

Santa Monica Airport: Is it Ruining Our Neighborhood **Air**?

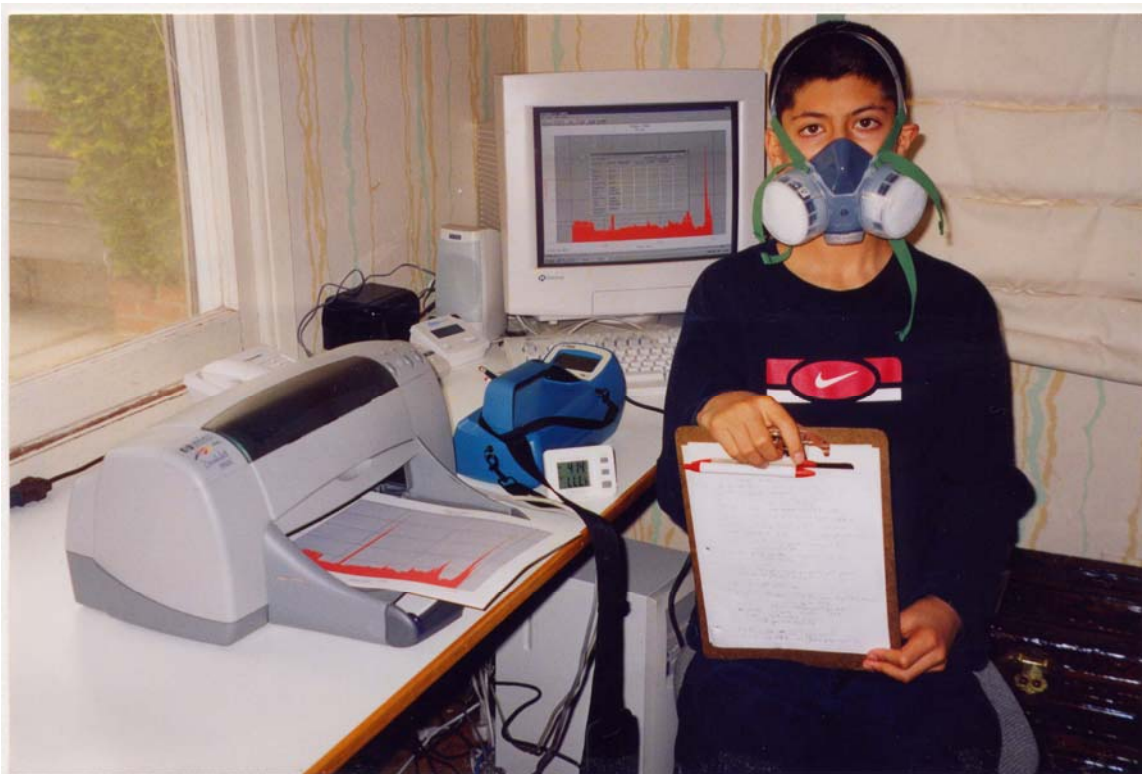


Photo taken by author at Sardis Ave. and Armacost Ave.

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7th Grade Science Fair Project
April, 2002



Author taking measurements at gate to east of Museum of Flying



Materials used in Airport and Ultrafine Particle Study

ACKNOWLEDGEMENTS

The author wishes to acknowledge the following scientists for their help in making this experiment possible:

John R. Froines, Ph.D.
Professor of Toxicology, UCLA School of Public Health
Director, Southern California Particle Center and Supersite

Andrea Hricko, M.A.
Director, Community Outreach and Education
Southern California Environmental Health Sciences Center
(USC and UCLA) at USC Keck School of Medicine

Charles Kersey
Office of Air Quality Education
California Air Resources Board

Jim Lerner, Ph.D.
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California Air Resources Board

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SUMMARY

New research is showing that ultrafine particles are highly toxic. There is insufficient data on ultrafine particle emissions from airports. Data was taken using a P-Trak™ Ultrafine Particle Counter. Measurements were taken less than 100 meters from airport activity, away from auto traffic, and were taken between 11 a.m. and 6 p.m., during peak aircraft operation times. Weather, wind, and temperature were monitored. Clover Park had an overall mean particulate level (14,695 pt/cc; range 4,690 - 27,500) that was similar to a no-traffic condition (19,567 pt/cc; range 17,100 - 21,400) primarily because it is rarely downwind and the aircraft are high in the air by the time they reach the park. The mean level at the gate to the east of the Museum of Flying was twice as great (35,335 pt/cc; range 5,400 - 500,000+) due to the closeness of aircraft activity and its higher, jet-based activity level. The intersection of Sardis & Armacost Aves., E of the airport, had the highest mean level (47,365 pt/cc; range 6,120 - 398,000), possibly due to WSW prevailing winds and greater aircraft activity. Planes usually begin take off and landing on the eastern end of the airport, and aircraft exhaust is produced near ground level. Measurements taken adjacent to the airport on Bundy Dr., a busy street, showed that *combined* airport and automobile traffic further augmented mean particulate levels (66,457 pt/cc; range 14,400 - 239,000). The latter observation was confirmed in a follow-up set of measurements when the mean from combined auto and air traffic (56,104 pt/cc; range 4,940 - 300,000) was found to be greater than the mean from auto traffic alone (41,276 pt/cc; range 10,800 - 428,000), despite the fact that measurements from auto traffic were taken within one to two meters from their source. At all locations, fumes were associated with peak ultrafine particle levels. The highest levels were generated by jet aircraft idling and taxiing. According to the Directors of the Southern California Particle Center and Supersite, funded by the U.S. EPA and California Air Resources Board, these are quite significant findings that may represent the first national study of airport sources of ultrafine particulates and justify continued measurements in the vicinity of airports.

BACKGROUND REPORT

This project will measure ultrafine particles from Santa Monica Airport because the author frequently notices the odor of aircraft exhaust in the neighborhood, and he has been concerned with its health hazards.

Santa Monica Airport is the busiest single runway airport in the United States. Its operations exceed 200,000 annually. The aircraft include single and multi-engine piston (propeller planes that use aviation gas, which is similar to automobile gasoline), turbo-prop (propeller planes run by turbine engines that run on jet fuel), turbo-jet (jet aircraft, run by turbine engines), and rotocraft (helicopters with turbine or piston engines). Statistics show that aircraft operations are increasing over time.¹⁶

Airports are major sources of pollution due to aircraft, ground vehicles, stationary power generating equipment, and aircraft refueling and maintenance operations.¹⁶ One 747 arriving and departing from JFK International creates as much smog as a car driven 5,600 miles. Furthermore, airplane pollution has not been as strictly regulated as automobile emissions.¹⁴

Airports are a source of pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, and the three worst: 1,3 butadiene, formaldehyde, and benzene, which appear to be the greatest carcinogens.^{13,16} Particulate matter is a newly identified health hazard from airports. Particulate matter, or PM, is also known as dust, dirt, soot, smoke, and liquid droplets in the air. It is the largest cause of haze or smog. There are two ways that particles get into the air. One way is a direct release of particles from motor vehicles, fires, factories, construction sites, unpaved roads, and tilled fields. The other way is an indirect formation when gasses from burning fuels react with sunlight and water vapor and change into particles.²²

Particulate matter causes a variety of health problems. Some of these health effects include aggravated asthma, increases in respiratory symptoms, chronic bronchitis, decreased lung function, and premature death, particularly in sensitive individuals such as children, the elderly, and people who already have heart and lung disease.¹⁵ More than a dozen studies have linked particulate matter to premature birth and infant deaths.^{2,17} Researchers from the Harvard School of Public Health and the University of Basel, Switzerland, concluded that as many as eleven percent of infant deaths in the United States - about 3,000 per year - may be a result of microscopic particles in the air. This, as yet unpublished, study is based on earlier research by the EPA and Centers for Disease Control that looked at 4 million infants in 86 urban areas and compared the numbers of deaths with changing rates of particulate pollution. The study concluded that as particulate matter increased in the air, the infant death rate rose by ten to forty percent.²³

Another study by UCLA researchers, which was published in 2001 and focused on 97,518 newborns in Southern California, concluded that mothers are twenty percent more likely to have a baby prematurely when exposed to higher amounts of microscopic particles in the last six weeks of pregnancy.²⁰

The Children's Health Study, sponsored by the California Air Resources Board, has been following 5,500 children in 12 communities for 10 years from elementary through high school.³ The scientists have reported that children who are living in communities with higher amounts of particulate matter, nitrogen dioxide, and acid vapor have lungs that develop and grow more slowly; their lungs are also less able to move air through them. This decreased lung development may have permanent health effects as the children grow up.⁵ In addition, the researchers found that children who move away from study communities show increased lung development if the new communities have lower particulate pollution. The children show decreased lung development if the new communities have higher levels of particulates.¹ The study also found that children with asthma who are exposed to higher concentrations of particles are more likely to develop bronchitis.¹¹


A March 6, 2002 article by the Journal of the American Medical Association reported that greater inhalation of fine particle matter in heavily populated areas increases the chances of dying of lung cancer, heart attacks, and respiratory failure. The researchers studied over 500,000 adults for about 16 years, in 156 cities, and found that doubling the follow-up time tripled the mortality rates. Regardless of personal health habits, deaths related to fine particulate matter remain the same. Larger particles and gaseous pollutants such as nitrogen dioxide, carbon monoxide, and ozone did not have an effect on mortality rates. However, pollutants such as sulfate particles and sulfur dioxide are associated with increased mortality rates. The American Lung Association comments that the inhalation of fine particles has an equivalent danger to inhaling second hand smoke. The risk of inhaling fine particle matter is also similar to the risk of being moderately overweight.^{18,19} This study suggests that the decreased lung development and increased asthma observed in the Children's Health Study, described earlier in this report, was affected by the fine particle matter.

Particulate matter is also an environmental hazard. It lands on soil and waters, which changes the land's chemical and nutrient balance. This, in turn, creates problems for the health of animals and plants.²² People who ingest animals and plants that have been polluted by particulate matter are also indirectly affected.

Particulate matter is measured in several groups: large particles (greater than 10 microns in diameter), coarse particles (less than 10 microns but greater than 2.5 microns in diameter), fine particles (less than 2.5 microns but greater than 0.1 microns in diameter), and ultra-fine (less

than 0.1 of a micron in diameter). As a comparison, a micron is a millionth of a meter. A human hair is 70 microns thick.⁷

Ultrafine particles are more dangerous than larger particles because it is easier for them to bypass the nasal and lung defenses and lodge in the bottom of the lung. New unpublished data has shown that ultrafine particle matter is extremely toxic, and people should be exposed as little as possible.ⁱ Researchers are studying whether ultrafine particles are more toxic than larger particles and diesel samples.¹² These particles can enter the body through cells and directly into the bloodstream. Scientists think that when it enters the bloodstream, it causes particle-related heart problems.

Ultrafine particles are shaped like linked circles:
During fuel combustion, organic chemicals can bind 
more easily on these particles because of the greater surface area available. When the chemicals are released into cells, they create toxicity. In addition to the greater toxicity because of the surface area, fuel combustion produces great numbers of ultrafine particles, which makes them dangerous to health even though their mass is small relative to all particulate matter.⁴ Epidemiologic research suggests that even when particulate matter is below U.S. and European standards, it still affects health and longevity.⁶

We know that rotocraft, single piston, turboprop, and turbojet planes emit ultrafine particle matter. However, scientists do not have good methods to measure the amount of ultrafine particles coming from aircraft and don't know their percentage relative to all particulate matter.^{8,10} One of the ways scientists estimate amounts of ultrafine particles is by seeing how much black carbon (soot) and carbon monoxide is in the air. They measure those toxins because their levels tend to be similar to ultrafine particles.^{i,16}

A June 1999 Los Angeles Unified School District (LAUSD) study predicted emissions generated from Santa Monica Airport.¹⁶ They used mathematical modeling to estimate levels of several carcinogens, large particulate matter, and lead. Their risk analysis did not include levels contributed by no-airport (background) sources. The current acceptable margin of safety for cancer is a one-in-one-million risk over a lifetime. The LAUSD study found that the cancer risk for areas immediately adjacent to the airport, particularly the "maximum exposed individual" south of the airport's centerline and east of Bundy Drive, is thirteen in one million. With anticipated increases in turbojet and piston activity, the risk will be 22 and 26 in one million, respectively. The study also found that the

ⁱ Conversation with John R. Froines, Ph.D.

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amount of particulate matter exceeds California standards, but not national standards. There was so little available information on the quantity and toxicity of particulate matter that the investigator had to use other pollutants to estimate their levels. The report concluded that the study may have underestimated particle matter concentrations because their predicted levels did not match community reports of excessive soot and dust associated with increased jet activity.

Scientists also do not know the health effects of ultrafine particles combined with other pollutants.^{13,16}

This experiment will attempt to find out if ultrafine particles can be measured from the airport and past its borders. It will also examine whether wind affects particle concentration. If this experiment proves that ultrafine particles can be measured beyond the airport's borders, then it could be used to influence government officials to strengthen air quality standards and increase regulations on airport toxicity. For example, officials could make a regulation that would require pilots to reduce engine power to the lowest point possible or shut down as many engines as possible while idling. Airlines, like Delta, are already following these procedures. These simple procedures can reduce ground pollution levels by up to 40%. Government officials could also replace the 10% domestic ticket tax with an aviation fuel tax to provide airlines with an incentive to replace aging and inefficient aircraft with newer, quieter, and more fuel-efficient planes. They could subject airports to the same reporting requirements as other major polluters.¹⁴ This experiment will also encourage scientists to conduct more studies on ultrafine particles from airports.

HYPOTHESES

Levels of ultrafine particle matter from airport activity will be measurable from areas immediately adjacent to Santa Monica Airport. The particulate levels will be worst to the east of the airport because of the sea breeze. The stronger the wind, the less particulate matter there will be because the wind will move it to a different location.

PURPOSE

The purpose of this investigation is to find out if the quality of the air in the Sunset Park neighborhood of Santa Monica is diminished by ultrafine particulates from Santa Monica Airport. It will also determine whether or not ultrafine particulate matter can be measured adjacent to the airport. There is insufficient data on ultrafine particle emissions from airports. This project is important because airport activity is increasing annually, and the community

has been complaining of excessive soot and dust from the airport, which suggests that particulate matter from Santa Monica Airport exceeds health standards. When ultrafine particle matter is inhaled into the deep parts of the lung, it can aggravate lung conditions such as asthma and bronchitis. It can also cause infant death, premature birth, lung cancer, heart attacks, and respiratory failure. The author conducted this experiment because some mornings and evenings he smells aircraft exhaust from home.

MATERIALS

1. Model 8525 P-Trak™ Ultrafine Particle Counter, borrowed from the Southern California Environmental Health Sciences Center, University of Southern California division
2. TrakPro™ software
3. P-Trak™ Ultrafine Particle Counter Operation and Service Manual
4. 3M 7281 respirator mask to filter out airborne organic vapors and particles that do not contain oils
3. Earplugs
4. Thermometer/clock
5. Clipboard, paper and pen
6. Computer
7. Printer

PROCEDURE

Find suitable locations for measuring particulate matter - places that are less than 100 meters from aircraft activity and more than 100 meters, or as far away as possible, from automobile traffic. Ultrafine particles condense into bigger particles after traveling 100 meters (approximately 10 yards shorter than the length of a football field) and cannot be measured by the P-Trak™ Ultrafine Particle Counter. Auto traffic is a source of particulate matter, so it was avoided in order to increase the likelihood that the particles measured were from the airport.

Three locations were found: The southern end of Clover Park, the gate to the east of the Museum of Flying, and Sardis Ave. at Armacost Ave. (See Appendix 1 - Aerial Photo of Measurement Locations.) The Clover Park site borders an active aircraft parking lot and taxiway. The site near the Museum of Flying is adjacent to an active aircraft parking lot and inside an inactive automobile parking lot. The Sardis and Armacost site is directly beneath the east landing path, where aircraft fly very low to the ground. This location is not quite 100 meters from auto traffic; however, it was selected because aircraft fly directly overhead and the auto traffic on nearby Bundy Dr. is obstructed by a tall block wall, covered with plants.

Data was taken at four other sites as well: 2747 Armacost Ave., Sardis Ave. at Bundy Dr., Bundy Dr. between Woodbine St. and Palms Blvd., and 29th St. midway between Pearl St. and Ocean Park Blvd. Measurements were taken at 2747 Armacost Ave., a few houses north of Sardis and Armacost, to see if particulate levels would be diminished by houses blocking the wind and auto exhaust. Sardis and Bundy was chosen to provide a comparison particulate sample of airport activity with auto traffic. Measurements were taken at Bundy south of Woodbine to show particle levels with auto traffic only. Data was taken on 29th St. to observe particulate levels in a no-traffic situation.

Go to a measurement site between the hours of 11 a.m. and 6 p.m., when hourly aircraft operations are highest.

Prepare P-TrakTM Ultrafine Particle Counterⁱ:

1. Insert alcohol cartridge into P-TrakTM. The alcohol causes microscopic particles to grow into larger droplets that are easier to detect and count.
2. Attach inlet screen, which helps to prevent large particles and fibers from entering the P-TrakTM and clogging the internal fittings.
3. Calibrate instrument by letting it warm up for 60 seconds with the inlet screen. Then put on the "zero filter" and let it filter for 30 seconds until the zero reading is stable.
4. Go to log mode by pressing the ↓ key and press the ↗ key to select the mode. End by pressing the ↗ key again. The data log mode is used to record particle concentration readings over a period of time and store these readings in the instrument memory.

Take measurements through the inlet screen only. The probe assembly and sample tube were not used because the inlet screen promotes the least particle loss, the fastest response to particle concentration changes, and is well-suited to area sampling.

Log data with P-TrakTM while taking handwritten notes on time, aircraft and automobile activity, particulate levels, wind patterns, and weather changes in order to annotate graphs. The wind notes were cross-checked against the internet information, which was given in one-hour cycles. The author only noted whether propeller planes had piston or turbine engines if he was certain of their type. Airport activity was noted as being in the foreground when approximately less than 50 meters away, in the midground

ⁱ TSI Incorporated. *P-TrakTM Ultrafine Particle Counter Operation and Service Manual*. January, 2000.

when around 50-100 meters away, and in the background when nearer to 100 meters away.

Move on to next site and repeat procedure.

After taking measurements, download weather data from the internet. Check Santa Monica weather using one of two websites: National Weather Service - Internet Weather Source, <http://weather.noaa.gov/weather/current/KSMO.html> or Weather Interface - Texas A&M Meteorology, http://www.met.tamu.edu/personnel/students/weather_interface.html (enter **KSMO** for the **Station Identifier**, and select "**Fully Decoded METAR Obs**"). The latter website was recommended by a senior meteorologist at the Southern California Air Quality Management District. Eventually, only the National Weather Service was used because it proved to be more consistent in its reporting of weather.

Download data files from the P-Trak™ into the computer by using the USB cable and TrakPro™ software.

Create graphs of particulate matter levels at different times, wind/weather/temperature conditions, and locations.

Download updated TrakPro™ 3.2 software from www.tsi.com in order to be able to annotate graphs.

ANALYSIS

Clover Park had an overall mean ultrafine particle level of 14,695 pt/cc. This mean was similar to a no traffic condition (19,567 pt/cc) taken on 29th Street for comparison data, even though there was less wind at Clover Park at each measurement time than on the day that the 29th Street sample was taken. The Clover Park site had a low mean particulate level because it is rarely downwind, it is a quieter area of the airport, and it is protected by a row of parked aircraft. Aircraft normally take off from the east end of the airport, so by the time they are in the vicinity of Clover Park, they are high in the air. Time, weather, and temperature did not affect particle levels at Clover Park. Additional observations made on a data log on 3/2/02 (16,000 pt/cc, accidentally deleted on the P-Trak™ Ultrafine Particle Counter) match the overall mean for Clover Park. Differences between the mean samples for 2/18/02 (19,634 pt/cc) and 3/6/02 (9,756 pt/cc) were explained by the movement of ground support vehicles. (See Appendix 2 - Table of Overall Means, Appendix 3 - Table of All Data Gathered, and Appendices 4 - 30, graphs and data logs.)

The gate to the east of the Museum of Flying had an overall mean particulate level of 35,335 pt/cc, which was

more than twice as great as Clover Park's overall mean level. Particle counts were high at the gate to the east of the Museum of Flying because one could get close to the aircraft. There is also a lot of idling and taxiing that occurs at that location, which creates a lot of particles. The majority of planes operating near the Museum of Flying run on jet fuel and are used regularly. Jet fuel-based aircraft produce more exhaust than other kinds of aircraft. Also, this location has additional aircraft activity from the Museum of Flying. The NNE and E upwind directions on 2/10/02 may have caused higher low points (24,900 pt/cc & 22,900 pt/cc) for the ranges of particles during two of the sampling periods. Time, weather, and temperature did not have an effect on the particle counts at this location.

At 2747 Armacost Ave., NE of the airport, the overall mean level of ultrafine particles was 42,488 pt/cc. The WSW and SW wind directions may explain the higher overall mean level than the site near the Museum of Flying. Strong winds may have decreased the peak particle count on the first of two days that data was taken, 2/19/02 (73,900 pt/cc) compared to the second day, 2/20/02 (138,000 pt/cc). However, the mean particulate level for both days was roughly equivalent, possibly due to greater aircraft activity on 2/19/02. Time, weather, and temperature did not seem to have an effect on the particle counts.

At Sardis Ave. and Armacost Ave. the overall mean particulate level was 47,365 pt/cc, which was higher than the overall mean at 2747 Armacost Ave. possibly because there are no houses blocking the wind. The higher level at Sardis and Armacost may also be due to aircraft producing more exhaust at that end of the airport. Planes normally take off and land at the east end of the airport. The prevailing wind is WSW, pushing the particulates to the ENE, and the fume production is closer to the ground.

Rain and wind speed may have accounted for differences between mean particle counts on 2/20/02 and 3/6/02. Although there was more airport activity on 3/6/02, and particle ranges were similar on both dates, the mean particle concentration was only half as much on 3/6/02. The most likely explanation is that the rain brought the ultrafine particles to the ground so that there were less particles circulating in the air. The low mean on 3/2/02 was due to the fact that there was very little aircraft activity that time and day. Time and temperature did not make a difference in the particle count at Sardis and Armacost.

Sardis Ave. and Bundy Dr. had a mean particle concentration of 66,457 pt/cc. Data was taken at this location to provide a comparison particulate sample of airport activity *with* auto traffic. The peak particulate level at Sardis and Bundy when a jet took off (see graph), was lower than the peak level at Sardis and Armacost when a jet took off just a few minutes earlier, possibly because the wind changed from WSW to variable.

After completing all measurements, the author decided to take an additional sample on 4/5/02 in order to show what part of the ultrafine particulates measured at Sardis and Bundy come from auto traffic. Measurements were taken at Bundy Dr., between Woodbine St. and Palms Blvd. The mean particle level at this location was 41,276 pt/cc. However, the author did not think it would be appropriate to compare the new data on auto traffic only with the old data on combined air and auto traffic for several reasons. First, on 4/5/02 the P-Trak™ Ultrafine Particle Counter was not calibrating to zero but to approximately 6,000 pt/cc. Second, on the day that the old data was taken at Sardis and Bundy, it was raining lightly, which may have lowered the particle counts. Finally, old data from Sardis and Bundy was taken at a later time of day with different amounts of airport activity and auto traffic, which may have altered the amount of particles in the air. Therefore, the decision was made to go back to Sardis and Bundy to take an additional sample of particles in order to compare combined air and auto traffic vs. auto traffic only.

The mean amount of particles at Sardis and Bundy (combined auto and aircraft exhaust) on 4/5/02 was 56,104 pt/cc, as opposed to Bundy and Woodbine (auto exhaust only) which was 41,276. When comparing these locations, it appears that airport activity augments particle concentrations. This finding is particularly impressive because the measurement instrument was held out of the window of a parked car, only one to two meters from the source on Bundy and Woodbine. The same thing could not be done at Sardis and Bundy.

After much deliberation, the author decided that the calibration problem did not have an effect on the data because the mean particulate level at Sardis and Bundy was lower than the previous mean from that location. If the calibration had had an affect, the mean particle concentration may have been higher.

At all locations, higher levels of particulates were found when fumes were present. The highest levels of ultrafine particles were generated by jet aircraft idling and taxiing.

If this study could be conducted again, measurements would be taken at consistent times of day and days of the week, for the same length of time. The author originally planned to take measurements at consistent times and lengths of time, but more time was needed at each spot to observe aircraft activity than was expected, and a lack of time forced the author to take measurements at different times, for different lengths of time. Measurements were also not taken consistently because wind speed and direction would change hourly while taking long measurements.

Another problem was that at the location near the Museum of Flying, pilots who owned private planes were suspicious of the author's activity. The gas mask made the author look even more suspicious, so he was inclined not to

wear it, even though the author was sometimes exposed to extreme amounts of aircraft exhaust. The gas mask did not filter out all exhaust fumes, but it protected against much of it.

There were a few glitches that occurred with the equipment. Since the P-Trak™ Ultrafine Particle Counter can measure only up to 500,000 particles per cubic centimeter, particulate ranges that go beyond 500,000 pt/cc cannot be measured. Scaling on the x-axis of the graphs is unchangeable due to problems with the software. Annotating graphs can only be accomplished by downloading an upgrade to the TrakPro™ software. The system will only allow ten annotations, including corrections. When printing range data, the software cuts off digits in the thousandths on the first channel. In order to get the correct data, the author had to write in the correct ranges for the first channel from the computer monitor.

Statistical tests for significance were not done because Dr. Richard Berk, Director of the UCLA Statistical Consulting Center stated that it was not justified since the author took samples at different days and times. This was a study of the feasibility of measuring particles at Santa Monica Airport.

CONCLUSION

This experiment was designed to find out if the amount of ultrafine particulate matter that comes from the Santa Monica Airport can be measured and if the surrounding neighborhoods are harmed by it. New research is showing that these particles are highly toxic. There is also insufficient data on the amount of ultrafine particles that come from airports.

Data was taken using a P-Trak™ Ultrafine Particle Counter. Locations for measurement were less than 100 meters from airport activity and more than 100 meters, or as far away as possible, from auto traffic. Measurements were taken between the hours of 11 a.m. and 6 p.m., when hourly aircraft operations are highest. Weather, wind, temperature, time, particle levels, and airport/auto activity were monitored for each time period that measurements were taken.

It was hypothesized that 1) levels of ultrafine particle matter would be measurable from areas immediately adjacent to Santa Monica Airport, 2) particulate matter levels would be worst to the east of the airport because of the sea breeze and 3) the stronger the wind, the less particle matter there would be because the wind would move the particles to a different location.

Clover Park had an overall mean particulate level that was similar to a no-traffic condition on 29th St. between Pearl St. and Ocean Park Blvd. Particles are blown away

from the park because it is rarely downwind. The low overall mean particulate level was also due to the fact that aircraft take off towards the ocean and are high in the air by the time they reach the park. In addition, there is a barrier of aircraft near the fence.

The overall mean particulate level at the gate to the east of the Museum of Flying was twice as great as the overall mean particulate level at Clover Park. The measurement site near the Museum of Flying is much closer to aircraft activity than at Clover Park. Furthermore, jet fuel-based aircraft occupy the majority of the active aircraft parking lot.

2747 Armacost Ave., which is NE of the airport, had an overall mean particulate level that was higher than the site near the Museum of Flying. This may have been due to the fact that the prevailing wind is WSW, pushing the particulate matter to the ENE. The overall mean particulate level was even greater at Sardis Ave. and Armacost Ave., which is a few houses south of 2747 Armacost Ave. The higher overall mean particle count at Sardis and Armacost may have occurred because there are no houses blocking the wind. Planes usually take off and land on the eastern end of the airport; therefore, exhaust levels are higher on that end and produced near ground level.

Measurements were taken at Sardis Ave. and Bundy Dr., a busy street, to see how airport-related particulate levels would be affected by added automobile traffic. The mean particulate level at this site near the airport was much higher than all other sites. To confirm this finding, additional data was taken at Bundy Dr. (between Woodbine St. and Palms Blvd.) and again at Sardis Ave. and Bundy Dr., in order to compare auto traffic alone vs. auto traffic with airport activity. The comparison of mean particulate levels clearly showed that airport activity augmented the particle concentrations.

The highest levels of ultrafine particles were generated by jet aircraft idling and taxiing. In general, fumes were associated with increased ultrafine particle levels.

The first hypothesis was supported because ultrafine particle matter was measurable from areas immediately adjacent to Santa Monica Airport. The second hypothesis, that particulate levels would be worst to the east of the airport because of WSW prevailing winds, was also proven. It is possible that stronger wind reduced the range of ultrafine particulates at 2747 Armacost Ave. on 2/19/02 compared to 2/20/02, which was my third hypothesis. However, general lack of variability in the wind speed and data from 2747 Armacost, makes this difficult to confirm.

The air quality of Santa Monica is being diminished by the airport and may represent a risk to human health.

Researchers at the Southern California Particle Center and Supersite, funded by the U.S. Environmental Protection Agency and the California Air Resources Board, are

investigating the toxicity of ultrafine particles and are finding that they appear to be toxic. According to Director John R. Froines, Ph.D., the author's study may represent a key research finding and be the first study of airport sources of ultrafine particulates in the nation. The aircraft-related particle concentrations found by the author are very high and similar to those found in studies where ultrafine particles from the air are concentrated 40 times. Constantinos Sioutas, Sc.D., Deputy Director of the Particle Center, commented that the concentrations the author found "are very impressive in that they are about 5 times higher than those measured 10-20m downwind of a freeway! This by itself would make it worthwhile doing measurements in the vicinity of airports and also collecting samples for in vitro analysis."ⁱ These scientists have been studying mobile sources of ultrafine particle emissions, but have not been paying attention to airports because they did not think that it would be possible to find the kinds of levels that the author found. Dr. Froines and his colleagues have concluded that the data appears to be correct and agreed that the instrument would not give spurious readings due to vapors formed from combustion. They would like to send the data to the U.S. Environmental Protection Agency and the California Air Resources Board for possible posting on their websites. Measurements made at UCLA show that ultrafine particles condense into larger particles within 100 meters, which can travel distances of 50-100 miles; therefore, they contribute to pollution in a wide radius.

Additional research is required to further estimate the combined airport and automobile traffic sources of ultrafine particles and to determine the relative contribution of airport vs. automobile sources. Future studies should take ultrafine particle measurements inside the Museum of Flying and at office buildings bordering the airport to see if particulates could be affecting the health of workers. Studies should also be done on the levels of ultrafine particles associated with jet exhaust fumes, which have been noted by the author at distances of a half mile or more from the airport. The author would take measurements in the morning and evening, when the wind is calm, to see if particulate levels would be higher at locations adjacent to the airport. Aircraft activity could be controlled more easily if measurements were taken at consistent times of day and days of the week. Means would be easier to compare if quantities of measurement time were equal. In order to take proper measurements without being questioned by authorities, asking permission to take measurements may be advised.

The author learned how to use the TrakPro™ software for the P-Trak™ Ultrafine Particle Counter without any instruction and uncovered glitches in it. He learned so much about ultrafine particles that he found two mistakes in

ⁱ E-mail communication on March 21, 2002.

a March 6, 2002 Los Angeles Times article on particulates and lung cancer regarding how long ultrafine particles can float in the air and how they are formed.

As a result of this study, the author went to Hollenbeck Middle School in Boyle Heights (East Los Angeles) to present his science experiment to seventh grade students and show them how to use the P-Trak™ Ultrafine Particle Counter. This was part of an educational program sponsored by Southern California Environmental Health Sciences Center - a joint UCLA and USC program. In addition, the author participated in Cal EPA's Earth Day celebration on Children's Environmental Health, April 22, 2002, in Sacramento, CA. He joined two students from Hollenbeck Middle School and Andrea Hricko, Director of the USC Community Outreach Program of the Southern California Environmental Health Sciences Center, to present their concerns about particle-related air pollution. The author also reported on the health hazards of ultrafine particulate matter and the results of his study at an April 15, 2002, City of Santa Monica Environmental Task Force meeting and at the June 8, 2002, Friends of Sunset Park annual meeting.

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