Chapter 7

“Black, Black, Black Is the Color of My True Love’s ...” Exhaust

Diesel exhaust

Major impacts: Lung cancer, heart and lung disease, mental impacts, asthma and more

Introduction

California’s Proposition 65 (the Safe Drinking Water and Toxic Enforcement Act of 1986) mandates an inventory listing toxic materials and public warnings of their presence. The list is long, but one substance alone, diesel exhaust, accounts for 70 percent of the airborne toxic effects of all toxic air contaminants (TAC) combined. The primary problem is heavy polycyclic aeronautic hydrocarbons (PAHs) caused by incomplete combustion of heavy petroleum fuels. But diesel exhaust warrants many other concerns, too. In a recent study, prenatal exposure to PAHs was correlated with physical changes in children’s brain structure along with mental problems, slower reasoning, hyperactivity, and more.

The reason why diesel exhaust is so polluting and toxic is inherent in diesel combustion. The walls of the engine’s cylinders must be kept relatively cool, but the combustion in the center is very hot. This allows partial combustion of the heavy fuel and the generation of polycyclic aromatic hydrocarbons (PAHs), the most problematic carcinogenic compounds in the atmosphere. And while diesel exhaust is ubiquitous, there are areas of special concern in certain locales. Many of these are downwind of rail yard and truck multimodal facilities. For example, the plume of materials from the BNSF Railway facility in San Bernardino, California, was estimated at about 2,500 excess cancer deaths per lifetime. Note that since the lifetime risk of cancer is on the order of one quarter of all deaths (250,000 afflicted among each million in population), the excess amounts to only about a 1 percent increase even in this especially impacted area with just a few thousand people.
One key reason for this relatively low risk today is the 91 percent reduction in diesel emissions from trucks during the past 30 years, from 1,100 milligrams of emissions per kilometer traveled (mg/km) in 1972, to about 100 mg/km in 2002, as Figure 7-1 shows. Further progress is occurring, resulting in development and production of very clean-burning diesel engines. This is well advanced in long-haul trucks, but almost totally lacking in three-axle diesel vehicles (including school buses, dump trucks and delivery vans) and, regretfully, most trains. Cars pose special problems in trying to maintain diesel soot reduction techniques, assuming they are not part of some scam (viz. Volkswagen)

Figure 7-1. PM$_{2.5}$ emission factors for heavy- and light-duty trucks, 1972–2002. Cars produced about one-tenth the emission volume that trucks do.
Figure 7-2. The gray shaded area shows the size range and lung deposition for diesel exhaust.

And on top of this, there is Volkswagen. I was amazed in 2009 that it ever made the ARB’s smog emission limits. Well, a “defeat device” that sensed when the car was being tested turned on emission controls. Once testing was done, the device turned off the pollution control system, after which time the car emitted 10 to 40 times more nitrous oxide than allowed.

Even greater problems appear in Europe, where about half of all cars have diesel engines. That may be why Paris and other European cities still have such dirty air, despite claims of widespread use of “clean diesel.” In addition, the manufacturers’ mileage claims are inflated by about 40 percent, using tricks while they do their own tests.

How can I protect myself?

Essentially all diesel exhaust comes from one of seven sources:

1. Heavy duty (typically eight-axle) diesel-powered trucks on freeways and major highways
2. Lighter duty (often three-axle) diesels on secondary streets, such as delivery and dump trucks, school buses, and the like
3. Railroad diesel engines, especially downwind of a rail yard
4. Off-road and construction diesel-powered equipment
5. Diesel-fueled water pumps for agriculture
6. Peaking diesel-powered electric backup generators used to respond to short term power needs
7. Diesel-powered cars

Do your homework. Explore the websites of transportation agencies and other reliable sources for data on heavy truck use.

For each of the diesel sources given above, different types of protection are needed:

• For sources 1 and 2 (diesel on vehicular roadways), follow the “How can I protect myself” guidelines in Chapter 8 for ultra-fine particles and in Chapter 9 for highways.

• For diesel source 3, become aware of railroad activities, and especially rail yards, because some of the worst levels of toxic air contaminants occur downwind of rail-truck facilities. Check the Chapter 7 (Diesel exhaust) section about the Roseville, California, rail yard. That segment shows that diesel exhaust in rail yards is more toxic than that emitted by trucks on roadways.

• For diesel sources 4 and 5, don’t sweat it, as they are not close to you for extended periods.

• For source 6, learn where such generators are in relation to wind direction, and ascertain how often they run. Usually such facilities, if in cities, have particle controls on them.

• For source 7, read on to learn more about Volkswagen cheating.

More about Volkswagen's diesel cheating

Cheating on “clean diesels”? I am shocked! Shocked! But I was really shocked when told in 2009 that the Volkswagen diesel had passed the ARB’s stringent dynamometer emission tests. Make no bones about it – diesel combustion is essentially filthy, and only by extensive and expensive efforts can its problems be overcome. I had no clue that a corporate fix was on.
There had been several earlier examples of shenanigans with “defeat devices” by homegrown and foreign auto companies, but this one from Volkswagen was a lulu, with pollution up to 40 times greater than the maximum allowable standard. The heart of the matter is that California’s vaunted vehicle testing and validation programs have an “Achilles heel”: what is seen in laboratory dynamometer tests is not what appears on the highway. Volkswagen knew that, and if not for a fluke West Virginia based on-road test that revealed the discrepancy, could have continued cheating for years to come.

This is not the first time lab results and real-world results differed. I was working on lead pollution from highways in 1973. We had models from the U.S. EPA, but California wanted to validate these by on-road testing. My work found that the elevated freeways that were supposed to be the cleanest by the EPA model were the dirtiest, dumping 400 percent more lead than the California standard into downwind houses. My data helped Jerry Brown version 1.0 (in his first term as California’s governor) win a sweeping victory against both industry and the EPA, which opposed establishment of separate California standards. The stunning reductions in California air pollution encouraged most of the world to follow California, with the exception of Europe and its diesel fixation based on mileage claims. But automotive manufacturing companies hire the contractors to do the testing. What could possibly go wrong in this scenario? It probably explains why on-road mileage of diesels in Europe is about 40 percent worse than advertised.

By the mid 1980’s, it had become clear that something was wrong in the Los Angeles basin. Ozone precursor gasses and ozone itself were not decreasing in the way the laboratory measurements and air quality models predicted. The answer came from a series of tests made in a freeway tunnel in Van Nuys, in the San Fernando Valley region of Los Angeles. Tunnels are nice to use because the volume of air and the number and types of cars and trucks were both accurately known. Thud the tunnel studies were able to compare the predicted auto emissions from ARB dynamometer laboratory tests to real-world conditions. The tunnel tests revealed carbon monoxide (CO) and hydrocarbon (HC) emission values 300 percent and 400 percent higher, respectively, than expected on the basis of dynamometer tests. The on-road tests identified a sad result – most California cars were clean, but a small number of “gross emitters” were discharging two-thirds of all highway pollution. These cars include modified vehicles with
bypassed catalytic converters, old throw-away cars, unregistered cars, cars with fake smog check clearances, and the like.

In order to rectify the problem of “gross emitters,” the California Inspection and Maintenance Review Committee (IMRC), a state board on which I served for years, repeatedly recommended on-road testing to identify “gross emitters.” The technique is actually simple, using an infrared beam aimed across a freeway on-ramp to measure pollutants. If this test had been modified to also detect nitric oxide (NO), that would have immediately identified the diesel cheaters, and the pollution would have been stopped years ago. Regretfully, the IMRC was shut down in 2011.

And even post-Volkswagen, laboratory dynamometer tests cannot protect us in real-world conditions. “Wear” aerosols – from the roadbed, resuspended freeway dust, brake drums, and other sources resulting from abrasion, cannot be realistically measured in the lab. But health data on children living near freeways in Los Angeles, and our data on heart disease in the Central Valley, show that roadways are still causing health problems. Medical studies points to “wear” aerosols and ultra-fine metals from brakes as potentially toxic agents. This very important problem of very fine and ultra-fine metals from brakes will be covered in the next chapter.

California needs to initiate truly realistic on-road testing not only to catch “gross emitters” and to detect cheating by “defeat devices,” but also to measure “wear aerosols” by size and composition. These tests should include realistic freeway actions such as braking and accelerating, as I and my team are doing in an ongoing U.S. EPA study in Detroit. Only with such data can we propose legislation that can rectify these problems and protect the health of Californians.

**The special case of diesel trains and rail yards**

The Union Pacific rail yard in Roseville, 15 miles northeast of Sacramento, California, is one of the largest in the western United States, and has a major repair and testing missions. As normal operating procedure, diesel engines are often left idling for extended periods of time. California Air Resources Board analysis in 2004 indicated about 900 excess cancer deaths per lifetime downwind of the rail yard. Note that the BNSF intermodal rail yard in San Bernardino had a predicted cancer death rate of about 2,500 per lifetime, much worse than Roseville.
We participated in tests of rail yard impacts both for diesel and other pollutants emitted from the repair activities. One of the goals was to make a direct measurement of diesel components, and especially the heavy PAHs like benzo[a]pyrene, a potent carcinogen in diesel smoke, for comparison with the ARB model. We also wished to evaluate other potential particulate pollutants emitted by comparing downwind sites to upwind or control sites. Figure 7-3 illustrates a comparison between a downwind site (Denio’s Roseville Auction) and an upwind site for sulfur, associated with the sulfur in diesel fuel. Many other metallic aerosols followed the same pattern.

Figure 7-3. Comparison of very fine sulfur, Denio site vs. an upwind site.

For the comparison of cancer death rates, we measured speciated organics as a function of particle size. Figure 7-4 is one such plot, showing that these PAHs deposit deep in the lung.
Figure 7-4. Roseville rail yard coronene and pyrene concentrations (pg/m³) delineating the different size fractions of the eight-stage DRUM sampler (Davis Rotating-drum Universal size-cut Monitoring impactor) and the after-filter.

Figure 7-5. Comparison of Roseville rail yard and truck diesel PAH profiles.
Rail yards have a variety of diesel sources—some of which are unique to them, such as idling diesels and stationary diesels under test, as in the Roseville rail yard. As an additional complication, the BNSF rail yard in San Bernardino is an intermodal facility that is subject to heavy truck traffic from the Port of Los Angeles and Long Beach. Both diesel testing and port-to-rail transit traffic are likely to generate enhanced cancer rates downwind.

References


Chapter 8

“It Was an Itsy Bitsy Teenie Weenie Yellow …” Ultra-fine Metal

Copper and other ultra-fine transition metals

Major impacts: Cardiopulmonary conditions, especially ischemic heart disease and permanent loss of lung function in children

[For the antiquity-challenged, the 1960 song that inspired the title of this chapter was about a young girl suffering a mild case of hypothermia due to a questionable swimwear choice.]

Introduction

I probably take more pride than I should or deserve for highlights in my career – the first, the only, the biggest. But I am embarrassed about one record. I am told that I hold the record at the Trauma Intensive Care Unit of the University of California, Davis, Medical Center for the most ribs broken in a single fall from a ladder – seven – by a patient who survived. Knowing that now, I really should not have been climbing a long ladder onto the roof of Arden Middle School in the rain with my colleague, Betty Turner (combined ages circa 140 years) on that December day in 2002.

We were responding to a request by the principal to add Arden Middle School to a network of air sampling stations we were setting up. The network was designed to evaluate the effects of freeways on Sacramento, as part of our research with the Health Effects Task Force of what is now Breathe California of Sacramento-Emigrant Trails (at that time an affiliate of the American Lung Association). The study focused on the health-compromising implications of aerosols from two heavily traveled north-south freeways, Interstate 5 and California Highway 99. The six-site network stretched 50 miles, from the western side of the Sacramento Valley west of Davis to the foothills of the Sierra Nevada east of Sacramento. The request from the principal of Arden Middle School was based on her concerns about the school’s proximity to the intersection of two main arterials. The school grounds are 50 feet downwind of the signal-controlled...
intersection of multi-lane Watt Avenue at Arden Way, and those streets were and are heavily
used and often congested. Arterial streets were never part of our plan to evaluate air quality
adjacent to freeways, but I had one extra air sampler, just brought back from the Aerosol
Characterization Experiment-Asia (ACE-Asia) study (see Chapter 10, The Mad Hatter Had a
Point) and, lacking any available staff at that moment, the geezer squad swung into action.

Once again, I am struck about how lucky I have been in my career. I was not at all
interested in Arden Middle School because it was not part of our plan, but it turned out to be the
key to unlocking one of the major detrimental health effects affecting the nation. When we
finally completed our analysis of the results in spring 2003, we discovered that Arden Middle
School – downwind of 65,000 vehicles per day, 1.5 percent of which are heavy trucks traveling
on Watt Avenue – was subject to about the same amount of pollution as locations measured
downwind of Interstate 5 carrying 265,000 vehicles per day, 12 percent of which are heavy
trucks.

These results were a wake-up call that we had better look more closely at Arden Middle
School, triggering intensive studies in 2006 and 2007. Table 8-1 illustrates the results of these
and other comparative studies.

### Table 8-1. Measurements at Arden Middle School, in suburban Sacramento, and
comparative data and theory. The theory value is based on three sources, averaged.

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Sampling dates</th>
<th>Mass data, very fine particles</th>
<th>Mass theory, very fine plus ultra-fine</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size modes</td>
<td></td>
<td>0.26 to 0.09 µm</td>
<td>0.30 to 0.0 µm</td>
<td></td>
</tr>
<tr>
<td>Sacramento, Interstate 5</td>
<td>Winter 2002</td>
<td>4.1 µg/m³</td>
<td>265,000 vehicles/day</td>
<td></td>
</tr>
<tr>
<td>Fresno, 1st Street</td>
<td>Winter 2001</td>
<td>4.2 µg/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arden Middle School, Watt Avenue</td>
<td>Winter 2006</td>
<td>4.0 µg/m³</td>
<td>6.4 ± 0.8 µg/m³</td>
<td>65,000 vehicles/day</td>
</tr>
</tbody>
</table>
These results could be explained only by the anomalous fact that for the first time in decades we were measuring aerosols at a study at a stop light, with braking and acceleration. We all noticed the plumes of black smoke when the diesels accelerated as the light turned green.

Figure 8-1. Ultra fine metals at Arden Middle School 50 feet downwind of Watt Avenue

Three other long-term research efforts now came to bear. The Health Effects Task Force (HETF) already had spent several years looking at the enhanced heart attack death rate in the southern San Joaquin Valley, which we showed was associated with enhanced ischemic heart disease (HETF, 1997). A separate key study in Los Angeles showed large losses of lung capacity in children growing up near freeways. And UC Davis environmental health teams identified a relationship between freeway proximity and incidence of autism, with metals a likely cause.
Figure 8-2. Death rates from heart attacks by location in the California Central Valley.

The lower dotted line traces the reduced rate of ischemic heart disease that resulted from a 1990 cleanup of ultra-fine metals from oil extraction operations. Note that the cleanup did not reduce heart attack incidence in Bakersfield (dotted circle), which is upwind of most of the oil fields.

A search of the scientific literature confirmed what we already suspected: these metals are known constituents of brake pads and drums, plus some zinc from zinc thiophosphate, a stabilizing additive in motor oil that we had seen before in ultra-fine modes (Zielinska et al., 2004).

All these data led to the hypothesis that the enhanced heart attacks in the southern San Joaquin Valley might be caused by ultra-fine particles of brake drums and pads from cars and trucks trapped at cities that experience intense winter inversions, as Bakersfield does. With assistance from a local non-governmental organization, we did a study in January 2009 simultaneously measuring coarse, fine, very fine and ultra-fine particles at five sites from Redding (at the northern end of California’s Central Valley) to Bakersfield (440 miles distant, at the southern end of the valley). This study also benefitted from much better data on deaths rates, including data that showed one specific source of mortality was ischemic health disease (IHD),
the largest single cause of death in the San Joaquin Valley. It also used data from extensive EPA studies on metals in rats, and our data from Watt Avenue tying these metals to braking. Thus, in summary, the resulted in peer reviewed papers in a special US EPA journal proving that very fine and ultra-fine insoluble metallic particles were the cause of thousands of fatal heart attacks.

When added to the earlier work on loss of lung function in children growing up near (less than 1 mile) Los Angeles freeways and the data on enhanced autism rates for pregnancies near freeways, the seriousness of the very fine and ultra-fine metals becomes urgent.

And now we know what you can do protect yourselves.

Figure 8-3. Very fine and ultra-fine metals that correlate with ischemic heart disease (IHD) mortality. IHD is usually the largest single reason for heart attack mortality in the California Central Valley.
Figure 8-4. The gray shaded area shows the size range and lung deposition for very fine particles with diameters between 0.25 micrometers and 0.1 micrometers, and ultra-fine particles with diameters less than 0.1 micrometers. These are normally written in a short version, for very fine (0.25 > Dp > 0.1 µm) and for ultra-fine particles, (Dp < 0.1 µm).

**How can I protect myself?**

Know the sources:

- Avoid the outdoor areas where such particles exist, especially downwind of roadways where heavy braking routinely occurs (Chapter 9, Outdoor Air Quality)
- Learn of other industrial sources of ultra-fine metals, especially car shredding operations, and ultra-filter the air in your house (Chapter 10, Indoor Air Quality)

**Nitty-gritty details**

*Comparison of diesel exhaust to ischemic heart disease death rates*

The California Proposition 65 (law on toxics) limit for notification: 10 deaths per million people per 70-year lifetime, or approximately a 0.001% increase in the total death rate
Diesel exhaust is the most ominous of the old Prop 65 toxic air contaminants (TACs), resulting in about 70 percent of all cancer cases attributable to TACs combined. Using the fact that about 20 percent of all deaths are from either cancer or heart attacks, we can estimate the enhanced death rate, deaths per million people per 70-year lifetime:

- **Downwind of Union Pacific rail repair yard, Roseville, California:**
  - approximately 800 deaths per million people per 70-year lifetime: *about a 0.5 percent increase in the cancer death rate*

- **VW diesel cheating** (if continued at the present level – estimate by the *Sacramento Bee*):
  - approximately 900 deaths per million people per 70-year lifetime: *about a 0.5 percent increase in the cancer death rate*

- **Downwind of the worst California rail-truck facility, in San Bernardino**
  - approximately 2,500 deaths per million people per 70-year lifetime: (ARB report, San Bernardino BNSF): *about a 1.3 percent increase in the cancer death rate*. This rate equates to < (fewer than) 1,000 people in the city of San Bernardino

Now compare that to the impact of very fine and ultra-fine metals from brakes:

- **Bakersfield, in the city center:**
  - *approximately 25 percent increase in the heart attack deaths* (this rate affects about 350,000 people in the city of Bakersfield)

Thus the death rate in Bakersfield, enhanced by approximately 25% in the death rate of the single largest source of mortality in a city of 350,000 people, can be compared to the enhanced death rate at the worst California site impacted by diesel, about 1.3% in a population of no more than a few thousand people. So while vast efforts are being made to control diesel, and with considerable success, very fine and ultra-fine metals, proven killers, slide by under the radar. As I said in Chapter 4, “...the Worst of Acts”.

**Note added in proof:**

We have just published a paper on Detroit that includes the final statement of the abstract: “…….*This result supports earlier publications showing the ability of very fine and ultra-fine particles to transport to sites well removed from the freeway sources. The concentrations of very fine and ultra-fine metals from brake wear and zinc in motor oil observed*
in Detroit have the potential of being a significant component in statistically established PM$_{2.5}$ mortality rates.”

Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit, Thomas A. Cahill, David E. Barnes, Jonathan A. Lawton, Roger Miller, Nicholas Spada, Robert D. Willis and Sue Kimbrough (the last 2 EPA OAPQS North Carolina), Atmospheric Environment (9/2016)

Detroit is a lot bigger than Bakersfield. The word is getting out.

References


Thomas A. Cahill, David E. Barnes, Jonathan A Lawton, Roger Miller, Nicholas Spada, Robert D. Willis and Sue Kimbrough, *Transition metals in coarse, fine, very fine and ultra-fine particles from an interstate highway transect near Detroit*, in press, Atmospheric Environment (2016)


**Shut down Tom – attempt No. 3**

*Ultra-fine particles and the massive governmental screw-up at the World Trade Center*

• George Bush, president, 2003 – World Trade Center air was not safe to breathe!

None of us can forget when we first became aware of the WTC disaster on September 11, 2001. But my concerns were raised higher when three days later, I saw TV coverage showing blue fumes coming up from the collapsed piles after a rainstorm on September 13. Blue smoke is bad smoke, especially in industrial fires, because it indicates very fine particles that go deep into the lung and even the bloodstream and heart. I felt both helpless and worried for the workers and firemen working in such conditions.
About two weeks later, I received a phone call from Bob Leifer, Department of Energy physicist with a laboratory on Varick Street in New York. His laboratory was at the southern limit of sites that still had electrical power. We had collaborated on the Mount St. Helens work, and I respected his expertise. He asked if I could send one of my Davis Rotating-drum Universal size-cut Monitoring impactor (DRUM) samplers to him. I had invented the current DRUM sampler in 1985, and it has been the work horse of my research for decades. It was designed to address problems with EPA required sampling protocol, which required 24 hr average filters analyzed only for mass. The standard protocol also calls for operating this unit only one day in 6. (see Chapter 4) The DRUM gives data in 8 size modes, not one size mode, every 3 hr, not every 24 hr, and is routinely analyzed for mass, 42 elements, soot, and occasionally organic matter.

Well, one had just come back from Beijing and ACE-Asia, (Chapter 19), so a cleaned it up, reloaded foils, and just made the FedEx pickup at 4 p.m. that Friday.

Robert got the sampler up and running by October 2, and ran it flawlessly until we shut down in mid-December. At that time, we analyzed the samples at the Advanced Light Source, Lawrence Berkeley National Laboratory, and at Lawrence Livermore National Lab. By Christmas we had the results, which showed that, despite what the EPA and White House press releases asserted, the air was most assuredly not “safe to breathe,” and that people could expect massive detrimental health effects. These health problems included both the “WTC cough” (from coarse particles) and loss of lung function and eventual ischemic heart disease (from ultra-fine particles) as a result of breathing emissions from the fuming collapsed material piles, on which hundreds worked with minimal protection. There were high levels of strange elements, some toxic, in very fine size modes, predictably harmful to health.

As soon as I had results in early January, I called EPA Region II, and was told that it was none of my business. The EPA contact person asked just two questions: “Who asked you to do it? Who paid for it?” They had zero interest in our findings. Then I asked the University of California's Washington lobbyist to present our material to the committee headed by then-Senator Hillary Clinton on this topic. The committee was scheduled to conduct hearings later that month, and UC contacted her staff and mentioned our work. The Senate staff said that our work not needed, as they already had their experts lined up, including a senior professor from New York University. When the hearing was finally held, the NYU professor testified that his
data showed that the aerosols experienced in New York City were regional in nature from upwind sources, and not the WTC smolder pile. I was aghast.

Finally, I called my friends at EPA research in North Carolina, and their first question was “What did you find?” It turns out they at they were not even allowed to go to New York City to help because it was “a regulatory matter.” Some of them went anyway. So, frustrated at every turn, we made our results public in a news conference in Davis. Our work was added to work other work done in September but only now made public. It showed the dust was as basic chemically as Drano, and hence very irritating and damaging to mucous membranes, information that had been given to the EPA in September but never released. We got enough ink to get invited to come to a House of Representatives hearing in New York City at the end of February, with the U.S. EPA Ombudsman in attendance. I was hesitant to go, but Sylvia Wright of the UC Davis News Service office said we must go. So Sylvia, my wife Ginny, and I headed off to New York.

The hearing was bizarre. I was grilled for about an hour, under oath, by the Ombudsman’s lawyer, replete with leading and compound questions and trickery. They were trying to get at what EPA Administrator Christie Whitman knew about the dangers of the WTC smoke and when she knew it. The hearing also focused on asbestos, of which we saw very little. Ginny was beside herself because I did not have my lawyer to deflect unfair questions. A large audience there wanted EPA blood. I was very careful to avoid saying any more than I knew.

I subsequently met with Dr. Stephen M. Levin, who was treating WTC workers, and a reporter for the New York Daily News who, unlike the New York Times, was covering the story well. Levin was director of the World Trade Center Worker and Volunteer Medical Screening Program. I then got a call from ABC News, which did an interview with me at the WTC site that ran on the national news. Even though six months had passed since the collapse of the towers, a bitter burned insulation-like smell permeated the air, and the pile was still hot. Sylvia took some photos at the interview that I have shamelessly used everywhere. Now people knew who we were, and that, unlike the EPA, we were worried about current and future health impacts. The “air is safe to breathe” comment was in Whitman’s September press release, which had declared air at the WTC site and vicinity as “…safe to breathe,” but it was not. We began getting some strong negative pushback in response to our work.
As a result of my visibility I got into contact with Cate Jenkins. Cate, a senior EPA chemist, had become a whistleblower who accused the EPA of underestimating the toxicity of the fumes in the World Trade Center vicinity. She was under some sort of protection, and people sent her the most amazing information, which she then copied to us all. We added our results to her network, and received all sorts of documents. Some of these were reports that would suddenly appear on the EPA website, only to be removed the next day. Some sort of fix was in play!

The next action was something new to me. A good friend at U.S. EPA phoned me and leaked that the EPA was funding a grant at a famous old New York university to challenge my data. He apologized to me, and I allayed his concerns.

In such situations my only resource was the peer-reviewed literature, which we prepared and submitted. I have never seen that other group’s report (which was never released), but my data is published in the peer-reviewed literature. One reviewer was so set against our publishing the data (see Figure 8-5) that the editor had to remove him from the referee list, since everybody else was effusive in praise of our work. Not only was it important, with the help of the Livermore lab, but it also was in many ways the most complete aerosol event analysis ever done, with seven different analytical methods, some done for the first time (Cahill et al., 2004).

I met with and challenged a senior NYU professor on in this testimony before Hillary Clinton. It turns out that he had made measurements, but at the surface and in the wrong direction from winds, so despite being closer than we were, he did not see the plume. He did not have the capability we had with the DRUM and its three-hour time resolution, vital for seeing plumes from the collapse pile.
Figure 8-5. Anomalous size distribution of World Trade Center aerosols. The unusual aerosols from 2.5 µm to 0.75 µm were as caustic as Drano, burning throat and bronchial membranes.

Things began to unravel for the Bush Administration just before the September, 2003 meeting of the American Chemical Society in New York. The year before, at a national American Association for Aerosol Research meeting in North Carolina, I was taken aside by two investigators from the Office of EPA Inspector General Nikki Tinsley. She was about to issue an extensive report showing how the press releases of Christie Whitman, including cautions on health impacts, had been truncated by the White House before release. This was especially true for an EPA release in September that “… air was safe to breathe and the water safe to drink.” But the next phrase was deleted by the White House. My paraphrase: “However, our measurements raise concerns for working on the (collapse) pile and people coming back to work closer than Water Street.” This White House emasculation of Christie Whitman’s statement was widely
reported, and probably helps explain the White House sensitivity to what came next, with me as
the target, since my work was cited more than 10 times in her report.

She had compared the press releases that EPA Administrator Christy Whitman wrote with
statements that the White House finally released, and found key phrases of concern had been
deleted and other false comfort inserted. Tinsley released her report in August 2003, just a month
before a major American Chemical Society (ACS) meeting in New York City that included a
major session on WTC results. The ACS decided to hold its own news conference, and selected
me and one other colleague to present our work, first on the dust cloud that spread immediately
upon the collapse of the buildings, then my work on the plume from burning debris that
continued to smolder throughout the days and weeks following the collapse. This announcement
generated extensive news coverage.

Figure 8-6. Assessment of very fine dust at the World Trade Center site.

With Sylvia’s help we prepared a news release:
Trade Center debris pile was a chemical factory, says new study

The fuming World Trade Center debris pile was a chemical factory that exhaled toxins in a particularly dangerous form that could penetrate deep into the lungs of rescue workers and local residents, says a new study by UC Davis air-quality experts.

The new work helps explain the unusual pollutants and extraordinarily high concentrations found by an earlier UC Davis study, the first to identify very fine metallic aerosols in unprecedented amounts from Ground Zero. It will be essential to understanding the growing record of health problems.

The conditions would have been “brutal” for people working at Ground Zero without respirators and slightly less so for those working or living in adjacent buildings, said the study’s lead author, Thomas Cahill, a UC Davis professor emeritus of physics and atmospheric science and research professor in engineering.

“One that we have a model of how the debris pile worked, it gives us a much better idea of what the people working on and near the pile were actually breathing,” Cahill said.

“Our first report was based on particles that we collected one mile away. This report gives a reasonable estimate of what type of pollutants were actually present at Ground Zero.

“The debris pile acted like a chemical factory. It cooked together the components of the buildings and their contents, including enormous numbers of computers, and gave off gases of toxic metals, acids and organics for at least six weeks.”

Two days later, two of my secret sources independently informed me that a copy of my press release from my ACS presentation had arrived on George Bush’s desk, with a yellow sticky note saying, “Look what UC is doing to us.” Both of my sources agreed that “Bush had a cow” and told the Secretary of Energy to respond appropriately.

So the next Monday, after I had returned to Davis, I was called to a meeting with the vice chancellor of research and the dean of engineering, the organization that administered most of my grants. I was truly expecting praise, but instead got a scolding. The director of the Lawrence Livermore National Laboratory (LLNL), which at that time operated under the management of the University of California, had:
a) terminated all of the grants of my research group (LLNL previously had given us $16K for work at the World Trade Center);

b) cut my access to my colleagues at Livermore (permanently lost);

c) My New York colleagues who worked for DOE was suddenly retired, and

d) the building we had used was barred from further studies.

When I got back, Livermore asked UC Davis administrators to order me to pen an apology because I had not first sent my press release for review at Livermore and for using data that Livermore had not approved for release.

I was stunned, but responded first by showing the vice chancellor the peer-reviewed and published article in the journal *Aerosol Science and Technology (AS&T)* giving Livermore credit for the data and grant, and second by pointing out that because the data was public, we and Livermore personnel could report and apply the data as we wished. I did at least write an explanation, but I was pissed and lost all respect for him. Two weeks later, I received through a roundabout route a note from the director of the Livermore lab indicating that “he really liked the work.”

In addition,

a) The EPA had contracted with a famous old New York university to refute my data, (note: their report was never released. My data is in the peer reviewed literature),

Happily, none of the White House pressure reached the National Science Foundation, which was funding both the large Aerosol Characterization Experiment-Asia (ACE Asia) program and the new program to measure aerosols on the Greenland ice cap (see Chapter 20, Global climate change).

My data drew criticism because it was so unlike anything anyone had ever seen before, especially anomalous levels of vanadium, silicon and other materials in very fine size modes that would lead deep into the lung. I gained some insight from my old buddy, Professor Ian Kennedy of the UC Davis Department of Engineering, an expert in ultra-fine metals. He told me that this was similar to situations seen in the late 1980s hospital incinerator probes in which metals that
should not be seen at the temperature of combustion were present, and tied to chlorine in the
waste.

A search of scientific literature led me to exactly what I needed. I made a model, and every
toxic element I expected to see, based on the chlorine, was there, in the right ratios, and every
element my model said should not be there was absent. The article I wrote, one of my best,
(Cahill et al, 2005), laid that question about the products of high-temperature combustion to rest.

Lawyers representing first responders contacted me, and I agreed to help them establish a
fund to cover the detrimental health effects I had predicted. As the health effects began to show
up, we gained traction. It took a while, and cost me three days of time for discovery of all my
files at UC Davis by the opposition lawyers, but we won a massive settlement in favor of the first
responders.

"Fallout: The Environmental Consequences of the World Trade Center Collapse", he cited me as
one of three “environmental heroes,” along with Cate Jenkins – my EPA “leak” source protected
by her whistleblower status. I was just lucky to have the ability to respond quickly and
effectively following discovery of the air quality data. Any of my colleagues and all U.S. EPA
scientists would have done the same given the opportunity. In fact, many EPA scientists snuck
up to New York from North Carolina and also made measurements despite the ban.

In response to a massive lobbying effort by the first responders and John Stewart, in
December 2015, Congress indefinitely extended the fund for which we had fought. This is
terribly important because the rate of heart attacks from ischemic heart disease will soon begin to
rise among WTC first responders and demolition workers. While indefinite extension of the fund
is great news, attaining that authorization should not have been so hard. After all, if the City of
New York, the federal OSHA safety people, and the U.S. EPA had done their jobs and followed
laws and regulations, these thousands of people would not be sick today.

At the conclusion of the 10-day rescue phase to find and rescue trapped people, when
survivors were no longer being found, the rescue workers should have been ordered to back
away. At that point, the fire department should have deployed personnel wearing full-face
canister respirators, and the operation should have shifted to concentration on extinguishing the
fires before attempting cleanup. I cringed when I saw firemen with useless paper masks raking
debris in search of firemen’s badges. California firefighters returned from the WTC site suffering from pneumonia because the caustic fine dust had burned their sensitive nose and throat membranes.

The story does not end here. As the health effects I had predicted started to appear, Eric Gillin, a reporter for *Esquire* magazine, became nervous. He had been standing close to the WTC south tower when it collapsed, and saved the backpack he had been carrying at the time. He had sealed the dust-covered backpack in a plastic bag, which he had been keeping in a closet for five years. He asked if I could I learn something from analyzing the particles on the bag. Recall that we had no aerosol data from the monster collapse clouds.

So I agreed to help, and designed an instrument to gently vacuum dust off fabrics at about the same wind velocity at which they had been deposited. Gillin came out to Davis, camera crew in tow, and we did the work. The bag’s contents included a book, some papers, a transit schedule, and the debris-caked shirt he had been wearing that day as he had been enveloped in the furiously virulent cloud of dark grit that cloaked lower Manhattan.

When we called Gillin after completing our analysis of the results, he was really nervous, but then we told him most of the collapse dust that had coated him and his bag was harmless gypsum from the drywall used in the center walls of the WTC. His relief was palpable.

Gillin’s resultant article, titled “The Bag,” was published in the April 2007 issue of *Esquire*. It begins on page 133, immediately following a photo of Hilary Swank’s feet. I recommend you read the article yourself – it is an accurate representation and well written. Upon my request, *Esquire* published an accompanying sidebar article on the smolder fumes, showing how toxic they were. Good work on all sides.

Amazingly, the story still does not end there. About a month after publication of the *Esquire* article, I received a furious and insulting phone call from someone asking who had paid me off to cover up the WTC conspiracy. Without realizing it, my data showed that there was no trace of thermite (or thermate) in the south tower collapse, driving a garlic-coated stake through the center of their ridiculous hypothesis. I still received nasty emails with similar accusations about twice a month. But I also get praise from my physics colleagues at meetings for sticking my neck out when the EPA-White house cover-up of the dangers the dust posed to workers was in full play.
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This is a good time to celebrate the volunteer experts that again and again have set me on the right path. I have learned to stop and listen to those people living within the problem. In the last chapter, we talked about Arden Middle School right downwind from the Watt Avenue stop lights. The Principal asked us to measure because of her concerns and being fully aware of how a bad result could harm her school’s reputation. We did it as a favor to her, not expecting much. Well, she was right, I was wrong, and the Watt data at Arden Middle School helped unlock the mystery of the excess heart attacked deaths all over California. Later in Chapter 14, we will meet a rancher near Moneo Lake who was worried enough about the dust that he volunteered his ranch as a location for our (unauthorized) air sampler. I can think of cores of other examples, including right now a high school in China where students are collecting samples for us. Now we always go to the site, sit down with locals over coffee or a beer, and listen.
Section C

Mitigation – Yes, You Can Do Better

The threats outlined in the Chapters 7 and 8, diesel carcinogens and ultra-fine metals, impact the population as a whole most severely for people who live near heavily traveled roadways. In Chapter 9, we address how you can evaluate the degree to which you are at risk from local roadways, and Chapter 10 starts the discussion of how you can make your indoor area essentially free from these threats. Detailed instructions of how to build an inexpensive but highly effective indoor air filtration system are given step by step in Appendix B.

Chapter 9

Outdoor Air Quality – My Way or the Highway

Living with heavily trafficked roadways

Introduction

My students and I had done very detailed study of pollution from Los Angeles freeways, data that caused Ronald Reagan’s Air Resources Board to try to shut me down. (Chapter 11) But with the election of Jerry Brown 1.0 as California’s governor in 1976, pretty much everybody thought that our troubles were over. Abundant data showed that only with the catalytic converter on cars could Los Angeles lower its appalling ozone impacts, which also required the removal of lead from gasoline. I also helped remove the sulfur from gasoline. California was the only state that could set standards more stringent than those of the U.S. EPA because California had initiated pollution control measures 20 years before the federal Clean Air Act was written. The stunning success that these anti-pollution measures caused many of us to assume that our problems were over, and we left for other tasks.