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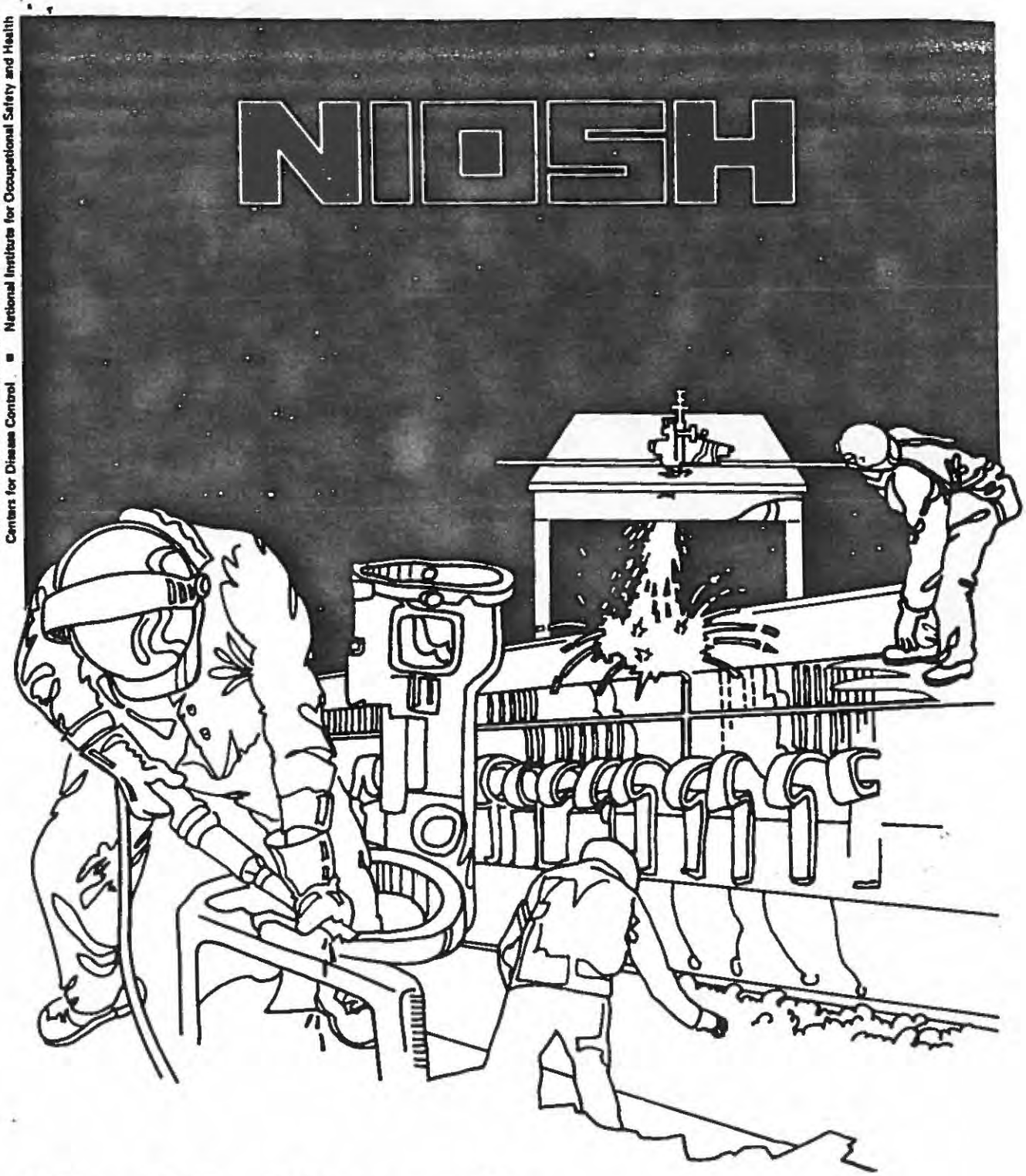

Health Hazard Evaluation Report

HETA 82-123-1258
GOODYEAR AEROSPACE CORPORATION
AKRON, OHIO

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.

HETA 82-123-1258
FEBRUARY 1983
GOODYEAR AEROSPACE CORPORATION
AKRON, OHIO

NIOSH INVESTIGATORS:
Paul L. Johnson, I.H.
Peter Boxer, M.D.

I. SUMMARY

In February 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate workers exposed to solvents in the Antiskid Manufacturing Area (Departments 652 and 645). At Goodyear Aerospace Corporation, Akron, Ohio, twenty-one employees in this area clean, inspect, test, repair, and assemble aircraft antiskid brake system components. Solvents escaping from two malfunctioning degreasers (one containing Freon, the other containing 1,1,1-trichloroethane) were believed to have caused health problems during the previous year.

On March 30, 1982, NIOSH conducted an environmental/medical evaluation that included air sampling for measurement of exposure to organic vapors and metals, review of selected company and private physician medical records, and the administration of a medical questionnaire to 21 exposed workers (Departments 652 and 645) and to 17 non-exposed (Department 675) workers.

At the time of the survey, the Freon degreaser had been shut down and ventilation was increased to the area. Four air samples (two personal breathing zone and two general area) indicated that the primary solvent vapor in the area was 1,1,1-trichloroethane from a small ultrasonic degreaser and that exposure levels were less than 5 ppm (8-hour, time-weighted average). The current OSHA standard is 350 ppm while NIOSH recommends that this solvent be handled with caution by minimizing exposure based on the National Cancer Institute Bioassay testing of closely related chloroethanes, which were found to be carcinogenic in laboratory animals.

Between March 1981 and January 1982, approximately 20 cases of possibly solvent-related health problems were recorded in the clinic records. No such cases were recorded for February and March 1982.

The questionnaire data suggest that a variety of health problems, including dizziness, headache, and mucous membrane irritation occurred at a higher than expected frequency in the antiskid manufacturing department over a period of several months prior to the NIOSH investigation. According to both questionnaire data and clinic records, complaints decreased after installation of improved ventilation, and essentially ceased after the Freon degreaser was shut down in early February 1982.

Information collected suggests that the two malfunctioning degreasers and less than adequate general ventilation were likely responsible for the health problems experienced during the previous year. However, no health hazards were identified at the time of the NIOSH survey. Several deficiencies were noted which may be responsible for employee discomfort and, under higher production rates, may result in more significant health effects. Recommendations are presented in Section IX to further minimize potential exposures to solvents.

KEYWORDS: SIC 3728 (Aircraft Parts and Auxiliary Equipment), Freon, 1,1,1-Trichloroethane, Methyl Chloroform.

II. INTRODUCTION

In February 1982, NIOSH was asked by an authorized representative of UAW, Local 859 at Goodyear Aerospace Corporation, Akron, Ohio, to evaluate employee exposures to airborne contaminants generated in the Wheel and Brake Antiskid Assembly Area. Several months prior to the submittal of the request, four workers from this area became ill and reported to the company medical department with symptoms which included headaches, dizziness, nausea, tiredness, burning eyes, rash, and dry skin. Earlier, in March 1981, 11 workers from the same area had been seen in the medical department for similar health complaints.

III. BACKGROUND

The antiskid area is situated in a concrete block structure within a large hangar. Major activities include inspection, cleaning, repair, and testing of wheel and brake antiskid system components. Twenty-one employees are assigned to this area. All work first shift (day shift), except two that are on second shift and one on third shift. Two degreasers are used in the cleaning process: a Freon degreaser and an ultrasonic, 1,1,1-trichloroethane (methyl chloroform) degreaser. Prior to the NIOSH survey, there were problems with the operation of both degreasers. The major deficiency, in both cases, involved the chiller coils which are responsible for condensation of the solvent vapors. There were also deficiencies in the operation of the exhaust and air supply systems that service this area. The following actions had been taken by Goodyear prior to the NIOSH survey in an effort to achieve better air quality in the Antiskid area.

A. A project was developed to relocate both degreasers outside of the main Antiskid Assembly area.

B. The Freon degreaser was shut down.

C. A new heat exchanger was installed in the 1,1,1-trichloroethane degreaser.

D. Air flow was increased to the area.

E. Ventilating systems were balanced.

IV. METHODS

A. Environmental

After a walk-through of the Antiskid area to observe the work process and evaluate material usage, the decision was made to conduct air sampling for organic vapors and metals. Since the Freon degreaser was shut down, the primary organic air contaminant was expected to be 1,1,1-trichloroethane emitted from the ultrasonic degreaser. Methyl ethyl ketone (MEK) was used in small quantities (usually in open trays) to clean parts. Since small

quantities of a variety of oils and cleaning solvents were used, two bulk air samples were obtained for qualitative organic vapor analysis.

Air samples were obtained using a standard charcoal tube technique. Air was drawn through 150 mg charcoal tubes at a rate of 50 cubic centimeters per minute (cc/min) using battery-operated sampling pumps. The two personal breathing zone samples were obtained by attaching the charcoal tube on the collar, near the breathing zone of the worker.

The charcoal tubes were analyzed on a gas chromatograph equipped with a flame ionization detector after desorption with carbon disulfide. Contaminant peaks on the bulk air samples were identified by further analysis using mass spectrometry.

One worker in the RGR area was engaged in silver soldering activities on the day of the NIOSH survey. This worker was monitored for metals exposure using a mixed cellulose ester membrane (AA) filter at a sampling rate of 1 liter per minute (lpm). The sample was ashed with concentrated nitric acid and the residue dissolved in dilute nitric and perchloric acids. The resulting solution was analyzed for 27 trace metals by Inductively Coupled Plazma-Atomic Emission Spectrometry.

B. Medical

A questionnaire was administered to 21 employees in Departments 652 (Antiskid Manufacturing) and 645 (Inspectors). The questionnaire contained questions pertaining to demographic information, medical history, occupational history, job parameters, and adverse health effects which have been reported in the literature to result from excessive exposure to solvents. Included were questions pertaining to eye, nose, and throat irritation; skin irritation or rash; nausea or vomiting; numbness or tingling of arms or legs; loss of muscle strength; headache; dizziness; lack of coordination or loss of balance; reduced ability to concentrate; and behavioral changes. Seventeen employees, primarily from Department 675 (Return Goods Area - Customer Service and Modification), served as an unexposed comparison group, and filled out an identical questionnaire.

Company medical records of employees of Departments 652 and 645 were reviewed. In addition, employees who had seen private physicians for possibly work-related conditions signed releases permitting NIOSH to obtain their medical records.

V. EVALUATION CRITERIA

A. Fluorocarbons[1-3]

Freon TF (Fluorocarbon 113) is a trade name for trichlorotrifluoroethane. Fluorocarbons are a group of organic materials which are used as refrigerants, aerosol propellants, and degreasers of electronic equipment. Their irritative effects are relatively mild, but may become severe if the fluorocarbon contacts an open flame or heated metallic object, yielding highly irritant decomposition products. Dermatitis is rarely seen. Acute exposure to high levels can lead to tremors and incoordination. Exposure to high levels of fluorocarbon vapor may cause sleepiness, dizziness, and unconsciousness. Sudden deaths due to cardiac arrhythmias have been reported at extremely high concentrations, above those found in industry. The OSHA standard for the vapors of this substance is 1000 ppm.

B. 1,1,1-Trichloroethane[1,3,4]

1,1,1-Trichloroethane (methyl chloroform) is a degreaser and solvent of relatively low toxicity. Vapor may be mildly irritating to eyes. At vapor concentration over 1000 ppm, anesthetic effects including lightheadedness, dizziness, and incoordination have been reported. Liver and kidney toxicity are low. As is the case with other halogenated hydrocarbons, cardiac arrhythmias resulting from excessive exposure have been reported. No physiological effects have been reported when vapor concentrations are below the TLV. Repeated skin contact can lead to dermatitis secondary to defatting. NIOSH recommends that 1,1,1-trichloroethane be treated in the workplace with caution because of its similar chemical structure to four other chloroethanes which have been shown to be carcinogenic in laboratory animals.[6] The current OSHA standard is 350 ppm.

C. Methyl Ethyl Ketone (MEK)[3,5]

MEK may be absorbed via inhalation or percutaneously. Vapors may irritate the eye, nose, and throat. High concentrations can cause central nervous system toxicity, manifested by headache, nausea, lightheadedness, vomiting, dizziness, incoordination, and unconsciousness. Toxic concentrations are not voluntarily inhaled since they are highly irritating. Repeated skin exposure to MEK can cause a dermatitis. The current OSHA standard is 200 ppm.

VI. RESULTS

A. Environmental

1. Air Sampling

The two general area and two personal breathing zone air samples for 1,1,1-trichloroethane ranged from 3.3 to 5.1 ppm (see Table I). Trace amounts of MEK, methyl isobutyl ketone, toluene, and cellusolve acetate were found on the air sample obtained for qualitative analysis. Air concentrations ranged from 0.1 to 0.6 ppm for each of these solvent vapors. This area air sample was located to maximize the chance of finding an airborne vapor concentration; therefore, personal exposures to these substances for the work shift would have been significantly less than the range indicated above. There were no detectable amounts of any organic vapor except 1,1,1-trichloroethane on either of the two breathing zone samples.

Trace amounts of sodium and phosphorus were detected on the air sample taken for metals analysis. Concentrations were considered as being background level. No other metal was identified on this sample.

2. Ventilation

Ventilation was increased from 9200 CFM to 10450 CFM in this area, which placed it under a positive pressure with respect to the hangar. There was a very noticeable air current through the doors from the Antiskid area to the hangar.

A table-top exhaust booth and a clean-table exhaust hood were both operating efficiently, having an average capture velocity at the face in excess of 150 feet per minute.

3. General Observations

The following deficiencies were noted during the survey and were discussed at the closing conference.

a. Open trays of MEK were being used in a horizontal, laminar flow, clean bench. Room air was drawn through high-efficiency particulate air (HEPA) filters in the base of the cabinet, directed up the back of the cabinet, and released through a laminar flow grill toward the face of the hood to prevent dust contamination on the parts being handled (similar to Sketch A, Figure I). HEPA filters do not remove organic vapors; therefore, the solvent vapors from the cleaning solvents are directed at the face of the worker. If solvents are to be used in these cabinets, they should be exhausted to the outside of the hangar (similar to Sketch B, Figure I).

b. Several containers containing liquids were not marked as to the contents.

c. In another part of the hangar, aircraft tires are tested on a dynamometer. Occasionally, a tire blows. The heavy smoke that is generated contaminates the hangar area and all buildings within the hangar. Exposure levels to the emission products are unknown, since there has not been an industrial hygiene evaluation during such an event. However, the reportedly obnoxious odors cause considerable discomfort to the workers in any area that they permeate.

B. Medical

The questionnaire of one exposed individual contained insufficient information for use in the analysis. Accordingly, data obtained from 20 exposed and 17 unexposed individuals were analyzed. The mean age of the 20 exposed workers was 53 years (range 34 to 62), compared to a mean age of 43 years (range 19 to 60) for the unexposed workers.

The following symptoms were reported on the questionnaire:

Symptom	20 Exposed Workers	17 Unexposed Workers
Skin Rash/Dry/Irritation	11	9
Impaired Memory	9	1
Eye Irritation	8	7
Nose/Throat Irritation	7	6
Dizziness	7	3
Headache	6	4
Nausea/Vomiting	4	2
Unusually Cold Fingers	4	1
Loss of Muscle Strength	4	2
Trouble Concentrating	3	1
Lack of Coordination	3	0
Numbness/Tingling in Extremities	3	3
Behavioral Changes	2	0

The difference between the proportion of exposed and unexposed individuals reporting each symptom is not statistically significant at the 5% level, except for impaired memory ($p=0.018$, Fisher's exact test, one-tailed). This was also true when inspectors, who have much lower exposures, were excluded from the analysis.

For 10 of the 13 symptoms included on the questionnaire, the proportion of exposed individuals reporting the symptom exceeded the proportion of unexposed individuals with the symptom. The probability that such a pattern could occur by chance alone is less than 1% ($p<0.01$, Wilcoxon Signed Rank Test).

Review of company medical records revealed that since March 1981, 11 of the individuals in the exposed group had been seen at the company clinic for dizziness and faintness, problems possibly related to exposure to solvent vapors. In November 1981, four individuals presented to the clinic with a variety of symptoms which they related to excessive fumes, including fatigue, headache, blurred vision, drowsiness, faintness, and shortness of breath. At that time, these symptomatic individuals and six other asymptomatic workers in the same department received laboratory tests, including a complete blood count, blood chemistry profile and, in some cases, chest X-rays. Only one abnormal laboratory result was found, a slightly elevated SGPT in one asymptomatic worker (SGPT=55; upper limit of normal=50). This worker was seen by a private physician and the SGPT elevation was confirmed. While the reason for the isolated elevation of a liver enzyme was not clear, at the private physician's request, the employee was removed from the work area which contained potentially hepatotoxic chemicals. A repeat SGPT was 27 in February 1982, and this worker returned to the Antiskid Manufacturing Department. Liver function tests will be obtained on this employee periodically. Four other workers from the Antiskid Manufacturing Department saw the same private physician in November 1971 and had a physical examination and laboratory tests. The chemistry profiles of each were normal, and no medical disorders with a likely occupational etiology were noted.

Two complaints of nausea from exposure to excessive solvent fumes were reported in January 1982. One worker was reported to have collapsed with brief loss of consciousness in January. She quickly recovered when she was removed to fresh air and oxygen was administered. No possible solvent-related health problems were recorded in the clinic records for February-March 1982.

Other than solvent exposure, the only other issue raised by the workers concerns dermatitis. Two products routinely used in the Antiskid process are "Skydrol 500" and "Chevron Hyjet 4". The "Skydrol 500" is a fire-resistant hydraulic fluid made by Monsanto. Their Material Safety Data Sheet for this product indicates that it is primarily a phosphate ester and may cause irritation. The "Chevron Hyjet 4" is made by Chevron and is primarily tributyl phosphate, which is an irritant to the eyes, skin, and respiratory system. Workers commented that gloves were to bulky or that the chemicals eat through the gloves. A barrier cream is supplied to the workers, and a number of workers who use the cream reported that, to some extent, it protects against the irritant effects.

VII. DISCUSSION

In general, increased airflow to the area and the shut-down of the Freon degreaser have resulted in a much improved work environment according to the workers. Conditions on the day of the NIOSH survey represented a minimal exposure situation due to these improvements and also due to the slow production rate. Employees felt that work was off as much as 50% compared to some periods in 1981 when there was a significant amount of overtime worked.

The proportion of exposed workers reporting any specific symptom was not statistically significantly higher than the proportion of unexposed workers reporting the same symptom, except for impaired memory. The average age of the exposed group was 10 years higher than that of the unexposed group, and the median age of the exposed workers reporting memory loss was 56 years. It is possible that the higher frequency of impaired memory in the exposed group affects the disparity in ages between the exposed and unexposed individuals. When inspectors (mean age=53 years, same as for exposed group as a whole) were excluded from the exposed group in order to include only those workers most heavily exposed to solvent vapors, the difference between the proportion of exposed and unexposed workers reporting impaired memory remains statistically significant.

Caution must be exercised in interpreting differences in the frequency of symptoms in exposed and unexposed groups on the basis of statistical significance, because of the small size of the study group. Also, the majority of the "unexposed" comparison group are exposed to solvents, although not to Freon, and probably to a lesser extent than the workers in the exposed group. Thus, any difference in frequency of symptoms due to solvent exposure will tend to be obscured because of the comparison group's exposure. It is noteworthy that despite this major difficulty with the comparison group, for 10 of 13 of the symptoms on the questionnaire, the proportion of workers in the Antiskid Manufacturing Department reporting the symptoms exceeded the proportion of individuals in the comparison group with the symptoms, a result which is statistically significant at $p<.01$. The questionnaire data thus suggest that a variety of health problems did indeed occur at a higher than expected frequency in the Antiskid Manufacturing Department over a period of several months prior to the NIOSH investigation. According to both questionnaire data and clinic records, complaints decreased after installation of improved ventilation, and essentially ceased after shutting down the Freon degreaser in early February.

VIII. CONCLUSION

Information collected suggests that the two malfunctioning degreasers and less than adequate general ventilation were likely responsible for the health problems experienced during the previous year. However, no health hazards were identified at the time of the NIOSH survey. Several deficiencies were noted which may be responsible for employee discomfort and, under higher production rates, may result in more significant health effects. The following recommendations are presented to eliminate or minimize potential exposures to solvents in the Antiskid area.

IX. RECOMMENDATIONS

1. The Freon degreaser should not be used until the proposed relocation to an area outside of the main Antiskid assembly area occurs.

2. The exhaust system in the area where the degreasers are to be relocated should be given special attention since the intended space is even smaller than the area where they are currently located. The following engineering controls will help to minimize exposure to degreasing solvent vapors.

   a. Install lip exhausts to the outside of hangar.

   b. Install roll-top lid that automatically opens or closes at the touch of a button.

   c. Install automatic unit shut-off when either the solvent temperature or the cooling coils get too hot.

   d. Utilize a hoist speed of 11 fpm or less. The current hoist that services the Freon degreaser was set at 30 fpm. A slower speed will minimize solvent exposure due to "solvent dragout".

3. Finding a satisfactory glove for protection against the Monsanto Skydrol 500 and Chevron Hyjet 4 products will need to be a trial and error procedure. Chevron recommends a polyethylene glove and Monsanto recommends an NRB glove. Any glove manufacturer can be contacted for assistance in finding a glove material that meets chemical resistance and dexterity requirements. Neither product has actually been submitted to permeation testing. If it is not possible to find thin enough gloves which can resist the corrosive action of Skydrol and Chevron Hyjet 4, use of the barrier cream by all workers using these materials should be actively encouraged.

4. Solvent cleaning of parts should be done only where the hood is exhausted to the outside.

5. All containers of solvents or other liquids should be clearly labeled as to their contents and kept covered when not in use.

6. The fans that evacuate the contaminated air from the dynamometer test area should be attached to a dual system that would direct the emission products to the outside of hangar when a tire blows.

X. REFERENCES

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XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Paul L. Johnson Industrial Hygienist Industrial Hygiene Section
	Peter Boxer, M.D. Medical Officer Medical Section
Field Assistance:	Richard Gorman Industrial Hygienist Industrial Hygiene Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies
Report Typed By:	Debra A. Lipps Clerk-Typist Industrial Hygiene Section

XII. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. UAW, Local 859
2. Goodyear Aerospace Corporation
3. NIOSH, Region V
4. OSHA, Region V

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 I

Air Sampling Results

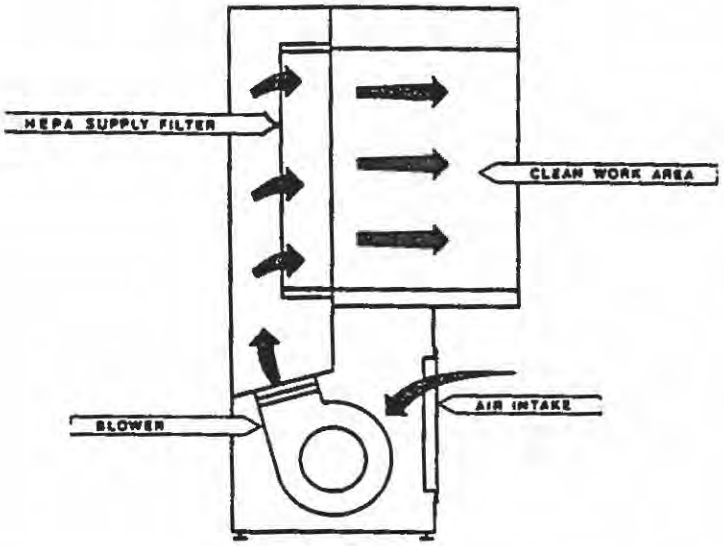
Goodyear Aerospace Corporation
Akron, Ohio
HETA 82-123

March 30, 1982

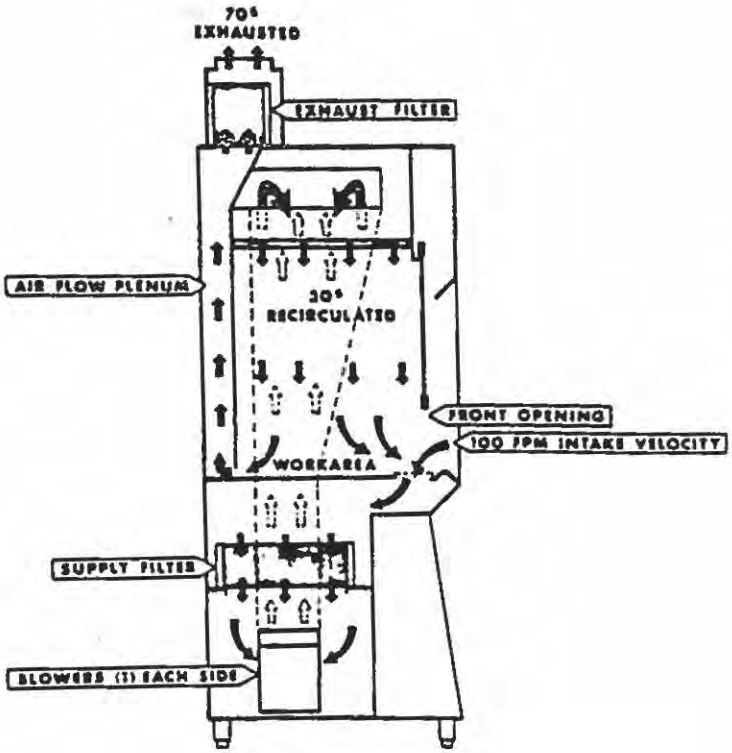
Sample Description	Sample Type	Sampling Time	Sample Volume, Liters	1,1,1-Trichloroethane (ppm)
Worker, Valve Repair	PBZ*	0735-1510	22	4.5
Tric Degreaser, Left Side, Next to Spray Nozzle	Area	0735-1515	24	5.1
Tric Degreaser, Just Below Top Rim of Solvent Reservoir	Area	0755-1515	21	4.6
RGR Worker	PBZ	0758-1523	24	3.3
OSHA Standard (8-Hour TWA)				350
NIOSH Recommended Criteria				**

* PBZ: Personal Breathing Zone

** In light of NCI Bioassay data on other chloroethanes that have been shown to cause cancer in animals, NIOSH recommends that exposure to 1,1,1-trichloroethane (methyl chloroform) be minimized until ongoing studies are completed.



Sketch A. Hrizontal Laminar Flow Clean Bench



Sketch B. Class II-Type B Biological Safety Cabinet

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