboxyhemoglobin concentration (%)	Principal symptoms
50	7	Slight headache
100	12	Moderate headache and dizziness
250	25	Severe headache and dizziness
500	45	Nausea, vomiting, collapse possible
1000	60	Coma
10000	95	Death

* From reference 2

Table 2

Arterial Blood Gases and Carboxyhemoglobin (CO-Hb) Levels Obtained
at Frederick Memorial Hospital
During Two Episodes of Acute Illness Among Employees at Rotorex

Date	ID No.	History	Smoke Level (%)	CO-Hb[a] TX	0_2[b] PH	Arterial Blood Gases[c] PO2	PCO2	HCO3
FEB 3	577	No	0.0	No	7.40	82.5	37.2	22.8
	---	No	13.3	Yes	7.46	507.3	26.6	19.0
	166	No	0.4	Yes	7.40	243.2	31.7	19.6
	---	No	13.9	Yes	7.43	99.9	35.6	24.6
	528	Yes	13.8	Yes	7.43	78.4	21.5	22.5
	522	Yes	14.4	Yes	7.38	129.5	23.9	25.1
	123	Yes	14.8	Yes	7.67	93.0	15.3	15.6
	106	Yes	5.0	No	7.46	93.9	19.9	20.7
FEB 19	---	No	0.3	No	7.44	2.6	32.4	21.9
	---	No	1.1	Ukn	7.42	84.3	39.6	25.3
	308	No	0.0	No	7.44	99.6	29.1	19.4
	238	No	0.0	Ukn	7.40	95.6	32.4	20.0
	319	Yes	0.0	Yes	7.45	--	26.4	18.4
	206	Yes	1.9	Yes	7.41	99.2	27.9	17.3
	528	Yes	6.1	Yes	7.43	62.5	33.1	21.6
	321	No	1.0	Yes	7.41	91.2	33.1	20.5
	---	Yes	2.4	No	7.44	101.7	26.6	17.9
	209	Yes	4.0*	No	7.43	99.7	27.8	18.2
	089	No	0.0	No	7.44	103.9	30.1	21.1
	205	Yes	4.0	No	7.39		23.3	19.8
	014	Yes	0.3	Yes	7.50	107.0	20.8	16.3
	275	No	5.0*	No	--	--	--	--
	274	Yes	3.6	No	7.43	83.9	28.9	19.1
	---	No	0.8	No	7.43	83.9	28.9	19.1
	---	Ukn	8.0*	No	--	--	--	--

(a) = Normal range: non-smoker 0-1.3%, smoker 1.3-9.0%
(b) = Indicates if oxygen therapy was administered at any time before arterial blood gas was drawn.
(c) = Normal values for arterial blood gas: PH 7.35-7.45, PO_2 80-100mm Hg, PCO_2 35-45 mmHg, HCO_3 20-29 mmol/l
* = C0-Hb level done at National Medical Service, Willow Grove, PA.

Table 3

Conditions Inside Rotorex Plant on February 3 and February 19, 1986;
Reported by First Shift Workers

Conditions	February 3				February 19			
	Present	Absent	Don°t know	%	Present	Absent	Don°t know	%
Chemical exposures	49	130	72	19.5	32	179	47	12.4
Odors of:								
gas or diesel fumes	85	130	35	34.0	56	166	36	21.7
sweet, fruity smells	10	192	48	4.0	6	207	45	2.3
freshly mown hay	7	195	48	2.8	6	209	43	2.3
dry cleaning fluid	28	168	54	11.2	18	194	46	7.0
Visible haze, mist or fog	150	73	27	60.0	122	110	26	47.3
Idling forklift in work area	49	159	42	19.6	47	168	43	18.2

Table 4

Prevalence of Symptoms Among Employees of Rotorex
on February 3 and February 19, 1986

Symptom	February 3			February 19		
	Present	Absent	%	Present	Absent	%
Lightheadeness	30	219	12.0	34	222	13.3
Headache	57	192	22.9	62	194	24.2
Sleepiness	38	211	15.2	35	221	13.7
Numbness	4	245	1.6	5	251	1.9
Dizziness	24	225	9.6	20	235	7.8
Weakness	28	221	11.2	31	225	12.1
Nausea	29	220	11.6	24	232	9.4
Blurred vision	11	238	4.4	14	242	5.5
Rapid heart beat	9	240	3.6	12	244	4.7
Stomach pain	11	238	4.4	13	243	5.1
Chest pain	20	229	8.0	19	237	7.4
Shortness of breath	15	234	6.0	20	236	7.8
Sore throat	34	215	13.7	35	221	13.7
Passed out	2	246	0.8	4	252	1.6
Vomited	2	247	0.8	2	254	0.8
Felt like floating	19	230	7.6	--	---	---
Disoriented	14	235	5.6	5	251	1.9

Table 5

Percentage of Ill Workers at Rotorex by Exposure
in the Pump Assembly Room, Odds Ratios, and p-values

	Headache + 1 symptom	Headache + 2 symptoms	Headache + 3 symptoms	Headache + 4 symptoms	Headache 5 symptoms
February 3, 1986					
% PAROOM employees ill	17.2	16.2	13.1	13.1	12.1
% non-PAROOM employees ill	13.0	9.7	5.8	5.2	3.9
Odds Ratio	1.39	1.79	2.44	2.76	3.40
p-value	0.36	0.13	0.04	0.03	0.01
February 19, 1986					
% PAROOM employees ill	15.4	12.1	10.3	8.8	8.8
% non-PAROOM employees ill	13.1	10.9	9.7	8.0	4.6
Odds Ratio	1.20	1.21	1.06	1.13	2.06
p-value	0.63	0.65	0.89	0.80	0.17

Table 6
Association Between Duration of Exposure in the Pump Assembly Room and Illness
February 3, 1986

Illness	Unexposed (O.R.)	1-60 minutes (O.R.)	61-390 minutes (O.R.)	MH-X^{2*}	p-value
Headache + 1 symptom	20/133 (1.00)	5/31 (1.09)	10/41 (1.61)	1.31	0.52
Headache + 2 symptoms	15/138 (1.00)	4/32 (1.15)	10/41 (2.24)	3.45	0.06
Headache + 3 symptoms	9/144 (1.00)	2/34 (0.94)	9/42 (3.43)	7.32	0.007
Headache + 4 symptoms	8/145 (1.00)	2/34 (1.07)	9/42 (3.88)	8.38	0.004
Headache + 5 symptoms	6/147 (1.00)	1/35 (0.70)	9/42 (5.25)	12.47	0.000

February 19, 1986

Illness	Unexposed (O.R.)	1-60 minutes (O.R.)	61-390 minutes (O.R.)	MH-X^{2*}	p-value
Headache + 1 symptom	23/143 (1.00)	5/24 (1.30)	6/44 (0.85)	0.18	0.67
Headache + 2 symptoms	19/147 (1.00)	5/24 (1.61)	4/46 (0.67)	0.71	0.40
Headache + 3 symptoms	17/149 (1.00)	4/25 (1.40)	3/47 (0.56)	1.00	0.32
Headache + 4 symptoms	14/152 (1.00)	3/26 (1.25)	3/47 (0.69)	0.38	0.54
Headache + 5 symptoms	8/158 (1.00)	3/26 (2.28)	3/47 (1.26)	0.13	0.91

* Mantel-Haenszel Chi Square Value

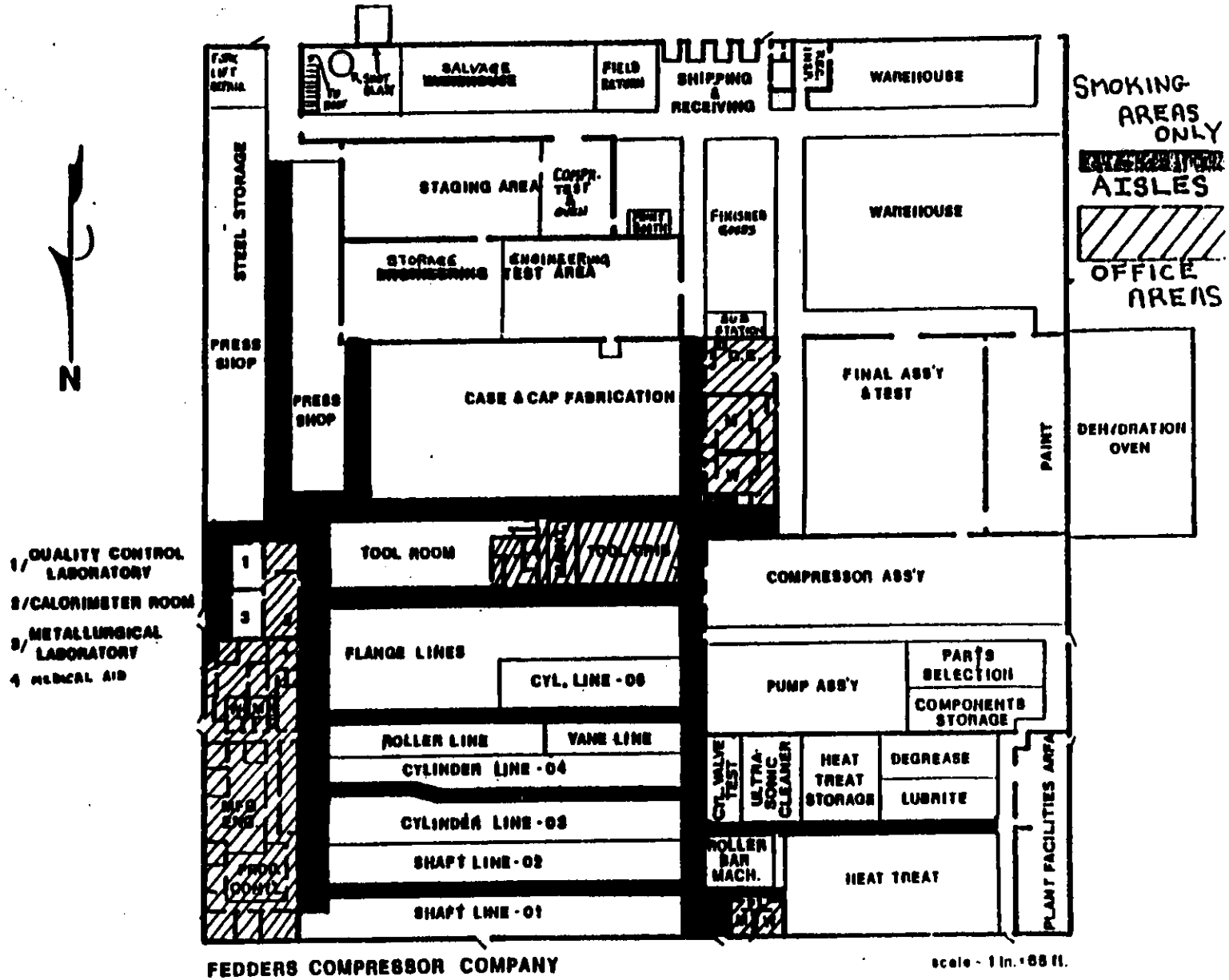
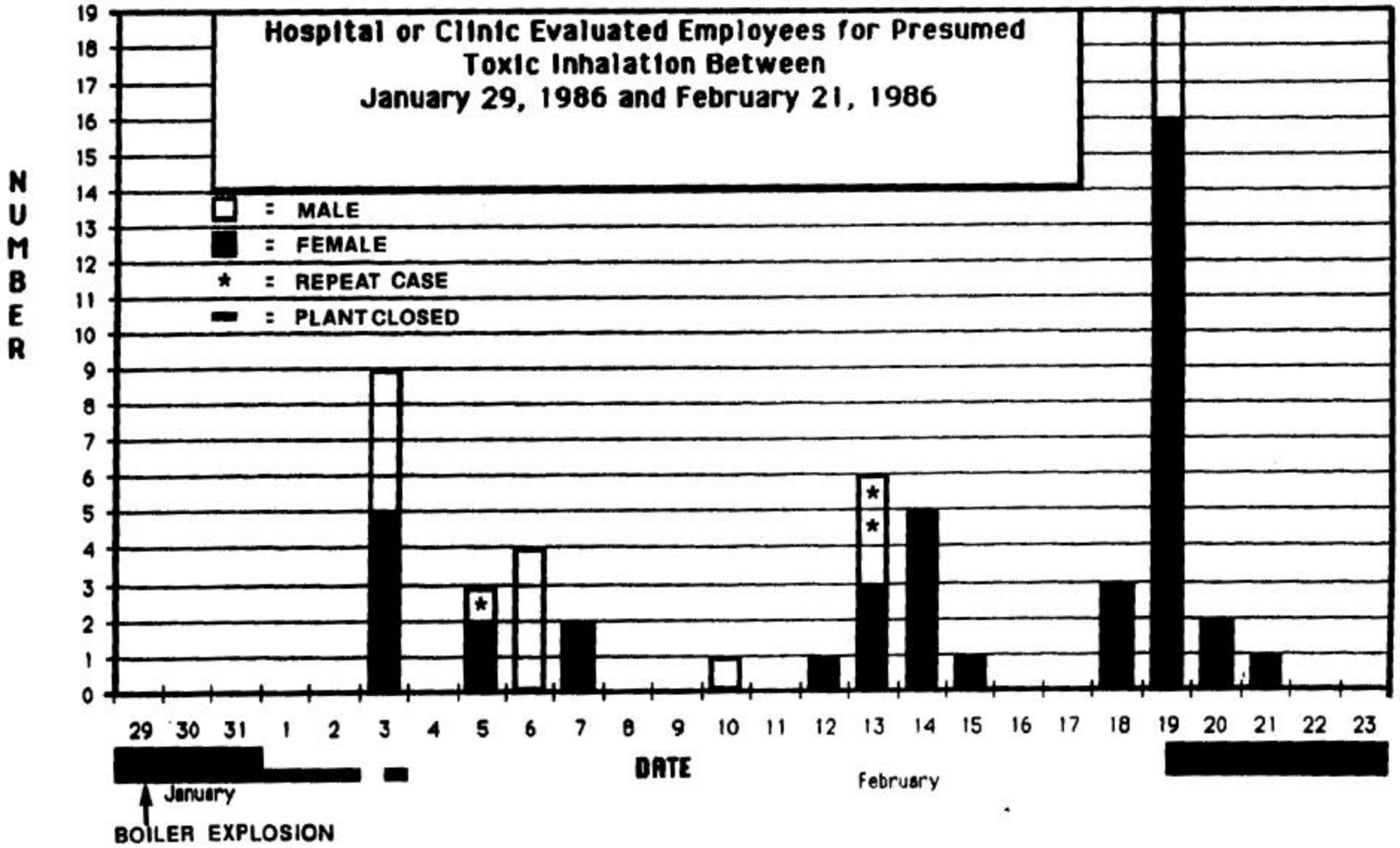

N
SALVAGE
FIELD RETURN
SHIPPING & RECEIVING
WAREHOUSE
SMOKING AREAS ONLY
AISLES
OFFICE AREAS
STEEL STORAGE
STAGING AREA
STORAGE
ENGINEERING TEST AREA
FINISHED GOODS
WAREHOUSE
PRESS SHOP
PRESS SHOP
CASE & CAP FABRICATION
FINAL ASS'Y & TEST
PAINT
DEHYDRATION OVEN
1/ QUALITY CONTROL LABORATORY
2/ CALORIMETER ROOM
3/ METALLURGICAL LABORATORY
4 MEDICAL AID
1
3
TOOL ROOM
COMPRESSOR ASS'Y
FLANGE LINES
CYL. LINE - 05
PUMP ASS'Y
PARTS SELECTION
COMPONENTS STORAGE
ROLLER LINE
VANE LINE
CYLINDER LINE - 04
CYL. VALVE TEST
ULTRA-SONIC CLEANER
HEAT TREAT STORAGE
DEGREASE
LUBRITE
CYLINDER LINE - 03
SHAFT LINE - 02
ROLLER BAR MACH.
HEAT TREAT
PLANT FACILITIES AREA
SHAFT LINE - 01
FEDDERS COMPRESSOR COMPANY
scale - 1 in. = 65 ft.

FIGURE 1

FIGURE 2


Hospital or Clinic Evaluated Employees for Presumed
Toxic Inhalation Between
January 29, 1986 and February 21, 1986
= MALE
= FEMALE
* = REPEAT CASE
= PLANT CLOSED
NUMBER
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
DATE
January
February
BOILER EXPLOSION

APPENDIX A

AGREEMENT TO PARTICIPATE IN MEDICAL STUDY

I, _____, agree to
(print name)

participate in a study of employees at ROTOREX, Inc., Walkersville, MD. This study is being conducted by employees from the National Institute of Occupational Safety and Health (NIOSH) in responce to a request for a health hazard evaluation. The purpose of the study is to determine whether employees had any adverse health effects from exposures to toxic chemicals at work.

I understand that the study will consist of:

1. A quetionnaire asking you to describe work conditions from February 3rd, 1986 to February 19th, 1986.

I understand that my participation in this study is voluntary, that I may withdraw from the study at any time, and that all medical and other personal information I provide will be considered confidential in accordance with the Privacy Act of 1974 (Public Law 93-579). I understand that unless I give my written permission, this information will not be given to anyone else, except as required by law or court order.

I understand that other than emergency treatment, medical care is not provided. If I am injured as a result of negligence of a NIOSH employee, I may be able to obtain compensation under the Federal Tort Claims Act (28 USC 1346 (b)).

All questions concerning my participation in this have been answered to my satisfaction. Further inquiries may be directed to Dr. Peter Kerndt or Dr. Tom Sinks, Hazard Evaluations and Technical Assistance Branch, NIOSH, 4676 Columbia Parkway, Cincinnati, Ohio; Telephone: (513) 841-4386.

SIGNITURE: _____ DATE:____

ADDRESS: _____

_____

PHONE: _____

HEALTH HAZARD QUESTIONNAIRE
ROTOREX

I.D.# _____

NAME _____

DATE _____

(PLEASE FILL IN BLANKS OR CIRCLE THE CORRECT ANSWER)

1. How old are you? _____

2. What is your sex?

   1 - male
   2 - female

3. How many years of school did you complete?

   1- less than 12
   2 - high school graduate
   3 - some vocational or college training
   4 - college graduate or more

4. How many cigarettes do you smoke a day?

   1 - none
   2 - 1/2 a pack or less
   3 - about 1 pack
   4 - 2 or more packs

5. On a scale of 1 to 10, 1 being the safest and 10 the most dangerous, how safe did you think you were at work after the explosion of the boiler ?

   1 2 3 4 5 6 7 8 9 10

(IF YOU DIDN'T WORK ON FEB. 3rd, THE FIRST DAY OF FULL OPERATION AFTER THE EXPLOSION SKIP TO QUESTION 15)

6. On February 3, did you notice any of the following unusual conditions inside the plant?

CONDITIONS	YES	NO	DON'T KNOW
chemical exposures	1	2	9
(if yes specify) _____			
odors of:			
deisel or gas fumes	1	2	9
sweet, fruity smells	1	2	9
reshly mown hay	1	2	9
dry cleaning fluid	1	2	9
haze, mist or fog	1	2	9
idleing towmotor in your work area	1	2	9

7. Did you feel sick at work on that day?

1 - yes
2 - no
3 - don't remember

(If you answered yes, did you have any of the following symptoms?) please circle the correct answer

SYMPTOMS	YES	NO	DON'T KNOW
lightheadedness	1	2	9
headache	1	2	9
sleepiness	1	2	9
numbness or tingling	1	2	9
dizziness	1	2	9
weakness	1	2	9
nausea	1	2	9
blurred vision	1	2	9
racing heart beat	1	2	9
stomach pain	1	2	9
chest pain	1	2	9
shortness of breath	1	2	9
sore throat	1	2	9
passed out	1	2	9
vomiting	1	2	9
felt like floating	1	2	9
disorientation	1	2	9

8. What time was it when you first began to feel ill? (If you were not sick leave blank.)

_____AM/PM

9. If you were ill on that day were you.....?

1 - seen by the nurse and sent home
2 - seen by a physician
3 - stayed at work
4 - not sick
9 - don't remember

10. Before you first experienced symptoms, did you witness other workers becoming ill?

1 - yes
2 - no
3 - don't know

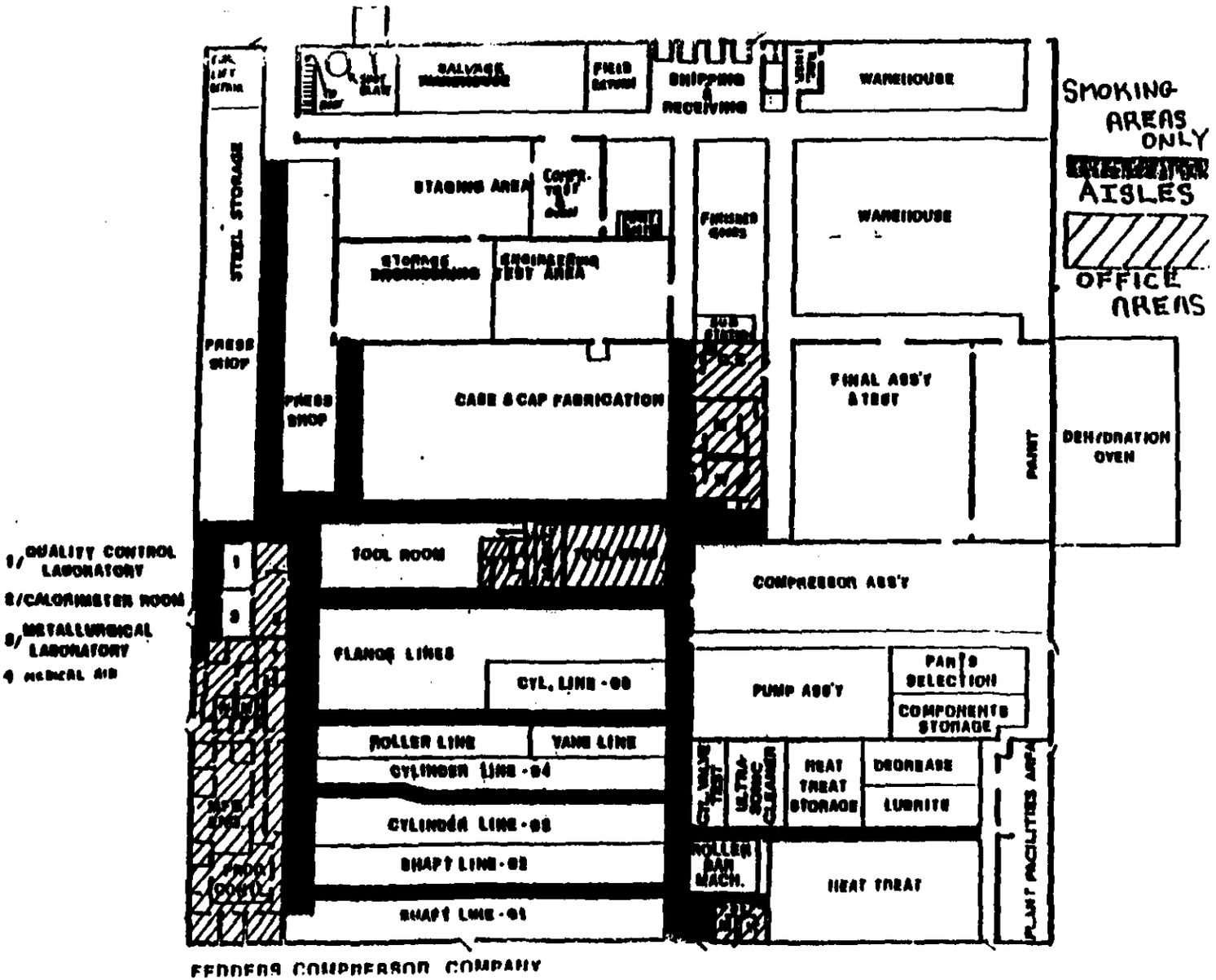
11. What did you think was the direct cause of illness on Feb. 3rd?

1 - Chemicals, ventillation
2 - Psychological factors
3 - Other
9 - Don't know

12. On February 3, did you enter the pump assembly room ? (refer to floor plan on next page)

1 - yes
2 - no
9 - don't remember

13. How long were you in this area? _____



14. Please mark with an "X" where in the □ plant you worked on February 3, 1986.

15. On a scale of 1 to 10, how safe do you think it was to return to work in the plant after the illnesses on Feb. 3rd ?

    1 2 3 4 5 6 7 8 9 10

16. From Tuesday, February 4th thru Tuesday, February 18th were you sick at work ?

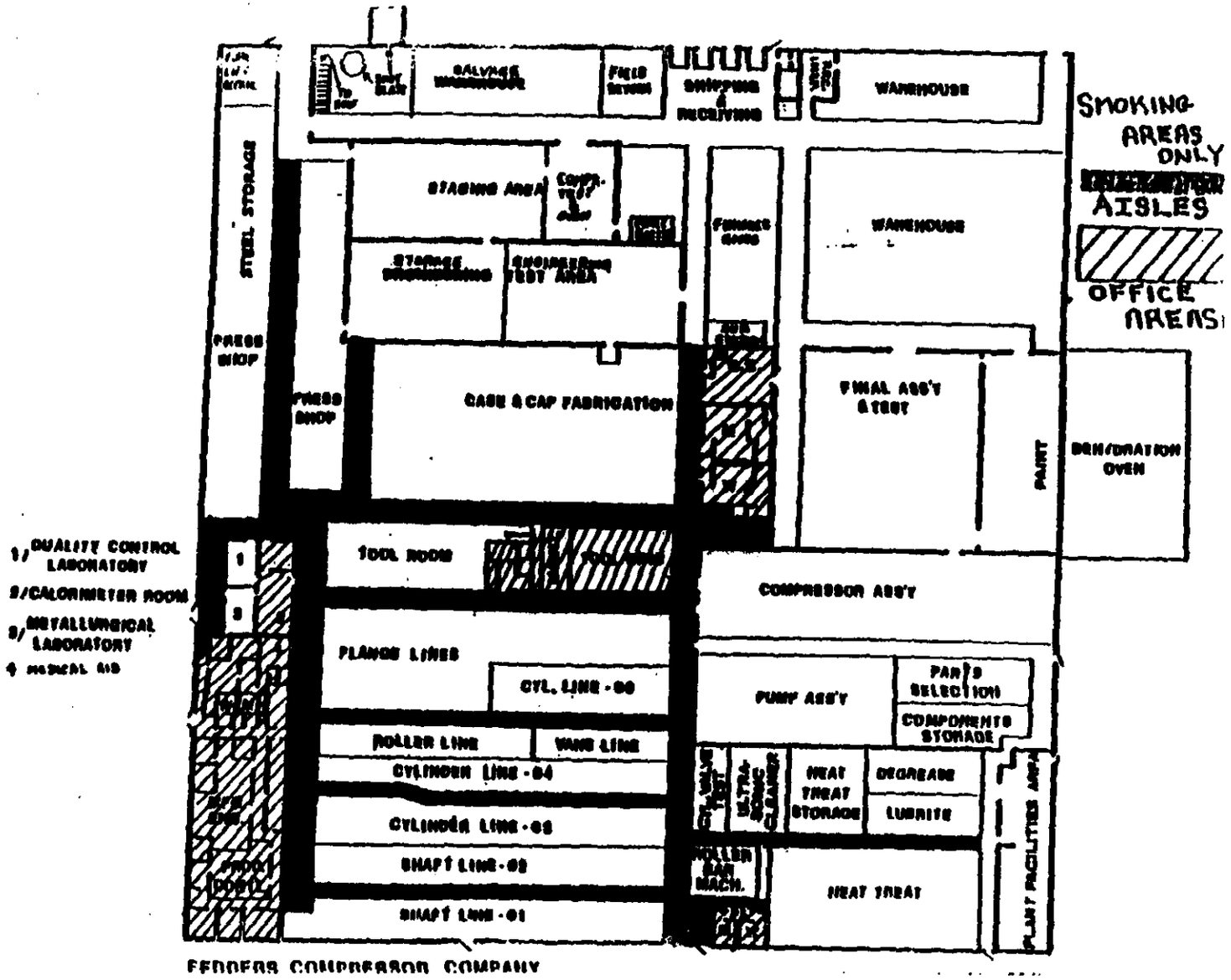
    1 - yes
    2 - no
    9 - OK
    (IF NO OR DON'T KNOW PLEASE GO TO QUESTION 20)

17. As a result of this illness were you seen by a physician ?

    1 - yes
    2 - no
    9 - OK

    Who _____

    What were your symptoms?
    SPECIFY _____



18. Please mark with an "X" where you worked in the plant between Feb. 4 and the 18 when you became ill.

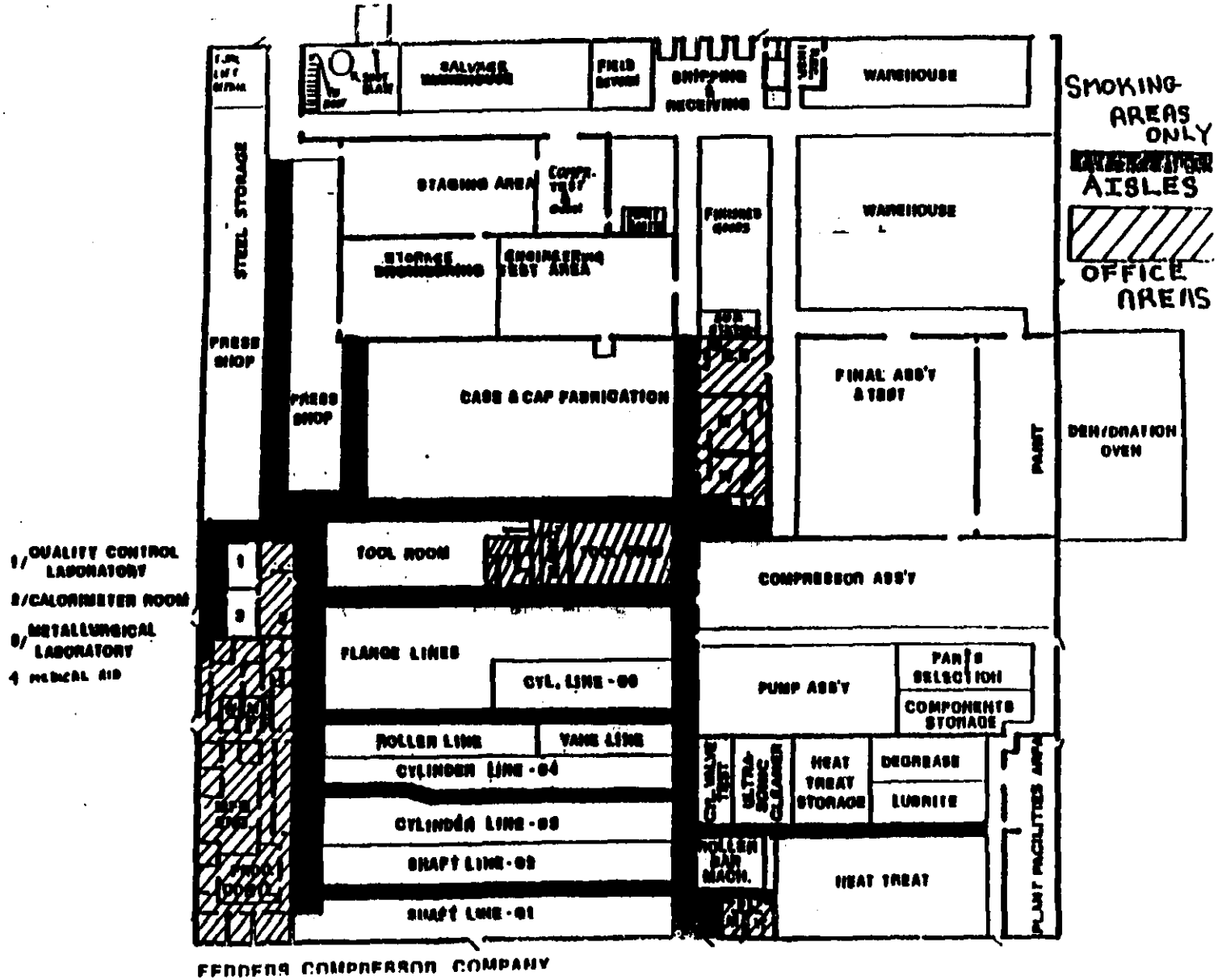
19. From the 4th to the 18th did you see a physician because of concern that you might have been exposed to some agent ?

1 - yes
2 - no
9 - OK

20. Did you work on Wednesday, February 19th ?

1 - yes
2 - no
9 - OK

(IF YES PLEASE CONTINUE, OTHERWISE YOU ARE DONE)



21. Please mark with an "X" where in the plant you worked on February 19, 1986.

22. On February 19th, while working, did you notice any of the following unusual conditions inside the plant?

CONDITIONS	YES	NO	OK
chemical exposures	1	2	9
(specify) _____			
Odors of:			
deisel or gas fumes	1	2	9
sweet, fruity smells	1	2	9
dry cleaning fluid	1	2	9
freshly mown hay	1	2	9
haze, mist or fog	1	2	9
idleing fork lift in your work area	1	2	9

23. How long were you in the pump assembly room on Wednesday, Feb. 19th? _____
(time)

24. Did you feel sick at work on that day?

1 - yes
2 - no
3 - don't remember

(If you answered yes, did you have any of the following symptoms?)

Please circle the correct answer

SYMPTOMS	YES	NO	DON'T KNOW
lightheadedness	1	2	9
headache	1	2	9
sleepiness	1	2	9
numbness or tingling	1	2	9
dizziness	1	2	9
weakness	1	2	9
nausea	1	2	9
blurred vision	1	2	9
racing heart beat	1	2	9
stomach pain	1	2	9
chest pain	1	2	9
shortness of breath	1	2	9
sore throat	1	2	9
passed out	1	2	9
vomiting	1	2	9
disorientation	1	2	9

25. What time was it when you first became ill on Wednesday, Feb. 19th.? (IF YOU WERE NOT SICK SKIP AND LEAVE BLANK)
_____AM/PM

26. How did you first become aware of illness in the plant on Wednesday Feb. 19th?

1 - became ill
2 - saw someone become ill
3 - saw the emergency team
4 - told by fellow worker
5 - told by supervisor
9 - news media

27. If you were ill that day were you .....?

1 - seen by the nurse and sent home
2 - seen by a physician
3 - stayed at work
4 - not sick
9 - don't remember

28. What do you think was the direct cause of this illness ?

1 - Chemicals, ventillation
2 - Psychological factors
3 - Other
9 - OK