Industrial Hygiene In-depth Survey Report of Exposure of Fuelmen

at

Allied New York Services, Inc.
JFK International Airport

Survey Conducted By:
Charles S. McCammon
Michael S. Crandall

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Report Written By:
Charles S. McCammon

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Industrial Hygiene Section
Industry-wide Studies Branch
Division of Surveillance, Hazard Evaluations, and Field Studies
National Institute for Occupational Safety and Health
Cincinnati, Ohio

PURPOSE OF SURVEY:	To determine the extent of exposure to jet fuel and jet exhaust of fuelmen working at JFK Airport.
EMPLOYER REPRESENTATIVES CONTACTED:	Mr. Charles Hoffman Operations Manager (212) 995-9760
	Mr. J. Keating Vice President
EMPLOYEE REPRESENTATIVES:	Mr. Dan Casey Fuelman (212) 995-9760
	Mr. Ralph Viviana Shop Steward International Brotherhood of Teamsters, Local 553
STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	4582 Airports and Flying Fields

ABSTRACT

Two visits were made to Allied Fueling to estimate worker exposure to carbon monoxide in the cabs of their fueling vehicles. A third survey was conducted to estimate worker exposure to jet fuel and jet exhaust. Personal samples were collected for hydrocarbons, oxides of nitrogen and polynuclear aromatic compounds. This survey was conducted in conjunction with the retrospective mortality study currently being done on the fuelman. No appreciable exposure via inhalation was found to oxides of nitrogen, general hydrocarbons or polynuclear aromatics.

INTRODUCTION

Under the Occupational Safety and Health Act of 1970, the National Institute for Occupational Safety and Health (NIOSH) was mandated and authorized to conduct research and health studies toward the development of health standards and to respond to requests to investigate complaints of adverse workers' exposure. In compliance with this mandate, the Industry-wide Studies Branch of the Division of Surveillance, Hazard Evaluations and Field Studies investigated the potential exposure of fuelmen at JFK Airport.

This report summarizes the sampling conducted for jet fuel and jet exhaust at Allied Fueling, JFK Airport. Various personal samples were collected for hydrocarbons, oxides of nitrogens, polynuclear aromatics and carbon monoxide. A previous report[1] summarizes the exposure of these fuelmen to carbon monoxide.

DESCRIPTION OF FACILITY

Allied Fueling, a part of Allied New York Services, Inc., at JFK Airport, is under contract to the New York Port Authority to provide fueling services for all airplanes and helicopters using JFK Airport. Allied currently handles about three million gallons of jet fuel per day, which amounts to over a billion gallons per year. The main office of Allied at JFK are located in Building 90 adjacent to the Port Authority offices. The facilities are owned by the Port Authority and leased to Allied.

Allied is responsible for the maintenance of the vehicles used for fueling while the Port Authority owns the vehicles. These vehicles include 135 hydrant carts and 90 tank trucks.

The hydrant carts are Ford pickup chassis onto which a pumper/filter system for the fuel has been constructed. The carts are used to transfer fuel up to 100 psi from inground pits to the airplane wings at a reduced pressure. So, actually the carts act more as a pressure reducer than a pumper. The tank trucks used have a capacity up to 10,000 gallons and are used in areas where underground fuel lines are not available.

All the carts are gasoline powered with the exhaust being vented under the front bumper. This exhaust system is the same for fueling vehicles around the country as a precaution to keep the hot exhaust away from the fuel. This same exhaust system is used in the gasoline powered tank trucks. Some of the newer tank trucks have diesel engines and are exhausted behind the cab. This diesel exhaust is not vented upwards but rather the exhaust pipes go up to the top of the cab and then are brought back down to ultimately be vented at ground level behind the cab.

DESCRIPTION OF THE WORKFORCE

All the hourly workforce belong to the International Brotherhood of Teamsters, Local 553. The local president is James McGuire. The foremen and some of the office staff are salaried. The workforce, with the exception of the office staff, are all men with an average age of 45. There are workers on duty around the clock with the largest number in the shifts between 6:00 a.m. and midnight.

A brief description of the jobs in the company are:

1) Fuelman - fuels airplanes and helicopters with either carts or tank trucks.
2) Utility Man - cleans pits, wash and cleans trucks, sumps trucks, clean-up fuels spills, and other odd jobs.
3) Mechanics - maintenance and repair of vehicles and other equipment.
4) Tank man - receive fuel at tank farm, general maintenance and operation of tank farm.

DESCRIPTION OF OPERATION

Planes are fueled by either the carts or tank trucks. Both procedures are quite similar. When a plane is fueled, the cart or truck is parked near or under the wing of the plane to be fueled. so that access to the refueling panel is possible by the lift on the back of the cart. Ground wires are set as soon as the vehicle is stopped and the engine is turned off; the truck is grounded first and the plane is grounded second. The panel under the wing is opened to read the gauges and to reach the fuel tanks switches. When carts are used, a pressure line is attached to the pit, (the underground fuel line), connection to allow the pit valve to be opened. This pressure line is run off a compressor located on top of the motor under the hood. If this line is not maintained at a high enough pressure, then the fuel valve in the pit cannot be opened. A nozzle is connected from the cart into the pit followed by hydrant-pressure line. Two nozzles are then connected from the top of the cart into the wing of the plane. The fuel is started by activating a deadman switch on a pressure line so that if it is unattended or released, the flow of fuel will be stopped. Once the plane is filled with the proper amount of fuel, the nozzles, pressure lines and ground wires are disconnected in the reverse order in which they were connected.

The process may vary depending on if a tank truck versus a cart is used, the type of plane being fueled and the type of equipment being used. If a tank truck is used, the fuel is pumped from the tank into the wing with the tank truck providing the fuel pump. Regardless of the vehicle used, the workers are not in the cab during the fueling operation.

DESCRIPTION OF PAST EXPOSURES

After an initial visit by NIOSH, the company hired a consulting firm to check the CO levels in all the vehicles. Any vehicles found over 50 ppm were inspected for faulty exhaust systems. No other sampling has been conducted.

DESCRIPTION OF MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

The safety program at this location is run by Mr. Ray Sullivan, who is the Training and Safety Supervisor. All new employees are taught basic safety considerations of the job and job procedures by Mr. Sullivan and they then serve a short apprenticeship under an experienced worker. All workers are issued gloves and ear muffs for noise protection and eye goggles to protect against fuel spills or dripping. A preemployment physical is required. No periodic physicals are required or provided. Emergency medical care is available within 5 to 15 minutes at the JFK Medical Center.

POTENTIAL EXPOSURES AND CONTROLS USED

The major emphasis of this survey was to investigate the fuelmen's exposure to the fuel-Jet A, (see Appendix for specifications) a kerosene fuel, and jet exhaust which contains a large number of organic compounds.

Workers' exposure to the fuel is from several sources, the major one being skin contact which is exhibited by the prevalence of dermatitis on the hands of many of the fuelmen. Other potential exposures include the inhalation of fuel vapors and the ingestion of fuel from smoking or eating with fuel on the hands. The other potential exposure which the fuelmen complained of was from the hydraulic fluid dripping into their eyes. The hydraulic fluid used is Hy Jet IV made by Chevron and called "Skydrol" by the fuelmen. This fluid is labeled as a "fire resistant aircraft fluid" and is a phosphate ester. The fuelmen complained of a painful stinging of the eyes when the skydrol would accidentally drip into their eyes.

Another major health hazard to the workers is noise from the jet engines. Although the worker are issued ear muffs, they are rarely worn. The goggles issued to the workers which protects their eyes from fuel splashed are also seldom, if ever, worn.

In addition to these potential health problems, there are the more obvious potential safety problems such as the explosion of the fuel and being hit by other service vehicles and aircraft in the terminal area. The company takes good precautions against these safety hazards.

DESCRIPTION OF SURVEY METHODS

Personal samples for nitrogen dioxide and nitric oxide were collected on a solid sorbent sampling tube described in the NIOSH Analytical Methods # S320 and S321[4]. Samples were collected at 20 mL/min for 6 to 7 hours using MDA Model 808 Accuhaler pumps.

The personal samples for hydrocarbons were collected at 20–50 mL/min using the MDA Accuhaler pumps on 150-mg tubes of activated charcoal and porous polymer. Bulk area samples were collected at 1 Lpm using MSA Model G pumps. Prior to analyzing the personal samples, the bulk area samples were analyzed by gas chromatography/mass spectrometer to determine which, if any, hydrocarbons were present. Once the major hydrocarbons were indentified, then the personal samples were analyzed for these contaminants. A bulk analysis of the jet fuel, Jet A, was conducted to determine the amount of benzene present in the fuel. Personal and area samples for polynuclear aromatic hydrocarbons (PAH's) were collected at 1-1.5 Lpm using MSA Model G pumps. The PAH sampling train consisted of glass fiber/silver membrane filters to collect the particulate fraction and a solid sorbent tube of porous polymer used to trap the gaseous PAH fraction. A total benzene soluble fraction was determined as well as specific analysis of the following PAH's: fluoranthene, pyrene, benz(a)anthracene, chrysene, and benzo(a)pyrene. The specific PAH analysis was accomplished using a high pressure liquid chromatography (HPLC) equipped with a UV detector.[5]

APPLICABLE STANDARDS

The Federal Occupational Safety and Health Administration (OSHA) standard for nitrogen dioxide (NO_2) is 5 ppm as a ceiling value (not to be exceeded), for nitric oxide (NO) the standard is 25 ppm as an 8-hour time-weighted-average (TWA), and for polynuclear aromatic hydrocarbons (PAH) the[3] OSHA standard, as defined in the coke oven standard, is 0.15 mg/m^3 for an 8-hour TWA as the benzene soluble fraction.[2] The American Conference of Governmental Industrial Hygienists (ACGIH) recommends various levels for limits of exposure to contaminants. The ACGIH recommends a Threshold Limit Value (TLV®) of 25 ppm for NO with a Short Term Exposure Limit (STEL) of 35 ppm. The STEL value is the maximum concentration to which workers can be exposed for a period of 15 minutes. Other ACGIH recommendations include a ceiling limit of 5 ppm NO_2 with a proposed change to 3 ppm as a TLV and a TLV limit of 0.2 mg/m^3 as benzene solubles for PAH's.[5] NIOSH also recommends exposure limits: 25 ppm as a TWA for NO and 1 ppm as a ceiling valve for NO_2.[6]

TOXICITY OF JET FUEL

Much of the information concerning jet fuel toxicity comes, not unexpectedly, from the military. The bulk of current information on jet fuel, including mutagenic and oncogenic potential, comes from the work of the Aerospace Medical Research Laboratory (AMRL) at WrightPatterson Air Force Base. Acute toxicity tests by AMRL on rats and mice which were administered as single oral doses of JP-4 in corn oil resulted in no rat deaths even at doses up to 8000 mg/kg. For mice, a dose of 1000 mg/kg resulted in one death out of three. A subsequent saturated vapor inhalation test of 6-hour duration, at an estimated JP-4 concentration of 38 mg/L, resulted in poor coordination and convulsions in several of the rats tested but no mortalities.[7] Additional testing was conducted by this same group on the effects of JP4 via inhalation at levels of 2.5 and 5.0 mg/L with controlled amounts of benzene (12.5 and 25 ppm respectively for each level). Test animals included dogs, monkeys, rats and mice. In summary, their studies found CNS depression, lethargy, emesis, increased red blood cell fragility in female dogs at the high dose, increased incidence of chronic bronchitis in rats, and only a very slight oncogenic response. Based on this work, the researchers recommend a safe exposure level of 2.5 mg/L.[8]

JP-4 is primarily a military jet fuel while commercial jets use Jet-A. Information on the composition of various types of jet fuels is sketchy at best with wide variations even within a type of fuel, eg. Jet A. Jet fuels are typically specified by performance characteristics rather than specific composition. The specifications for Jet A are listed in the appendix. Jet A is different from other jet fuels, such as JP-4, in its increased aromatic compound composition, therefore the "A" designation.

The Air Force conducted mutagenic and oncogenic studies on JP-8, which is the military equivalent to Jet A. In this study, JP-8 was subjected to a matrix of invitro assays employing microbial cells, mammalian cells in culture and in vivo tests measuring potential germ cell effects in mice and rats. The conclusions were that JP-8 produced a moderate increase in the unscheduled DNA synthesis in WI-38 cells. These data suggest that the material could interact with DNA producing nonspecific lesions. No evidence for mutagenicity was evident in the test battery and the indications for mutagenic and carcinogenic potential are minimal at best. The study concludes by stating, "There is no suggestion of significant genetic risk associated with this material."[9]

In a study sponsored by the American Petroleum Institute, Jet A was subjected to the Ames test, the Mouse Lymphoma Assays, and the invivo bone marrow cytogenetics assay. In these tests, Jet A gave a negative response to the Ames test, and a positive response to the other two tests.[10]

In looking at the chronic effects of workers exposed to jet fuel, Swedish researchers reported on 29 workers in an aircraft factory who were chronically exposed to jet fuel vapor. Twenty of the 29 exposed workers reported acute symptoms of dizziness, respiratory tract irritations, heart palpitations, a feeling of pressure on the chest, nausea and headache. The researchers concluded that chronic exposure resulted in increased rates of symptoms indicative of neurasthenia and psychasthenia and signs indicative of polyneuropathy in the groups exposed to jet fuel as compared to control groups.[11]

RESULTS AND DISCUSSION

The results of the sampling for carbon monoxide are reported in a separate industrial hygiene report.[4] The samples for NO/NO_2 resulted in no measurable levels of NO and NO_2 levels ranging from 0.26 to 1.7 ppm with an average of 0.7 ppm. These levels are all well below the OSHA standard and only one sample was above the NIOSH recommended level of 1 ppm.

Only two of the nineteen particulate samples for PAH showed any measurable levels. One sample, #19PN, had a benzene soluble fraction of 0.24 mg/m^3 (detection limit of 0.02 mg/sample or for this sample, an equivalent lower limit of detection of 0.07 mg/m^3) and the other sample #3PN, was 1.22 mg/m^3. Neither of these samples had measurable levels of any of the five specific PAH's. For the gaseous fraction of PAH's, fourteen of the nineteen samples had measurable levels of PAH's as shown in Table I. Most of these samples had levels of benzene solubles barely above the detection limit of 0.02 mg/sample but owing to the relatively small sample volumes, the resulting concentrations are in the range of interest, ie. 0.1 mg/m^3 and up. It is possible that the meaningful levels of the specific PAH's existed in the workplace but because of the small sample volumes there was not enough sample to detect these compounds. To test this idea, a sample calculation was made using an average sample volume of 320 liters and a detection limit of 0.04 mg/sample for benzo(a)pyrene (BaP), which resulted in a lowest detectable concentration of 0.125 mg/m^3. Since a level of 1.0 mg/m^3 of BaP is considered by OSHA as an unofficial recommended level, then even with the limited sample volumes used the samples are all well below this level. Therefore one can conclude that the workers' sampled during this survey were not exposed to excessive levels of the five specific PAH's analyzed but they were exposed to gaseous organics as measured as benzene solubles.

It is interesting to note in looking at the data in Table I, that the three highest samples, #6PN, 21PN, and 25PN were all collected during the day around the TWA terminal. The main TWA terminal is horseshoe shaped so that the planes are lined up opposite each other, tail to tail. During the morning hours around 9-11:00 a.m., these terminals have planes constantly coming and going. What often happens is that a worker will be fueling one aircraft while one opposite the horseshoe starts up its engines and sits for awhile, letting the engines run. During this time, the exhaust from the jet engines is blown right at the workers servicing the jet on the opposite side of the terminal. When a jet other than the one being refueled is "run ning up" its engines, the workers generally seek shelter for the exhaust is hot, smelly, makes it hard to breathe, and is blown with great force, carrying with it much dust and debris.

The bulk samples collected for hydrocarbons resulted in only trace quantities of toluene, xylene, ethyl benzene, a diethyl benzene and methyl indan isomer and naphthalene. None of these hydrocarbons were found in levels large enough to quantitate. The bulk analysis of the jet fuel showed a benzene concentration of only 0.2% volume per volume whereas the specifications on the fuel say it should be closer to 15%.

CONCLUSIONS AND RECOMMENDATIONS

Worker exposure to carbon monoxide, oxides of nitrogen, polynuclear aromatic hydrocarbons (PAH), and general hydrocarbons was assessed at JFK Airport. The only appreciable exposure was to the volatile fraction of PAH's and these exposures were limited. In general, worker exposure to jet exhaust, with the exception of the volatile PAH's seems to not constitute a health hazard but rather is an odorous nuisance. The only possible way to reduce worker exposure to the exhaust would be to adjust plane scheduling so that workers were not opposite another aircraft while its engines were running. The only other choice would be to push the airplanes out of the terminal area before allowing the planes to start up their engines. The limited worker exposure does not seem to warrent this type of actions.

Several general work practices should be followed by the workers as a matter of safety and precaution. Goggles and hearing protection, currently required to be worn by the fuelmen by OSHA, should be worn as directed. Noise levels taken around the terminal area (specifically near Allegheny) during heavy aircraft traffic, ranged continually from 85-95dBA (the current 8-hour OSHA Standard is 90dBA). When the Concord took off near the Allied service area, noise levels exceeded 110dBA for a short period of time. In short, the hearing protection provided by the company, ear muffs, should be worn when out in the terminal area. Also, the goggles were instructed for use while fueling an aircraft to avoid getting fuel splashed in the workers eyes. This should be done. Workers should be properly educated concerning the hazards of jet fuel and the necessity for promptly cleaning any off their skin should contamination occur. This includes the removal of clothing contaminated with fuel. Furthermore, workers should be instructed to wash their hands frequently, especially before eating, smoking, drinking, or going to the bathroom.

Gloves should be worn during fueling operations. Cotton lined latex or rubber gloves offer comfort and protection from fuel exposure. Should the inside of the gloves become contaminated, the gloves should be discarded. Dermatitis was common among the workers from skin exposure to fuel. By following the recommendations of frequent washing and the use of gloves, much of this problem should be alleviated, but more importantly, these practices will reduce the amount of worker exposure to jet fuel through skin absorption. Moisurizing creams should be made available at the washing stations, either as lotions or in combination with the hand soap, to replace the natural moisture removed from the skin by the fuel and by frequent washings.

REFERENCES

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TABLE I
RESULTS OF GASEOUS FRACTION FOR POLYNUCLEAR
AROMATIC HYDROCARBONS

SAMPLE #	JOB TITLE - LOCATION*	SAMPLE VOLUME (LITERS)	BENZENE SOLUBLES** (mg/sample)	CONCENTRATION (mg/m^3)
1PN	Fuelman - AA (Day)	325	0.05	0.15
2PN	Fuelman - IAB (Day)	341	0.04	0.12
3PN	Fuelman - TWA (Day)	353	0.06	0.17
4PN	Fuelman - AA (M-2)	338	0.04	0.12
5PN	Fuelman - IAB (Day)	305	0.04	0.13
6PN	Fuelman - TWA (Day)	364	0.13	0.36
10PN	Fuelman - AA (Day)	368	0.06	0.16
11PN	Fuelman - East (Day)	334	0.04	0.12
13PN	Fuelman - TWA (D-2)	290	0.02	0.07
14PN	Fuelman - TWA (D-2)	289	0.02	0.07
18PN	Fuelman - Allegheny (Aft)	352	0.03	0.09
19PN	Fuelman - United (D-2)	288	0.02	0.07
21PN	Fuelman - TWA (Day)	302	0.06	0.20
22PN	Fuelman - Allegheny (Aft)	83	0.02	0.24
23PN	Fuelman - TWA (D-2)	323	0.02	0.06
25PN	Area (In Truck) - AA/TWA (Day)	51	0.16	3.14
26PN	Fuelman - Pan AM (Day)	367	0.10	0.27
27PN	Fuelman - TWA (D-2)	367	0.06	0.16
28PN	Fuelman - TWA (D-2)	383	0.04	0.10

* IAB - International Arrival Building

Day - Day Shift, 7:00 a.m. - 3:30 p.m.

D-2 - D-2 Shift, 2:30 p.m. - 10:30 p.m.

Aft - Afternoon Shift, 3:00 p.m. - 11:30 p.m.

M-2 - M-2 Shift, 6:00 a.m. - 2:30 p.m.

** Limit of Detection = 0.02 mg/sample