

NIOSH



Health Hazard Evaluation Report

HETA 82-075-1545
PRATT & WHITNEY AIRCRAFT
WEST PALM BEACH, FLORIDA

PREFACE

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

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

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I. SUMMARY

In December 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate occupational exposure to chlorinated solvents at Pratt & Whitney Aircraft (P&WA), West Palm Beach, Florida. The request was prompted by reported findings of elevated blood chloroform levels and an increased prevalence of cancer in the workforce.

Industrial hygiene and medical surveys were conducted in December 1981 and March 1982. The industrial hygiene evaluation included; 1) full shift and short term air sampling using standard charcoal sorbent tubes and a photoionization detector to evaluate current solvent exposures of 30 degreaser operators, 2) review of past industrial hygiene sampling data and, 3) water sampling to evaluate trihalomethane contamination levels. The medical evaluation included; 1) review of the "blood-chloroform" test, 2) pre- and post-shift urine sampling to monitor total trichloro compounds (TCC), 3) questionnaire survey and, 4) evaluation of cancer mortality using a proportional mortality ratio (PMR), a proportional cancer mortality ratio (PCMR) to correct for some inherent biases in the PMR and a case control study to determine if persons who died of cancer were more likely to have worked in areas of higher solvent exposures.

Eight-hour, TWA concentrations ranged from 0.3 to 22.9 ppm for Trichloroethylene (TCE), 0.8 to 7.2 ppm for Perchloroethylene (PERC), and 0.5 to 2.0 ppm for Methylchloroform (MC). All were well below the current OSHA standards (TCE-100 ppm, PERC-100 ppm, MC-350 ppm) and below the 25 ppm considered by NIOSH to be achievable using engineering controls. NIOSH recommends that TCE and PERC be considered human carcinogens and therefore exposures minimized and that MC be handled with caution due to its chemical similarity to TCE and PERC. The urine test results, which measured total trichloro compounds (TTC) in post shift samples and ranged from 0.5 to 83.0 ug/gr, showed good correlation ($R=0.92$) with the 8-hour TWA exposure data. Peak exposures to degreasing solvents were estimated to be in the 200-300 ppm range. Occasional symptoms such as lightheadedness, headache and eye irritation reported by 20-30% of those interviewed, suggests that peak levels may occasionally exceed these values. Past environmental data indicates that 8-hour TWA exposures to degreasing solvents were generally below 25 ppm back as far as TWA data was available (1973). Analysis of water samples indicated that the new aeration units are maintaining tri-halo-methane (THM) concentrations below 0.2 ppm which is on the low end of the range (0.2-1.0 ppm) normally found in the surrounding localities. It's possible that exposures to background concentrations of chlorinated solvents, which average 2-5 ppm in the plant, are responsible for a significant portion of the reported blood-chloroform concentrations.

A PMR of 156 for all cancers suggests that a 56% increased proportion of mortality due to cancer was present in this group. However, for the seven individual cancer death categories that appeared statistically significant in the PMR analyses, none remained elevated in the PCMR. This indicates that the elevated PMR was artifactual. Furthermore, there was no indication, from the case control study, that those persons who died of cancer were any more likely to have worked in an area of higher degreasing solvent concentrations than their matched controls who died of some other cause.

Eight-hour TWA exposures to chlorinated degreasing solvents are low, but current and past short-term exposure data and worker reports of occasional lightheadedness of short duration suggest a potential health hazard for those operating the vapor degreasers. Based on the data evaluated, we find no excess cancer risk associated with work. Recommendations are made in Table 3 and Section VIII that will reduce peak exposures to degreasing solvents.

KEYWORDS: SIC 3722 (Aircraft Engines and Engine Parts), vapor degreasers, trichloroethylene, perchloroethylene, methyl chloroform, blood-chloroform, total trichloro compounds, cancer

TABLE 12

Case/Control Analysis of 74 Known Cancer Deaths and Their Matched Controls
 Risk Factor = Exposure to Degreasing Solvents

	EXPOSED CASES	EXPOSED CONTROLS	UNEXPOSED CASES	UNEXPOSED CONTROLS	ODDS RATIOS	CONFIDENCE INTERVALS
Comparison #1 (background to intermediate)	19	29	50	40	0.50	0.24 - 1.05
Comparison #2 (background to high)	4	4	32	32	1.00	--- - ---
Comparison #3 (background to intermediate & high)	26	35	48	39	0.61	0.31 - 1.17

II. INTRODUCTION

In December 1981, NIOSH received a request from P&WA, Government Products Division of United Technologies, West Palm Beach, Florida to evaluate employee exposure to chlorinated hydrocarbons. Subsequent to receiving the P&WA request, a similar request was received from an authorized representative of the International Association of Machinists (IAM), Local 971. Both requests were prompted by a preliminary study that reported (1) an elevated uptake of chlorinated hydrocarbons via the analysis of blood samples (reported as blood chloroform concentrations) taken from 10 P&WA employees; and (2) a possible increase, as high as a nine-fold, in the cancer rate in the workforce.

Our initial efforts were primarily directed at collecting information related to the preliminary study at the P&WA plant and to employee exposures to degreasing solvents. A NIOSH industrial hygienist, occupational physician, and an epidemiologist visited the plant site on December 14-16, 1981 to collect the information necessary to decide what methods could best be used to evaluate the request. On December 22, 1981, a letter was forwarded to Pratt & Whitney and Local 971 that recapped the NIOSH activities of this site visit, identified what NIOSH believed were the main issues that needed to be evaluated and briefly discussed the methods that would be used to study them. On February 24, 1982, a letter was forwarded that discussed the study protocol in more detail was sent.

A follow up environmental/medical survey was conducted on March 15-19, 1982. This survey concentrated on measuring current exposures to degreasing solvents via standard air sampling techniques. Also, a questionnaire was administered and pre and post shift urine samples, to be analyzed for total trichloro compounds, were collected from each worker monitored.

Interim Report No. 1, issued in April, 1982 summarized the findings of the March visit and discussed the blood test used by the contracting University. Although the analytical results of the NIOSH air sampling conducted were not yet available, deficiencies noted in the degreasing operations, along with recommended corrective actions, were presented at that time.

In July 1982, Interim Report No. 2 was issued. This report presented the results of the air sampling, discussed the urine testing and questionnaire data from the March survey, and provided a status report of the issues still pending. Also, results of water samples taken by Water Supply Section of Palm Beach County Health Department and analyzed by EPA were reported.

In August 1983, Interim Report No. 3 was issued. This report presented an evaluation of the epidemiologic studies performed by the contracting university and results of additional epidemiologic evaluations conducted by NIOSH. This report was presented to Pratt & Whitney and the union at the plant site on August 16, 1983.

TABLE 11

Cause Specific Proportional Cancer Mortality for 74 Deaths

CAUSE OF DEATH	OBSERVED	EXPECTED	PCMR*
All Cancers	74		
Buccal Cavity	1	2.65	0.38
Digestive Organs	18	7.77	1.01
Esophagus	2	1.87	1.07
Stomach	4	2.81	1.42
Large Intestine	3	5.91	0.51
Rectum	1	1.82	0.55
Liver	1	0.99	1.01
Pancreas	6	3.96	1.54
Respiratory System	30	29.20	1.03
Larynx	0	1.20	0
Lung	29	27.79	1.04
Prostate	1	2.00	0.50
Testis	2	0.56	3.51
Kidney	0	2.11	0
Bladder	1	0.44	0.70
Skin	4	1.83	2.19
Eye	0	0.06	0
Brain	5	3.01	1.66
Thyroid	0	0.15	0
Bone	0	0.35	0
Hematopoietic	8	7.56	1.06
Lympho Sarcoma	2	1.64	1.22
Hodgkin's Disease	0	1.01	0
Leukemia	5	2.75	1.82
Other Lymphatic	1	2.02	0.49
Cancer Residual	4	5.32	0.75

* Although some PCMR's were elevated (>1), none were statistically significant ($p < 0.05$).

This final report represents a compilation of the data presented in previous letters and interim reports and includes a review of past exposure data.

III. BACKGROUND

Pratt and Whitney Aircraft is part of United Technologies Corporation. The Government Products Division, which was the subject of this evaluation, is based in West Palm Beach, Florida. This division primarily designs, develops, markets, and supports high performance jet and rocket engines for military use. Established in 1958, the plant is located on a 7,000-acre tract in Palm Beach County near the northern edge of the Everglades. Having a work force of 7200 people, it is reported to be the second largest employer in the state. There are 1465 hourly employees of which 1070 are represented by Local 971, IAM.

In August 1980, the Palm Beach County Health Department (PBCHD), which has regulatory authority, was notified by P&WA that various volatile organic compounds (VOC's) had been detected in the potable water supply of its facility. The contaminated wells were taken out of service and frequent monitoring was initiated. During the ensuing weeks P&WA met with PBCHD to discuss the extent of the problem and possible corrective actions. In December 1980, an aeration device was added to P&WA's water treatment plant, and three additional aeration units were added in January 1982. The aeration devices allow the VOC's to volatilize prior to the normal treatment process. In a letter to NIOSH dated February 2, 1982, the PBCHD stated that the aeration devices were effectively removing VOC's from the well water. P&W continued frequent monitoring and forwarded periodic reports to the PBCHD.

In an effort to determine what methods might be useful in evaluating whether the contaminated water had adversely affected the health of employees, P&WA contracted with the University of Miami to develop a study protocol. In a letter to P&WA dated November 2, 1981, the university investigators reported elevated blood chloroform levels in P&WA workers studied and the suggestion of a nine-fold increase in crude cancer-associated mortality rates among active employees at the P&WA facility over the past 18 years. This prompted P&WA to request NIOSH to further evaluate exposure to degreasing solvents and cancer mortality.

Although there are literally hundreds of chemicals used at the P&WA facility, the NIOSH investigation concentrated on the issue of exposure to chlorinated degreasing solvents. If other potentially significant exposures were observed during the course of the NIOSH field survey, they were to be brought to the attention of P&WA Health and Safety Personnel for corrective action.

Union officials were made aware of the scope of the NIOSH evaluation and were briefed as to the availability of Fort Lauderdale OSHA to respond to other issues of concern while the NIOSH study was in progress.

TABLE 10 (Continued)

Genito-Urinary	0	1.90	0
Nephritis	0	0.72	0
Diseases of Skin	0	0.13	0
Disease of Bones	0	0.45	0
Non-Specific	0	3.84	0
External Causes	43	49.12	0.88
Accidents	32	31.89	1.00
Suicide	8	10.62	0.75
Total Residual	5	1.62	3.08
Cancer Residual	4	3.45	1.16

* statistically significant ($p < 0.05$)

There were 15 chlorinated solvent degreasers in operation at the P&WA facility during the time of the NIOSH field visits. Most of the degreasers were manufactured by Detrex, and most were the original units installed in the late 1950's and early 1960's. Two of the degreasers were enclosed with local exhaust ventilation. All were vapor degreasers. Improvements such as roll-top lids and temperature safety switches were added over the years. The primary degreasing solvents used are Trichloroethylene (TCE), Perchloroethylene (PERC) and Methyl Chloroform (MC). Possible routes of exposure include breathing in-plant air contaminated with solvent vapors, skin absorption after direct skin contact with the solvents, and in the past, ingestion of contaminated drinking water. There are approximately 50-60 workers whose jobs requires them to spend part of their work day operating a degreaser.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

1. Water Contamination

Since water pollution is not an issue normally studied by NIOSH, EPA and the Palm Beach County Health Department (the local regulatory agency) were contacted for assistance in studying this issue. Past exposure to solvents in drinking water will probably remain unknown since this type of water analysis data was not available on the P&WA water system prior to 1980. (There was no requirement to run this type of analysis.) Up until March 1982, most of the water sampling was conducted by P&WA with analysis by one of several EPA approved laboratories. During the time frame of NIOSH's followup field survey (March 15-19, 1982) the PBCHD arranged to collect a number of raw and finished water samples for analysis by the EPA laboratory in Athens, Georgia. The sampling and analytical procedures were in accordance with EPA guidelines and are not presented in this report. However, the results are discussed in Section VI.

2. In-Plant Exposure to Degreasing Solvents

a. Current Exposures

It is general procedure when evaluating a workplace that has a large number of employees (>7000 in this case) to select a smaller group of workers who most likely have the highest exposures to monitor first. Accordingly, those individuals who were most likely to operate the vapor degreasers in each area during the time of our survey were evaluated.

TABLE 10

Cause Specific Proportional Mortality for 239 Deaths

CAUSE OF DEATH	OBSERVED	EXPECTED	PMR
Infective Disease	3	1.74	1.73
Tuberculosis	0	0.57	0
All Cancers	74	47.70	* 1.56
Buccal Cavity	1	1.64	0.61
Digestive Organs	18	11.11	* 1.62
Esophagus	2	1.14	1.76
Stomach	4	1.77	2.26
Large Intestine	3	3.71	0.81
Rectum	1	1.15	0.87
Liver	1	0.62	1.61
Pancreas	6	2.41	* 2.49
Respiratory System	30	17.89	* 1.68
Larynx	0	0.73	0
Lung	29	17.01	* 1.71
Prostate	1	1.33	0.75
Testis	2	0.57	3.51
Kidney	0	1.31	0
Bladder	1	0.91	1.10
Skin	4	1.23	* 3.26
Eye	0	0.04	0
Brain	5	2.06	* 2.43
Thyroid	0	0.09	0
Bone	0	0.30	0
Hematopoietic	8	5.47	1.46
Lympho Sarcoma	2	1.14	1.75
Hodgkin's Disease	0	0.86	0
Leukemia	5	2.08	* 2.40
Other Lymphatic	1	1.30	0.77
Benign Neoplasm	0	0.68	0
Allergic, Endocrine	4	4.07	0.98
Asthma	0	0.24	0
Diabetes Mellitus	1	3.04	0.33
Diseases of Blood	1	0.46	2.18
Mental Disorders	1	2.28	0.44
Nervous System	10	12.11	0.83
CNS	9	9.64	0.93
Circulatory	85	89.41	0.95
Rheumatic Heart	1	2.05	0.49
ASHD	73	75.87	0.96
Respiratory Disease	4	10.56	0.38
Pneumonia	0	3.86	0
Emphysema	2	2.57	0.78
Digestive System	9	14.02	0.64
Ulcer	2	1.07	1.87
Liver	2	9.24	0.22

(cont.)

TABLE 9a

Proportional Mortality For All Malignant Neoplasms
By Five Year Age

AGE	OBSERVED CANCER DEATHS	PROPORTIONAL MORTALITY RATIO
30-34	2	1.42
35-39	3	2.11
40-44	0	0.0
45-49	13	2.01
50-54	12	1.54
55-59	22	1.75
60-64	20	1.60
65-69	1	1.01
70-74	1	4.75
All Ages	74	1.56

TABLE 9b

Proportional Mortality for All Malignant Neoplasms
By Five Year Calendar Time

YEAR	OBSERVED CANCER DEATHS	PROPORTIONAL MORTALITY RATIO
1965-69	4	1.77
1970-74	21	1.20
1975-79	41	1.80
1980-	8	1.65
All Years	74	1.56

Each person monitored wore two sampling devices. One was run for the majority of the shift and estimated that individual's average exposure for that work day. The other was activated only when that person was operating a vapor degreaser. The latter will represent the average exposure while performing degreasing operations. A direct reading instrument (HNU Photoionization Meter) was used to estimate peak exposures during performance of specific degreasing tasks.

Area samples were positioned at selected locations (Table I) to estimate employee exposures in plant areas other than the immediate vicinity of the vapor degreasing units.

All air samples (except HNU data) were taken using standard 150 mg charcoal sorbent tubes and analyzed in accordance with the provisions of NIOSH Method P&CAM 127¹ with the following modifications:

Desorption Process:	Samples and standards were desorbed with 1 mL carbon disulfide containing 1 microliter per milliliter ethyl benzene as an internal standard.
Gas Chromatograph:	Hewlett-Packard Model 5731 equipped with a flame ionization detector.
Column:	12' x 1/8" stainless steel packed with 20% SP-2401, 0.1% Carbowax 1500 on 100/120 mesh Supelcoport.
Oven Conditions:	75°C isothermal.

b. Past Exposures

Past or "historical" environmental data was reviewed to evaluate worker exposures as far back in time as the data permitted.

B. Medical

1. Evaluation of Blood Chloroform Test

The Blood Chloroform Test used by the University hired by P&WA was being developed under contract with EPA.² Both EPA and the NIOSH Experimental Toxicology Branch, Division of Biomedical and Behavioral Science were conducted for technical assistance regarding interpretation of results.

2. Pre- and post-shift urine samples were collected from those employees working with degreasing solvents and were analyzed for total trichloro compounds (TTC). TTC compounds were determined by chromic acid oxidation of trichloroethanol to trichloroacetic acid and colorimetric analysis of the latter compound using Fujiwara reaction.³