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 NO. 77-63-449

McDONNELL AIRCRAFT COMPANY
ST. LOUIS, MISSOURI

DECEMBER 1977

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health on July 11-14, 1977, at the McDonnell Aircraft Company in St. Louis, Missouri. Based on the medical evaluation of employees in Department 151 and the industrial hygiene survey, it is determined that employees were not exposed to toxic concentrations of contaminants during this evaluation. Potential contaminants studied included: iron oxide, nickel, chromium, sulfuric acid, sodium hydroxide, hydrochloric acid, hydrofluoric acid, nitric acid, hydrogen sulfide, sulfur dioxide, nitrogen dioxide, nitric oxide, toluene, xylene, benzene, refined petroleum solvents, tetrachloroethylene, acetone, and styrene.

It is our opinion that workers in the masking operations may occasionally be exposed to concentrations of organic solvents, and workers involved in the etching operations may occasionally be exposed to concentrations of acids and/or associated emissions such as nitric acid, nitrogen dioxide and nitric oxide which have produced medical symptoms among the employees. These substances are known to produce nose, throat and skin irritation, dizziness and headaches - symptoms which were reported by workers in private interviews during the survey and are important indications of excessive exposure.

From this limited evaluation, the authors feel that no definitive statement can be made concerning the workers in Department 151 having an increased incidence of deaths which could be directly attributed to occupational exposure.

Detailed information and some recommendations concerning the results of the medical-environmental evaluation are contained in the body of this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services; Information 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:

a) McDonnell Aircraft Company; St. Louis, Missouri
b) Authorized Representatives of Employees
c) Local Union - Lodge 837; Director of Health and Safety; International Union Headquarters
d) U.S. Department of Labor - Region VII
e) NIOSH - Region VII

For the purpose of informing the approximately 77 "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 (NIOSH) received such a request from an authorized representative of Aerospace District Lodge 837, International Association of Machinists and Aerospace Workers, AFL-CIO, regarding the employees' alleged complaints that on "some days, the fumes are so bad that there is a stinging sensation in the nose. We also absorb these fumes through pores in the skin". The request also expressed some concern because of the number of men that have passed away in the Department over the last 5 years. The request covered the chemical milling operations in Department 151 in Buildings 51 and 52.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

McDonnell Aircraft Company has 22,100 employees involved in various aspects of manufacturing aircraft. The chemical milling operations of metal parts are conducted in Buildings 51 and 52. Approximately 70 percent of the parts (6000 per week) are aluminum alloys, 30 percent (3000 per week) are titanium alloys, and approximately 30 parts are steel alloys such as inconel.

Operations in Building 51 involve metal cleaning, masking and scribing areas. The cleaning operations involve six tanks (e.g., 1 alkaline soap, three rinse, 1 deoxidizer, 1 desmut) of 4000 gallon capacity. There is a potential exposure primarily to sodium chromate, chromic acid, sulfuric acid, and hydrofluoric acid in the cleaning area. No ventilation was

provided on these tanks. The parts are dipped in a liquid coating (solvents with styrene-butadiene synthetic rubber) and allowed to dry at room temperature on a slow-moving conveyor or rack system. The liquid mask for large parts is added via a hose. There is a separate area for dipping of titanium and steel parts. The scribing operations involve cutting off the solid rubberized mask on various parts prior to etching. There is a potential exposure to toluene, xylene, naphtha (benzene), styrene, perchloroethylene, and acetone in the masking and scribing areas. Employees involved in the masking operations are rotated every 4 hours and are provided respirators.

Operations in Building 52 involve aluminum etch, titanium etch and steel-titanium etch areas. The aluminum etching operations involve six tanks (e.g., 3 etch, 1 desmut, 2 rinse) of 3300 gallon capacity. All three etch tanks are provided with slot ventilation with a face velocity of approximately 800 linear feet per minute. There is a potential exposure primarily to sodium hydroxide, nitric acid and hydrofluoric acid. The titanium etching operations involve two tanks (e.g., etch and rinse) of 4400 gallon capacity. There is a potential exposure primarily to nitric acid and hydrofluoric acid. The titanium etch tank is provided with slot ventilation with a face velocity of approximately 800 linear feet per minute. The steel-titanium etching operations involve a line of five tanks of 500 to 600 gallon capacity. Tank 1 contains a concentrated metal salt (e.g., iron, nickel, chromium), nitric acid, and hydrochloric acid. Tank 2 contains hydrochloric acid and Tank 3 is a water rinse solution. Tanks 4 and 5 involve potential exposure primarily to nitric acid and hydrofluoric acid. All five tanks are provided with slot ventilation with a face velocity of 800 linear feet per minute.

B. Evaluation Progress and Methods

1. Progress

An initial walk-through survey was conducted on May 18-20, 1977, to better identify potential exposures to the various contaminants. Several employees were interviewed to more fully quantitate the complaints from employees. Subsequent contacts were made with various manufacturers of products used in the operations covered by this evaluation to more fully quantitate potential exposure. A follow-up environmental-medical survey was made during July 11-14, 1977. The follow-up survey was accomplished during normal operations. Activities (e.g., processing of larger parts, change or make-up of solutions, etc.) which may generate higher concentrations of the contaminants were not conducted at the time of the survey. For instance, only a few titanium parts were masked and there was minimal metal cleaning operations conducted during the survey. It is noted that McDonnell Aircraft Company has industrial hygiene personnel who have conducted previous surveys of various contaminants in both Buildings 51 and 52.

2. Evaluation Design and Methods

Breathing zone samples (plus some general area samples) were obtained on workers who were considered to have the highest potential exposure. The following is a summary of the sampling methods used during the survey:

a. Charcoal tube samples were obtained for organic vapors (e.g., toluene, xylene, benzene, petroleum solvents, perchloroethylene and acetone). These samples were collected using Sipin pumps at a sampling rate of 50-200 cubic centimeters of air per minute (ccm).

b. Midget impinger samples were obtained at 1000 ccm using MSA Model "G" Pumps. The impinger solutions used were: 15 percent sodium acetate for analysis of hydrofluoric acid; triethanolamine for analysis of nitrogen dioxide; 7.5×10^{-3} N hydrochloric acid for analysis of sodium hydroxide; 0.1 N sodium hydroxide for analysis of nitric acid; and 0.5 N sodium acetate solution for analysis of hydrochloric acid.

c. Filter samples in three-piece cassettes were obtained at 1700 ccm using MSA Model "G" Pumps. AA filter samples were obtained for nickel-chromium-iron, and sulfuric acid. Polyvinylchloride (PVC) filters were obtained for chromic acid.

All of the above samples were analyzed in accordance with appropriate procedures contained in the NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 75-121, Cincinnati, Ohio 1974. In addition, direct reading gas detector tubes were used to evaluate the employees' exposure to potential airborne contaminants such as nitrogen dioxide, hydrogen sulfide, and sulfur dioxide. Further explanation of the regulations regarding gas detector tubes appear in the Code of Federal Regulations (CFR) as Title 42 CFR Part 84 under the Occupational Safety and Health Act of 1970.

A medical survey consisting of questions concerning the employees' work history, work hygiene, smoking history and a history of past and current symptoms was administered to 32 of 77 employees comprising the two shifts in Buildings 51 and 52. The survey was preceded by a walk-through of these buildings to acquaint the medical examiners with each station and step of the chemical milling process.

C. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are: (a) NIOSH Criteria Documents with recommended

standards for occupational exposure; (b) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation; and (c) Federal Occupational Health Standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor (29 CFR 1910.1000). For the substances evaluated during this study, the primary environmental criteria used were:

SUBSTANCE	STANDARD OR GUIDE mg/M3*
Iron oxide, fume (Fe_2O_3)	5.0 (b)**
Nickel, inorganic and compounds as Ni	0.015 (a)
Chromic acid as chromium trioxide (CrO_3)	0.05 (a)
Chromium VI as Cr	0.001 (a)
Sulfuric acid (H_2SO_4)	1.0 (a,b,c)
Sodium hydroxide (NaOH)	2.0 (a,b) (15 minute sampling period & 8-hour TWA)
Nitric acid (HNO_3)	5.0 (a,b,c)
Hydrofluoric acid (HF) as fluoride	2.5 (a,b,c)
Hydrochloric acid (HCl)	7.0 (b)
Hydrogen sulfide (H_2S)	15.0 (a) (10 minute sampling period)
Sulfur dioxide (SO_2)	5.0 (a)
Nitrogen dioxide (NO_2)	1.8 (a)
Nitrogen oxide (NO)	30.0 (a)
Toluene	375.0 (a,b)***
Xylene	434.0 (a,b)
Benzene	3.2 (a)****
Refined petroleum solvents	350.0 (a)
Tetrachloroethylene (perchloroethylene)	339.0 (a)
Acetone	2400.0 (a)
Styrene, monomer (Phenlethylene)	420.0

*Approximate milligrams of substance per cubic meter of air sampled.

**Reference letters in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

***In case of a mixture of air contaminants which produce similar biological effects, particularly with organic solvents, the overall effects are considered as additive. An employer shall compute the equivalent exposure as follows:

$$*Em = \frac{C_1}{L_1} + \frac{C_2}{L_2} \ldots \frac{C_n}{L_n}$$

Where:

Em is the equivalent exposure for the mixture.
C is the concentration of a particular contaminant.
L is the exposure limit for that contaminant, from Table Z-1, Z-2, or Z-3.

*The value of Em shall not exceed the value of 1.

****The current ACGIH-TLV for benzene is 30 mg/M^3 with a reference that benzene is a chemical substance associated with industrial processes which are suspect of inducing cancer in man. However, recent studies from clinical as well as from epidemiological data are conclusive at this time that benzene is leukemogenic because it produces progressive, malignant disease of the blood-forming organs. Based on this more recent data NIOSH recommended to OSHA that an emergency standard for benzene be 3.2 mg/M^3. OSHA has recently published an emergency standard for benzene of 3.2 mg/M^3.

Occupational health exposure limits for individual substances are generally established at levels designed to protect workers occupationally exposed on an eight-hour per day, 40 hour per week basis over a normal working lifetime.

Two compounds which were also studied during this evaluation are not included in the above list as the two compounds are considered as business confidential - proprietary information under paragraph 5(b) of NIOSH's regulations on health hazard evaluations (42 CFR Part 85). Sample results for these two compounds were less than one percent of the established environmental criteria. Therefore, these two compounds are not considered further in this report as the two compounds are not considered as significant from an exposure standpoint.

2. Medical Criteria

a. Toxic Substances[1,2,3,4,5,6,7]

(1) Iron Oxide (Fe_2O_3)

Inhalation of iron oxide fume or dust causes an apparently benign pneumoconiosis termed siderosis. Fe_2O_3 alone does not cause fibrosis in animals' lungs and the same probably applies to humans. Such medical problems should not occur at levels less than the environmental criteria of 5 mg/M^3.

(2) Nickel, Inorganic Compounds

Many lung cancers and nasal cancers in nickel refinery workers appear to have been induced by inorganic nickel, and no single nickel-containing substance can be implicated as the causative agent. NIOSH, therefore, recommends that all forms of inorganic nickel be controlled as carcinogens. NIOSH has also found that workers can be adversely affected by skin contact with nickel, and that because nickel is often found in the non-occupational environment, some individuals may develop a sensitivity to nickel regardless of precautions taken in the workplace. It is recognized, therefore, that the recommended standard cannot completely protect these individuals from developing recurrent dermatitis when occupationally exposed to nickel. However, the recommended standard will greatly reduce the risk of unsensitized workers becoming sensitive to nickel in the course of their employment.

(3) Chromic Acid, Chromium VI

Chromic acid is a strong oxidizing agent but not a strong acid. However, chromic acid and chromate dusts are severe irritants of the nasopharynx, lungs and skin. Chromium compounds, especially the hexavalent compounds, are associated with high incidence of bronchogenic cancer in humans. Continued inhalation may lead to perforation of the nasal septum. Certain forms of chromium VI produce skin ulcers, lung irritation and lung cancer.

(4) Sulfuric Acid

Sulfuric acid is a severe irritant of the eyes, respiratory tract and skin. It destroys tissue due to an intense dehydrating action when concentrated; milder irritation results when dilute. Systemic effects on acute exposure include pulmonary fibrosis, bronchiectasis and emphysema.

(5) Sodium Hydroxide

Lye, common name of sodium hydroxide, exerts extreme corrosive action on eyes, mucous membranes and skin. Extreme pulmonary irritation may result upon inhalation of aqueous mist.

(6) Nitric Acid

Nitric acid is a powerful oxidizing agent and an irritant to eyes, mucous membranes and skin. High concentrations in mist or vapor may cause pneumonitis, pulmonary edema and fibrosis. Burns as a result of direct contact are similar to those of other strong acids with an additional yellow stain at the site of the burn. Erosion of teeth has also been noted.

(7) Hydrofluoric Acid

Hydrofluoric acid as a gas or mist is a severe respiratory irritant and in solution causes severe and painful burns of the skin. It is also a primary irritant of the eyes and other exposed mucous membranes. The burns of the skin result due to deep tissue destruction as the fluoride ion readily penetrates the skin and causes necrosis of soft tissues and decalcification of bone. Exposure to low concentrations may produce a chronic irritation of the nose, throat and bronchi. Bronchial irritation may then result in pulmonary edema.

(8) Hydrochloric Acid

HCl gas is an irritant of the eyes, mucous membranes and skin. Exposure to the gas causes severe upper respiratory irritation which results in cough, burning throat and a choking sensation. Gross anatomical inspection reveals local inflammation and ulceration of mucous membranes of nose, throat and larynx. Chronic exposure may lead to erosion of teeth.

(9) Hydrogen Sulfide

The greatest danger is from the acute effects of hydrogen sulfide. Systemically, high concentrations can become an asphyxiant as hydrogen sulfide can depress the respiratory centers of the brain, resulting in death. Chronic exposure may lead to respiratory tract pneumonitis and pulmonary edema, gastro-intestinal problems, headache, dizziness, chest pain and cough. It is also irritating to the eyes and to mucous membranes of the nose and throat.

(10) Sulfur Dioxide

Locally, sulfur dioxide is irritating to conjunctiva and mucous membranes of the upper respiratory tract. High exposure may produce laryngeal edema, and therefore, death by asphyxiation; otherwise, it causes bronchitis, penumonitis, pulmonary edema and death. Low exposures result in nasopharyngitis, fatigue, altered sense of taste and smell, and dyspnea upon exertion. Its irritant properties are due to the rapidity with which it forms sulfurous acid on contact with moist membranes.

(11) Nitrogen Oxides (Nitric Oxide and Nitrogen Dioxide)

These vapors are irritating to the eyes and mucous membranes. High concentration causes respiratory irritation, coughing, chest pain and eventual pulmonary edema. Lower exposures may show only mild bronchial exposure to be followed later by acute pulmonary edema. This may result later in bronchiectasis or emphysema. Methemoglobinemia of mild degree has also been noted upon exposure to nitrous fumes containing small amounts of nitric oxide. The chief toxic effect of NO has been ascribed to the formation of methemoglobin and subsequent action on the central nervous system. The effects of exposure to NO and NO_2 are considered additive.

(12) Toluene

Toluene is seldom a source of acute poisoning in industry. The vapor is primarily an irritant of skin, eyes and mucous membranes of the upper respiratory tract. Primary effect of chronic and acute exposures is central nervous system depression and narcosis. Unlike benzene, little hematologic effect is seen.

(13) Xylene

Xylene in concentrated vapor is irritating to the eyes, nose and throat. Repeated skin contact will cause dermatitis with drying and fissuring. Xylene vapor is also narcotic and may act as a vasodilator.

(14) Benzene

In high concentration benzene causes narcosis. Concentrations above 3000 ppm are irritating to the eyes, nose and respiratory tract; continued exposure may cause an initial state of euphoria followed by giddiness, headache, nausea, a staggering gait and narcosis. The greatest hazard, however, is that benzene can have an insidious and often irreversible effect of injury to the bone marrow. This may result in aplastic anemia, benzene-induced leukemia, bleeding under the skin and other effects associated with decreased clotting ability of blood. Dermatologic effects are erythema, vesiculation or a dry dermatitis.

(15) Refined Petroleum Solvent

Naphtha or petroleum vapor is narcotic. High concentrations may cause lightheadedness, drowsiness, possibly irritation of eyes, nose and throat. Direct contact may defat the skin leading to drying or cracking of the skin. Naphtha vapor is also irritating to conjunctiva and mucous membranes of the upper respiratory tract.

(16) Tetrachloroethylene (Perchloroethylene)

This solvent is primarily used for degreasing. Again, its vapor is narcotic with symptoms of headache, dizziness, nausea, uncoordination and somnolence. The vapor also causes irritation of the eyes and upper respiratory tract. Liver involvement, a mild hepatitis, may occur. Tests conducted by the National Cancer Institute have shown that tetrachloroethylene has carcinogenic potential.

(17) Acetone

Exposure to very high vapor concentrations well above those easily recognizable by odor can cause eye, nose and throat irritation. Very high concentration exposure can result in narcosis. Due to the defatting action of acetone, blisters, dermatitis, and ulcers may be caused by direct contact to the skin. The central nervous system involvement includes headaches, dizziness, uncoordination, stupor, general feeling of oppression and unconsciousness.

D. Evaluation Results and Discussion

1. Environmental Results and Discussion

Table IA shows the results of environmental samples for organic solvents used during masking-scribing operations, and Table IB shows the results of environmental samples for various compounds used during metal cleaning operations in Building 51. The maximum concentrations were for xylene and perchloroethylene which were less than fifteen and eleven percent of their respective environmental criteria. Even when considering the combined effects covered by this evaluation, employee exposure would be a maximum Em of less than 0.33 or thirty-three percent of the environmental criteria of Em = 1 at the time of the survey. Sulfuric acid and chromic acid (as Cr or CrO_3) were not detected during metal cleaning operations. The only positive sample was less than one percent of the environmental criteria for hydrofluoric acid. Several direct-reading detector tube samples (Draeger and/or Bendix) were obtained for sulfur dioxide and hydrogen sulfide during metal cleaning operations and for the monomer of styrene during masking operations. No sulfur dioxide (results less than 1.3 mg/M^3 or not detectable), no hydrogen sulfide (results less than 1.5 mg/M^3), and no styrene (results less than 21 mg/M^3) were detected and results are well below the environmental criteria for these substances.

Table IIA shows the maximum atmospheric concentrations to be 15 percent of the environmental criteria established for sodium hydroxide and slightly less than 14 percent for nitrogen dioxide during aluminum etching operations. All other results were 2 percent or less of the respective environmental criteria established for hydrofluoric acid and nitric acid.

Table IIB shows the maximum atmospheric concentrations to be 8 percent or less of the respective environmental criteria established for nitrogen dioxide, hydrofluoric acid, and nitric acid during the titanium etching operations. To be specific, the results show the concentrations to be approximately 8 percent of the respective environmental criteria for hydrofluoric acid and nitrogen dioxide and 6 percent of the environmental criteria for nitric acid.

Table IIC shows the maximum atmospheric concentrations to be less than 4 percent of the respective environmental criteria established for nitrogen dioxide, hydrofluoric acid, nitric acid, and hydrochloric acid during titanium etching operations in the steel-titanium etch area. Two general area samples were obtained for analysis of iron, nickel, and chromium due to the steel etching operations, although no steel parts were etched during the survey. Results for iron were less than 2 percent of the environmental criteria for iron. No nickel or chromium was detected on either sample. Analysis of a bulk sample of the steel-etch solution showed the following results:

Density	Iron (Fe)
1.59 gr/ml	137 mg/gr of solution
Nickel (Ni)	**Chromium (Cr)**
148 mg/gr of solution	24.5 mg/gr of solution

The steel-etch solution contains a concentrated salt of the various metals such as iron, nickel, and chromium. Nickel and chromium are of particular interest due to their potential as carcinogens.

Several direct-reading detector tube samples (Draeger and/or Bendix)* were obtained for sulfur dioxide, hydrogen sulfide, nitric oxide, and nitrogen dioxide. No sulfur dioxide (results less than 1.3 mg/M^3) and no hydrogen sulfide (results less than 1.5 mg/M^3) were detected and were below the environmental criteria. The results for hydrogen sulfide are not unusual, although the NIOSH investigators occasionally smelled hydrogen sulfide around the aluminum etching operations. The maximum result of breathing zone samples for nitric oxide was 3 mg/M^3 (10 percent of the environmental criteria). The result for nitrogen dioxide was positive but less than 0.9 mg/M^3 (less than 50 percent of the environmental criteria) during titanium etching operations when the operator did not wash down the titanium part prior to transfer of part to the rinse solution. Several samples for each contaminant were obtained during etching operations at the aluminum line, titanium line and the steel-titanium line. A sufficient number of samples were obtained to conclude that exposure to these contaminants (e.g., H_2S, SO_2, NO and NO_2) did not constitute a health hazard. An Ecolyzer Model 7100 (Energetics Science, Inc.)* instrument with strip chart for continuous monitoring of nitric oxide and nitrogen dioxide was set up during the shift on the platform of the titanium etch line. Also, an Ecolyzer H_2S Analyzer (Energetics Science, Inc.)* instrument with strip chart for continuous monitoring of hydrogen sulfide was set up during the shift on the platform of the aluminum etch line. Monitoring results from these instruments for nitric oxide, nitrogen dioxide and hydrogen sulfide confirm the results obtained from the detector tubes.

2. Medical Results and Discussion

Tabulated results of major portions of the questionnaire are presented in Tables III, IV, and V. Reference will be made to them as the topics are discussed.

All the employees interviewed were male. The profile of the average worker in Buildings 51 and 52 is an employee, 38½ years old, has been working for McDonnell Aircraft Company for longer than a decade and has spent about 7 years at his present job. Table III contains the exact results of the survey population.

A large part of the employees were able to state at least one chemical being used in their work area or knew the general category of chemicals being utilized. Twenty-eight of thirty-two were unaware of any previous

* Use of instruments manufactured by different firms does not imply endorsement of the instrument by NIOSH.

jobs they held in which they were subjected to chemicals, irritating dusts, solvents or fumes. The remaining 4 were unsure about their previous jobs and were unable to state an agent of possible exposure.

The past and present medical history of the employees revealed: 26 with no medical problems, 4 taking medications regularly, and 3 having medical conditions requiring them to visit a physician. Employees did not report any significant health problems requiring hospitalization in the recent past that could be occupationally related.

Over half of the employees knew of at least one person who was transferred away from Buildings 51 and 52 due to a health condition. The common reason for such a transfer was said to be "fumes".

Work habits of the employees interviewed are found in Table IV. Most employees replied that while they smoke in the area of work, few preferred to eat there. (Those on the mask line were forbidden to smoke). The majority washed their hands before eating but few did before smoking. It appears that the workers do not feel they contaminate themselves with chemicals by smoking with unwashed hands. Respirators are worn only in the titanium masking corner in Building 51 mandatorily, but two workers donned them when adding hydrofluoric acid into etch tanks or when the mechanical fume scrubbers broke down.

The smoking history portion of the survey is quite important in this analysis. In order to identify the airborne contaminants responsible for the chronic respiratory problems (e.g., cough, sore throat, shortness of breath), it is necessary to have a sample of exposed workers without concurrent cigarette exposure. As can be seen in Table IV, there are only 3 of 32 who have never smoked. The average years smoked is 20.4. Many smokers most certainly began smoking in their teens and have continued to smoke at over a pack a day since. It, therefore, becomes very difficult to assign causal relationship of respiratory distress to job-related airborne contaminant exposure. Of the 13 people complaining of any sort of respiratory problem, only one was a non-smoker. During the course of the interview, many commented that a large number of previous employees of the department had died of heart attacks and lung cancer. In this regard, we requested the company and the union representatives to review their records for the past ten years concerning any deaths in this department. Copies of death certificates were also obtained to ascertain the cause of death. There was a total of eight confirmed deaths; one death attributed to cancer of the stomach, two deaths attributed to cardiac arrest and coronary thrombosis, one death attributed to pneumonia, one death attributed to nasopharyngeal cancer, and three deaths attributed to cancer of the lung. The ages varied from 43 to 58 years. However, unless the deceased employees were very different in smoking habits from those surveyed, it would be very difficult to implicate job exposures of chemicals since the two greatest hazards of cigarette smoking are coronary heart disease and bronchogenic cancer.

It is recommended that the reader refer to Table V for the remainder of the discussion. The table is designed to show which complaints were encountered in which work area. Noteworthy points will be discussed.

The masking area consistently reported complaints of eye irritation, headache, dizziness and skin rash. The seven employees interviewed from the masking line show that eye irritation and headache appear in over half of them, with dizziness and skin rash being complained of in 3. Most complained that the fumes in the area were the major cause. More complaints were centered in the masking process than any other work area.

The titanium etch and aluminum etch lodged the next most complaints. Specific complaints may be found in Table V. Employees from both areas had problems with eye irritation and redness and itching of skin. Workers in the titanium area also complained of throat dryness and discomfort. With only 4 people interviewed in the department, 3 complaints of throat problems attract some concern.

Scribing also showed a department of 4 employees surveyed with 3 complaining of skin rash. In handling the mask coating by hand, it appears as if the workers in this area are becoming sensitized to a degree of developing a rash. The rash was limited in all cases to the forearms, back of hands and fingers.

The cleaning area employees (2) had one complaint of throat irritation while the one employee in steel and titanium etch also reported throat discomfort.

The most common complaints listed overall can be found in the righthand total column on Table V.

E. Conclusions

1. Based on the above medical and environmental information, it is determined that employees were not exposed to the contaminants covered by this evaluation in concentrations which could be considered as toxic at the time of the survey.

2. However, it is our opinion that workers in the masking operations may occasionally be exposed to concentrations of organic solvents, and those workers involved in the etching operations may occasionally be exposed to concentrations of acids and/ or accompanying emissions (e.g., nitric acid, nitrogen dioxide and nitric oxide) which have produced medical symptoms among the employees sufficient to produce nose, throat and skin irritation, dizziness and headaches -- symptoms which were reported by workers in private interviews during the survey and are important indicators of exposure to the indicated substances. Medical symptoms reported by employees indicate the need to evaluate potential polluting operations in the worker's environment.

3. From this limited investigation, the authors feel that no definitive statement can be made concerning the workers in this department having an increased incidence of deaths which could be directly attributed to occupational exposure. The presence of non-occupational factors,

particularly smoking which can predispose an individual to coronary and lung problems, made the potential contributions to said disease from occupational exposure impossible to evaluate in this population in this study. Also, workers who are heavy smokers (e.g., 1 or more packs) are probably more susceptible to the effects of chronic respiratory irritants than those who do not smoke. Therefore, it appears prudent to maintain exposures of employees to occupational respiratory irritants as low as practical. No further epidemiological study should be conducted at this time. It is apparent that the population employed in the area in question is not large enough to be fully studied. Also the chemical exposures are too many to pinpoint a causal relationship to any one agent.

4. In reviewing the medical symptomatology and environmental results in discussions with union and management representatives, it is felt that the primary problems may occasionally occur during other environmental conditions (e.g., closed doors and windows, etc.) and/or different operational conditions (e.g., processing of larger metal parts, higher production rates, etc.) than were conducted during this survey. There was limited titanium masking or metal cleaning operations conducted in Building 51 during this survey. Also, maintenance, large chemical additions or changing of solutions, and similar operations which may give rise to higher airborne concentrations of contaminants were not conducted, and therefore, not evaluated during the survey.

5. Discussions with employees indicated that they have been instructed, at least verbally, on the proper protective equipment (e.g., aprons, gloves, etc.) and safety measures which must be observed for various operations. However, many employees stated that they have not been informed of the hazards or toxic effects from exposure to the chemicals they are working with in various operations. Some employees were observed not following good work practices such as wearing gloves when required, not washing hands prior to eating or smoking, and not having a new chemical cartridge for respirator at start of shift if employee wears a respirator. Indiscriminate eating, drinking and smoking (except Building 51 on smoking) at most job sites was noted. Several good work practices such as frequent covering of work sites (e.g., work tables, benches, etc.) with clean material such as plastic and paper, and water spraying of parts prior to removal from the large titanium etch tank were also noted. Some employees felt that operations were somewhat curtailed although most indicated average operating conditions during the survey. It is our opinion that operating conditions were normal except as noted in #4 above during the evaluation, particularly when one considers that large parts constitute approximately 10 percent of production and approximately 30 stainless steel parts are processed per week.

6. Inhalation and/or absorption of various contaminants produces respiratory tract irritation in addition to effects on other bodily

organs (e.g., liver, etc.) and systems (central nervous system, dizziness, etc.). However, the ingestion of contaminants via smoking, eating or drinking and the direct skin contact (e.g., no gloves, short sleeves, or T-shirts, etc.) with contaminants can also directly affect the gut or gastrointestinal tract. Several methods recommended to prevent employee contamination are: (a) good personal hygiene habits (e.g., washing hands, frequent changing of clothing particularly if contaminated, wearing of long sleeve shirts, etc.); and (b) good work practices (e.g., wear gloves provided by employer - change when contaminated on inside, take gloves off properly to avoid hand contamination, have clean work area, etc.). Both of these preventative measures are shared by management and employees, but the employee must assume and practice good personal hygiene and work practices as mandated by common sense or management.

V. RECOMMENDATIONS

In view of the above information, the following recommendations while not binding under the law are offered as suggestions to management and union for their consideration to further alleviate potential hazards and to provide for a more desirable working environment for all personnel in this department:

A. An improved educational program should be instituted so that employees are made aware of the toxicity and hazards associated with the materials handled in this department. Good work practices and first aid procedures should also be included in this program.

B. Personal hygiene of employees (e.g., washing hands, changing clothes, etc.), routine clean up of the work area, and use of required protective clothing should be stressed. Employee education about the importance of personal hygiene when eating and smoking should be stressed. Employees should be instructed not to eat, drink or smoke at work stations. Employees should heed medical advice on the hazards of smoking.

C. Since hydrofluoric acid,is used in this department, consideration should be given to having magnesium oxide ointment available in the dispensary to treat potential hydrofluoric acid burns. Magnesium oxide will precipitate the fluoride ion and prevent nerve and blood vessel damage.

D. Employees suffering irritation, dizziness, or other symptoms believed to be work-related should report such symptoms to the foreman or others as covered by internal company procedures, and operations should be investigated for any sources of operational malfunctions or excessive emissions.

E. It is recommended that the industrial hygiene department monitor for various airborne contaminants during various operations (e.g., titanium masking, processing large parts, changing or adding chemicals in tanks, etc.) and environmental conditions (e.g., closed windows, closed doors, etc.) which could result in significantly higher concentrations than

found at the time of this survey. This should include the metal cleaning and the steel etching operations where potential nickel and/or chromium exposure may occur. The results of these surveys should be made available to the employees upon request.

F. Employee contact with some substances in the scribing area are responsible for the dermatitis (skin on hands and forearms) problems. Alternate methods of accomplishing the work (e.g., long sleeve shirts, surgeon or other gloves, barrier creams, etc.) without continued contact of the materials should be implemented.

G. The general and local exhaust ventilation systems should be evaluated to determine the optimum operating efficiency. A few recommendations (e.g., local or general ventilation on titanium masking area, parts on conveyor drying - masking area, etc.) were offered during the survey. It is felt that implementation of these recommendations would improve exposure of employees working around the racks in the masking area, and those in areas downwind.

H. The company should evaluate and modify their current respiratory protection program to assure compliance with the requirements described (outlined as eleven criteria for a "minimal acceptable program") in the Occupational Safety and Health Administration Standard, Title 29 of the Code of Federal Regulations, Part 1910, Section 134.

I. The restroom facilities located near the cleaning area of Building 51 should be upgraded as they were in very poor condition when examined at the time of the survey.

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VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report & Evaluation Accomplished By:

Raymond L. Hervin
Regional Industrial Hygienist
Kansas City, Missouri

Raymond Stroman
Physicians Assistant
Cincinnati, Ohio

Pierre Belanger
Ray Ruhe
Clint Collins
Industrial Hygienists
Cincinnati, Ohio

Tim Dyches
Medical Student
Cincinnati, Ohio

Originating Office :

Jerome P. Flesch, Acting Chief
Hazard Evaluation and Technical Assistance Branch
Cincinnati, Ohio

Analytical Laboratory Services :

Donald D. Dollberg, Ph.D.
John L. Holtz
Stephen Billets, Ph.D.
Soo Wang Kim
Michele Bolyard

Richard Kupel
Chemists, National Institute for Occupational Safety and Health
Cincinnati, Ohio

McDONNELL AIRCRAFT COMPANY
JULY 12-13, 1977

TABLE IA

ATMOSPHERIC CONCENTRATIONS OF TOLUENE, XYLENE, REFINED PETROLEUM SOLVENTS, ACETONE AND PERCHLOROETHYLENE DURING MASKING AND SCRIBING OPERATIONS IN BUILDING 51

Job and/or Area Classification	Sample Number	Time of Sample	Toluene	Xylene	Refined Petroleum Solvents	Acetone	Perchloroethylene
			mg/M^3--approximate milligrams of substance per cubic meter of air				
Chemical Mill Operator #1 - Rack Mask	A-1	7:10-11:05	6	32	2	2	17
Chemical Mill Operator #1 - Rack Mask	A-13	11:40--2:35	5	29	2	2	13
Chemical Mill Operator #2 - Dip Mask	A-2	7:15-11:00	12	28	2	3	17
Chemical Mill Operator #2	A-15	12:30--2:50	6	31	2	2	18
Chemical Mill Operator #3 - Curve Mask	A-3	7:30-10:55	12	30	3	3	19
Chemical Mill Operator #3	A-14	11:40--2:30	8	38	3	3	20
Chemical Mill Operator #4 -Scribe	A-4	7:40--2:45	9	15	1	1	8
Chemical Mill Operator #4 - Scribe	A-5	7:45--2:50	11	11	1	1	6
Chemical Mill Operator #5 - Scribe	A-6	7:50--2:55	9	17	1	1	9
Chemical Mill Operator #6 - Scribe	A-7	7:55--2:45	6	13	1	ND	6
Mask - Dip Tank - General Area	A-8	12:45--1:00	11	65	5	6	37
Mask - Dip Tank - General Area	A-9	12:45--1:00	ND	ND	ND	ND	ND
Chemical Mill Operator #7 - Scribe-Dip	A-10	7:35-10:50	10	47	3	4	25
Chemical Mill Operator #8 - Demask-Dip	A-11	7:40-10:50	4	48	4	4	28

Job and/or Area Classification	Sample Number	Time of Sample	Toluene	Xylene	Refined Petroleum Solvents	Acetone	Perchloroethylene
			mg/M^3--approximate milligrams of substance per cubic meter of air				
Chemical Mill Operator #9 - Scribe	A-12	7:40--2:45	14	13	1	1	25
Chemical Mill Operator #10--Scribe	A-17	11:45--2:55	7	11	ND	ND	6
Chemical Mill Operator A - Dip Mask	B-30	3:30-10:45	7	29	2	2	16
Chemical Mill Operator B - Dip Mask	B-31	3:30--8:50	10	30	2	2	18
Chemical Mill Operator C - Rack Mask	B-32	3:40-10:50	5	23	2	2	11
Chemical Mill Operator D - Rack Mask	B-33	3:40--8:50	12	27	2	2	17
Chemical Mill Operator E - Rack Mask	B-34	3:45-10:50	5	26	2	1	10
Chemical Mill Operator F - Scribe	B-35	3:45--8:55	8	46	4	3	20
Chemical Mill Operator G - Scribe	B-36	3:50--8:55	6	36	3	2	16
Chemical Mill Operator H - Scribe	B-37	3:55--8:55	7	30	2	2	16
Chemical Mill Operator I - Scribe	B-38	4:00-10:45	2	1	ND	ND	1
Chemical Mill Operator J - Scribe	B-39	4:00-10:45	3	2	ND	ND	1
		EVALUATION CRITERIA	375	434	350	2400	339
		NIOSH LIMIT OF DETECTION	0.01 mg/sample	0.01 mg/sample	0.01 mg/sample	0.01 mg/sample	0.01 mg/sample

The above samples were analyzed for benzene and no benzene was detected.

Note: Sample Numbers preceded by A were obtained on 7/12/77. Sample Numbers preceded by B were obtained on 7/13/77.

TABLE IB

ATMOSPHERIC CONCENTRATIONS OF HYDROFLUORIC ACID (HF), SULFURIC ACID (H_2SO_4), AND CHROMIC ACID (as Cr) DURING METAL PARTS CLEANING OPERATIONS IN BUILDING 51

Job and/or Area Classification	Sample Number	Time of Sample	Sample Result mg/M^3*	Environmental Criteria mg/M^3*
General Area by Tanks 3-4	A-2	6:56--2:50	0.002 HF	2.5 for HF
Chemical Mill Operator	A-2	7:05--2:10	None Detected-Cr	0.05 Chromic acid as CrO_3 0.001 as CrVI as Cr
Chemical Tanks - General Area	A-1	7:00--2:50	None Detected-Cr	0.05 Chromic acid as CrO_3 0.001 as CrVI as Cr
Chemical Mill Operator	B-3	3:20-10:50	None Detected-Cr	0.05 Chromic acid as CrO_3 0.001 as CrVI as Cr
Chemical Mill Operator	A-1	6:59--2:50	None Detected-H_2SO_4	1.0 for H_2SO_4
General Area of Chemical Tanks	A-2	7:05--2:40	None Detected-H_2SO_4	1.0 for H_2SO_4
General Area of Chemical Tanks	B-2	3:20-10:50	None Detected-H_2SO_4	1.0 for H_2SO_4

NIOSH LIMIT OF DETECTION is 0.0001 milligrams per milliliter (ml) of impinger solution for HF; 0.0002 mg/sample for Cr; and 0.016 mg/sample for H_2SO_4.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

Note: Sample Numbers preceded by A were obtained on 7/12/77. Sample Numbers preceded by B were obtained on 7/13/77.

McDONNELL AIRCRAFT COMPANY
JULY 12-13, 1977

TABLE IIA

ATMOSPHERIC CONCENTRATIONS OF SODIUM HYDROXIDE (NaOH), NITROGEN DIOXIDE (NO_2), NITRIC ACID (HNO_3) AND HYDROFLUORIC ACID (HF) DURING ALUMINUM ETCHING OPERATIONS IN BUILDING 52

Job and/or Area Classification	Sample Number	Time of Sample	Sample Result mg/M^3*	Environmental Criteria mg/M^3*
Al Etch Operator-Side B	A-1	7:19-10:55	0.1--NaOH	2.0 for NaOH
Al Etch Operator-Side A	A-2	7:25-10:48	0.2--NaOH	2.0 for NaOH
Al Etch Operator-Side A	A-4	11:40--3:49	0.1--NaOH	2.0 for NaOH
Al Etch Loader-Side A	A-3	7:23-10:48	0.1--NaOH	2.0 for NaOH
Al Etch General Area	A-5	12:10--3:15	ND --NaOH	2.0 for NaOH
Al Etch Operator-Side B	B-6	3:23--7:50	0.2--NaOH	2.0 for NaOH
Al Etch Operator-Side B	B-8	8:37-10:45	ND --NaOH	2.0 for NaOH
Al Etch Operator-Side A	B-7	3:20--7:41	0.1--NaOH	2.0 for NaOH
Al Etch Operator-Side A	B-9	8:37-10:55	0.3--NaOH	2.0 for NaOH
Al Loader-Side B	A-2	7:24-10:52	0.07-NO_2	1.8 for NO_2
Al Etch Operator-Side B	A-7	11:43--2:55	0.09-NO_2	1.8 for NO_2
Al Loader-Side B	A-8	11:47--2:55	0.02-NO_2	1.8 for NO_2
Al Loader-Side A	A-4	7:47-10:55	0.03-NO_2	1.8 for NO_2
Al Etch Operator-Side A	A-3	7:47-10:54	0.04-NO_2	1.8 for NO_2
Al Etch Operator-Side A	A-9	11:46--2:52	0.02-NO_2	1.8 for NO_2
Al Etch Operator-Side B	A-1	7:19-10:55	0.09-NO_2	1.8 for NO_2
Al Etch Operator-Side A	A-6	11:40--3:49	0.03-NO_2	1.8 for NO_2
Al Etch General Area	A-11	12:10--3:15	0.03-NO_2	1.8 for NO_2
Al Etch Operator-Side B	B-14	3:23--7:50	0.08-NO_2	1.8 for NO_2
Al Etch Operator-Side B	B-21	8:37-10:45	0.24-NO_2	1.8 for NO_2
Al Etch Operator-Side A	B-15	3:20--7:41	0.05-NO_2	1.8 for NO_2
Al Etch Operator-Side A	B-18	8:37-10:55	0.09-NO_2	1.8 for NO_2
Al Line General Area	B-19	3:40--9:17	0.05-NO_{23}	1.8 for NO_{23}
Al Etch Loader A-Side B	A-5	11:43--2:55	0.03-HNO_3	5.0 for HNO_3
Al Etch Loader B-Side B	A-2	7:33-10:46	0.01-HNO_3	5.0 for HNO_3
Al Etch Operator B-Side A.	A-3	7:47-10:51	0.03-HNO_3	5.0 for HNO_3
Al Etch Operator B-Side A	A-7	11:46--2:52	0.03-HNO_3	5.0 for HNO_3
Al Etch Operator A	A-1	7:25-10:46	0.01-HNO_3	5.0 for HNO_3
Al Line Area De Smut	B-14	3:53--9:17	0.05-HNO_3	5.0 for HNO_3
Al Etch Loader-Side B	A-1	7:27-10:50	0.02-HF	2.5 for HF
Ti Etch Platform General Area	A-4	12:10--3:15	0.04-HF	2.5 for HF

Job and/or Area Classification	Sample Number	Time of Sample	Sample Result mg/M^3*	Environmental Criteria mg/M^3*
Al Etch De Smut General Area	B-7	3:40--9:17	0.02-HF	2.5 for HF

NIOSH LIMITS OF DETECTION are 0.002 mg per milliliter (ml) of impinger solution for NaOH, 0.0016 mg/sample for NO_2, 0.0006 mg per ml of impinger solution for HNO_3, and 0.001 mg per ml of impinger solution for HF.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

Note: Sample Numbers preceded by A were obtained on 7/12/77. Sample Numbers preceded by B were obtained on 7/13/77.

McDONNELL AIRCRAFT COMPANY
JULY 12-13, 1977

TABLE IIB

ATMOSPHERIC CONCENTRATIONS OF NITROGEN DIOXIDE (NO_2), NITRIC ACID (HNO_3), HYDROFLUORIC ACID (HF) AND HYDROCHLORIC ACID (HCl) DURING TITANIUM ETCHING OPERATIONS IN BUILDING 52

Job and/or Area Classification	Sample Number	Time of Sample	Sample Result mg/M^3*	Environmental Criteria mg/M^3*
Ti Etch Loader Operator	A-5	7:54-10:58	0.09-NO_2	1.8 for NO_2
Ti Etch Loader Operator	A-10	11:50--2:46	0.06-NO_2	1.8 for NO_2
Ti Etch General Area	A-12	12:13--3:13	0.04-NO_2	1.8 for NO_2
Ti Mill Operator	B-16	3:26--7:40	0.13-NO_2	1.8 for NO_2
Ti Mill Operator	B-17	8:37-10:37	0.05-NO_2	1.8 for NO_2
Ti Line General Area Platform	B-20	3:50--9:20	0.09-NO_2	1.8 for NO_2
Ti Line General Area Desk	B-21	3:44--9:38	0.09-NO_2	1.8 for NO_2
Ti Etch Loader A	A-4	7:42-10:50	0.01-HNO_3	5.0 for HNO_3
Ti Etch Operator A	B-11	3:26--7:40	0.14-HNO_3	5.0 for HNO_3
Ti Etch Operator A	B-12	8:37-10:37	0.03-HNO_3	5.0 for HNO_3
Ti Line Platform Area	B-15	3:45--9:20	0.30-HNO_3	5.0 for HNO_3
Ti Line Desk	B-16	3:44--9:38	0.08-HNO_3	5.0 for HNO_3
Ti Etch Loader B	A-2	7:42-10:50	0.02-HF	2.5 for HF
Ti Etch Platform General Area	A-5	12:13--3:13	0.12-HF	2.5 for HF
Ti Line Platform General Area	B-8	3:45--9:20	0.20-HF	2.5 for HF
Steel-Ti Etch Operator	A-1	7:55-10:58	0.1-HCl	7.0 for HCl
Steel Etch General Area	A-2	12:21--3:14	0.1-HCl	7.0 for HCl

NIOSH LIMITS OF DETECTION are 0.0006 mg per milliliter (ml) of impinger solution for HNO_3, 0.0016 mg per sample for NO_2, 0.001 mg per ml of impinger solution for HF, and 0.004 mg per ml of impinger solution HCl.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

Note: Sample Numbers preceded by A were obtained on 7/12/77. Sample Numbers preceded by B were obtained on 7/13/77.

McDONNELL AIRCRAFT COMPANY
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TABLE IIC

ATMOSPHERIC CONCENTRATIONS OF NITROGEN DIOXIDE (NO_2), NITRIC ACID (HNO_3), HYDROFLUORIC ACID (HF), AND HYDROCHLORIC ACID DURING ETCHING OF TITANIUM PARTS IN THE STEEL-TITANIUM (Ti) ANK LINE IN BUILDING 52

Job and/or Area Classification	Sample Number	Time of Sample	Sample Result mg/M^3*	Environmental Criteria mg/M^3*
Steel-Ti Etch General Area	A-13	12:21--3:14	0.07-NO_2	1.8 for NO_2
Steel & Ti Etch Operator	A-6	7:54-10:58	0.10-HNO_3	5.0 for HNO_3
Steel & Ti Etch Operator	A-8	11:50--2:46	0.09-HNO_3	5.0 for HNO_3
Steel & Ti Etch General Area	A-10	12:21--3:14	0.04-HNO_3	5.0 for HNO_3
Steel & Ti Etch Operator	A-3	7:55-10:58	0.03-HF	2.5 for HF
Steel & Ti Etch General Area	A-6	12:21--3:14	0.01-HF	2.5 for HF
Steel & Ti Etch Operator	A-1	7:55-10:58	0.1-HCl	7.0 for HCl
Steel Etch General Area	A-2	12:21--3:14	0.1-HCl	7.0 for HCl

NIOSH LIMITS OF DETECTION are 0.0006 mg per milliliter (ml) of impinger solution for HNO_3, 0.0016 mg per sample for NO_2, 0.001 mg per ml of impinger solution for HF, and 0.0004 mg per ml of impinger solution for HCl.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

HHE 77-63 McDonnell Aircraft Company

Buildings 51 & 52, St. Louis, Missouri

July 11- 14, 1977

Table III Survey Population

1. Total participating in survey..... 32

2. Sex: all male

3. Age
   - Mean..... 38.5
   - Median..... 36.0
   - Range..... 29 - 62

4. Total years employment at McDonnell Aircraft
   - Mean..... 13.3
   - Median..... 13.0
   - Range..... 4 - 21

5. Years at current position
   - Mean..... 6.6
   - Median..... 4.5
   - Range..... 1 - 19

6. Work Areas of Employees surveyed
   - Cleaning (#51)..... 2
   - Masking (#51)..... 7
   - Scribing (#51)..... 4
   - Aluminum Etch (#52)..... 12
   - Titanium Etch (#52)..... 4
   - Steel and Titanium Etch (#52)..... 1
   - Miscellaneous..... 2
   - Total..... 32

HHE 77-63 McDonnell Aircraft Company

Buildings 51 & 52, St. Louis, Missouri

July 11 - 14, 1977

Table IV Work Habits - Smoking History - Complaints

A. Work Habits	Yes	No
1. Do you eat, drink or smoke in your work area?	27	5
2. Do you wash your hands before eating or smoking?	31	1
3. Do you change your clothes before going home?	1	31
4. Are you required to wear a respirator on the job?	1*	31
5. Do you actually wear a respirator on the job?	2*	30

B. Smoking History

1. Smokers = 25 (78%) Non-smokers = 7 (22%)

   Mean packs per day = 1.4 Mean years smoked = 20.4

   Mean packs per day X mean years smoked = 28.6 pack years

2. Non-smokers who previously smoked = 4

   Mean packs per day X mean years smoked = 16.3 pack years

3. Never smoked = 3

C. Complaints

1. Employees reporting work-related health complaints = 20
2. Employees reporting non-work-related health complaints = 2

HHE 77-63 MCDONNELL AIRCRAFT COMPANY

BUILDINGS 51 & 52, ST. LOUIS, MISSOURI

JULY 11 - 14, 1977

TABLE V COMPLAINTS / WORK AREA

WORK AREA / COMPLAINTS	CLEANING	MASKING	SCRIBING	ALUMINUM ETCH	TITANIUM ETCH	STEEL & TITANIUM ETCH	TOTAL
UNUSUAL TIREDNESS	0	1	1	1	0	0	3
WEIGHT LOSS	0	0	0	0	0	0	0
LOSS OF APPETITE	0	1	0	0	0	0	1
SKIN RASH	0	3	3	0	1	0	7
SKIN ULCERS	0	0	0	0	0	0	0
REDNESS & ITCHING	0	1	0	2	1	0	4
COUGH	0	0	0	0	0	0	0*
CHEST DISCOMFORT	0	1	1	1	0	0	3
SHORTNESS OF BREATH	0	2	0	1	0	0	3
EYE IRRITATION	0	5	0	3	2	0	10
NOSE / NOSEBLEED	0	0	0	0	1	0	1
THROAT	1	0	0	0	3	1	5
HEADACHE	0	4	0	1	1	0	6
DIZZINESS	0	3	0	0	1	0	4
EXTREMITY PROBLEMS	0	0	0	0	0	0	0
GASTRO-INTESTINAL	0	0	0	0	0	0	0
TOTAL	1	21	5	9	10	1	47

* FREQUENT COUGH DUE TO SMOKING = 2