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

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 78-37-509

FRANKLIN INSTITUTE
PHILADELPHIA, PENNSYLVANIA

JULY 1978

I. TOXICITY DETERMINATION

Based on the results of medical interviews, environmental sampling, observed work practices and a pertinent literature review, it was determined that the illnesses experienced by attendants of the Solar Energy Demonstration Van could not be attributed to an occupational exposure to a toxic substance. There was no toxic exposure from acetone, ethanol, methyl isobutyl ketone (MIBK), methanol, amyl acetates, or formaldehyde under the conditions of use observed during this survey conducted on February 6-7, 1978.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies of this report have been sent to:

1) The Franklin Institute Research Labs, Philadelphia, Pennsylvania
2) Authorized Representative of the Employees
3) U.S. Department of Labor - Region III
4) NIOSH - Region III
5) The affected employees

For the purpose of informing the two affected employees, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health received such a request from the employer to evaluate the potential hazard associated with employee exposure to an unknown substance. According to the requestor, "the exhibitors had liver and nervous disorders. They were in the exhibit part of the van and felt sick in their stomachs and coldness in their hands."

IV. HEALTH HAZARD EVALUATION

A. Description of the Process

The facility surveyed was a self-propelled recreational vehicle consisting of a Dodge chassis with a body manufactured by the Travel Queen Corporation, with the following identifying numbers - date of manufacturer August 1976, Vehicle Identification Number 9494 P.A. #10016 and manufacturer I.D. 1203. The interior aft of the driver's cab had been modified for use as a solar energy demonstration exhibit. Visitors entered one of two van doors, proceeded past video tape displays along an aisle between illuminated exhibit boards and non-functional mock-ups illustrating four types of solar energy systems, received printed handouts promoting solar energy systems and exited through a second door. The van and crew traveled extensively throughout the continental United States spending one to four days at exhibit sites in metropolitan areas. During displays the two attendants had four to six hours of public contact daily. Meals and living accommodations were provided in good quality commercial facilities. There were no potable water, sanitary waste, or cooking facilities aboard the van. The exhibit van and crew cab are cooled by two roof mounted air conditioners and an engine-driven air conditioner. Only the cab area is heated. Electricity to power the displays and accessories is provided by either an external power source or by a gasoline driven 110v AC generator mounted at the rear of the vehicle. Storage lockers located in the display area and behind access panels on the exterior of the vehicle contain small quantities of touch-up paints, cleaning supplies, and miscellaneous hand tools. The displays consist of houses fashioned of plexiglass so that the tubing, pumps, fans and other elements associated with the heating/cooling systems are visible within. While there are pumps and moving fluxes on the displays, they are not functional as solar heating/cooling units. Two 300 watt lamps, which simulate solar energy, are mounted six to seven inches from the plexiglass roof containing the simulated energy collector elements.

The interior of the van had been refurbished in September 1977. The renovation included new paneling, carpeting, and displays. The initial physical symptoms among the van attendants appeared several weeks into the

first tour after van modification. The atmosphere of the van was subsequently evaluated by chemists of the National Bureau of Standards who concluded that there was "no significant concentration of organic materials (including carbon monoxide) in the interior of the van either while the van was idle or while it was operated in a manner similar to the reported operational procedure during demonstration."

B. Evaluation Design

Five hypotheses were initially postulated:

1) That the physical symptoms were attributable to heat buildup within the mock-ups due to the sun-simulating flood lamps, resulting in offgassing of fluorocarbon pyrolysis products from the construction materials in the mock-up.

2) That the physical symptoms were due to offgassing of formaldehyde or hydrocarbon compounds from the materials used to bind the carpet, paneling, etc. to the vehicle.

3) That the symptoms were due to contaminants introduced by the auxiliary power generator, the air conditioner units, or the vehicle motor.

4) That the physical symptoms were due to the cleaning materials used.

5) That the physical symptoms were caused by factors other than exposure to an environmental contaminant originating in the van.

Hypotheses (1)-(4) were explored by reviewing a list of materials used in refurbishing the van and collecting high volume area samples both at floor level and immediately adjacent to the simulated solar collector where light from the flood lamp struck the plexiglass. Samples were also collected during vehicle motor, auxiliary power generator, and air conditioner operation. These tests were intended to establish the identity of contaminants. In addition, bulk samples of all cleaning materials were collected, and each cleaning material was used to clean one of the mock-ups during air sampling. Hypothesis (5) was explored by interviews with present and former van attendants.

C. Evaluation Method

Sampling was conducted in the parking lot of a motel in Winston-Salem, N.C. on February 7, 1978.

Area samples for airborne contaminants were collected as follows: charcoal and florisil tubes were used to sample for volatile organics. Sipin pumps were used at a flow rate of 200 cc/minute for sampling times of about three hours. Samples of shorter duration were drawn during air conditioner operations and vehicle operations. The carbon tubes were desorbed with carbon disulfide and the florisil samples were desorbed with ethyl acetate. Both samples were then analyzed using gas chromatograph techniques. MSA pumps operated at 1 liter per minute were used to draw air through two impingers in series containing deionized water to collect formaldehyde.

if present. Again sampling times were about three hours except for shorter samples of about one hour during air conditioner and vehicle operation. The formaldehyde samples were analyzed by the NIOSH colormetric method P&CAM 125. The sensitivity of this method was 0.1 ppm and the detection limit 0.4 micrograms of formaldehyde. Samples using all three methods were taken immediately adjacent to the simulated solar collector where light from the flood lamps struck the plexiglass at each mock-up, at floor level at each end of the mock-ups, in the crew cab while the vehicle was operated under city and highway driving conditions, and while the available air conditioning unit was operated. In addition, one of the three cleaning compounds was used to clean each of the mock-ups during our sampling. Direct reading indicator tubes for carbon monoxide were aspirated during operation of the auxiliary generator, hydrogen fluoride tubes during operation of the mock-ups and methylene chloride tubes at other convenient times. Air circulation measurements were made using the Alnor Junior velometer and smoke tubes. Air temperature measurements were made at the surface of the plexiglass mock-up beneath the flood lights.

The medical evaluation included telephone interviews with each of the two employees reported to have been ill. Topics discussed during the telephone interview included symptoms, previous medical history, work activities, working conditions, other activities while on the road and exposure to potentially harmful substances. Each ill employee was questioned about the other's illness to verify the timing of events and environmental conditions. The two persons currently working on the van, one of whom was present at the onset of the second episode of illness, were interviewed concerning the operation of the van and exhibits and environmental conditions. Information from the attending physicians concerning the same reported biochemical abnormality, elevated serum bilirubin, was obtained.

D. Evaluation Criteria

There are a number of criteria available to assess the potential toxicity of contaminant exposures. Those with the widest usage are the NIOSH Criteria Document Recommendations, the Threshold Limit Values (TLV) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), and the Code of Federal Regulations, Title 29, Part 1910.1000 used in the enforcement of the Occupational Health and Safety Act. There is no current occupational health standard for limonene, a $C_{10}H_{16}$ hydrocarbon sometimes used in lemon scented air fresheners, which was detected in one air sample. There is also no current occupational health standard for the alkanes $C_{11}H_{24}$, $C_{12}H_{26}$, $C_{13}H_{28}$, or methyl salicylate which were components of one of the cleaning compounds. Environmental criteria for the substances evaluated are presented in Table I.

The medical data were evaluated by the criterion that to validly diagnose an illness to be of occupational origin at least one of three features must exist: (1) symptoms or medical findings characteristic of exposure to something presumed to exist in the work environment at the probable time of exposure, (2) symptoms or medical findings compatible with the biologic effects of something determined by testing or reconstruction of circum-

stances to have been present in the work environment in an amount sufficient to cause such effects, or (3) symptoms or medical findings that occur among two or more persons under circumstances implicating something in the work environment as the cause. In the absence of one of these conditions, the mere occurrence of a similar illness at the same time in two or more people with potential common sources of exposure outside of work, as well as at work, is not sufficient to establish an occupational cause.

E. Evaluation Results and Discussion

1. Medical

In order to preserve the confidentiality of the information provided by the two ill employees as required by Title 42 of the Code of Federal Regulations, the specific symptoms and other features of their illnesses will not be discussed in this report.

The two ill employees first noted symptoms in Fort Worth, Texas shortly after noon on October 28. The onsets were within one half hour of each other. Both were much improved the next day. After consulting a physician and relying on the statement of their hotel manager that there was a "flu" epidemic in the area, they considered their illness to be "flu" and proceeded to Shreveport, Louisiana, where the second episode occurred on November 1. Again the onset was at noon, and both experienced symptoms within a half hour of each other but in the reverse order. Both had recurrent symptoms for about a week, followed by gradual improvement during the next few weeks. One had residual symptoms at the time of the interview. Both reported some other symptoms on the day prior to and/or earlier on the day of onset of the acute illnesses.

Neither had any medical problems prior to the trip. There was no evidence that alcohol or drugs were involved in the illnesses. One of the two smoked cigarettes, but usually not in confined spaces in the presence of the other, who was a former smoker.

All van employees were aware of an odor in the van somewhat similar to that of a new car. Neither ill employee noticed any odor, smoke, or fume in or around the van prior to their onset of illnesses. The van was parked outdoors each time, and the air conditioners were operating prior to each episode. Both said the temperature within the van was comfortable. The van's motor had not been operating for at least two days prior to each episode. The generator was operating for an hour in the morning of the day of the second episode. Both employees had a blood test for carbon monoxide within two hours of the onset of the second episode; the result of each employee's blood test for carbon monoxide was negative.

The van attendants cleaned the exhibit models with either ethyl alcohol or one of the other cleaning products the day before the onset of each episode, but otherwise recalled no apparent exposure to any chemicals. They used the vacuum cleaner for the first time after arriving in Shreveport and emptied the dust bag on the day prior to the onset of the second episode. Neither could recall any other unusual activity or environmental condition prior to the onset of either episode.

According to their medical records, only one of the van attendants had an elevated bilirubin; the other's serum bilirubin, tested within a week of the onset of the second episode, was at the upper limit of the normal range. The one with the elevated bilirubin, which was only slightly above normal, also had an elevated direct bilirubin. This is indicative of hepatic rather than hematologic dysfunction. Both had normal liver enzyme levels. An elevated direct bilirubin, in the presence of a slightly elevated total bilirubin, but in the absence of elevated liver enzymes or symptoms of a liver disorder, is not readily explained. If the elevated bilirubin which returned to normal over a period of a month, reflected a subclinical disorder, it was probably related only temporally to the acute illnesses in question.

2. Environmental

a. The levels of airborne contaminants measured during the survey period were well below the previously defined accepted criteria for occupational exposures. (See Table I)

b. Results of analysis of bulk samples and comparison of the compounds contained in them with the air sampling results indicated that only ethanol in trace quantities could also be detected in air samples (Table II).

c. Acetone, methyl isobutyl ketone, n-amyl acetate, sec amyl acetate, and formaldehyde were not detected in any of the air samples.

d. A small peak identified as limonene and three small and unidentified peaks eluting before the carbon disulfide solvents were observed. There were no other compounds detected.

e. Samples using direct reading indicator tubes for methylene chloride, carbon monoxide, hydrogen fluoride were negative.

f. Smoke tube dispersion patterns indicated good general air circulation within the van, both with the doors open continuously and with the doors open intermittently and the air conditioner in operation.

g. Air temperatures at the point where light from the flood lamp struck the plexiglass roof was 112^{o}F unshielded and 80^{o}F when the thermometer bulb was shielded from the incident light. Ambient room temperature was 59^{o}F.

V. Conclusion

1. The levels of airborne contaminants measured during this survey did not present a health hazard. There were no noticeable odors at any time during the survey.

2. The open van doors and dilution air from the air conditioner unit provided adequate general ventilation.

3. No air temperatures were measured which suggested the possiblity of thermal decomposition products of fluorocarbons.[3] This correlates with the published thermal output characteristics of incandescent luminaires.[5]

4. The measured levels of airborne contaminants at the floor level were the same as the measured levels at the mock-ups. This suggested that off-gassing of the materials used to affix the carpet to the floor had ceased.

5. No contaminants attributable to the operation of the auxiliary power generator, the air conditioning unit in the van or the motor vehicle engine could be demonstrated.

6. The hypothesis that the illnesses experienced by the van attendants were the result of exposure to toxic substances is not supported by the available medical and environmental information. The degree of occupational use/exposure of any chemicals is negligible.

V. REFERENCES

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5. Illuminating Engineering Society of North America, IES Lighting Handbook, 5th Edition, New York 1975.

6. U.S. Department of Labor, Code of Federal Regulations, Title 29, Part 1910.1000, U.S. Government Printing Office, Washington, D.C.

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Table I

Comparison of Current Health Standards and Recommended Health Standards
Various Compounds with Measured Values

Franklin Institute
Philadelphia, Pennsylvania

HE 78-37
February 7, 1978

Substance	OSHA Standard[6]	NIOSH Recommended Standard	AGCIH[1] TLV	Measured
acetone	1000 ppm	--	1000 ppm	N.D.*
ethanol	1000 ppm	--	1000 ppm	trace detected but not qualified
methyl isobutylketone	100 ppm	--	100 ppm	N.D.
n-amyl acetate	100 ppm	--	100 ppm	N.D.
sec amyl acetate	125 ppm	--	125 ppm	N.D.
formaldehyde	3 ppm 8 hr TWA 5 ppm ceiling 10 ppm max ceiling for 30 minutes	1 ppm ceiling[4] 30 minutes	2 ppm ceiling	N.D.
alkanes ($C_{11}H_{24}$, $C_{12}H_{26}$, $C_{13}H_{28}$)	--	--	--	N.D.
methyl salicylate	--	--	--	N.D.
limonene	--	--	--	trace detected but not qualified

*N.D. = none detected

NOTE: NIOSH TWA Recommendations are based on up to a 10-hour exposure and 40-hour work week unless otherwise noted.

Table II

Analysis of Bulk Samples

Franklin Institute
Philadelphia, Pennsylvania

February 7, 1978

Bulk	Components
Rubbing Alcohol	Acetone, ethanol MIBK
Brillianize® cleaner	Methanol
Trewax® (CS_2 Extract) cleaner	Amyl Acetates Alkanes ($C_{11}H_{24}$, $C_{12}H_{26}$, $C_{13}H_{28}$) Methyl Salicylate (wintergreen oil)