An Occupational Health Survey of Selected Airports

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AN OCCUPATIONAL HEALTH SURVEY OF SELECTED AIRPORTS

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I. INTRODUCTION:

A. Airport Activities:

Since 1950, the domestic and international air passenger traffic has more than tripled, and cargo traffic has more than doubled. The rapid growth of population in the United States and its concentration in the major metropolitan areas, which originate and terminate the great bulk of airline traffic, have created increased demands for scheduled air carrier service.[1]

An airport is a facility which often consists of an aggregation of industrial, business, and commercial establishments, governmental as well as private, collectively engaged in the air transportation of people and goods. The operation and logistical support of this facility usually include the maintenance of the aircraft and other equipment, the "maintenance" of its operating and service personnel, and the ministration to certain needs of passengers, visitors, and others of the airport population. Airports vary greatly with respect to size, traffic volume, the distances from communities served, and the size and character of those communities.[2]

On a typical day according to United Airlines Mainliner Magazine some 1800 aircraft are reported to land and take off from Chicago's O'Hare International Airport. More than 80,000 travelers pass through O'Hare terminal in an average day. During 1970, more than 32 million passengers reportedly used O'Hare's facilities.

The tremendous feat of airlifting 80,000 persons per day from Chicago's O'Hare International Airport calls for exacting coordination and team work by thousands of workers. It is reported that the number of direct airline employees in Chicago reaches 24,000. Those indirectly involved totaled at least another 24,000.[3]

The major airport of today may be considered a satellite community. Its population will include a relatively stable, highly diversified employee group, ranging from several hundred to many thousand, and a highly unstable transient group of travelers and visitors varying between a few hundred to tens of thousands per day. Depending on its size, this satellite community will demonstrate varying degrees of self-sufficiency and house a varying number of activities. Police and fire protection; water and sewage treatment systems; surface transportation systems of taxis, limousines, car rental agencies, and buses; food and entertainment facilities; personal service establishments, such as barber shops and medical services; retail businesses providing clothing, books, gifts, and insurance; hotel accommodations for passengers delayed in transit; industries of various types; education facilities for training airline employees; and short and long range communications facilities. One or more can be found in all airport communities.[1]

A large commercial airport may cover an area of several thousand acres with many different kinds of buildings with numerous employees serving the needs of passengers and visitors.

Table I lists FAA operated aircraft traffic control towers by rank order of air carrier operations for fiscal year 1969. This table indicates the number of aircraft. An operation is identified as either a landing or a take off.

In contrast to the nations larger airports, some small airports may have but one or two commercial flights per day.

The Federal Aviation Agency uses the air traffic hub structure to measure the concentrations of all civil air traffic. Within this one medium are consolidated all the social and economic factors that determine a community's ability to generate air carrier or general aviation traffic. The hub structure is constructed from airline data because these constitute the longest, most reliable series of air traffic facts available. It is expressed in terms of passengers since they are the principal source of airline revenue and since the distribution of passengers, mail and cargo, by types of communities is well correlated. The air traffic hubs are not airports; they are metropolitan areas and cities which airlines serve.[1]

Of the approximately 6,000 airports in the United States, 85 percent of the airline traffic is handled by only about 70 of the large and medium hub airports, and only about 600 of the 6000 airports have paved runways and organized services, 230 of them with Federal Aviation Agency controlled tower facilities.[4]

A recent study by the American Transport Association of the impact of air transportation corporations on 23 major hub cities in the United States found that in Kansas City the airline industry was the largest private employer and contributed some 353 million dollars annually directly to the business mix there.[3]

B. <u>Industrial Hygiene and Safety Programs</u>:

Injuries often occur at airports. The type of injuries and where they occurred at one airport was obtained by Dr. Gordon S. Siegel during a study of the Baltimore Friendship International Airport.

The Baltimore Department of Aviation reported 70 injuries, occurring from the period January 1, 1961, through May 20, 1962.[1]

Visitors to airports	17 (24 percent)
Scheduled airlines passengers	24 (34 percent)
Department of Aviation employees	22 (32 percent)
Airport tenant employees	7 (10 percent)
Females	32 (46 percent)
Males	38 (54 percent)

Types of injuries:

Falls (stairways or ramps)	22
Other falls	14
Collisions	3
Operating equipment	23
Automobile accidents	1
Shock	1
Injured by debris	2
Miscellaneous	4

Chain Robbins, Deputy Administrator of OSHA, told a recent meeting of the Air Transport Association that "U.S. Airlines have one of the poorest employee safety records in America." He noted that accident frequency in airlines is nearly three times that of all industry, rivaling that of mine workers. He said most airline industry accidents occur during ramp operations, cargo handling, aircraft and food servicing. Ramp operations have an accident frequency average nearly six times greater than that of passenger service operations. He commended airlines for their safe passenger records, but challenged them to have the same kind of record for their ground employees.[5]

C. Scope of Survey:

The objective of the present survey was to describe the potential occupational health hazards present in airport operations. No attempt was made to evaluate safety hazards since those conducting the survey were trained in the health aspects of health and safety as they relate to the work environment.

This survey was conducted primarily to define potential industrial hygiene hazards, but also attempted to determine what medical and industrial hygiene services are provided those associated with the airline industry. The surveyors were not physicians and, therefore, did not evaluate medical facilities. Only medical information obtained from the literature and from a questionnaire used for this survey is included in this report. Some recommended control guidelines and practices are also included.

Medical services will be discussed first.

II. MEDICAL SERVICES:

The American Medical Association, in its publication "Scope, Objectives and Functions of Occupational Health Programs," outlines the essential activities of an occupational health program:[6]

1. Maintenance of a healthful work environment.

2. Health examinations, including preplacement examinations and indicated periodic examinations.

3. Provision or expedition of diagnosis and treatment for occupational injury and disease.

4. Appropriate immunization programs.

5. Maintaining accurate and complete medical records of each employee.

6. Health education and counseling.

The "Guide to Organization and Operation of Airport Medical Services" says:[2]

> An airport medical service should have a written, tested emergency plan with provision for adequate communications to assure medical coverage as needed. In addition:
>
> 1. Airport tenants should provide for their employees occupational health services on the order of those recommended in the American Medical Association's statement on "Scope, Objectives and Functions of Occupational Health Programs" as stated above.
>
> 2. Emergency treatment should be available at the airport for cases occurring among the airport population of such urgency that to send the patient to an outside facility would endanger life or limb or unduly increase or prolong suffering.
>
> 3. Adequate medical participation should be provided at any time in the rescue and emergency treatment of victims of an aircraft accident.
>
> 4. Persons among the airport population who are required by local, state, or Federal regulations to pass medical examinations for various purposes, e.g., food handlers, barbers, and travelers subject to immigration, should be able to obtain such examinations with the promptness required and with a minimum of expense and inconvenience.

5. Aviation medical services should be available to include medical examination and surveillance of airmen, the rendering of advice concerning persons flying, and consultation to the airport authority and tenants of aeromedical problems.

6. The interest of local physicians should be considered in any arrangement for the provision of medical services to airport populations.

It has been estimated that only about 100 airports have enough activity to warrant a formal medical or nursing station program. Only very few of these have such comprehensive programs as yet. There is serious doubt that many airports can support a full-time medical practice among airport tenants and passengers alone.[4] Obviously, there are large numbers of smaller airports, both commercial and general-aviation, in which no elaborate medical facilities are needed. There are, however, basic requirements applicable to all airports. These are: (1) a medical advisor; (2) a tested communications system which will summon medical aid as needed; (3) a written, tested accident emergency plan with provision for adequate communications to assure medical coverage as needed; and (4) a written, up-to-date, tested general disaster plan.[2]

A. <u>Survey Findings--Employee Health Services</u>:

Forty-one businessess were surveyed at the Denver Stapleton International Airport. Only one company had medical facilities at the airport.

If one eliminates the airline personnel of the one major airline which operates a base maintenance facility in Denver, 2145 people were employed in the remaining 40 establishments. One of these establishments had a full-time physician, eight did not have any agreement with a physician to give their employees emergency or other medical care, while 31 had made such an agreement. Thirty establishments did not have an employee responsible for giving first aid when a doctor or nurse was not present. Only one of the companies employed a registered nurse, she worked the day shift only.

Twenty-one businesses had an arrangement for all their employees to take pre-employment medical examinations, three required some of their employees to take pre-employment medical examinations, the balance did not have any arrangement for physical examinations.

Eighteen had arrangements for periodic medical examinations. Fifteen had an arrangement for employees to obtain inoculations for immunization against some type of illness, usually flu shots.

These findings at the Denver Stapleton Airport are considered typical for a medium sized airport.

B. Survey Findings--Airport Emergency Services:

A questionnaire as shown in Appendix A was completed during an interview with the airport managers of the 2nd, 4th, 5th, 6th, and 18th largest airports in the United States (rank order of air carrier operation, 1969). Only one of these airports had a nurse available at the airport at all hours for the treatment of employee and/or passenger injuries. None of these airports had a physician available at the airport at all times for the treatment of passenger illness. Only one had a physician available at the airport at all hours for the treatment of employee injuries. Most depended upon private clinics located near the airport for medical services. All five of the airports had someone trained in first aid available at the airport at all hours for the treatment of employee and/or passenger injuries (airport police, fire department, etc.). At only three of the five airports had arrangements regarding handling of emergencies been worked out with local hospitals.

One airport did not have a written official airport disaster plan. One did not have a first aid room for the treatment of injuries.

These findings are probably similar to the findings of Dr. Reighard, who studied an airport where 5,000 workers were regularily employed.

Some of the more significant findings of Dr. Reighard[7] were:

1. No employer provided health services for employees which could be considered an integral part of an industrial health program. The most comprehensive programs found were those of several airlines.
2. Few employees at airports, other than flight crew personnel, received any form of periodic health examination, including audiometric examinations for those exposed to noise.
3. Of 218 food service employees, only two, those employed by one of the airlines, were given preemployment examinations. There was no periodic medical examination or inspection of any of the food service personnel.
4. All employers had some sort of workmen's compensation coverage.
5. All employers maintained some form of safety program for review of occupational hazards and education of employees in accident prevention. For the smaller employers, this tended to be informal but identifiable as a program.
6. The nature of employment of approximately 70 percent of workers at an airport clearly demonstrates the need for periodic medical examinations for reasons of safety, health maintenance, and public protection.
7. The lack of an integrated occupational health program for any employee group could not be interpreted as a lack of interest on the part of the employers. Employers had a great deal of interest

in the provision of adequate occupational health services, but were unable to overcome the many problems inherent in the provision of services to small organizations. All the employers had made some arrangement for the most pressing medical needs, especially for emergency care of on-the-job illness or injury.

8. Accident rates among employees were not readily available, and there was a universal lack of data on the extent of absenteeism.

Dr. Siegel[1] indicates that these findings of Dr. Reighard at a large eastern airport are thought to be typical of large and medium United States airports during the early 1960's. The findings of Dr. Siegel at the Baltimore airport were in accord with the findings of Dr. Reighard.

III. INDUSTRIAL HYGIENE SERVICES

A. Introduction:

Dr. Siegel has stated that "as far as could be determined, an industrial hygiene survey of an entire airport including operations of all tenants has never been reported. He stated "an industrial hygiene survey of an entire airport, where extensive aircraft repair and maintenance facilities are maintained, should be most interesting and informative."[1]

This report contains information concerning industrial hygiene surveys at selected airports.

B. Methodology:

The method used was the preliminary industrial hygiene survey. It consisted of a short interview with the management of an establishment, and a brief tour of the facility by an experienced industrial hygienist. A survey form, similar to the one shown in Appendix B, was completed at each establishment. This was followed by a walk-through survey of the facility. This part of the survey allowed the surveyor to observe the production and maintenance operations and to note potential exposures of workers to toxic chemicals, physical hazards, or other hazardous working conditions.

The preliminary survey evaluation was based entirely on the professional judgement of the industrial hygienist making the survey; usually no samples were taken or instruments used to assist in the evaluation. A few surveys requiring instrumentation were conducted at some operations.

Walk-through surveys were conducted at all non-government and non-office type businesses at Denver's Stapleton International Airport, Billing's (Montana) Logan Field, and Los Angeles International Airport.

The survey at the Billings, Montana Airport would indicate that potential occupational health hazards at small airports are not unlike those found in small auto repair facilities - (solvents, welding hazards, exhaust gases, etc.).

Surveys at the Denver and Los Angeles Airports had shown that the greatest potential for exposure to toxic materials occurred in the major maintenance base facilities of the major airlines. However, in general, occupational health hazards were better controlled in these facilities.

Most surveys were limited to the major maintenance base facilities at airports. The following major maintenance base facilities were visited: Frontier Airlines, Denver; Western Airlines, Los Angeles; Continental Airlines, Los Angeles; Flying Tiger Airlines, Los Angeles; United Airlines, San Francisco; TransWorld Airlines, Kansas City; Delta Airlines, Atlanta; Eastern Airlines, Miami; and National Airlines, Miami.

At most airports a number of businesses may be located near the airport. Each type of business has individual potential hazards. A number of governmental agencies are also located at the airports. These two groups of businesses were not surveyed.

C. Observations of Industrial Hygiene Surveys:

1. General Information

The first industrial hygiene survey was at the Denver Stapleton International Airport. A list of 90 tenants and concessionaires located at the airport was obtained from the Director of Aviation in Denver. Forty-one of the non-office type businesses were then visited to determine actual or potential health hazards in the work environment.

Complaints were received from workers exposed to carbon monoxide, jet exhaust gases, ammonia, and other hazards. Over 40 different types of potential health hazards were identified. Some of these are recorded in Table II. Thirty of the 40 businesses employed less than 50 people. However, in the opinion of the surveyors one-fourth of these businesses needed industrial hygiene attention. Potential health hazards at the Los Angeles International Airport were similar to those at the Denver Airport.

2. Office Personnel

The Denver survey indicated that although various businesses are listed with the airport director, many of these are office type activities and present no significant occupational health hazard. For example, car rental agencies have offices at the airport, but maintenance activities are located elsewhere.

Exposure to jet exhaust gases and odors and to the health hazards associated with the use of copying or duplicating equipment were the primary complaints of office workers. One worker stated he had experienced headaches when working with duplicating equipment which requires cleaning a rubber blanket with a perchloroethylene solvent. (Greenberg[8] has an excellent discussion of health hazards in the modern office in the December 1965 issue of Industrial Hygiene Review.)

Though the office worker usually has few complaints concerning health hazards this group should not be overlooked as a source of potential complaints during periodic walk-through surveys.

3. Warehouse and Air Freight Personnel

Carbon monoxide from the indoor operation of internal combustion engines can be a serious health hazard. The fork lift truck is a potential source of carbon monoxide exposure in warehouses. Several methods have been proposed to eliminate the carbon monoxide health hazard associated with the use of fork lift trucks. Battery powered lift trucks, and dilution ventilation are the most effective methods of controlling exposure to carbon monoxide. Good maintenance of catalytic afterburners on exhausts of fork lift trucks is essential where such devices are used.

The spillage of radioactive substances, mercury or other toxic or hazardous materials is always a potential hazard to air freight workers. Several instances of spillage of these materials were reported during the survey. Advance plans should be made to handle such emergencies. Dr. Siegel[1] reported that one air freight company had breakage of a package containing live virulent poliomyelitis virus. No procedures were noted to handle such a contingency.

It is unlikely the air freight worker will have the technical background to evaluate the potential danger caused by breakage of packages containing hazardous material. For example, he is unlikely to know the characteristics of various radioactive materials and the potential health hazards involved in handling or ingesting such materials. He probably will not know the decontamination procedures required for decontamination of an area after spillage of radioactive materials or substances such as mercury. For this reason advanced written emergency plans should be formulated to protect the air freight worker until authorized assistance is available. Such plans should include phone numbers of persons to be contacted in case of emergency.

4. Cafeteria and Kitchen Employees

Dermatitis; work in a hot, humid atmosphere; and exposure to acrolein from the burning of fats are some well known potential health hazards of kitchen employees. In recent years, exposure to microwave radiation has become a potential health hazard to the kitchen and cafeteria employees. After prolonged use, the doors on the microwave ovens may not fit properly, in which case microwave leakage may cause eye injury.

An instrumental survey was conducted of 31 microwave ovens located in kitchens and cafeterias at one airport. Thirteen of 31 units checked showed leakage greater than 10 mw/cm^2 the presently accepted Threshold Limit Value for exposure to microwave radiation. The vendor of these units had been advised several days before the survey that measurements would be taken around the doors of microwave units. The company had made an effort to tighten doors suspected of leakage. However, the vendor did not have microwave detector equipment for checking leakage around oven doors. The leakage measured indicates that all microwave ovens should be checked with a microwave detector periodically.

Microwave ovens are also used on board the aircraft of some airlines. However, most airlines do not use microwave ovens on airplanes. Microwave radiation from microwave ovens on board 747 and 707 aircraft of two airlines at one airport was measured. None of the 14 units checked showed any leakage. Both airlines monitor the ovens for microwave leakage on a routine schedule. For example, one airline reportedly checks the microwave ovens on board each airplane for microwave radiation after each 5 days of operation.

5. Ramp Workers

a. Noise:

(1) General Information

Undoubtedly the most ubiquitous health hazards for persons employed at airports is exposure to high noise levels. One medical director estimated that of approximately 3000 workers for whom he was responsible for occupational health care, 1000 would be exposed to noise. Noise induced hearing loss is the most significant physical health problem caused by excessive noise exposure, and has long been recognized as one of several causes of deafness.

The revelant properties of noise are frequency and level of intensity. In expressing the intensity or loudness of noise, it is customary to employ the decibel system, which is logarithmic in nature. The weakest sound that the ear can hear under ideal listening conditions corresponds to a sound pressure of 0.0002 microbars, this value being considered as 0.0 dB. All noise measurements in this report are in reference to 0.0002 microbars sound pressure. In addition to frequency and intensity, the duration of exposure, its time distribution, and an individual's susceptibility to noise-induced hearing loss are other important factors influencing the development of hearing-loss disorders.[9]

A frequency-intensity description of a noise is called its spectrum which is an important factor in determining whether the noise is a hazard to hearing. Spectral determinations are made by dividing the range of frequencies comprising a given noise into contiguous frequency bands, a full octave or narrower in bandwidth, and measuring the sound levels in each band. Overall readings of a noise which reflects the energy contributed by all of the frequencies, can also provide some indication of the noise hazard, especially if such readings are weighted to reflect the ear's sensitivity to sounds of different frequency. One such overall reading, called sound level "A" or dBA, is less sensitive to low frequency energy much as the human ear is and shows some correlation with apparent noise-induced hearing loss.[10] Sound level "C" or dBC represents an unweighted overall reading of the strength of a noise and is of limited value in identifying noise hazards to hearing.

Various noise criteria have been proposed for interpreting noise measurements. Some require a frequency-intensity description of a noise. On the other hand, noise criteria have been proposed by the American Conference of Governmental Industrial Hygienists which are based on a single number which is obtained by obtaining a sound level measurement with a standard sound level meter operated on the A-weighing network with slow meter response.

The criteria values apply to total time of exposure per working day regardless of whether this is one continuous exposure or a number of short-term exposures but does not apply to impulsive or impact noises.

(2) Noise Measurements

A preliminary noise survey was conducted at the ten airlines at one airport. No attempt was made to determine exposure times for ramp workers. Exposures would be expected to vary from one airport to another depending upon meteorological conditions, the type of aircraft equipment being used, the physical characteristics of the airport, the number of flights per day, and other factors.

Where time permitted an octave band analysis was made with a Bruel and Kjar Model 1613 octave filter set, otherwise a general radio type 1565A sound level meter was used to obtain dBA and dBC measurements. In some instances the aircraft engines were turned off before a dBC measurement could be made. Noise measurements are reported in Table III. All measurements were taken near the ear of the worker and thus do not represent noise levels at other locations around an aircraft.

Cohen and Ayer conducted a noise study at two major airports in 1964.[11] Noise from various types of aircraft was evaluated. Employees working outdoors in the ramp locations at both airports were predominantly exposed to noise of engine warm up, idle; and taxi operations of aircraft. Also intruding in the ramp work areas as well as in most other outdoor locations at both airports was take-off noise.

Comparison of the data for pure jet and combined prop-jet and propeller aircraft showed that although both had equivalent overall noise levels (between 100 and 108 dB), their octave band spectra tended to differ. Specifically, the jet aircraft noise had more sound energy concentrated in the higher freqency octave bands (above 300-600 hertz) than did the prop-jet and propeller aircraft noise. The lowest level noise for all aircraft were associated with the idling operations; the highest levels occurred during the last stages of engine warm up and the beginning of the taxi operation. The taxiing noise for pure jet and prop-jet aircraft contained pronounced high frequency components. The sites where measurements were taken were typically 50 to 100 feet from the nearest engine.

Maximum levels for jet take-offs ranged from 104-111 dB; for propeller take-offs the range was 95-106 dB. These measurements were taken about 1/4 mile from the most heavily used take-off runway.[11]

Hundreds of ramp workers are exposed to high noise levels. The airlines recognize the noise hazard potential and have provided ear muffs and/or ear plugs to employees to prevent hearing loss. However, audiometric examinations were not provided by all major airlines for all employees exposed to high noise levels. Also workers at two different airlines at one airport complained that one brand of ear muffs did not provide adequate protection. One worker claimed that the last time he had his annual audiometric examination, he had lost hearing in higher frequencies. He implied this was due to inadequate hearing protection.

Thousands of airline workers are required to wear hearing protection. It would seem advisable that an official agency test and certify various types of hearing protection devices for use at specified noise levels and that all workers exposed to high noise levels should be provided periodic audiometric examinations.

b. Jet Exhaust Gases:

Proposed or possible expansions of existing major airports which will bring them to levels between 500,000 and 1,000,000 landing and take-off cycles per year, will result in a noticeable air pollution problem for large distances downwind from the airport, it was reported by James A. Fay of the Fluid Mechanics Laboratory of Massachusetts Institute of Technology (63rd Annual Meeting of the Air Pollution Control Association, June 14-18, 1970).

Ingram and McCabe[12] indicate that the idling of engines of aircraft during warming up periods, taxiing, and testing, contribute gases and vapors of thousands of gallons of burned fuel each day directly to an airport area.

A number of complaints were received from airport personnel during the survey concerning exposure to jet exhaust gases. At one airport, engines of 707's and 720's were started at the gate prior to being pushed back from the gates. Ramp workers at another airline complained that they were exposed to the jet exhaust gases from these planes. These workers had lodged a formal complaint with their union stating they would not work on the ramp while the engines of the 707's and 720's were being warmed up prior to take-off. It was stated that 707 and 720 aircraft do not have self start capability. A solution proposed by the union was to park planes with auxillary power units at gates where exhaust gases cause a problem for workers at opposing satellites. These planes (727, 737, DC9, etc.) were reported to have a source of air for starting the engines after push back.

Exposure of workers to jet exhaust gases may or may not be a serious health hazard. However, at those airports where complaints of irritation to the eyes and mucous membranes are a problem, cooperative efforts should be made to determine the best way to alleviate or eliminate the problem. The potential exposure of workers to exhaust gases should be considered by those responsible for the design of airports.

c. Jet Exhaust Blast:

Jet exhaust blast was another problem reported. At one airport it was stated that the jet exhaust tipped over mail transfer units at the airport Post Office. The walls of the room where the employees worked were blackened by the jet exhaust particulate matter. The workers complained of eye irritation.

6. Airport Maintenance Workers (Not aircraft maintenance)

Dr. Siegel[1] has an excellent discussion of the hazards which may be encountered by airport maintenance personnel. He states: "The physical maintenance of the airfield is of prime importance in flight operations safety. The maintenance of radar installations, certain directional lighting equipment, and other navigational aids is the responsibility of the Federal Aviation Agency. This Agency has expert industrial hygiene capability in the areas of its operations and closely monitors the safety and exposure of its employees. Maintenance of runways, taxiways, and aprons is usually the responsibility of City or County Departments of Aviation. These employees are engaged in patrol work, structural repair and maintenance operations, wild life control, grass and foliage trimming, lighting and power maintenance, as well as ramp and apron cleanup. Heavy snowfalls, in particular, will force these men to engage in heavy physical activity over prolonged periods of time with attendant fatigue and chilling. These workers, plus workers employed by other tenants who are exposed to the elements (particularly crews that service aircraft), must be protected against the effects of strong sunlight and other marked extremes of temperature. (Number 393 Delta Airlines maintenance bulletin devotes an entire issue to the prevention of accidents during winter operations).

"In addition to the aircraft utilizing the airfield portion of the airport, there is a continuous stream of motor vehicle activity. Evidently very few companies which employ vehicular drivers require any sort of physical examination associated with driving qualifications, and periodic vision and other examination of drivers is the exception rather than the rule. Much of the ground vehicular traffic is radio-directed.

"Fire and explosion is an ever-present hazard on the airfield. Vast quantities of highly flammable and explosive mixtures are constantly being transferred from field depots to tank trucks to aircraft. Some spillage is unavoidable. Elaborate precautions must be taken, such as the installation of explosion-proof electrical outlets on the ramps and aprons and "deadman" controls on fuel trucks to insure cutoff of fuel flow if anything happens to the operator during fueling.

"In addition to the hazards associated with moving aircraft and vehicles, there is an ever-present hazard of falls, particularly from ladders or aircraft fusilages and motor vehicles. This hazard is intensified during icy weather conditions. Many types of tools and devices must be used regularly.

"Strong blasts of air are generated by propellors and jet engine operations. Small objects on the ramp may become lethal projectiles and scrupulous runway, ramp, and apron housekeeping is mandatory.

"The operation of jet aircraft produces significant noise hazards to certain maintenance personnel."[1]

The size of the work force required to provide airport maintenance varies considerably. One large airport had a work force of about 800 people to provide maintenance of service roads, taxiways, run-ways, grounds, buildings, custodial service, security, space heating and other related service. Small airports may only employ 3 or 4 people for maintenance and service activities.

In addition to the hazards mentioned previously, maintenance workers may also be exposed to welding fumes, cadmium fumes from silver soldering (brazing), epoxy resins, solvent vapors, paint thinners and pigments, free silica from sand blasting operations, and noise from aircraft, compressors, sweepers, or other equipment.

7. Baggage Handling

Workers in the baggage handling area may be exposed to noise, carbon monoxide, and extreme temperature variations. Speech interference because of noise may also be a problem.

Noise exposure to baggage handlers varies depending upon the number and type of aircraft operating in the area and the physical surroundings. Table IV lists the noise readings obtained during a survey at one airline's baggage handling area.

Carbon monoxide may be generated in the baggage handling areas by the equipment used to move baggage. Table V lists the carbon monoxide values obtained at one airline's baggage handling area.

Baggage handlers stated that exposure to low temperatures and wind caused discomfort during winter months.

In the opinion of the surveyors, telephone communication could have been greatly improved at one baggage handling area by the use of a sound proof booth.

8. Airline Reservations

Many workers are employed to make airline reservations. Inadequate ventilation had been a problem at one airline where a number of airline reservation workers were employed in the same room. Treatment of the air in such rooms may be necessary to control simultaneously its temperature, humidity, cleanliness and distribution to meet the requirements of the work force.

9. Air Crew Personnel

No attempt was made to determine the potential health hazards of air crew personnel.

10. Aircraft Maintenance Facilities

Maintenance activities at many small airports consist of expedient first line maintenance only. On the other hand, some airports have large areas devoted to aircraft maintenance and repair, with many buildings and many industrial processes involved. Large numbers of airport workers may be engaged in such activities.

Hughes Airwest magazine reports that during a busy week their 45 airplanes take off and land more than 6,000 times. To keep their airplanes flying safely, their computer keeps track of more than 43,000 different classifications of spare parts.[13]

At a major maintenance base facility parts must be available to overhaul and repair any part of an airplane. The overall maintenance function is the same for all maintenance base facilities. However, organizational structures are different. Also, methods for performing various maintenance procedures may differ from one airline to another. Most maintenance base procedures could be classified under two major headings: Maintenance and Overhaul. Overhaul activities may be subdivided into airframe overhaul activities and power plant overhaul activities.

a. Potential health hazards in major maintenance facilities:

Some of the potential health hazards at major maintenance base facilities will be discussed in terms of certain toxic materials or operations. It is not the intent of the author of this report to present a detailed discussion of control procedures for the occupational hazards mentioned.

(1) Noise

Noise is generated at a number of operations such as in the sheet metal shop; various riveting operations; during metalizing, various grinding operations; during use of impact wrenches for putting nuts on bolts, etc.

The psychological effect of noise exposure could not be evaluated. One worker stated that noise from a balancing wheel made him feel tired at the end of the day whether or not he worked. The noise level was considered below present noise criteria.

(2) Carbon Monoxide

Most maintenance facilities have a garage area where gasoline fueled vehicles are serviced and repaired. Tailpipe exhaust ventilation had not been provided in some of these facilities, thus providing a potential source of carbon monoxide exposure.

At some maintenance facilities ground power units are used inside of buildings and thus may be a source of carbon monoxide exposure. Some ground power units have a combustion engine which drives a generator to supply power to aircraft during repair. At one maintenance facility workers did complain of exposure to carbon monoxide from the exhaust of ground power units.

(3) Metal Cleaning and Degreasing

(a) Metal Cleaning

A number of physical methods or compounds are used for metal cleaning. These include aluminum oxide, shot peen (small steel pellets), wet blast (slurry of water and glass beads), dry honeing (dry glass beads), and walnut hulls. These procedures are usually done in enclosed exhaust ventilated cabinets.

(b) Metal Degreasing

Metal degreasing is the process of removing oils, greases, waxes, and fats from metal parts. Several procedures are used including vapor degreasing, spray washing, steam and hot water cleaning, dipping, wiping, brush application, and ultrasonic cleaning.

The choice of cleaning method is influenced by many factors, including: composition and structure of the parts to be cleaned, soil or dirt to be removed, and sequence of the cleaning operation. The operation preceding cleaning frequently determines the nature of the contaminant and hence the cleaning method, and the next following operation may regulate the degree of cleanliness required.

Four types of material are commonly used for degreasing small parts (1) solvents such as stoddard solvent and kerosene; (2) non-flammable halogenated solvents such as perchlorethylene or trichloroethylene; (3) alkaline solutions; (4) emulsifying cleaners.[14] One finds numerous small parts cleaning booths where these and other solvents such as chloroform are sprayed on parts in booths provided exhaust ventilation. Vapor degreasers containing chlorinated hydrocarbons and dip tanks containing caustic, acid, and chromate materials are used in all maintenance base facilities.

Ultrasonic cleaners are used at a number of locations at maintenance base facilities.

"Ultrasonic cleaners are made of three basic components: generator, transducer, and a cleaning tank containing a suitable cleaning agent. Cleaning agents may be organic solvents, mild alkalies, mild acids, detergents, and water.

"The generator produces a high frequency alternating current which the transducer changes to high frequency, 20KC to 40KC band, sound waves. The transducer is generally connected to the bottom of the cleaning tank and is designed so that the face of the tank bottom is the point of maximum pressure. As the pressure phase of the second wave travels through the cleaning solution, alternate positive and negative pressures are created. In the zone of the cleaning solution, where the negative pressure exists, the boiling point of the solution drops because of lowered pressures. As the pressure is reduced to less than the vapor pressure of the cleaning solution, thousands of minute air bubbles are formed. A half cycle later, the pressure in the same zone becomes positive, and the vapor bubbles implode with a small quantity of energy, but at great pressures (about 10,000 lbs/in^2), and with temperature of approximately 20,000°F. The formation and inward bursting of these minute vapor pockets with the large pressures and temperatures is the cavitation principle which does the scrubbing."[15]

The hazards which may be encountered during the use of ultrasonic equipment has not been extensively investigated. Siedlecki[16] indicates the potential hazards of ultrasonic degreasers to be exposure to the vapors of the solvent, high intensity noise, and overheating of the body from ultrasonic energy. An important potential hazard is exposure to vapors of the solvent.

Many water base chemicals are available for use in ultrasonic cleaners. Organic solvents are less available. Because of their relatively high cost they are primarily used in vapor degreasers. This system permits redistillation and reusing the same basic solvent without a large loss. Halbert[17] lists the following solvents as commonly used in ultrasonic tanks and degreasers: "perchlorethylene, trichloroethylene, 1,1,1, trichloroethane (methyl chloroform), trichlorotrifluoroethane, trichlorotrifluoroethane azeotropes (methylene chloride base and alcohol base), and methylene chloride." Where such solvents are used equipment must be adjusted to prevent escape of solvent vapor since as a rule of thumb all solvents used in ultrasonic tanks or degreasers must be heated to approximately 80% of their boiling point in order to cavitate.

According to Siedlecki there are no known physiological effects from airborne ultrasound. Last[18] indicates that a study by the Institute of Otology of London University showed no loss of hearing attributable to ultrasound.

Skillern[19] studied human response to measured sound pressure levels from ultrasonic devices used for cleaning, welding, and drilling. The ultrasonic cleaners had operating frequencies from 18,000 hertz to 80,000 hertz. At levels of 80-90 dB subjective intolerance was manifest; above 90 dB individuals had a feeling of malaise, fatigue, or would leave the location where the ultrasonic instruments were operating. Responses reported from a study at the University of California were fatigue, pain, nausea, and blood changes.[20] However, this report listed only a minor amount of information regarding sound pressure levels and frequencies.

Last[18] has an observation concerning the responses of individuals to ultrasound sound pressure levels. He indicates that the ultrasonic and sonic energy radiated by tanks shows there is considerable energy radiated at one-half and one-third frequency of the fundamental and much less as the series continues. If the tank is operating at 40 K Hz, the half frequency will be ultrasonic and the third frequency on the borderline of audibility. This third aspect he states probably accounts for a problem that occassionally arises where ultrasonic cleaners are used. Someone within range complains of being made ill by the apparatus. It is likely that this is an affect of a subharmonic that is close to the limit of hearing and causes some stimuli to reach the brain but the stimuli is not interpreted as sound.

Low frequency components may be loud enough for sound insulation to be necessary just as for any other source of audible noise in industry.[18]

Metal cleaning in the airline industry covers a wide field; an adequate discussion of all its ramifications would require more space than can be allotted in this report. For additional information the reader is referred to Industrial Hygiene and Toxicology[21] and Air Force Pamphlet AFP-161-6-4.[15]

(4) Electroplating

Electroplating is a major activity in airline maintenance base facilities. About 80 persons were employed at one plating shop.

Chromium, copper, tin, cadmium, and silver, are the metals most often plated.

Patty[22] discusses some of the recommended control procedures for plating operations as follows:

Plating solutions containing arsenic require very effective exhaust ventilation. Cadmium plating and lead fluoroborate plating operations do not ordinarily present harmful exposures even though unventilated. Copper, zinc, and nickel acid plating operations seldom necessitate mechanical exhaust. Cyanide baths frequently require exhaust and alkaline plating baths sometimes evolve offensive amounts of alkali mists requiring exhaust measures. It is good practice to ventilate all hot baths in order to control excessive humidity and there is some merit in making it general practice to hood and ventilate all plating baths as a safeguard against any change in plating procedures that might cause harmful exposures; but such recommendations in many cases cannot be justified by air analyses.

It is important that cyanides be kept locked and stored where they cannot cause a catastrophe from accidental contact with acids. When cyanide salts react with acid highly toxic hydrogen cyanide is produced.

Ammonia from zinc cyanide plating operations may reach annoying levels unless the plating department has adequate ventilation.

Plating operations were generally well controlled. The electroplating operations at one facility were described as "fantastic" by the industrial hygienist conducting the survey. The plating room floors had carpeting and certain treated effluent from the plating tanks passed through a large fish aquarium.

The ventilation of plating tanks should be checked on a frequent routine schedule. At one maintenance base it was stated that the ventilation had not been checked on the plating tanks for a period of three years.

(5A) Some Hazards of Common Type Welding Procedures.

Welding is a major activity at a maintenance base facility. For example, one airline had 42 welding booths at one location. All types of welding are employed including electron beam welding.

Several factors determine the hazard to exposed personnel:

(a) The size of the space where welding is done.

(b) The number of welders working in a given space and the type of welding being done.

(c) The type of metal being welded, and whether or not the metal has previously been coated or painted.

(d) The type of welding rod.

(e) The type of flux used.

(f) The ventilation provided.

The potential hazards are (1) explosion or fire, (2) eye and skin hazards, (3) absorption of toxic fumes and gases.

(a) Explosion or Fire.

Welding should not be conducted near combustible materials nor in or near explosive atmospheres.

(b) Eye and Skin Hazards.

"During welding operations, the flame or arc gives off radiant energy in the form of infrared and ultraviolet radiation. The eye may be injured if eye protection is not used. Unprotected skin may also be burned by the intense heat produced at the welding site."[23] Workers in nearby areas must be protected from ultraviolet radiation.

(c) Absorption of Toxic Fumes and Gases.

1. Metal Oxide Fumes.

"The fumes evolved during welding and cutting will depend on the composition of the metal being welded or flame cut, including its surface coating and on the composition of the electrodes."[24]

Welding is conducted on a variety of metals at an airline maintenance base facility; for example, stainless steel, molybdenum, copper, zinc, titanium, and magnesium. Beryllium is used in some small parts on some aircraft (747's) and there is a potential health hazard if welding is done on beryllium or its alloys.

Silver brazing (often referred to as silver soldering) is always a serious potential health hazard since some silver solders contain a high percentage of cadmium. Welding on painted materials (such as materials painted with a lead base paint) also constitute a serious potential health hazard.

2. Gases

Carbon monoxide, oxides of nitrogen, hydrogen fluoride and ozone are the gases most likely to be produced in irritating or toxic concentrations.

Many fluxing compounds contain harmful substances which are liberated into the air during welding processes. Some of these substances are hydrochloric acid, and hydrogen fluoride from fluxes that contain fluoride.

Inert gas metal arc welding such as argon produces ozone by the action of ultraviolet light on the oxygen of the air. Nitrogen dioxide may also be produced from the nitrogen in the air. Where carbon dioxide is used as the shielding gas, carbon monoxide may be produced.

Hydrochloric acid and/or phosgene may occur where welding is conducted in a room where chlorinated hydrocarbon solvents are present.

In general local exhaust ventilation had been provided to control welding contaminants. Local exhaust ventilation is usually the most effective method of controlling toxic air contaiminants resulting from a welding procedure.

All welding procedures should conform to recommendations of the American Welding Society.[25]

(5B) Hazards of Electron Beam Welding

In electron beam welding, a type of welding less frequently encountered than other types of welding, the kinetic energy of fast moving electrons is used as a source of heat. A heated filament produces a supply of free electrons which are accelerated by means of a high potential and focused into a beam of smaller diameter.

Electron beam welding has certain advantages over other types of welding. For example, the electron beam process makes welds of much narrower width then those made by any other fusion welding process. Also, the depth-to-width ratio may be 20 to 1 with a negligible heat affected zone at either side of the weld bead. Higher melting point metals can be welded and locations that are inaccessible to other welding processes can be reached.

Advantages of the electron beam welding process which is performed in a vacuum arise from the high power densities possible. This procedure provides the purest atmosphere available. A vacuum of 10^{-4} mms Hg is equivalent to an impurity concentration of 0.13 ppm whereas the best inert gas available for welding contains 50 ppm impurity. Thus, one of the main applications of electron beam welding is for welding of reactive metals.

The identification of potential hazards to health and/or safety associated with electron beam welders and welding, and the recommendation of safe practices to be followed in the use of this equipment and process, are subjects now under active study by a special committee of the American Welding Society (AWS).

In a draft report of their findings, this AWS Committee has stated that there are four potential hazards from electron beam welders during welding: (1) electric shock, (2) X-radiation, (3) fumes and gases, and (4) radiated light. These hazards apply to an electron beam welder in good operating condition and used for the purpose for which it was built.

A radiation survey should be made at the time of the installation of an electron beam welder. Since shielding may be disturbed or omitted after maintenance checks, periodic monitoring is advisable. Monitoring is essential if modifications are made to the equipment or the gun transferred to a new chamber which has not been checked.

Other hazards arise from the electrical supply and the optical radiation from the molten weld pool. The beam itself is not visible. Appropriate filter glasses must be worn for viewing the weld pool.

A feature of the electron beam welding process requiring special attention is that metal is vaporized and recondenses on the walls of the vessel and exposed parts of the gun. Periodically this deposited metal must be removed. Suitable precautions must be taken during this operation if the material is toxic (e.g. beryllium) or likely to present a pyrophoric or explosive hazard due to its finely divided form.[26,27]

(6) Metalizing (Metal Spraying)

Metals, in the form of wire, are fed through a spray gun, in which a hydrogen, or acetylene, torch melts the wire. Compressed air or other gases are used to atomize and spray the metal onto the surface to be coated. The exposures involve not only air-borne particles of the sprayed metal and its oxide, but also, ozone, nitrogen oxides, and utraviolet light. Obviously the spraying of the more toxic metals offers the more serious potential inhalation exposures.[28]

Nickel, chromium, tungsten, cobalt, bronze, and aluminum were some of the metals or compounds used by airline maintenance base facilities.

A water fall ventilation booth or other controls were used to protect the worker from any toxic materials being sprayed. Protection was also provided against ultraviolet light. Where metal was sprayed by the plasma torch method protection against high noise levels was provided.

(7) Heat Treating

One facility had two areas where heat treating of metals was conducted. Case hardening (casite) and heat treating of stainless steel and chromium molybdenium alloys were conducted. Lead burning was also done about three times a year. Patty[29] has a discussion of various heat treating procedures and recommended control measures.

(8) Paint Stripping

Paint stripping procedures vary somewhat from one maintenance base facility to another. However, the following description of the paint stripping procedure at one maintenance base facility is typical: an area is assigned, areas are masked off, a paper gutter is put up, the paint stripping chemical is applied by brush to an area 8 to 10 feet in length by 2' high. Rubber gloves, chemical cartridge respirators, face shields, and goggles are available for use. Showers are also available.

The composition of the paint strippers used vary. One was a methylene chloride base paint stripper activated with ammonia, another methylene chloride plus phenol, etc. Benzene may also be present in paint stripping compounds.

(9) Painting

A variety of paints and paint thinners are used by the aircraft industry. Materials used vary somewhat from one airline to another. One airline requires little exterior painting.

Polyurethane paints are used on the exterior of aircraft. Two or three coats are applied.

Isocyanates used in polyurethane paints characteristically have a low oral toxicity with a high chronic inhalation toxicity. All isocyanates have the potential for producing asthma - like symptoms. Toluene diisocyanate (TDI) vapors and mists have a severe irritating effect on the mucous membranes, especially the respiratory tract. Coughing and asthma like reactions may occur. Other symptoms that may be experienced are headache, depressed feeling, and insomnia. TDI is also a powerful irritant to the eyes and skin.[30] The capacity of TDI to produce allergic sensitization of the respiratory tract in man is its most serious toxicologic action and the one which determines the magnitude of the threshold limit value. The threshold limit value is 0.02 parts per million.[31]

The interiors of the aircraft are most often painted with a water base paint. However, one company used "high speed lacquers" for cabins.

The bottom of the wings, nose cone, and gear wells may be painted with epoxy paints to protect against hydraulic fluids. Precautions are required to prevent sensitization when working with epoxy paints. (The hazards of epoxy resins are discussed under a separate section.)

Polyvinyl paints may be used on seats or other parts. Where vinyl paints are used protection needs to be provided against ketones, toluene and xylene thinners.

Lead base paints are apparently not a major health hazard in the aircraft industry. They may be used for building and plant maintenance. One facility only used about 3 gallons of lead primer per year in other than building maintenance.

Respirators are the primary means used by the airline industry for reducing exposure of aircraft exterior painters to paint pigments and thinners. On the other hand, painting of aircraft parts is most often done in ventilated spray paint rooms or booths.

(10) Epoxy Resins

Epoxy resins are used in fiberglas and plastic shops and to bond arm rests, bulkheads, etc. Epoxy paints are also sprayed on the underneath side of the aircraft. "Epoxy resins are thermosetting substances modified by various agents into solid resins which find a wide range of uses. Converting epoxy compounds into useful products requires knowledge and control of a broad spectrum of chemical compounds classified as hardeners, accelerators, diluents, fillers, reinforcements and modifiers. The combination of basic epoxy resins, with the many adjuncts, has resulted in hundreds of different end products. Unfortunately, some of these materials, either individually or in combination, have proven to be potentially dangerous from the health and/or the fire and explosive standpoint with the degree of hazard ranging from nil to extreme."[32]

"Dermatitis, an inflammation of the skin, is the disease that most often attacks workers handling epoxy resins and the chemicals used to manufacture them. Redness, itching, swelling, blisters, oozing, crusting, and scaling can result from primary irritation or allergic sensitization dermatitis.

"Respiratory, nose and throat irritation, headache, nausea, intestinal upsets and other conditions may result from breathing the vapors or other materials used in manufacturing processes. Eyes are also affected by the fumes or direct contact.

"When completely cured, epoxy resins are inactive and have little potential danger for the workers. Wet, or uncured, resins and chemicals used to harden the resinous mixture, thin it, strengthen it, or make it flexible should be regarded and handled as hazardous materials.

"Outbreaks of dermatitis and other diseases can be avoided by following these basic rules:

A. Inform workers of possible hazards.

B. Provide ventilation to control vapors produced while mixing the resins and hardener as well as to control the fiberglas and epoxy particulates during tooling.

C. Maintain plant and personal hygiene through good plant housekeeping procedures, appropriate industrial cleaners, protective clothing, and where needed protective creams."[33]

The health hazards associated with the application of epoxy resins, were generally controlled by the airline industry; however, mixing of epoxy chemicals in some instances was not covered by adequate control procedures.

(11) Decomposition Products

Varnish and resin decomposition products should be controlled by local exhaust ventilation when it is required to heat such materials. Varnish on electric motors is often removed by baking off the varnish material.

Resin decomposition products may also occur during welding. Steel[34] discusses thermal decomposition products during welding and cutting of paint primed steel. He states that "nitrogen - containing media like polyurethanes and epoxy resins decompose under heat treatment to form nitrogen dioxide and, under certain conditions ammonia may also be produced. In addition to these common decomposition products, toxic substances are generated which are peculiar to specific media. Thus acrylic and polystyrene resins tend to revert to the toxic monomers; cresol and phenol are produced from cresol - and phenol-formaldehyde resins; polyurethanes may yield highly toxic cyanides and diisocyanates; and polyvinyl chloride may form hydrogen chloride and phosgene. Phosgene and hydrogen chloride are also decomposition products of chlorinated organic additives. Epoxy resins which are burnt or welded release decomposition products called, for want of a better name, epoxy residues. These substances give colour reactions typical of epoxy resins, and it is probably wise to assume that they have a similar physiological activity".[34]

(12) Battery Charging

Both lead-acid batteries and nickel-cadmium batteries are recharged at maintenance facilities. The production of hydrogen is a recognized hazard near battery charging operations. Sulfuric acid mist may also be produced during charging of lead-acid batteries, and a potassium hydroxide mist may be generated during charging of nickel-cadmium batteries. Workers complained at three nickel-cadmium battery operations of poor ventilation.

One operator said there had been a minor explosion during charging of nickel-cadmium batteries. The operator tests each cell. During one such testing the tester had been dropped across the electrodes causing the explosion. The worker claimed an allen wrench used for dismantling the electrodes could cause the same hazard potential. A worker in another facility mentioned that jewelry should not be worn when nickel-cadmium batteries are being charged.

The possibility of an explosion and irritation of the upper respiratory tract were the primary hazards to workers in the battery charging areas.

(13) Solvents

Numerous organic solvents are used in cleaning aircraft parts in degreasing tanks and spray booths; and often a solvent is added to a rag which is then used for cleaning purposes. A number of solvents are used as paint thinners, in paint strippers, in duplicating equipment, for spot cleaning fabrics (dry cleaning is sent to commercial cleaners), and in other applications.

Where solvents are used in degreasing tanks and spray booths, controls are generally provided. On the other hand, where solvents are used on cleaning rags, controls may not be adequate. "As a general rule solvents commonly used for cleaning have vapor pressures that will produce concentrations of the order of 100 to 1000 parts per million (ppm) and even greater in the breathing zone of the user when used in open pans or with cleaning rags even with good general ventilation".[35]

McFee has summarized the general physiological effects of organic solvents which is quoted with the publisher's permission:[35]

"All solvents affect the central nervous system to some extent acting as depressants and anesthetics, and causing other effects depending upon the degree of exposure and the solvent involved. These effects may range from mild unnoticed effects to narcosis and death from respiratory arrest.

"All solvents will cause dermatitis - inflammation of the skin. This may be caused by simple irritation by systemic damage to the skin. Even the most inert solvents will dissolve the natural protective barrier of fats and oils leaving the skin unprotected against further irritation and harm.

"The aliphatic hydrocarbons act primarily as depressants to the central nervous system, but otherwise they are generally as inert biochemically as they are chemically. The primary problem with this class of solvents is dermatitis.

"The cyclic hydrocarbons act much in the same manner as the aliphatics. Some undergo no change in the body but there are some that are metabolized to compounds with a low order of toxicity. The unsaturated cyclic hydrocarbons generally are more irritating than the saturated forms. The primary problem with this class of hydrocarbons is dermatitis.

"The aromatic hydrocarbon, benzene, is notorious for its effect on the blood forming tissues of the bone marrow. Gerarde[37] has shown that injury may result from a single exposure. Benzene should not be used for cleaning processes or any process where the concentration in the air is apt to exceed safe levels, (benzene concentrations should not exceed standards or guidelines established by governmental agencies).

"The liquid aromatic hydrocarbons (such as toluene and xylene) in general are local irritants and vasodialators causing severe pulmonary and vascular injury when absorbed in sufficient concentrations. They are also potent narcotics. The primary problem with the common aromatic solvents other than benzene are dermatitis and effects on the central nervous system.

"The effects of the halogenated hydrocarbons vary considerably with the number and type of halogen atoms present in the molecule. Carbon tetrachloride at one end of the scale is highly toxic, acting acutely by injury to the kidneys, the liver, the central nervous system, and the gastrointestinal tract. The present TLV is 10 ppm.

"The primary problem of chronic exposure to carbon tetrachloride is damage to the liver and kidney. Carbon tetrachloride has become the classical liver toxicant for use in studies on the effect of damage to the liver. As with benzene, this solvent should not be used for open cleaning processes where the concentration may exceed threshold levels.

"Trifluortrichloroethane (Freon 113) on the other hand has a very low level of toxicity. The present TLV is 1,000 ppm. Its only effect of known significance is the depressant effect on the central nervous system and this occurs at concentrations much greater than the TLV. Being non-flammable and of low toxicity it is a good general solvent to substitute for the more hazardous materials.

"The chlorinated hydrocarbons in general are more toxic than the common fluorinated hydrocarbon solvents. Specific effects and toxicities vary widely, but the most common problem with the chlorinated hydrocarbons of intermediate toxicity, e.g., trichloroethylene, is the depressant effect on the central nervous system, dermatitis, and injury to the liver.

"The alcohols are noted for their effect on the central nervous system and the liver but also vary widely in the degree of toxicity.

"Methanol has been responsible for several industrial fatalities and physiological injuries. It is noted for its impairment to vision. Methanol is slowly metabolized and produces toxic metabolities. For this reason its chronic toxicity is greater than that of ethanol.

"Ethanol obviously is the most important of the aliphatic alcohols. It is quickly metabolized in the body and largely converted to carbon dioxide and water. It is the least toxic of the alcohols.

"Propanol is metabolized to toxic byproducts and is more toxic internally than ethanol but less toxic than the higher homologues. Neither isopropanol nor n-propanol are considered as industrial health hazards. Higher homologues are generally more narcotic, irritating and toxic than the lower homologues.

"The common ketones generally exert a narcotic-type action. All are irritating to the eyes, nose, and throat and for this reason high concentrations are not usually tolerated. Lower, tolerable concentrations may impair judgment and thereby create secondary hazards. The lower saturated aliphatic ketones are rapidly excreted and for this reason cause only minor systemic effects. Of these acetone is the least toxic, but extremely flammable.

"The esters are noted for their irritating effects to all exposed surfaces including the respiratory tract. They are also potent anesthetics. Cumulative effects of the common esters used as solvents are not significant except for those conditions resulting from irritation.

"The primary response to the saturated and unsaturated alkyl ethers, such as ethyl and divinyl ether, is anesthesia. They are also irritating to mucous membranes. The greatest hazard with these ethers is their tendency to form explosive peroxides. Care should be taken to preclude this. Halogenated ethers are generally highly toxic and the reader should refer to the more comprehensive references (36, 37, and 38) for information on these materials.

"The glycol ethers exert their effects upon the brain, the blood, and the kidneys. Of these ethylene glycol monomethyl ether is the most toxic. It is rapidly absorbed through the skin and is noted for elicitation of neurological symptoms. Ethylene glycol monoethyl ether, on the other hand, is definitely less toxic than either ethylene glycol monomethyl ether or ethylene glycol monobutyl ether. There has been little evidence of industrial disease or injury from the use of ethylene glycol monoethyl ether.

"The previous statements indicate only the general toxicological effects to assist in the determination of hazard potential. Actual effects for a specific solvent or for a given mixture of solvents may vary considerably as indicated in the introductory paragraphs."[35]

As Dr. McFee points out the physiological effects of different solvents are far too complex and variable to be discussed in depth in a short article. The entire article by McFee is recommended reading.[35] Some of the solvents encountered were trichloroethane, acetone, toluene, benzene, xylene, methyl ethyl ketone, perchlorethylene (common name), trichlorethylene, Freon (several trade names), solvent naphtha, chloroform, kerosene (various trade names), Isopropyl alcohol, methyl alcohol, stoddard solvent (various trade names), methylene chloride, and Isobutyl alcohol. Numberous other solvents are used in various proprietory solvents whose identity it is time consuming to obtain.

For detailed information on specific solvents the reader sould consult more detailed references, such as Patty's Industrial Hygiene and Toxicology,[36] Gerarde's Toxicology and Biochemistry of Aromatic Hydrocarbons,[37] or the AIHA's Hygienic Guide Series.[38]

Manufacturers will usually provide information concerning the general composition of their trade name materials if a statement indicating that the information received will be kept confidential is included with the request.

The Condensed Chemical Dictionary,[39] The Merck Index,[40] Clinical Toxicology of Commercial Products,[41] and American Mutual Insurance Alliance's

Handbook of Organic Industrial Solvents[42] provide additional information concerning many solvents.

In general potential solvent hazards appeared to be well controlled by the aircraft industry. However, no samples were taken to evaluate a workers exposure to solvent vapors during paint stripping, paint spraying, or other operations where solvents are used. Carbon tetrachloride was not used by any maintenance base facility. Benzene was used in small quantities in some facilities.

(14) Mercury

Mercury is used in monometers in the avionics departments of maintenance base facilities. One facility estimated 100 pounds of Mercury is used per year. Potential hazards include the exposure to mercury during filling or breakage of the monometers, also during cleaning of mercury. Some facilities send their mercury elsewhere for cleaning. Careless handling of mercury can allow mercury vapor concentrations to rise to toxic levels. The insidious nature of mercury poisoning is such that an individual may be relatively free from symptoms for years and then develop serious chronic irreversible illness.[43]

Spills of mercury should be cleaned up immediately. Mercury not in use should be stored in well-stoppered containers or in suitable vessels under a layer of water. Mercury decontaminating agents such as polysulfide compounds should be used to reduce exposure from mercury concealed in cracks or crevices.

The cleaning of mercury should be well controlled to prevent the sorption of mercury through the skin or respiratory tract.

(15) Nondestructive Testing

Nondestructive testing is used to reveal defects in metals used in aircraft without damage to the parts being tested. Two nondestructive methods frequently used by the airline industry are radiographic and magnetic particle inspection.

(a) Radiographic Inspection

The depth of penetration of the X-ray is dependent upon the power of the X-ray beam. When the X-ray passes through the material onto a sensitive film emulsion, a shadow picture is obtained. Voids, holes, and cracks appear as dark areas. Operators and persons in adjoining areas must be protected from the radiation.

Gamma rays are also used to inspect metals for structural defects. The gamma rays most generally used have a greater penetrating power than most industrial X-rays. Their advantage is that tests can be made without much expense since a radioisotope is all that is required aside from the photographic equipment.

Cobalt-60 and iridium-192 were two of the gamma emitting isotopes used by the airline industry for identifying structural defects.

The subject of the precautions to be taken in using radioisotopes is too extensive for this report, but the most important precaution is that the storage, handling, and use of isotopes must always be performed under the strictest supervision, particularly when work is carried out on site. No one should be allowed to use isotopes unless they are thoroughly conversant with all the safeguards to be taken.

Some maintenance facilities at small operations use the services of outside firms for use of radioisotopes. Persons working with such isotopes or persons in adjacent areas must be protected from the gamma radiation from such sources. Control of the use of radioisotopes is under the jurisdiction of the U. S. Atomic Energy Commission.

Potential hazards to persons developing photographic film must also be controlled.

(b) Magnetic Particle Inspection

Although radiographic inspection will find deep-seated irregularities other methods are required to find non-visible, close-lipped discontinuities at or near the surface. Methods used in the airline industry are: magnaflux, magnaglo, and penetrant inspection. In the magnaflux inspection procedure magnetism is used in the defect detection procedure. Finely divided ferro-magnetic particles are placed on a magnetized part. If a defect is present it is shown by the pattern made by the particles. The color of the particles are selected to contrast with the surface of the part being examined. There are two types of inspection media. In the wet method, the magnetic particles are prepared in paste form and mixed with oil. This method is more sensitive to minute surface discontinuities. In the dry method dry powder is dusted on the magnetized material. This method is more sensitive to subsurface discontinuities.

Where the dry method is used the eyes and respiratory tract should be protected from dust particles. Combustible gases and vapors should not be used near the magnetic particle magnetizing equipment since such equipment may produce arcing.

Another method frequently employed in aircraft maintenance facilities is the penetrant inspection method. The part to be inspected is cleaned, a fluorescent penetrant is applied to the surface of the metal and the metal examined for defects under ultraviolet light.

Most penetrants are organic compounds that may cause dermatitis. Skin contact should be avoided and personal hygiene strictly followed. Ultraviolet equipment should be effectively shielded or filter lenses of the correct protective shade should be worn.[44,45]

(16) Radar

Maintenance base workers may be exposed to radar energies during testing of radar equipment during repair procedures. It was stated that the X band is usually used with a power output of 40,000 to 60,000 watts. The C weather band is used less frequently. The S band is only used occassionally. Potential radiation exposures are checked by the airlines. However, certain airlines still use neon tubes to determine leakage. Most airlines fed radar outputs from high energy units into an enclosed load. It was stated that leaks may occur in the flexible wave guide used to connect the receiver to the dummy load.

The following material is a selection of information obtained from a discussion of radar hazards appearing in the book Fundamentals of Industrial Hygiene published by the National Safety Council:[46]

"A radar unit essentially consists of a transmitter and receiver, usually operated through a common antenna. A pulse of energy is emitted by the transmitter and picked up as an echo signal by the receiver and converted by a display or sounding device into useable information.

"The potential health hazards reported for the handling and use of radar sets are: (1) X radiation from high voltage tubes, (2) radioactivity from radioactive activaters used in certain radar switching tubes, (3) thermal effects of electromagnetic radiation on the body or parts of the body, (4) toxicological hazards of gas fills as used in certain waveguides.

"Parts of the body most likely to become damaged by radio frequency energy include the eyes, testes, gall bladder, gastrointestinal tract, and certain other vital organs. There is some indication that other harmful physical and chemical effects may result from exposure to radio frequency energy.

"The point of exposure of a person to radar energies is usually near the front of the antenna, within its beam, or at the open end of the waveguide. The waveguide structure itself is usually sufficiently enclosed to eliminate the hazard except as the open end or at leaky joints.

"Workers should at no time look directly into a radar beam from a high energy unit. (In this instance, any unit producing a field strength at the point of observation in excess of 0.01 W/sq cm is considered a high energy unit.) Moreover, they should view the interior of microwave tubes, waveguides, and similar equipment only through a remote viewing device such as a periscope or telescope, unless microwave operation has ceased. The viewing device should be checked to determine that radar energy is not being deflected or focused at the eyepiece.

"Radar outputs from high energy units not fed into an antenna should be absorbed by an enclosed load, or passed into the atmosphere in such a direction or at such a distance that it will not produce a field greater than 0.01 W/sq cm at the location of any person or animal.

"Radar beams that must be discharged into a closed area should be absorbed by a microwave absorber. The reflected wave unit must be carefully monitored so that additional absorbers can be provided if necessary."[46]

The reader is referred to the National Safety Council article from which this information was taken for a discussion of potential safety hazards and medical surviellance recommendations.

(17) Integral Wing Fuel Tank Cleaning and Sealing

Chain Robbins discusses the materials used in fuel tank cleaning and sealing in an article appearing in the American Industrial Hygiene Association Journal:[47]

"The development of an integral or 'wet' wing has presented health and safety problems in the cleaning and sealing operations necessary to make the wing fuel tight. An integral wing is defined as one in which the raw fuel is in direct contact with the structural members of the wing itself. Sealing to prevent the loss of fuel is necessary around fasteners, rivets, lockbolts, and the periphery of the entire wing structure.

"In order to accomplish the seals, the metal surfaces are cleaned with methyl ethyl ketone in the confined space of the wing cavity. Subsequent to this cleaning operation a sealing material is manually applied to the desired locations. This sealer is composed of a polysulfide base material mixed with an accelerator which contains calcium dichromate and the solvent dimethyl formamide. Following this a topcoating material is brushed over the seal and the bare metal on the bottom wing panel to preclude softening of the seal and corrosion of the metal by the fuel. This topcoating material is a phenolic base with a mixture of methyl isobutyl ketone and butyl acetate as the solvent medium. The entire operation is performed manually and the estimated time spent cleaning and sealing one airplane wing (both right and left-hand sections) is about 3000 manhours. The wing cavities are small confined spaces and many of the sealing locations are such that the employees must literally sit or lie down to perform the job."

There is a two-fold hazard in working in confined spaces: (1) the increased possibility of fire and explosion, and (2) the possibility of toxic concentrations of air contaminants is much greater.

The reader is referred to Mr. Robbins article for a discussion of methods for controlling exposure to the hazards mentioned.

(18) Hydraulic System Testing and Installation

Fire resistant phosphate-ester type hydraulic fluids which can be used in aircraft required to operate at temperatures from minus 40° to plus 200°F are used by the airline industry.

Hydraulic system components undergo routine pressure testing by aircraft maintenance personnel. High pressure leaks may cause transient irritant effects upon the eyes and upper respiratory tract. Certain inhibitors used in some hydraulic fluids are reported to have caused severe skin reactions because of employee sensitization to the inhibitors used in the fluid.

Precautions to be used in the use of hydraulic fluids are discussed in the article from which the above information was summarized.[46]

IV. SUMMARY:

This report has presented the findings of a limited survey of occupational health services provided airline employees. Areas where major occupational health hazards may occur have been defined. Admittedly, other health hazards may be found at any airport, for example, at waste treatment plants. No attempt was made to define potential safety hazards. It was not the intent of this paper to give control procedures for the potential hazards defined, although some recommended guidelines and work practices were given.

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NIOSH participating personnel included: Douglas Johnson, Kenneth Kronoveter, Ray Hervin, George J. Butler, Raymond O. Rivera, and Frances F. Coesens.

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TABLE I FAA-OPERATED AIRPORT TRAFFIC CONTROL TOWERS BY RANK ORDER OF AIR CARRIER OPERATIONS: FISCAL YEAR 1969*

Tower and hub type 1/			Rank	Number**	Tower and hub type 1/			Rank	Number**
Chicago O'Hare	Ill.	L***	1	623367	Memphis	Tenn.	M	26	102758
Los Angeles	Calif.	L	2	430413	Portland	Oreg.	M	27	93373
John F Kennedy Intl	N.Y.	L	3	385529	Covington Gr Cinn	Ky.	M	28	92191
Atlanta Mun	Ga.	L	4	335006	Indianapolis	Ind.	M	29	90227
San Francisco	Calif.	L	5	305284	Las Vegas	Nev.	L	30	89492
Miami	Fla.	L	6	266745	Tampa	Fla.	M	31	89228
La Guardia	N.Y.	L	7	258279	Buffalo	N.Y.	M	32	88191
Dallas Love Fld	Texas	L	8	251279	Phoenix	Ariz.	M	33	79364
Washington National	D.C.	L	9	225609	Louisville Stand	Ky.	M	34	77868
Boston	Mass.	L	10	210217	Milwaukee Mitchell	Wisc.	M	35	75531
Newark	N.J.	L	11	208079	Salt Lake City	Utah	M	36	70655
Detroit Wayne	Mich.	L	12	201941	San Diego Lindberg	Calif.	M	37	70356
Philadelphia	Pa.	L	13	197511	Oakland	Calif.	L	38	70076
St Louis	Mo.	L	14	184031	Columbus Intl	Ohio	M	39	66687
Pittsburgh Gr	Pa.	L	15	169778	Windsor Locks	Conn.	M	40	64526
Denver	Colo.	L	16	157619	Rochester	N.Y.	M	41	63730
Cleveland-Hopkins	Ohio	L	17	149976	San Antonio Intl	Texas	M	42	62868
Kansas City Mun	Mo.	L	18	137252	Nashville	Tenn.	M	43	62683
Minn W Chamberlain	Minn.	L	19	137151	Charlotte	N.C.	M	44	61638
Baltimore Intl	Md.	M	20	129093	Wash Dulles Intl	Va.	L	45	61535
Honolulu	Hawaii	-	21	124468	Albany	N.Y.	M	46	56331
Houston	Texas	L	22	118978	Syracuse	N.Y.	M	47	53968
San Juan Intl	P.R.	-	23	116789	Jacksonville	Fla.	M	48	53814
New Orleans Moisan	La.	L	24	110761	Dayton	Ohio	M	49	53772
Seattle Tacoma	Wash.	L	25	103978	San Jose Mun	Calif.	N	50	52779

* From the FAA Publication "Air Traffic Activity" FY 1969. U.S. Department of Transportation - Office Management Systems.

** Figures represent number of aircraft, not people.

***The letters refer to the size of the hub (large, medium, small, and non-hub.) The designation is based on the number of passengers whereas the rank is based on aircraft. A non-hub airport enplanes less than 72,000 passengers per year.

TABLE II - Some Potential Exposures To Toxic Materials

Hazard	Code No.	Number Of Businesses In Which Hazard Was Observed	Control Measures (Establishments) Ade.	Mar.	Inade.
Noise	812	12	9	3	0
Paint Mist	521	7	5	2	0
Welding Gases	260	6	3	2	1
Ultraviolet Radiation	837	6	6	0	0
Cleaning Solvents or Degreasing Compounds	518,202,227 076,514,513, 204	17	8	7	2
Metal Fume	531	6	4	1	1
Carbon Monoxide	056	4	1	2	1
Dust	913	2	1	1	0
Jet Exhaust Gases	124	9	2	5	2
Lead	159	2	1	1	0
Ammonia	017	2	1	0	1
X-Ray	821	1	1	0	0
Microwave Radiation**					

**A number of microwave units are used at the airport. These units should be checked periodically to prevent eye injury. (Microwave radiation measurements were not made at this airport, but were at another airport.)

TABLE III

OCTAVE BAND ANALYSIS

SOUND SURVEY DATA SHEET

Equipment:	Type	Model
Sound Level Meter	B&K	2204
Analyzer	B&K	1613

Octave Band Analysis Re: 0.0002 Microbar

Location	Octave Band Center Frequency - Hertz												Comments
	dBA	dBC	31.5	63	125	250	500	1000	2000	4000	8000	16,000	
						Sound	Level	- dB					
Warm up DC-8	113	113	99	88	96	95	101	110	105	104	95	85	About 3' from plane
DC-8 Arriving at gate	97	100	81	84	83	82	88	91	99	95	87	74	
Background noise at gate	81	86	87	74	82	80	75	78	79	75	72	72	
DC-8 Departing from gate	104	104	89	90	88	85	95	97	101	97	92	82	25' from nose of plane
Warm up 747	109	109	94	95	95	96	99	99	99	102	97	86	5' from plane
Warm up 720B	110	111	94	94	93	90	100	103	104	101	95	83	
Departing 707	104	104	89	87	90	88	96	97	101	95	89	75	
Warm up 707	110	111	90	92	93	93	105	-	-	-	-	-	Not time to complete
Ground Power Unit	95	102	80	92	98	96	92	91	86	70	60	50	
Tram Area	92	98	84	87	85	90	93	96	96	93	83	70	50' from departing 707

TABLE III

dBA and dBC Sound Level Measurements

Operation	dBA	dBC	Comments
Ramp Area - 747			
747 Warming up at gate (Airline 1)	102	104	45' from nose of plane
747 Warming up at gate (Airline 2)	102	103	30' from nose of plane
During fueling of 747 (Airline 3)	92	-	
747 Warming up (Airline 3)	109	109	Near front of plane
Under belly of 747 being pushed out (Airline 1)	112	112	
747 Preparing for takeoff (Airline 3)	85	90	
747 Departing (Airline 4)	110	110	
747 Warming up (Airline 1)	108	-	At nose of plane
Ramp Area - 707			
707 Warming up (Airline 1)	110	111	
707 Departing gate (Airline 5)	104	104	
707 Departing gate (Airline 5)	104	105	
707 Departing gate (Airline 5)	104	105	
707 Departing gate (Airline 1)	112	113	
707 Arriving at gate (Airline 1)	116	-	
707 Departing gate (Airline 1)	111	-	
707 Arriving at gate (Airline 1)	110	-	
707 Departing gate (Airline 1)	116	-	
707 Water Wagon (Airline 1)	112	-	
707 Warming up (Airline 1)	114	-	

TABLE III (cont'd) dBA and dBC Sound Level Measurements

Operation	dBA	dBC	Comments
Ramp Area - 727			
727 at nose of plane (Airline 1)	101	101	
727 Departing gate (Airline 2)	102	-	20' from nose of plane
727 Arriving at gate (Airline 6)	102	-	20' from nose of plane
727 During unloading (Airline 6)	89	-	
727 Departing gate (Airline 7)	96	-	
727 Baggage loading (Airline 1)	96-102	-	
Ramp Area DC-8			
DC-8 Warming up (Airline 2)	113	113	
DC-8 Arriving (Airline 1)	97	100	50' from plane
DC-8 Arriving at gate (Airline 1)	101	-	
DC-8 Departing from gate (Airline 1)	104	104	25' from nose of plane
DC-8 Freighter (Airline 10)	112	-	At nose of plane
Ramp Area - 737			
737 Coming into gate (Airline 8)	114	-	10' under nose of plane
Ramp Area - 720 B			
720 B Warming up (Airline 8)	110	111	
Ramp Area - DC-9			
DC-9 Departing gate (Airline 9)	96	101	
DC-9 Approaching gate (Airline 9)	107	-	At nose of plane
Ramp Area - F-27			
F-27 Approaching gate (Airline 9)	114	-	20' from plane
F-27 Warming up (Airline 9)	115	-	At nose of plane

NOTE: F-27 has a high frequency noise - engines were turned off before dBC reading could be obtained.

TABLE III (cont'd) dBA and dBC Sound Level Measurements

Operation	dBA	dBC	Comments
Tram Area			
Tram Area (Airline 1)	92	98	50' from 707 warming up for departure
Jetway Area			
In Jetway (Airline 1)	87	89	747 ready for departure
Outside Jetway service stair platform	102	-	
In Jetway (door closed)	86	-	747 backing away
In Jetway (door open)	101	-	707 approaching
Transfer Area Control Room			
Transfer Area Control Room (Airline 1)	70	-	Door open, no planes in immediate area
Transfer Area·Control Room	96	-	Door open, 727 passing by
Ground Power Equipment			
Near Ground Power Unit	95	101	
Power Wagon Supply for DC-8	96	102	
Ground Unit pushing out DC-8	108	-	
Auxillary Power Unit	91	-	
Power Unit	103	108	
Riding on power unit used to push out 737	103	103	
Pay mover equipment	111	-	
Power Conversion Equipment	103	105	
Food Service Truck			
Platform on Food Service Truck	94	107	

TABLE III (cont'd)

dBA and dBC Sound Level Measurements

Operation	dBA	dBC	Comments
Baggage Areas			
Outbound baggage area (Airline 1)	72	80	Noise level varies
Outbound baggage area (Airline1)	91	94	747 warming up for departure
Baggage Area (Airline 2)	84	–	747 approaching south end of baggage area, measurement taken at north end.
Baggage Area (Airline 2)	96	97	737 approaching south end of baggage area, measurement taken near south end.
Test Cell			
Test Cell Control Room (Airline 8)	72	92	
Garage Service Area near test cell (Airline 8)	83	95	

TABLE IV - Noise Levels Baggage Handling Area

TIME	LOCATION	AVERAGE dBA	MAX. dBA	COMMENTS
0940-0945	Inbound baggage area	78	84	
0945-0950	" " "	78	82	
0950-0955	" " "	77	82	
0810-0815	" " "	75	84	
0815-0820	" " "	73	88	
0820-0825	" " "	74	85	
0825-0830	" " "	73	88	
0830-0835	" " "	80	88	
0835-0840	" " "	82	89	
0840-0845	" " "	75	84	
0855-0900	" " "	78	83	
0900-0905	" " "	75	82	
0905-0910	" " "	75	83	
0920-0925	" " "	75	88	
0925-0930	" " "	82	87	
0930-0935	" " "	77	82	
0745-0750	Outbound baggage area	73	80	
0750-0755	" " "	74	82	
0755-0800	" " "	73	96	Plane passing by
0800-0805	" " "	72	76	
0805-0810	" " "	73	86	Tow motor passing
0810-0815	" " "	74	90	Plane passing by
0815-0820	" " "	76	84	720 taking off
0820-0825	" " "	76	80	
0825-0830	" " "	75	82	
0830-0835	" " "	81	88	
0835-0840	" " "	81	88	
0840-0845	" " "	76	85	
0845-0850	" " "	94	96	5 minutes duration, 747 in area
0850-0855	" " "	80	86	
0855-0900	" " "	78	82	
0900-0905	" " "	74	88	Plane passing by
0955-1000	" " "	73	80	

TABLE V - Carbon Monoxide Concentrations - Baggage Handling Area

LOCATION	TIME	CONCENTRATION in PPM		SAMPLING METHOD
Outbound baggage area	0827-0930	average	14	MSA Portable Carbon Monoxide Indicator with Recorder
" " "		low	7	" " " "
" " "		high	39	" " " "
" " "	0811		10	" " " "
" " "	0813		15	" " " "
" " "	0820		25	" " " "
" " "	0821		30	" " " "
" " "	0823		25	" " " "
" " "	0825		20	" " " "
" " "	0826		25	" " " "
" " "	0850		10	Drager detector tube
" " "	0925		5	" " "
" " "	0950		10	" " "
Inbound baggage area	0900		25	" " "
" " "	0935		10	" " "
" " "	1000		25	" " "
Outbound baggage area	0800		15	" " "
" " "	0815		10	" " "
" " "	0830		20	" " "
" " "	0845		20	" " "
Inbound baggage area	0825		10	" " "
" " "	0840		25	" " "

APPENDIX A

AIRPORT SURVEY

1. Name of Airport: ______________________________

2. Name of Airport Manager: ______________________________

3. Name of Person Interviewed: ______________________________

4. Who Owns the Airport: ______________________________

5. Who Operates the Airport: ______________________________

6. What is the Approximate Geographic Size of the Airport: __________

____

____

7. What is the Present or Projected Scope of Operations: __________

   a. Number of Flight Arrivals and Departures: (Commercial General, and Military Aviation): ______________________________

   ____

   ____

   ____

   b. What is the Air Passenger Volume: ______________________________

   ____

   c. How Many Persons Are Regularly Employed at the Airport: ________

   ____

   ____

8. Does the Airport Have a Designated Airport Safety Officer: Yes No

9. Does the Airport Have a Management Tenant Safety Committee, or Its Equivalent: Yes No

10. Does the Airport Handle Passengers or Cargo From Foreign Countries: Yes No

11. Are Employees Adequately Immunized Against Contagious or Infectious Diseases Where Their Work Assignments Requires Them to Service Foreign Passengers or Cargo: Yes No

12. If Necessary Are Suitable Quarantine Facilities Available At the Airport for Control of Contagious Diseases: Yes No Not Applicable

13. Does the Airport Have a Written Official Airport Disaster Plan: Yes No

14. Does the Airport Have a First-Aid Room for the Treatment of Employee and/or Passenger Injuries: (Circle all answers that apply) Passenger Employee No

15. Does the Airport Have Someone Trained in First-Aid Available at the Airport At All Hours of Operation: Yes No

16. Does the Airport Have a Physician Available at the Airport at all Hours for the Treatment of Employee or Passenger Injuries: (Circle all answers that apply) Passenger Employee No

17. Does the Airport Have a Nurse Available at the Airport at all Hours for the Treatment of Employee or Passenger Injuries: Passenger Employee No

18. What Official Health Agency has Authority Over the Airport:__________

____

19. Are Overall Airport "Community" Health Statistics Available: (For Example)

a. Reports of Accidents and Acute Illnesses Occurring at the Airport: Yes No

b. Reports of Physicians Called to the Airport: Yes No

c. Records of Ambulance Calls to the Airport: Yes No

d. Insurance Company Reports: Yes No

e. Description of All Aviation "Incidents" with Life Endangering Potential: Yes No

f. Reports of Safety and Other Inspections: Yes No

20. What Is the Approximate Traveling Time Under Good and Poor Traffic Conditions From the Airport to the Nearest Hospital:____

____

____

____

21. Have Any Formal Arrangements Regarding Handling of Emergencies Been Worked Out with Local Hospitals: Yes No

22. How Long Does it Take to Transport a Person from the Airport to the Closest Physician's Office under Good and Poor Traffic Conditions:

____

____

____

____

____

APPENDIX B

OCCUPATIONAL HEALTH SURVEY FORM

1. Establishment Name____

   Address____

   City______________________________________Zip Code_____________

   Legal Owner____

2. Person Interviewed____

   Title______________________________Telephone No._________________

3. Card Code

4. Date

5. State Code

6. Company Number

7. Original survey - State and NSN (1)
   Original survey - NSN (2)
   Resurvey - NSN (3)

8. What is your chief product or service?

NOTE: Spaces for recording and coding answers have been omitted. A different questionnaire is now used by the National Institute for Occupational Safety and Health.

9. Size Code (based on total number of employees).

10. How many shifts do you have?

11. How many people are on your plant payroll at the present time?

12. Of this number, how many are normally in the work area as opposed to the office or outside areas?

13. Of those in the work area, what approximate percentage is male?

14. Does your plant do federal contract work?

Yes, Primary Contractor	(1)
Yes, Sub-contractor	(2)
No	(3)
Don't Know	(4)

15. A) Does your company employ an industrial hygieni...

Yes, At This Location (1)

Yes, At Corporate Headquarters (2)

Yes, On a Consulting Basis (3)

No (4)

(B) Name

Address

Telephone Number

(C) Estimate the average number of industrial hygiene man-hours that are devoted to your particular plant per week.

16. A) Do you have an agreement with a physician to give your employees emergency or other medical care?

Yes, Full Time	(1)	Yes, On Call	(3)
Yes, Part Time	(2)	No	(4)

B) Name

Address

Telephone Number

C) Estimate the average number of physician man-hours that are devoted to your particular plant per week.

17. A) Do you have a nurse in your facility at a regular time?

Yes, R.N.	(1)	Yes, Both	(3)
Yes, L.P.N.	(2)	No	(4)

B) Name

Address

Telephone Number

C) Estimate the average number of nursing man-hours that are devoted to your particular plant per week.

18. A) Do you have an employee responsible for giving first aid when no doctor or nurse is present?

Yes	(1)	
No	(2)	(Question 18-B Not Applicable)
Not Applicable	(3)	(Question 18-B Not Applicable)

B) Does he have any formal first-aid training?

Yes, Red Cross	(1)	No	(4)
Yes, Armed Service Medic	(2)	Don't Know	(5)
Yes, Other	(3)	Not Applicable	(6)

19. A) When you hire a new employee do you record information from him about his health on some regular form?

Yes, All Employees (1)

Yes, Some Employees (2)

No (3)

B) Before you hire a new employee do you require him to take a medical examination?

Yes, All Employees (1)

Yes, Some Employees (2)

No (3)

20. A) Do you provide periodic medical examinations for your employees in hazardous jobs?

Yes, Adequate	(1)	No	(3)
Yes, Inadequate	(2)	Not Applicable	(4)

B) Do you provide periodic audiometric examinations for your employees that are exposed to noise?

Yes, Adequate	(1)	No	(3)
Yes, Inadequate	(2)	Not Applicable	(4)

C) Do you provide periodic blood and urine examinations for your employees where appropriate?

Yes, Adequate	(1)	No	(3)
Yes, Inadequate	(2)	Not Applicable	(4)

20. D) Do you provide periodic physiological function tests (excluding audiograms) Where appropriate?

Yes, Adequate	(1)	No	(3)
Yes, Inadequate	(2)	Not Applicable	(4)

E) Do you provide periodic chest X-rays where appropriate?

Yes, Adequate	(1)	No	(3)
Yes, Inadequate	(2)	Not Applicable	(4)

21. Do you have an immunization program?

Yes (1)

No (2)

22. A) Are your employee absenteeism records:

Not Kept	(1)
Kept, Without Showing Nature of Absence?	(2)
Kept, Showing Nature of Absence?	(3)
Kept, Showing Nature of Sickness?	(4)

B) What is your average absentee rate (days/year/employee)?

Don't Know (99)

23. A) Does your company have a formal safety program?

Yes (1)

No (2)

B) Safety Supervisor

24. Is your workmen's compensation insurance carried with an insurance company or are you self-insured?

Insurance Company	(1)	- Name of Company
Self-Insured	(2)	
State Insurance Fund	(3)	
None	(4)	

25. In your establishment do you feel that there are any health hazards, even if you have them under control?

Yes (1) No (2)

What kind of hazards?

26. Have you had any occupational disease in your plant in the last year?

Yes, Dermatitis	(1)	No	(4)
Yes, Other	(2)	Don't Know	(5)
Yes, Combination	(3)		

27. How many years has this type of work been conducted in these facilities?

0-5	(1)	21-30	(4)
6-10	(2)	31-50	(5)
11-20	(3)	$\geq$ 51	(6)

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