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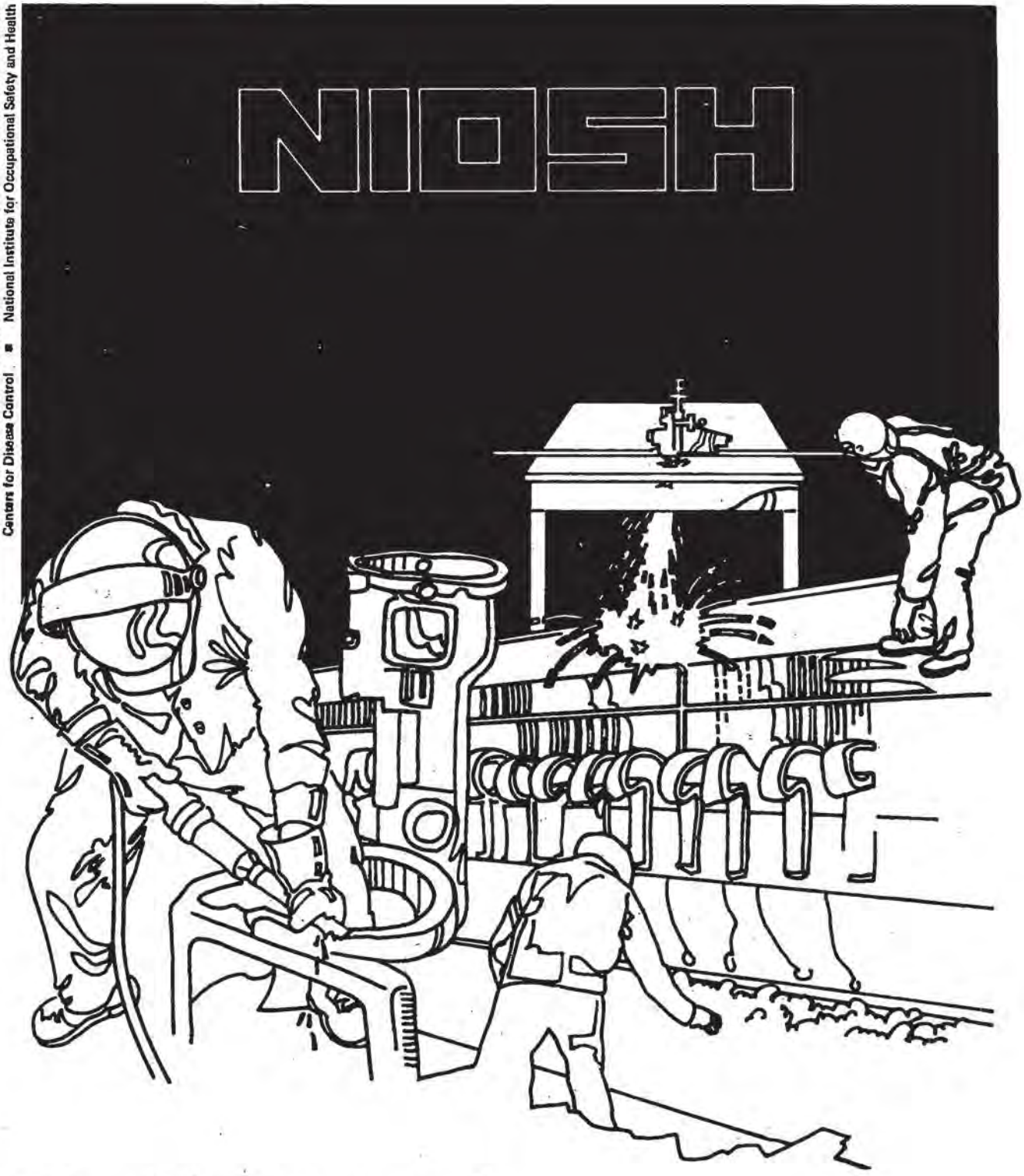

Health Hazard Evaluation Report

HETA 81-043-1207
REFRIGERATION WORKERS
SALT LAKE CITY, UTAH

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial nygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-043-1207
REFRIGERATION WORKERS
SALT LAKE CITY, UTAH
OCTOBER 1982

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I. SUMMARY

In October 1980 the National Institute for Occupational Safety and Health (NIOSH) received a union request to study the possibility of a neurological disease from exposures to trichlorofluoromethane (Freon 11) and dichlorodifluoromethane (Freon 12) among refrigeration workers in Salt Lake City, Utah.

On January 20, 1981, an industrial hygiene survey was conducted in Salt Lake City, Utah, and breathing zone and general room air measurements were obtained for Freon 115 (chloropentafluoroethane) and Freon 22 (chlorodifluoromethane) on refrigeration service personnel employed by Koldaire, Inc. These were the only Freons in use at the time of the survey.

All environmental measurements for Freon taken on January 20, 1981, were well below the evaluation criteria for Freon 115 (6320 mg/M^3) and Freon 22 (3500 mg/M^3). Values ranged from below the laboratory detection limit (0.02 mg/M^3) to 1.40 mg/M^3.

Due to the nature of the request attributing neurological disease or disorder to Freon exposures, an in-depth medical study was performed. Twenty-seven workers between the ages of 19 and 55 years were evaluated by physicians by questionnaire, physical examination, pulmonary function testing, and nerve conduction testing. Symptoms such as lightheadedness or dizziness were reported in 67%; chronic tiredness in 44%; breathing trouble in 33%; headaches in 33%; pressures in chest in 33%; numbness or tingling in fingers in 26%. Fourteen controls drawn from plumbers and insulators were observed by the physicians. The only statistical difference in the number and types of symptoms occurred for two symptoms. Lightheadedness and dizziness was reported of 21% of the control groups and 71% of the Freon-exposed group. Palpitations were reported by none of the controls and 36% of the Freon-exposed individuals.

All other comparisons of questionnaire response and physical findings showed no statistically significant differences. No evidence exists in this study to support the hypothesis that fluorocarbons or refrigeration work present a chronic hazard to the health of the workers. Occasional high exposures to fluorocarbons may be responsible for the excessive number of workers reporting symptoms of lightheadedness and palpitations.

On the basis of the environmental and medical data, NIOSH concluded that no serious chronic health hazard existed at the time of this evaluation to refrigeration workers in Salt Lake City, Utah.

KEYWORDS: SIC 7623 (Refrigeration and Air Conditioning Service and Repair Shops), Freon, peripheral neuropathy, refrigeration servicing.

II. INTRODUCTION

In October 1980 the National Institute for Occupational Safety and Health (NIOSH) received a union request to study the possibility of a neurological disease from exposures to trichlorofluoromethane (Freon 11) and dichlorodifluoromethane (Freon 12) among refrigeration workers in Salt Lake City, Utah.

On January 20, 1981, an industrial hygiene survey was conducted in Salt Lake City, Utah. Medical evaluations were conducted throughout 1981. Subjects were selected from Koldaire, Inc., and included all personnel involved in servicing. Results of the environmental and medical evaluations were discussed with individual workers and union and plant management in June of 1981.

III. BACKGROUND

This health hazard evaluation (HHE) was the result of a request by a union member who became ill while working in the refrigeration trade. He developed a progressive neurologic illness in 1978 which he attributes to exposures he encountered as a refrigeration serviceman. He was hospitalized at the University of Utah Medical Center in August 1978 by a neurologist. His diagnosis was distal axonopathy consistent with toxic chemical exposure. The neurologist caring for this worker invited ten co-workers to the University Medical Center for similar evaluations in October 1978. Many showed evidence of decreased sensory nerve conduction velocity, an early sign of distal axonopathy. A review of the literature showed no association between this illness and refrigeration work. A more in-depth study was proposed to further elucidate any relationship between refrigeration work and neurologic disease.

Refrigeration workers perform two major tasks, construction and servicing. Construction of refrigeration systems involves soldering and welding of copper tubing. This is done prior to introducing the refrigerant into the system. Once the system is constructed it is charged with a refrigerant gas. Usually one or more of the following are used: dichlorodifluoromethane (fluorocarbon 12, FC 12), monochlorodifluoromethane (fluorocarbon 22, FC 22), and chloropentafluoroethane (fluorocarbon 115, FC 115).

Servicing is the other major task and it involves checking the system for leaks and repairing them. Leaks are repaired using solder and a heat source. The freons are usually removed from the system before the soldering process is initiated. If the system is not flushed before soldering, fluorocarbons pass through the leak and into the heat source, thermal decomposition may produce phosgene, hydrogen chloride, and hydrogen fluoride gases.

IV. EVALUATION DESIGN AND METHODS

1. Environmental

Two general room and two breathing zone air samples were collected on January 20, 1982, in Salt Lake City, Utah, for Freon 115 and Freon 22 on charcoal tubes using vacuum pumps operated at 50 cubic centimeters per minute and analyzed according to NIOSH Method S-102.

Additional environmental sampling would have been conducted; however, individual mechanics must be followed throughout the work shift and would not have rendered any more additional, useful information.

2. Medical

The purpose of the medical aspect of this HHE was to assess the acute and chronic health effects common to refrigeration workers. This study focused on the organ systems known to be affected by fluorocarbons and their decomposition products, i.e., the cardiopulmonary system, and on the alleged toxicity to the nervous system, especially the peripheral nervous system. Medical examinations and testing were done on Saturdays thereby minimizing the detection of possible acute effects.

Subjects were selected from Koldaire, Inc., and included all personnel involved in servicing. This excluded several young employees who worked only in the warehouse area and who were not regularly exposed to welding fumes or fluorocarbons. In addition, the eight workers studied previously were invited to attend. All but one, the index case, who left refrigeration work on the advice of his personal physician, were still in the refrigeration trade. This resulted in a group of 30 workers, 28 of whom participated in the medical tests.

Tests included a complete medical history and physical examination performed by an occupational physician. Nerve conduction studies were performed by a neurologist and included a bilateral assessment of the following nerves: ulnar motor and sensory, median motor and sensory, peroneal, tibial, and sural. A standardized occupational history and symptom questionnaire was administered by one of two trained interviewers. Respiratory function was assessed with the forced vital capacity maneuver. A 12-lead ECG and chest radiograph were also used to assess cardiopulmonary status. Blood was obtained for a complete blood count, routine chemistries, and a zinc protoporphyrin level to assess prior lead exposure. A routine urinalysis was done. Information regarding respiratory symptoms was obtained through a self-administered, modified BMRC questionnaire. A second self-administered questionnaire gathered information on alcohol consumption.

Fourteen non-refrigeration workers were selected as controls from local union rosters of plumbers and insulators. Individuals were matched by age to the refrigeration workers with the longest employment and who were free of obvious neurologic disease. Prospective subjects for the comparison group were contacted by phone and interviewed by a physician to exclude previous neurologic disease and previous work in the refrigeration trade. A total of 32 individuals were contacted. Seven were not interested in participating, six had pre-existing neurologic disease, and three had worked in the refrigeration trade for more than a year. Of the sixteen scheduled for examinations, fourteen came. Of these, half were plumbers. The fourteen refrigeration workers used for this analysis had an average employment in the trade of 11.4 years (range 5-30 years).

V. EVALUATION CRITERIA

A. Environmental

The source of criteria used to assess the workroom concentrations of the chemicals was the recommended Threshold Limit Values (TLVs) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH), 1981.

	Environmental Limits 8-Hour Time-Weighted Exposure Basis
Chlorodifluoromethane (Freon 22).....	3500 mg/M^3 (ACGIH)
Chloropentafluoroethane (Freon 115)....	6320 mg/M^3 (ACGIH)

mg/M^3 = milligrams of substance per cubic meter of air.

Occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

B. Toxicological

The toxicity of fluorocarbons has been under investigation since the 1930s. The narcotic properties are well recognized and occur at concentrations in the 10-20 percent range. They were considered extremely safe at much lower dosages and found their way into many products as aerosol propellants. In the 1960s sudden deaths occurred in asthmatics using hand-held inhalers containing fluorocarbons. In addition, deaths from inhalation of other aerosol products containing fluorocarbons gave rise to renewed interest in fluorocarbon toxicology[1].

Aviado devised a classification scheme for propellants based on their acute cardiopulmonary effects[2]. FC 12 and FC 22 are Class III propellants indicating intermediate toxicity. They result in early respiratory depression and bronchoconstriction which predominates the influence on circulation. FC 12 produces depression of minute volume, bronchoconstriction, and reduction in compliance in most animal species tested at concentrations near 10 percent. FC 22 produces the same findings at concentrations of 20 percent. FC 22 produces the same findings at concentrations of 20 percent. FC 115 is a Class IV propellant with lower cardiopulmonary toxicity than Class III. Concentrations of 20 percent or more are required to produce the same effects as Class III propellants.

Cardiac effects for Class III and Class IV propellants include arrhythmias, tachycardia, myocardial depression and hypotension. Sensitization of the canine myocardium to preinjected epinephrine results in arrhythimias at concentrations of 5 percent for FC 12 and FC 22 and, at concentrations of 20 percent, FC 115[3].

In an extensive human volunteer study, Stewart et al. studied the effects of FC 12 on the cardiopulmonary and nervous systems[4]. Eight males underwent a four week exposure to 1000 parts per million (ppm) FC 12, eight hours per day, five days per week. No untoward health effects occurred either at the termination of the experiment or at a one year follow-up.

Speizer et al. reported that a significant number of pathology personnel experienced palpitations after use of FC 12 or FC 22.[5] Twenty-eight percent of pathology personnel reported palpitations while only 14 percent of radiology personnel experienced this symptom. Measured levels of FC 22 were near 300 ppm.

Neurobehavioral changes after acute inhalation of FC 12 have been reported in man and in animals[6,7]. Van Stee and McConnell observed elevation of liver enzymes in animals after FC 22 exposure[8]. They recommended monitoring SGOT and SGPT of exposed workers. There have been no reports of any fluorocarbon producing peripheral nervous system disease. The current TLV for all three fluorocarbons is 1000 ppm[9].

VI. RESULTS AND DISCUSSION

A. Environmental

On January 20, 1981, two general room and two breathing zone air samples were collected in Salt Lake City, Utah, on servicing personnel employed by Koldaire, Inc. for Freon 115 and Freon 22 for laboratory analysis. Concentrations of samples ranged from below the laboratory detection limit of 0.02 milligrams per sample to 14.0 mg/M^3--well below the evaluation criteria of 6320 mg/M^3 for Freon 115 and 3500 mg/M^3 for Freon 22 (refer to Table 4). Additional environmental sampling was not performed since extremely low levels were found on the initial survey. It is possible that occasionally workers may receive high exposures; this was not observed on the initial survey. Work on this particular day consisted of the repair of a leak in a large supermarket's refrigeration system. This is very typical work performed by employees in this line of work.

B. Medical

1. Index Case

The index case is a 33 year old white male who began refrigeration work in 1971 with Koldaire, Inc., working mainly in construction. In 1976, he began doing primarily servicing work. It was at this time that he states his health began to gradually decline with loss of weight, difficulty concentrating, depression, and weakness in the arms and legs. In the summer of 1978, he received a large exposure to fluorocarbons when a pipe that he was repairing broke open. Within hours he became ill and had to leave work. His symptoms included nausea, vomiting, abdominal pain, and weakness. He remained off work for three weeks seeing several doctors for this illness. He was evaluated at the University of Utah Medical

Center in late July by a neurologist who found abnormalitites in his nerve conduction velocities. The following values were obtained: left peroneal nerve was 40 m/sec (at the lower limit of normal), left tibial nerve was 22.6 m/sec (lower limit of normal is 35 m/sec), and left sural nerve was 20.8 m/sec (lower limit of normal is 37.5 m/sec). Following these findings he was hospitalized to discover the cause for his illness. No cause was found and he was discharged with the diagnosis of "axonal polyneuropathy, possibly on the basis of intoxication or metabolic defect."

He then returned to refrigeration work with a different company working as a construction supervisor. He left after eleven months. Since then he has worked as a truck driver and a pipefitter. He is currently unemployed. Convinced that his refrigeration work was responsible for his illness, he has filed a workman's compensation claim which was denied. He is presently pursuing an appeal of this decision.

This worker was examined at the University of Utah Medical Center on December 19, 1981, along with other members of the study group. At that time he appeared chronically ill and thin. His general physical examination was otherwise unremarkable. The neurologic examination revealed normal strength, coordination, reflexes, and gait. Sensory examination revealed a peripheral stocking-glove polyneuropathy. Laboratory examination was entirely normal. Nerve conduction studies had markedly improved giving the following results for the three previously reported nerves: left peroneal nerve was 46.5 m/sec, left tibial nerve was 45.6 m/sec, and left sural nerve was 34.9 m/sec. Other nerve conduction studies were consistent with the group as a whole.

2. Study Group

a. Physical Examinations

This group comprised 27 white males between the ages of 19 and 55 years with a mean age of 32 years. Mean duration of full-time employment in the refrigeration trade was 9 years ranging from a half year to 30 years. No cases of distal axonopathy were detected by physical examination. Ten had evidence of mild hypertension as defined by a systolic blood pressure greater than or equal to 140 mmHg but less than 160 mmHg and/or a diastolic blood pressure greater than or equal to 90 mmHg but less than 105 mmHg. Eight were found to have abnormalities in sensation in the arms or legs. These could be related to minor trauma in four, an acute back strain with sciatica in one, surgical repair of a fractured tibia-fibula in one, heavy callous formation of the hands in one, and previous spinal surgery for a hemangioma in another. These findings potentially confounded the nerve conduction studies. This was overcome by using the right- or left-sided nerve, whichever had the greatest nerve conduction velocity, or by excluding the person from the statistical analysis if both sides were involved.

b. Symptoms

Symptoms are listed in Table 1 with their corresponding frequencies. Each worker was asked if the symptom started or became worse while working in the refrigeration trade. If the response was positive, the respondent was then asked with which jobs or activities the symptom was associated. This number is found in the last column. The index case was excluded from this tally.

Table 3 shows mean age and mean number of responses on the symptom questionnaire for both groups. The refrigeration group reported 40 percent more symptoms on average, but this was not statistically significant.

Lightheadedness or dizziness was the most common symptom, reported by two thirds of the respondents. Exposure to freons was given as the cause, while phosgene, welding, and servicing were reported once each. Tiring easily occurred in 44 percent. Four workers attributed this to their work including painting (1), exposure to freon (1), exposure to cadmium (1), and long working hours (1). Four others associated it with work, but not associated with any particular activity.

Difficulty breathing was reported by 33 percent. This symptom was attributed to welding or soldering near freons (4), to phosgene exposure (1), to exaccerbation of pre-existing asthma by freons (1), and to cadmium (1). Headaches occurred in another 33 percent. Workers attributed their headaches to freons (2), phosgene (1), a combination of freon and phosgene (1), and checking leaks in systems (1). Pressure in the chest was also reported by a third of the respondents. Five indicated that this started or was made worse by work. Three others identified either phosgene (2), or soldering near freon (1) as the cause.

Twenty-six percent of respondents had numbness or tingling in their fingers lasting more than a day. Four said this started or was made worse during their refrigeration work. Two others reported phosgene (1) or freon (1) as the cause. Increased irritableness was reported by 26 percent. Two indicated that this started or was made worse with their job while one specifically felt that painting was the cause.

Burning eyes was a symptom reported by 22 percent. Four indicated specific exposures, namely welding (3) and use of a torch (1). Another 22 percent had palpitations. One associated this symptom with freon exposure. Perspiring occurred in another 22 percent. Only one felt that freon was the cause.

Eighteen percent claimed their fingers turned white from cold or vibration. Two reported freon burns from direct dermal contact with liquid refrigerant. Nausea was reported by 15 percent of workers. Two indicated that phosgene was associated with this symptom. Loss of muscle strength occurred in eleven percent. One worker reported a combination of freon and phosgene was the cause, while kneeling was responsible for this symptom in another.

Incoordination was present in another 11 percent. A combination of freon and phosgene was reported as the cause in one case. Seven percent reported losing the feeling in their fingers from cold or vibration. One said this was caused by a freon burn which also turned his fingers white. Another worker reported that handling cold pipes results in numbness.

In all, freons were reported as a cause for symptoms 29 times. A variety of symptoms were produced including dizziness (13), shortness of breath (especially during welding or soldering) (5), headaches (3), palpitations (1), perspiration (1), pressure in the chest (1), incoordination (1), tiring easily (1), and causing fingers to turn white and/or become numb as a result of dermal contact (3). Phosgene was implicated 11 times, in association with headaches (2), pressure in the chest (2), nausea (2), difficulty breathing (1), dizziness (1), numbness in fingers (1), and incoordination (1). Soldering or welding were mentioned 9 times. These activities were associated with the following symptoms: burning of eyes (4), difficulty breathing (3), pressure in chest (1), and dizziness (1). Cadmium was mentioned as a cause of symptoms only twice, i.e., difficulty breathing (1), and tiring easily (1).

As expected many respondents reported symptoms referrable to the cardiorespiratory system in accordance with the known welding toxicity of freons and their thermal decomposition products and fumes. Bronchoconstriction may account for trouble breathing and tightness in the chest. Subsequent hypoxia and hyperventilation could explain the dizziness, headaches, tingling in the fingers, tachycardia (palpitations), perspiration, and nausea. Lightheadedness or dizziness was, however, more strongly associated with simple freon exposure. This may result from the CNS depressant effects of fluorocarbons or from hypotensive effects as observed in laboratory animals.

Numbness or tingling in the fingers could be a result of toxic axonopathy; however, this is not consistent with the physical examination findings. Alternatively, direct repetitive trauma to the hands could result in these symptoms. This repetitive trauma was supported by the physical findings of calloused hands and multiple healed lacerations occurring about the hands.

Fatigue, irritableness, and headaches are nonspecific symptoms that could result from long working hours and/or physically strenous work. Burning of the eyes was reported by several workers and was strongly associated with welding and soldering. Few neurobehavioral symptoms were reported and few symptoms of chronic toxicity were reported, e.g., loss of appetite, loss of weight, and increased somnolence.

c. Respiratory Symptoms

There are 8 smokers, 8 ex-smokers, and 12 nonsmokers. Five subjects reported cough or phlegm for three months or more. Hemoptysis was reported by one while breathlessness Grade I was a symptom in three. Nine have wheezing with colds, but only four had wheezing apart from colds. Symptoms of chronic bronchitis were reported by two nonsmokers and one ex-smoker.

d. Blood and Urine

Blood and urine studies revealed few abnormalities. Only one test, SGPT, was abnormal in more than three workers. As seen in Table 5 all but one were mildly elevated. There were four drinkers, one nondrinker, and one ex-drinker in this group suggesting that these elevations were not merely a result of recent alcohol consumpton. In the study group, 20 subjects reported they drank alcohol while four reported they were nondrinkers and four reported they were ex-drinkers. As seen in Table 6, there was a trend for drinkers to have a higher SGPT. Table 7 shows the effect of employment on SGPT. Table 8 shows the interaction of the two factors, drinking status and length of employment, on the level of SGPT. These effects are small and not statistically significant, but they do indicate a trend of increasing values with drinking and duration of employment.

e. Pulmonary Function

No abnormalities were noted in the pulmonary function studies. Forced vital capacity, forced expiratory volume in one second, and the ratio of these two were normal in all subjects. There was little difference between smokers and nonsmokers, with smokers tending to have somewhat lower values for all three parameters.

f. Chest Radiographs

Several minor nonwork related abnormalities were noted and will not be mentioned specifically. One case of a diffuse bvilateral miliary nodular pattern was evident in a 43 year old worker who had no history of pneumoconiosis or other lung disease. A repeat chest x-ray was unchanged one month later. This worker refused further diagnostic testing. He was asymptomatic and had normal pulmonary function tests. His physical examination revealed no evidence of respiratory pathology. Since this patient had worked and traveled

in areas where coccidioidomycosis is endemic, it is believed that the chest x-ray represents an old, benign, granulomatous disease of fungal origin. He was advised to have repeat chest x-rays on an annual basis to follow any progress in this condition.

g. Electrocardiograms

There were 10 abnormal tests, four had sinus bradycardias, four had nonspecific ST-T changes, two had first degree A-V block, one had evidence of a previously undiagnosed inferior myocardial infarction, and only one tracing had a single premature ventricular contraction.

h. Nerve Conduction Velocities

These are shown in Table 9 for the entire group with the index case listed separately for comparison. These are not corrected for skin temperature. The average velocity for the group on the sural nerve conduction is low. Since this is a purely sensory nerve and lies close to the skin, its velocity is affected by skin temperature, decreasing the rate 2 m/sec per degree Centigrade below 30 degrees Centigrade. In Table 10 nerve conduction velocities are broken down by length of employment. No consistent differences are seen here even though one might expect to see somewhat slower velocities among the group with longer length of employment on the basis of a higher mean age.

The follow-up study results are shown in Table 11. Some of the nerves were not tested. Most changes occurred toward increasing nerve conductions while a few decreased. All changes were mild and probably within the limits of error of nerve conduction technique. No change in materials over this time period could account for the improvement in nerve conduction velocities.

VII. CONCLUSIONS

Based on environmental data and medical evaluations, no serious chronic health hazard existed at the time of this evaluation to refrigeration workers who participated in this study. The participation rate of 93 percent was high and enhanced the validity of the study. The fourteen controls that were part of this study showed no statistically significant difference from the exposed study group.

Peripheral nerve disease does not appear to be related to exposures encountered in the refrigeration trade.

VIII. RECOMMENDATIONS

Before working on a freon leak in a cooling system the worker should try to ventilate (with some sort of air fan) the freon in proximity to where the soldering and melting is going to occur. This would eliminate the possibility of creating phosgene exposures.

IX. REFERENCES

1. Jefferson IG. Accidental death of child playing with deodorant aerosol. Lancet 1:779, 1978.

2. Aviado DM. Toxicity of aerosol propellants in the respiratory and circulatory systems. X Proposed classification. Toxicology 3:321-332, 1975.

3. Reinhardt CF, Azar A, Maxfield ME, Smith PE, Mullin LS. Cardiac arrhythmias and aerosol "sniffing." Arch Environ Health 22:265-279, 1971.

4. Stewart RD, Newton PE, Baretta ED, Herrmann AA, Forster HV, Soto RJ. Physiological response to aerosol propellants. Environ Health Perspect 26:275-285, 1978.

5. Speizer FE, Wegman DH, Ramirez A. Palpitation rates associated with fluorocarbon exposure in a hospital setting. N Engl J Med 292:624-626, 1975.

6. Azar A, Reinhardt CF, Maxfield ME, et al. Experimental human exposures to fluorocarbon 12 (dichlorodifluoromethane). Am Ind Hyg Assoc J 33:207-216, 1972.

7. Lester D, Greenberg LA: Acute and chronic toxicity of some halogenated derivatives of methane and ethane. Arch Ind Hyg Occup Med 2:335-344, 1950.

8. Van Stee EW, McConnell EE. Studies of the effects of chronic inhalation exposure of rabbits to chlorodifluoromethane. Environ Health Perspect 20:246-247, 1977.

9. American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values for Substances in Workroom Air (3rd Edition). Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1971.

10. Mackison, FW, Stricoff RS, Partridge LJ (eds). Occupational Health Guidelines for Chemical Hazards: Occupational Health Guidelines for Dichlorodifluoromethane. Washington, DC: National Institute for Occupational Safety and Health of the US Department of Health and Human Services and the Occupational Safety and Health Administration of the US Department of Labor, 1981. (DHHS (NIOSH) Publication No. 81-123).

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XI. DISTRIBUTION AND AVAILABILITY

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

Copies of this report have been sent to:

1. United Association of Journeyman and Apprentices of the Plumbing and Pipe Fitting Industry.
2. Plumbers and Steamfitters Union, Local 466.
3. U.S. Department of Labor/OSHA - Region VIII.
4. NIOSH - Region VIII.
5. Utah Department of Health.
6. State Designated Agency.

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

TABLE 1

Symptoms Reported by Refrigeration Workers

Refrigeration Workers
Salt Lake City, Utah

Symptom	Frequency* N	Frequency* %	Number Reporting Specific Cause
Lightheadedness or dizziness	18	67	15
Easily tired	12	44	4
Breathing trouble	9	33	7
Headaches	9	33	5
Pressure in chest	9	33	3
Numbness or tingling in fingers	7	26	2
Irritablility	7	26	1
Trouble remembering	7	26	0
Burning eyes	6	22	4
Palpitations	6	22	2
Perspiration	6	22	1
Fingers turn white from cold	5	18	2
Difficulty moving fingers	5	18	0
Nausea	4	15	2
Pains in hands mainly at night	4	15	0
Numbness or tingling in toes	4	15	0
Increased effect from alcohol	4	15	0
Nose bleeds	4	15	0
Loss of strength	3	11	2
Abdominal pain	3	11	1
Incoordination	3	11	1
Depression	3	11	0
Numbness from cold or vibration	2	7	2
Change in gait	2	7	0
Problems buttoning clothes	2	7	0
Sore throat	2	7	0
Loss of 10 pounds or more	1	4	0
Increased sleep	1	4	0
Difficulty driving	1	4	0
Fainting	1	4	0
Loss of Appetite	0	--	--
Difficulty concentrating	0	--	--
Difficulty with meaning of words	0	--	--
Confused or disoriented	0	--	--

* Excludes index case

TABLE 2

Symptoms Reported by Refrigeration Workers and a Comparison Group

Refrigeration Workers
Salt Lake City, Utah

Symptom	Frequency Reported by Refrigeration Workers (n=14)		Frequency Reported by Comparison Workers (n=14)	
	N	%	N	%
Lightheadedness or dizziness*	10	71	3	21
Pressure in chest	6	43	2	14
Headaches	5	36	7	50
Palpitations*	5	36	0	0
Breathing trouble	4	28	4	28
Numbness or tingling in fingers	4	28	1	7
Irritability	4	28	1	7
Burning eyes	3	21		
Perspiration	3	21	4	28
Nausea	3	21	1	7
Abdominal pain	3	21	2	14
Fingers turn white from cold	3	21	1	7
Incoordination	3	21	0	0
Trouble remembering	3	21	2	14
Easily tired	3	21	3	21
Increased effect from alcohol	3	21	1	7
Numbness from cold or vibration	2	14	3	21
Depression	2	14	3	21
Difficulty moving fingers	2	14	1	7
Numbness or tingling in toes	2	14	1	7
Pains in hands mainly at night	2	14	1	7
Loss of strength	2	14	0	0
Nose bleeds	1	7	2	14
Fainting	1	7	2	14
Problem buttoning clothes	1	7	0	0
Change in gait	0	0	2	14
Increased sleep	0	0	2	14
Difficulty driving	0	0	1	7
Difficulty with meaning of words	0	0	1	7
Sore throat	0	0	0	0
Loss of appetite	0	0	0	0
Loss of 10 pounds or more	0	0	0	0
Difficulty concentrating	0	0	0	0
Confused or disoriented	0	0	0	0

* $p \leq 0.05$ by Fisher's exact test, two-tailed, a = 0.05.

TABLE 3

Refrigeration Workers Versus Comparison Workers

Refrigeration Workers
Salt Lake City, Utah

	Refrigeration Workers (n=14)	Comparison Workers (n-14)
Mean Age	34.4	34.6
Range	24-55	25-55
Mean Number of Symptoms	5.8	4.1
Range	0-17	0-11
SD	4.5	3.4

TABLE 4

Breathing Zone and General Room Air Concentrations of
Chloropentafluoroethane (Freon 115) and Chlorodifluoromethane (Freon 22)

Refrigeration Workers
Salt Lake City, Utah

January 20, 1981

Sample Number	Job Classification	Location	mg/M^3 Freon 115	mg/M^3 Freon 22
1	Refrigeration Servicer	Air Regulators	10	5
2	Refrigeration Servicer	Air Regulators	14	3
3	General Room	Air Regulators	*	*
4	General Room	Air Regulators	12	4
EVALUATION CRITERIA			6320	3500
LABORATORY LIMIT OF DETECTION mg/sample			0.02	0.01

* = below laboratory limit of detection

TABLE 5

Workers with Abnormal SGPT Level*

Refrigeration Workers
Salt Lake City, Utah

ID #	SGPT (IU/L)	Age (years)	Employment (years)	Alcohol Consumption
14	105	43	21.0	drinker
10	62	43	6.5	drinker
27	54	39	13.0	drinker
01	53	30	8.5	ex-drinker
18	51	29	6.5	nondrinker
17	47	28	9.5	drinker
Mean		35.3	10.8	

* SGPT normal range = 0-45 IU/L

TABLE 6

SGPT Level by Drinking Status

Refrigeration Workers
Salt Lake City, Utah

Drinking Status	N	SGPT (IU/L)	SD
Drinkers	20	32.7	22.0
Ex-smokers	4	30.2	16.0
Nondrinkers	4	28.0	15.5

TABLE 7

SGPT Level by Length of Employment

Refrigeration Workers
Salt Lake City, Utah

Length of Employment (years)	N	Mean SGPT (IU/L)	SD
> 8	14	35.3	24.5
≤ 8	14	28.1	14.0

TABLE 8

SGPT Level by Length of Employment and Drinking Status

Refrigeration Workers
Salt Lake City, Utah

Drinking Status	Length of Employment (years)	N	Mean SGPT (IU/L)	SD
Drinkers	> 8	11	36.4	26.5
	≤ 8	9	28.2	14.9
Nondrinkers and ex-drinkers	> 8	3	31.3	18.9
	≤ 8	5	27.8	13.8

TABLE 9

Maximal Nerve Conduction Velocities in Meters Per Second

Refrigeration Workers
Salt Lake City, Utah

Nerve	Mean Velocity	SD	Index Case Velocity	Lower Limit of Normal
Ulnar Motor[a]	60.0	4.6	64.2	48.0
Ulnar sensory[a]	41.8	4.6	39.4	37.0
Median motor[a]	60.4	4.4	59.2	48.0
Median sensory[a]	42.6	4.4	44.8	37.0
Peroneal[a,b]	49.7	3.2	46.5	40.0
Tibial[a,b]	48.0	6.4	45.6	35.0
Sural[a,b,c,]	36.8	4.0	34.9	37.5

[a] Subject with spinal injury excluded

[b] Subject with acute back strain and sciatica excluded

[c] One subject refused test

TABLE 10

Maximal Nerve Conduction Velocities by Length of Employment
(meters/second)

Refrigeration Workers
Salt Lake City, Utah

Nerve	Length of Employment			
	> 8 years	SD	≤ 8 years	SD
Ulnar Motor[a]	60.0	3.9	59.9	5.4
Ulnar sensory[a]	42.4	4.5	41.1	4.7
Median motor[a]	60.5	4.5	60.4	4.4
Median sensory[a]	42.1	4.5	43.1	4.4
Peroneal[a,b]	49.1	3.3	50.3	3.2
Tibial[a,b]	49.4	6.1	46.6	6.6
Sural[a,b,c,]	37.0	3.6	36.5	4.5

[a] Subject with spinal injury excluded

[b] Subject with acute back strain and sciatica excluded

[c] One subject refused test

TABLE 11

Follow-up Study Maximal Nerve Conduction Velocities
(meters/second)

Refrigeration Workers
Salt Lake City, Utah

	Left Ulnar Sensory		Left Median Sensory		Left Sural	
ID #	1978	1981	1978	1981	1978	1981
01	38.0	--	41.0	--	38.0	41.7
04	37.0	37.2	36.0	34.2	30.6	30.6
06	39.0	43.3	43.0	--	34.0	35.7
16	--	--	37.0	41.9	34.8	--
18	--	--	39.0	41.9	37.5	32.6
19	39.0	44.8	39.0	41.9	38.0	40.5
20	38.0	45.4	34.0	44.1	37.5	35.7
26	--	--	30.9	35.4	37.5	35.7

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