United States
Environmental Protection
Agency

National Risk Management
Research Laboratory
Cincinnati, OH 45268

Research and Development

EPA/600/SR-96/060 May 1996

Project Summary

Analysis of Soil and House Dust for Polycyclic Aromatic Hydrocarbons

Jane Chuang

It has been conjectured that jet turbine exhaust near airplane flight paths may result in significant human exposure to polycyclic aromatic hydrocarbons (PAH). EPA arranged access to a household located approximately eight miles from the end of a runway at the Greater Cincinnati and Northern Kentucky Airport, and collected soil, wipe, and dust samples in and around the household. House dust samples were collected inside the household and entryway dust and soil samples were collected outside. The objective of this study was to determine if abnormally high PAH concentrations existed in and around the selected household. The general concentration trend for the 19 PAH measured is house dust > entryway dust > soil. The concentrations of each target PAH in the wipe samples ranged from 0.007 to 0.54 μg/m². The sums of 19 PAH ranged from 0.13 to 0.88 ppm in soil samples, from 1.4 to 3.1 μg/m² in wipe samples, and from 0.97 to 4.0 ppm in dust samples. Seven of the target PAH are ranked as probable human carcinogens (B2) in the U.S. EPA's Integrated Risk Information System. The concentrations of B2 PAH account for roughly half of the concentrations of the sums of 19 PAH in most soil and dust samples but not in wipe samples.

This Project Summary was developed by the National Risk Management Research Laboratory's Sustainable Technology Division, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Little is known about possible exposure of individuals living near airports to polycyclic aromatic hydrocarbons (PAH). Very little data are available through traditional literature searches on the aerosol/smoke components of jet turbine exhaust. At major airports aircraft are routed through corridors or discrete pathways significantly localizeing the distribution of any fallout subject to meteorologic effects. The plume could move directly to the ground as a cohesive unit due to electrostatic charge or saturation effects and pass through open windows or be deposited on soil with subsequent track-in to residences, posing a risk of PAH exposure beyond that which might arise from contact with soil outdoors.

One household is located approximately eight miles from the end of runway 27 Left at the Greater Cincinnati and Northern Kentucky International Airport was selected for preliminary evaluation. The objective of this study was to determine if abnormally high PAH concentrations existed in and around the selected household. The homeowner volunteered to allow sampling in and around his home for measuring PAH in soil, dust, and wipe samples. According to the homeowner, since the extended runway opened in the summer of 1995, 72 to 80 turbine-equipped aircraft fly over the residence each day. Approximately 25 to 40 fly over between sunset and sunrise depending on the season. The airport began using this path as a corridor in February 1991. There was a

slight hiatus from February through July of 1995 as the runway was extended 2200 feet toward the west.

The EPA Risk Reduction Engineering Laboratory (RREL)* arranged access to the subject property and residence. In this study, the RREL developed a sampling design to collect soil, dust and wipe samples at different locations. Battelle prepared and furnished sampling media and procedures for sample collection. RREL conducted the sampling and provided the collected samples to Battelle for analysis for PAH. The final report summarizes the analytical procedures and the PAH results.

Procedure

The sampling design was established by RREL. Prior to the sampling, Battelle provided RREL the sampling media and reviewed the sampling procedures. A training session was held at Battelle to demonstrate the use of the High Volume Small Surface Sampler (HVS3) for designated areas in the carpet.

The sampling was conducted on September 27, 1995 by RREL staff members. A total of 10 soil samples, 5 wipe samples and 4 dust samples was collected. At each sampling site, soil was scraped from the top 2 cm surface with an area approximately 20 cm by 20 cm. When there were leaves or vegetation litter, these materials, generally about 0.5 cm deep, were carefully scraped away before taking the soil sample. Indoor and outdoor wipe samples were taken by quartz fiber filters thoroughly wet with hexane or by dry quartz fiber filters. The unused hexane and filters were sent back to Battelle for use in preparation of a wipe blank. Samples were taken from the top of the west barn roof, a wood floor area (30.5 cm by 61 cm) in the dining room and along the door jam and the door edge in an upstairs bedroom.

The HVS3 was used to collected samples of carpet-embedded house dust from designated areas. The HVS3 consists of a high-powered vacuum cleaner equipped with a sampling nozzle that can be adjusted to a specific static pressure within the nozzle, a cyclone which according to theoretical calculations will separate particles 5 μm mean diameter and larger, and a bottle to catch the sample. Neither the degree to which the HVS3 sampler removes the total dust load in the carpet nor the distribution of PAHs as a function of particle size were quantified in this study. It is known that deep dust can be exceedingly difficult to remove by vacuuming.

Prior to the sampling, the HVS3 was disassembled and cleaned. The HVS3 was operated according to the manufacture's instruction and an ASTM standard guide. A 76 cm by 100 cm rectangle was marked out with masking tape at the designated area and the width was subdivided into 10 7.6-cm wide segments. The HVS3 was run slowly forward and backward across the 100 cm length of the rectangle a total of eight times along each 7.6-cm width. After the eighth pass, the unit was gradually moved over to the next segment, and the procedure was repeated until all 10 segments had been sampled, for a total area of 0.76 m^2.

A sample was collected from an outdoor entryway door mat. The sample was collected by turning over the entryway mat and placing it on a clean sheet of aluminum foil. The back of the mat was then beaten for several minutes before it was removed from the foil. The loose particles on the foil were poured into a clean bottle. The collected soil/wipe/dust samples were stored at ≤4 °C in the dark and transported to Battelle for analysis.

Analytical Procedures

The dust samples were separated into fine (< 150 μm) and course fractions and only the fine fractions were subject to extraction. An aliquot of each dust and soil sample was spiked with known amounts of perdeuterated PAH, and each sample was extracted twice with 10 mL of hexane in a sonication bath for 30 min. The hexane extracts were combined, filtered, and concentrated for subsequent gas chromatography/mass spectrometry (GC/MS) analysis. A method blank for dust and soil samples was prepared by the same method described above.

Known amounts of perdeuterate PAH were spiked into each wipe sample and extracted with dichloromethane (DCM) by Soxhlet technique. The DCM extracts were concentrated to 1 mL and were fractionated using prepacked 1 g silica gel columns. Two elution solvents, hexane and hexane/DCM (1:1) were applied to the columns. The target hexane/DCM fractions were concentrated to 1 mL for subsequent GC/MS analysis. A hexane-wet filter was used as the method blank for wipe samples and was prepared by the same method.

The sample extracts and hexane/DCM fractions were analyzed by GC/MS using 70-eV electron ionization (EI). A Finnigan TSQ-45 GC/MS/MS instrument, operated in the GC/MS mode, was used. Data acquisition and processing were performed with an INCOS 2300 data system. Following injection, the GC column was held at 70 °C for 2 min and temperature-programmed to 290 °C at 8 °C/min. The MS was operated in the selected ion monitoring mode. Masses monitored were the molecular ions (M) and their associated characteristic fragment ions including M+1 ions and doubly charged ions.

Results and Discussion

The sums of the concentrations of probable human carcinogens (B2) and total target PAH in soil samples ranged from 0.036 to 0.42 and from 0.13 to 0.88 ppm, respectively. The concentrations of the well-known carcinogen, benzo[a]pyrene (BaP) in the soil samples ranged from 0.001 to 0.53 ppm. With few exceptions, the sums of the concentrations of B2 PAH are approximately half of the total target PAH concentrations in these soil samples.

The sums of the concentration of B2 and total target PAH in wipe samples ranged from 0.25 to 1.1 and from 1.4 to 3.1 μg/m2, respectively. The concentrations of BaP in the wipe samples ranged from 0.019 to 0.095 $\mu g/m^2$. In general, higher PAH concentrations were found in indoor wipe samples as opposed to the outdoor composite wipe samples. The sums of the concentrations of B2 PAH account for approximately 20 to 35 percent of the total target PAH concentrations.

The sums of the concentrations of B2 and total target PAH in the dust samples ranged from 0.25 to 1.8 and from 0.97 to 4.0 ppm, respectively. The concentrations of BaP in dust samples ranged from 0.035 to 0.19 ppm. In general, levels of PAH found in house dust samples were higher than those in entryway dust. The sums of the concentrations of B2 PAH are approximately half of the total target PAH concentrations in house dust samples but not in the entryway dust sample.

Conclusions and Recommendations

Additional samples should be collected to investigate the effect of aircraft exhaust emissions on exposure to PAH through deposition and through accumulation of PAH in soil and subsequent track-in to residences. The sample locations should consider the following factors: proximity to airports, flight patterns, prevailing wind, other relevant meteorological parameters such as temperature, indoor PAH sources, the influence of particle size on the PAH distribution, assessment of the extent to which the HVS3 sampling protocol recov-

* The Risk Reduction Engineering Laboratory (RREL) is now the National Risk Management Research Laboratory (NRMRL).

ers particle laden PAHs representative of the actual dust laden PAH distribution in the carpet, and the distribution and concentration of PAHs remaining in the carpet after sampling with the HVS3 protocol. The collected samples will be analyzed for target PAH. If justified by the results from this sampling campaign, a thorough pilot field study may be desirable to determine the temporal and spacial effects on PAH concentrations in soil and dust and the effect of jet engine exhaust on PAH exposure.

For a pilot study, one of the criteria for selection of households is to have similar indoor sources for these households so that the effect of proximity to airports can be better estimated. Any pilot field study should probably be carried out during four sampling campaigns: spring, summer, fall and winter. This approach will enable us to better understand the seasonal variation of climatic conditions.

The full report was submitted in fulfillment of Contract No. 68-D4-0023, Work Assignment No. 1, under the sponsorship of the U.S. Environmental Protection Agency.

Jane C. Chuang, is with Battelle, Columbus, OH 43201-2693
***James Heidman** is the EPA Work Assignment Manager (see below).*
The complete report, entitled "Analysis of Soil and House Dust for Polycyclic Aromatic Hydrocarbons," (Order No. PB96-177712/AS; Cost: $19.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Work Assignment Manager can be contacted at:

Sustainable Technology Division
National Risk Management Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection Agency
National Risk Management Research Laboratory (G-72)
Cincinnati, OH 45268

Official Business
Penalty for Private Use $300

EPA/600/SR-96/060

BULK RATE
POSTAGE & FEES PAID
EPA
PERMIT NO. G-35