Minority Report on Fugitive Emissions from Asphalt Plants

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Introduction

In the mid-1990s, several groups of citizens and environmental organizations began petitioning the US EPA to quantify so-called "fugitive" emissions from bituminous concrete, or asphalt hot mix, plants. These requests were based on observations and subsequent theoretical analysis suggesting that such emissions could be significantly greater in their volume and concomitant impact on the local environment than the word "fugitive" implied. In late 1996, the EPA decided to move forward with its own testing after the asphalt industry failed to conduct their own testing in an open manner as they had promised the EPA, producing a test report[1] which was heavily criticized by academic and research scientists, public health officers, citizens, environmental activists and even from within the EPA itself. The citizen or public representatives who participated in this program ultimately included staff from public health departments in Chelsea, Massachusetts and Boston, Massachusetts, engineering/science consultants from several diverse disciplines including chemists, environmental, chemical and mechanical engineers, environmental organizations from Massachusetts, Connecticut, North Carolina and Michigan, and citizen activists from those states and from Minnesota, New York and Virginia. Additionally the Massachusetts Department of Public Health and one Massachusetts State Senator with experience in construction provided comments.

The EPA committed to providing an opportunity for citizens, along with industry and other stakeholders, i.e., other government agencies, to help frame the test protocols. This opportunity was provided through a series of conference calls and day long meetings and written communications. The interaction was hosted and coordinated by the EPA's New England Regional office, and continued through the testing, compilation of test data, analysis and production of reports. The commitment of the EPA was laudable; however, the several year long interactions were adversarial at best, with hostility or distrust between the multi-state citizen group with its technical consultants and the technical staff from EPA's Research Triangle Park (EPA-RTP). The barely contained rancor resulted in most of the conference calls and meetings being conducted with mediators from the EPA's New England Regional Alternative Dispute Resolution Program.

At the point of testing, the EPA provided opportunity (travel and lodging) for only one citizen technical advisor from the East Coast cluster of public commenters to witness the primary test which took place in California at a drum style facility, the same facility that had been previously selected by industry[1], code labeled by the EPA as "Plant C." At a secondary test in Massachusetts, at a batch style facility labeled "Plant D," three citizens were on site for the three days of testing. The primary test observer was severely handicapped because of an inability to be at more than one place simultaneously, a prohibition on citizen photography coupled with the EPA's reluctance and even refusal to take requested photographs as had been promised the citizens, and the exclusion of the citizen from certain meetings which occurred between plant personnel and EPA officers with their testing consultants who were responsible for the test. It is against this less-than-open venture in cooperation that the test and subsequent data are to be viewed. ***Why are many citizen groups concerned about asphalt plants?***

Hot Mix Asphalt plants (HMA plants) and asphalt terminals have numerous characteristics that result in a large number of the general public being exposed to their hydrocarbon and particulate emissions. This is in contrast to the general experience where workers in industrial plants are frequently exposed to higher concentrations of pollutants for longer durations than the people who live near the plant. In the case of asphalt plants, this generalization is not correct because such plants, of which there are about 3,600 within the US, are often located in urban areas close to homes, schools and playgrounds with minimal setbacks. Further, the plants operate around the clock when fulfilling certain types of contracts so that while the workers might be exposed only eight hours per day, the neighbors breathe in the fumes day and night. While the operation of an asphalt plant might be seasonal, particularly in northern latitudes, the intensity of exposure during the peak production months is quite acute.

Anecdotal information collected by Boston Health Commission's Office of Environmental Health and by others shows that some individuals exposed to asphalt plant emissions have the same or similar symptoms: asthma, nausea, headaches, skin rash, etc. This information is not sufficient to indicate whether these physiological reactions were a result of hypersensitivity and allergies or whether this was a reaction of non-allergic people to levels of hydrocarbon and fine particulates high enough to elicit a response. Available epidemiological studies have shown statistically significant links between exposure to hydrocarbons and/or metal fume and childhood leukemia[2] and between exposure to asphalt fume and a variety of cancers. Dr. Eva Hansen[3] measured excess cancers in asphalt workers in Scandinavia. These included cancers of the mouth, esophagus, lung, and rectum. Dr. Hansen also found increases in non-pulmonary cancer, liver cirrhosis, bronchitis, emphysema and asthma in asphalt workers.

As a part of the interaction with the EPA, the multi-state citizen coalition held a conference call with EPA-RTP to discuss health effects of asphalt fume and to see if they could regulate emissions from HMA plants so that the exposure of the general population would be reduced. These discussions were unsatisfactory. EPA-RTP has acknowledged that their limited resources permit the consideration of only about 50 chemicals annually, out of a field of 50,000 chemicals not yet tested. Asphalt fume, a complex emission, is comprised of over 2,000 individual chemicals. Since EPA's current approach is based on considering each chemical by itself, knowledge about the health effects of each individual chemical will not be available for many decades. Further, even after this data has been compiled, the synergistic interactions between these chemicals in a complex mixture will not be available and would require further study. EPA-RTP suggested that the citizens undertake an epidemiological study to establish a statistical link between exposure to asphalt emissions and health effects. EPA would not act to curb these emissions in the absence of such a study. For environmental pollutants like asphalt fume, neither exposure nor toxicity are acute enough to cause immediate death. The physiological response might take time (for example, cancer often takes several decades to develop even with exposure to known carcinogens like tobacco smoke) or the irritants will produce a variety of negative health responses in a general population which, while significant in terms of loss of productivity and "life, liberty and pursuit of happiness", don't cause immediate death but still have an effect on mortality and morbidity. To track asphalt plant neighbors on a national basis over a long period of time is a massive job that is totally outside the ability and resources of any citizen group[4].

The current work is the culmination of an almost 6-year effort to quantify fugitive emissions from HMA production/handling. On the one hand, EPA agreed to measure these emissions by collecting and analyzing data from two plants, labeled Plant C, a large drum plant and Plant D, a batch plant. For this we are grateful. On the other hand, the work has certain shortcomings and this Minority Report presents a discussion of these issues which have not been resolved to our satisfaction. Given the contentious and contradictory nature of the latest document "RESPONSE TO COMMENT ON DRAFT EMISSIONS ASSESSMENT REPORT, AP-42 SECTION AND AP-42 BACKGROUND REPORT"[5], a point by point rebuttal has not been attempted; instead a few select examples are presented to illustrate that these differences continue due to lack of valid response from EPA. The discussion focuses on the major questions that this work was expected to answer which unfortunately have not been answered.

It should be noted that there is a difference between the EPA and the citizens in the way they respectively approach the issue of asphalt fume emissions. The citizens approach the issue from a public health perspective. Thus their concern is with both average exposures for long term effects and also with peak, short-term exposures for acute effects; particularly since much of the anecdotal information deals with the latter. The EPA's approach, as stated in the latest response [5] is to collect data to primarily enable the estimation of emission inventories and for air quality planning, although EPA acknowledges that the information could be used in other contexts, for example, in applications to State authorities to build new plants. EPA's published data on emission factors is not just an average number for all plants when data from individual plants varies by orders of magnitude, as much of this data is collected under ideal operating conditions. For example, much of the data used for developing stack emission factors was collected just after initial plant startup often during a preoperating test period where the plant owner is demonstrating to the state regulatory authorities that the plant can operate for short periods of time at the design operating rate while staying within the permitted emission limits. In these situations, it is not unusual to have engineers from the equipment suppliers standing by to adjust and tune the equipment (as was the case at Plant C for EPA's test) to make sure that the equipment is operating optimally. Once the test is successfully completed, these engineers depart and the on-going emissions are dependent on the skills of the plant operators and their internal maintenance staff.

Of equal importance, and most critically, citizens and public health officers are inclined to consider worst case scenarios while the EPA almost consistently opted to publish data that reflects the best case scenario. Additionally, these numbers don't show measures of variability despite our request. Such measures are buried in the appendices.

Recently, the EPA has been criticized for the lack of science to back up their decision-making[6]. Specifically, National Research Council mentioned "weak scientific performance" and "weak scientific credibility". The problems uncovered by citizen reviewers in this case indicate that the current project also suffers from similar shortcomings.

Unresolved Issues

Rather than repeat the arguments, pro and con, under each topic, the highlights of the positions of the two sides will be presented in this discussion of unresolved issues with emphasis on issues that concern the citizens. Additional details, particularly of the EPA position, are in the most recent document[5]. Specific references are provided to the Section number in this "Response to Comments" report.

1. The issue of volatile content and operating temperature

If asphalt did not contain a volatile fraction, there would not be any emissions of hazardous organic chemicals from hot asphalt. Unfortunately, all asphalts contain a volatile fraction which evaporates at the operating temperature of between 275° and 375° F. Further, the emissions increase exponentially as temperature increases. The issues here are as follows:

a. Why did the industry change the specification for the maximum allowable volatile content of asphalt from 0.5% to 1.0%? What are the implications of this change?
b. How is this volatile content measured now and how was it measured in the past?
c. How is the volatile content affected by seasonal variations in oil refining practice?
d. How is the volatile content affected by the various classes of additives that are sold to improve the performance of asphalt?
e. Are the maximum operating temperatures recommended by industry groups actually followed by plant operators? If not, what are the variations in temperature and what is the consequence of these variations?

The above issues are repeated below as captions for the discussion to follow which delineates the differing positions of the citizens and EPA in bold letters:

a. Why did the industry change the specification for the maximum allowable volatile content of asphalt from 0.5% to 1.0%? What are the implications of this change?

Traditional grades of asphalt use "proxy" properties such as viscosity at 140° F for specifying and differentiating between grades of asphalt. Under such specifications, the volatile content is a "not to exceed" value, typically 0.5% for the most common grade of asphalt AC-20. Certain users might allow a relaxation of these specifications. For example, in Massachusetts, the Mass Highway Department will allow their engineer in the field to relax the requirement for Loss on Heating from 0.5% to 1.0%. One of the problems with this type of specification is that the volatiles content of different batches of asphalt meeting the same viscosity specification will vary dramatically. For example, an article published by industry researchers[7] shows that the volatiles content of two different batches of AC-20 varied from 0.053% to 0.5%, a variation of one order of magnitude. This means that the emissions of asphalt fume would have also varied by an order of magnitude. Second, the "not to exceed" value for volatiles content is "based on original asphalt", i.e., before any blending. In other words, these specifications apply to the material that is shipped from a refinery, not necessarily to material that is shipped from a terminal to a hot mix plant. At a terminal, the terminal operator will add various diluents for altering viscosity. The potential effect of these diluents is discussed later in section d.

The old system of viscosity specification is being replaced by a new specification called "Superpave"which is based on measuring the properties of hot mix under simulated service conditions. This standard was jointly developed in concurrence with many parties including the government. However, the newer Superpave specification increases the permissible volatiles content to "not to exceed 1.0%".

Our concern is that the specification was changed by industry in order to make it easy and feasible for the industry to meet it under widely varying production conditions; otherwise, it would have remained at 0.5%. This means that the emissions from certain plants at certain times of the year, will be quite a bit higher than what is now shown in these reports. This increase is quantified in Table 1 later in this report. EPA's position is that this change is not relevant, and that anyone can use the volatility value they want in the equations presented. EPA also believes that the average volatility content of asphalts is less than 0.5% based on a set of samples analyzed in 1993 as a part of the SHRP program. (3.2.2) We strongly disagree that the range of volatility values measured in the SHRP program in 1993 is the relevant range for asphalts in use today after blending. Further, EPA arrives at conclusions about volatility of asphalts used around the country based on the SHRP data. This extrapolation would be correct only if equal quantities of each of the various asphalts in the database were sold each year in the US. There is absolutely no information to support that key assumption.

b. *How is this volatile content measured now and how was it measured in the past?*

The volatiles content of asphalt has traditionally been measured by the Thin Film Oven Test (TFOT), but the industry is moving to a slightly different test, the Rolling Thin Film Oven Test (RTFOT). We understand that a major reason for this change is because the results of the Rolling Thin Film Oven Test are more predictable, i.e., the method produces results with less systematic and random error.

There are two problems with either of these tests. First, both tests measure loss in weight on heating, which is not the same as measuring the volatiles content, particularly since some asphalt samples will gain weight as a result a pickup of oxygen and nitrogen. Nevertheless, because these tests are performed routinely, it is the only available data source for estimating the volatile content of original asphalt. Second, the loss of weight number obtained from the Thin Film Oven Test is lower than the loss of weight measured by the Rolling Thin Film Oven Test. However, the limited data, published by PES in the Plant C test report Appendix B.8, indicates that this difference is 0.16% at 325^{o} F. (For example, if the TFOT measured loss of weight as 0.3% and RTFOT measured the loss of weight as 0.46%, the difference would be 0.16%). When this difference was measured at two other temperatures, it was found to be less than 0.1%.

Thus, EPA's other explanation (3.2.2) that the volatiles specification was increased from

0.5% to 1% because of a change in the testing procedure from the Thin Film Oven Test to the Rolling Thin Film Oven Test is not supported by data. The citizens don't agree that a change of less than 0.16% should cause a relaxation of the specification by 0.5%, a value three times the measured change.

c. *How is the volatile content affected by seasonal variations in oil refining practice?*

Refinery operations change seasonally. For example, summer runs are designed to maximize gasoline production while winter runs decrease gasoline production and maximize fuel oil production. Seasonal variations in refining operations should affect the volatiles content of asphalt.

The citizens are concerned that no data is available on this subject. Similar concerns were raised by the Mass Department of Public Health. Such data might provide further insight why the specification was changed and might provide a better understanding of exposure suffered by neighbors of such plants.

d. *How is the volatile content affected by the various classes of additives that are sold to improve the performance of asphalt?*

In recent years, the industry has produced dozens of proprietary diluents and modifiers for the purpose of blending and for improving asphalt properties. These additives fall into different modifier families including the following: fibers, fillers, plastic/rubber, rejuvenating oils, antistripping agents, extenders and antioxidants. A partial list includes hydrolene (Sun Chemicals), Kraton polymers (Shell Chemicals), Elvaloy (Du Pont) and so on. The fibers and fillers are not expected to change the volatility but all others, which interact chemically with asphalt constituents, should alter the volatility of the asphalt, based on engineering principles. These substances are added in significant amounts: one or several percent by weight of the asphalt. In other words, the recommended amount of additive exceeds the percentage of the volatile component. Not only are these additives light compounds, but they can also alter the vapor pressure of the asphalt by increasing the volatility of some of the lighter components which otherwise might not have volatilized in the temperature range of 275 to 375^{o} F.

The citizens are concerned that the measurement of loss of heating of the original asphalt can bear little relation to the emissions from the asphalt that is actually used to prepare a hot mix. EPA's position is that this is not a significant issue. The two tests at Plant C and Plant D did not use any additives so there is no available data.

e. *Are the maximum operating temperatures recommended by industry groups actually followed by plant operators? If not, what are the variations in temperature and what is the consequence of these variations?*

The second factor that increases asphalt fume emissions is operating temperature. As such, emissions increase exponentially with temperature. State Highway Departments will specify a minimum and a maximum temperature for HMA when delivered to the job site where the pavement is being installed. In Massachusetts, this range is 275° to 325° F. Note that the actual temperature of the asphalt leaving the plant and being loaded into a truck is higher. The temperature has to be higher in order to compensate for cooling during transportation to the job site and this issue becomes critical when delivering to a distant job site. Also, note that there is no such restriction when delivering HMA for non- state supervised jobs. Also, according to an engineer who was the general manager of an asphalt plant and a plant designer internationally, who attended many of the planning meetings, many small private contractors who drive small trucks will demand a higher temperature at loadout since a smaller mass of HMA will cool faster.

There are also other factors that will increase emissions. For example, when a plant switches from one HMA mix formula to another, emissions will increase. The best example of this is when a plant making hot mix with Recycled Asphalt Pavement (RAP) switches to a formula without RAP. In the first instance, the plant would have operated at a higher temperature to provide the extra heat to evaporate the water associated with RAP since the RAP is stored in the open and not dried. When the change occurs to a formulation without RAP, the plant loadout will emit a higher level of organics because of overheating. This is a frequent problem at batch plants though this type of problem is not restricted to only batch plants. (Examples of this type of excursion exist in the data collected at Plant C, a drum mix plant where emissions increased by a factor of two to three over a 40 minute period[8].) This again means that the episodes of high emissions caused by variations such as high temperatures are missed by the total reliance on averages of data collected under ideal conditions, even though the high emissions on the day of the test did affect the average.

The citizens, based on personal observations, believe that such periods of high emissions are frequent, especially at batch plants. Further, the public health impacts of these emissions are more significant since batch plants are more numerous than drum plants, located closer to homes and service the small independents who are more likely to demand hotter asphalt. The Table below, Table 1, is based on equations published by EPA relating volatiles content and production temperature to various emissions. (Please refer to the Emissions Assessment Report[9], Table 1 on page 6 and Table 11.1-14 on page 11.1-31 in appendix A.) Table 1 on page 9 of this report shows the differences between EPA's numbers and ours on the basis of assuming 1% volatile content and an operating/loadout temperature of 375° F.

It can be seen that the emissions calculated by using EPA-derived equations, particularly emissions of noxious organic compounds, increase by more than 600% under conditions of higher operating temperature and volatility content. Both the EPA and the Citizen numbers would be increased by another 20 to 40% to compensate for the low bias introduced by the "background correction" and "Method 204", discussed later in this report. Finally, it should be noted that although the numbers in Table 1 are shown on an annual basis to help compare them to Table 1 in the Executive Summary of the Emission Assessment Report, the citizens are aware that actual annual emissions will be lower since a plant will not always operate with an asphalt with a high volatiles content at high temperatures. On the other hand, the table clearly shows the type of variation in emissions that is likely to occur under such conditions with its effects on nearby residents.

2. **Issues relating to how the data was collected and analyzed**

This process of planning, data collection and analysis has involved many discussions, agreements and disagreements.

The citizens are concerned that with time, EPA's responses have become more rigid, inconsistent and not based on data (or the lack thereof) in the reports. Only a few of the key issues are mentioned below. Others are found in the previous comments by the citizens to various draft reports by EPA[8, 10].

Table 1: Effect of Different Volatile Contents and Operating Temperatures on emissions

	<Batc h	**plant data>**	**<Drum**	**plant data>**
	EPA[a]	**Citizens[b]**	**EPA[c]**	**Citizens[d]**
Loadout emissions[e]				
- Total Particulate Matter	52	257	104	515
- Organic Particulate Matter	34	239	68	478
- Total Organic Compounds (Method 25A)	416	2,918	832	5,836
- Carbon Monoxide	135	947	270	1,893
Silo filling emissions[f]				
- Total Particulate Matter	59	211	117	423
- Organic Particulate Matter	25	178	51	356
- Total Organic Compounds (Method 25A)	1,219	8,550	2,437	17,100
- Carbon Monoxide	118	828	236	1,656

a. EPA estimates for batch plant in lb/100,000 tons of HMA. Volatility of 0.5%, 325° F.
b. Citizen estimates for batch plant in lb/100,000 tons of HMA. Volatility of 1.0%, 375° F.
c. EPA estimates for drum plant in lb/200,000 tons of HMA. Volatility of 0.5%, 325° F.
d. Citizen estimates for drum plant in lb/200,000 tons of HMA. Volatility of 1.0%, 375° F.
e. Loadout emissions for both batch and drum plants - See Table 11.1-14. AP-42.
f. Loadout emissions for plants with silo storage- mainly, but not exclusively, drum plants. See Table 11.1-14. AP-42.

a. *The issue of the "Background" correction*

Many of the methodological problems which occurred throughout this program are crystallized under EPA's topic of the "background correction". Background correction at Plant C refers to EPA's attempts to separately measure loadout emissions mixed with truck exhaust and just truck exhaust in order to subtract the truck exhaust values from the former to obtain a "pure" value for loadout emissions. But, the equipment for collecting the emissions in the tunnel at Plant C was not 100% efficient. Under such conditions of inefficient collection, the standard engineering practice is to use a tracer gas to measure the collection efficiency and then correct the raw emission data for this inefficiency of capture to arrive at a more appropriate estimate of the actual emissions. (Whether a single average collection efficiency factor should be used for adjusting all three runs or whether more time- specific collection efficiency factors should be used has been discussed extensively in previous comments[8] by the citizens. Also, the math works out such that if the truck exhaust value is high, the net value for the "pure" loadout emissions will be low.)

EPA conducted such a "background" run to measure just truck emissions. However, the data collected during the run had so many problems that EPA abandoned standard data reduction procedures to obtain an answer that they liked. There are three problems: First, the raw data shows a doubling in the background emissions from the first half to the second half of the run. What caused this doubling? Second, even if one uses the background data from the low first half of the run, the numbers are still too high. What is the cause of this result? Third, why did EPA abandon the standard engineering procedure for correcting measured emissions for capture efficiency? These various problems with this background run are discussed below:

i. <u>Inconsistent raw data:</u> The raw data, i.e., data as recorded, and not corrected for capture efficiency, shows two very distinct regimes in the run, with a break in between. The first regime is flat with little fluctuation and shows an average reading of 0.8 ppm of total hydrocarbons (THC). The second regime, which is also relatively flat, shows a value about twice this level. The first issue is what caused this doubling of measured emissions. EPA was unable to provide a credible explanation. The citizens believed that this increase was achieved by parking a second truck at the entrance to the tunnel so that the second regime was based on measuring emissions from two trucks. In the final RESPONSE TO COMMENTS report[5], EPA used only the first portion of the background run, hoping to avoid this inference that the background numbers were inflated. However, the second truck was at the entrance even in the first portion of the run, though for shorter time periods. Thus, as shown below, it is not clear that the lower values measured in the first regime represent exhaust from just one truck.

ii. <u>Is the background reading from the first half of the run low enough?:</u> By selecting only the data from the first half of the run and by not averaging the two regimes, it would appear that EPA has avoided problems with data reduction. Unfortunately, this is not the case.

iii. <u>Problems with data corrected for capture efficiency:</u> Standard protocol requires that when collection is not 100% efficient, the raw data has to be corrected for capture efficiency. Capture efficiency is measured with a tracer gas. Unfortunately, when correction is applied to the background data from the first half of the background run and subtracted from the combined loadout plus truck emissions to get "pure" loadout emissions, one gets negative values for several hazardous air pollutants. Since this is an impossible result, EPA decided to use the raw uncorrected background number rather than the capture-efficiency-corrected background number. Even after adopting this unusual procedure, some "pure" loadout emissions were still negative and they were assumed to be zero. There is a major problem with this procedure. There is no technical/ scientific justification for ignoring capture efficiency. The only justification is that it produces numbers acceptable to EPA. The citizens suggested that the background "correction" be eliminated and the loadout emissions data reported as "truck plus loadout emissions". This suggestion was summarily rejected. We reproduce the first paragraph of EPA's summary rejection (3.2.2):

"The background adjustment was appropriate. There was no improper manipulation of the data from the background test at Plant C and EPA did not manipulate the placement of the trucks to obtain higher uncorrected emissions for the background run. Further, we do not agree that the background run demonstrates that data was manipulated to produce biased results and do not believe that concurrently measured truck exhaust and road dust emissions should be included in the emission factor for load-out emissions."

EPA states further that:

"The only additional instruction provided to the truck drivers during the background test was to reduce the time of their travel from the exit of the tunnel to the arrival at the tunnel entrance.......At about the time trucks began driving faster to reduce gaps between trucks, the wind speed increased. This may have caused an increase in the diesel exhaust that entered the tunnel entrance or increased the capture of the diesel exhaust of the truck that was inside the tunnel." (Emphasis added.)

The problem with these explanations is that the raw data clearly shows that the reading doubled in the second half of the run. This doubling needs to be explained. Above, EPA is admitting that there may have been an increase in diesel exhaust entering the tunnel entrance, i.e., exhaust from two trucks was being counted, but this possible explanation is two paragraphs after the original denial. Also, note the statement, *"Dr. Nadkarni* [the citizen observer at the Plant C tests] *observed the operation of the trucks during the background run. The issue of manipulating the placement of the trucks was not raised by him during the test to either of the EPA personnel present."* This statement is incorrect. On the day of the run, he left early to catch a plane and was not present when the second half of the data was collected. Further, problems of this type are visible only after the data has been collected and viewed. Such insights are impossible in the field. Dr. Nadkarni had objected originally to the background "correction" because it seemed to be an unnecessary manipulation of data and the results. In retrospect, his concerns were well founded.

The explanations of why the background reading was not corrected for capture efficiency, in 3.3.4, are mutually contradictory. The tracers used to measure capture efficiency showed that capture efficiency was high early in the morning and decreased as the day wore on during all the runs at Plant C. The most reasonable explanation was that as the land around the plant heated up, there was an on-shore breeze which blew through the tunnel and decreased the capture efficiency. The capture efficiency data for the background run is consistent with this general statement. This also means that truck emissions captured in the second half of the background run, when corrected for capture efficiency, were three times those in the first half. This further confuses the issue. To the citizens, these problems raise serious questions about both the first and second half of the run. The general scientific procedure when data can't be explained is to reject it.

Finally, it should also be noted that the auditors from RTI were apparently not involved in a detailed analysis of this procedure of collecting "background" data.

This background correction introduces a low-bias in the published results for load out emissions. EPA's estimate of this bias introduced by not correcting for capture is about 20%. Both EPA and citizens' numbers in Table 1 would have to be increased by this amount to compensate for this unexplainable "background" factor. The citizens believe that the entire procedure is faulty and should be rejected.

<u>*b.*</u> <u>*Problems with enclosures*</u>

At Plant C, because the loadout enclosure did not meet the requirements of Method 204, an EPA protocol for constructing total enclosures for measuring pollutant emissions, a tracer gas was used to measure the capture efficiency. At Plant D, because the specially constructed loadout enclosure met the requirements of Method 204, it was assumed that all the emissions would be "captured". Method 204 gives precise design requirements which put limits on the size of Natural Draft Openings compared to the surface area of the walls, floor and ceiling of the enclosure with the desired ratio being less than 5%, the velocity at Natural Draft Openings to be at least 200 ft per minute and other limitations on the distance between the opening and the emission source. In essence, under Method 204, an induced draft fan collects the fumes from inside the enclosure and delivers them to the instrumentation at the sampling point. By controlling the openings (Natural Draft Openings) to a specific size, the intent is to force outside air into the enclosure, avoiding any loss of the material being sampled. As the data shows[8, 10], complying with these requirements still does not result in proper sampling of fumes inside this enclosure. This point is illustrated by the following situation.

i. The loadout enclosure is empty. The instrumentation measuring hydrocarbons is showing zero hydrocarbons since the fan is pulling in just air from the empty enclosure. (See paragraph vi below.)

ii. A truck stops under the loadout point. Hot mix asphalt is dumped into the truck from a silo (a single dump) or from a batch mixer (several dumps with a waiting period in between). During this period, the air and asphalt fume in the enclosure are pulled past the hydrocarbon measuring instrumentation by a fan.

iii. The truck loadout is complete, but the instrumentation continues to indicate and record hydrocarbon emissions from the hot mix sitting in the truck

iv. The truck leaves the enclosure. One should expect the fan to evacuate all of the fume from inside the enclosure and for the hydrocarbon reading to go to zero quickly. But this does not happen. As a matter of fact, the readings persist at a non-zero value for a long period of time showing that Method 204 does not do a good job of delivering hydrocarbons from inside the enclosure to the measuring point. In other words, since the emissions lingering in the enclosure are not delivered to the instrumentation for measurement, they are not "captured".

v. The truck will continue to emit hydrocarbons in the yard of the manufacturing plant. These are not captured by the sampling system attached to the enclosure. In the report, these have been estimated as the so-called "yard emissions".

vi. The next truck enters the enclosure. If the enclosure was doing the proper job, it would have shown an initial reading of zero, as mentioned above under i. However, this is rarely the case since these emissions linger in the enclosure.

Criticism of Method 204 was provided to the EPA before the Plant D tests but was ignored. One of the problems with Method 204 was illustrated during the first day of testing at Plant D. Method 204 requires that the inward velocity at any opening be maintained over 200 feet per minute (fpm) so that air is flowing into the enclosure and not out of the enclosure. Note that 200 fpm is less than 2.3 miles per hour, which is not much of a breeze. At Plant D, the citizens observed that some of the fumes were escaping from the top or the bottom openings in the downwind door of the tunnel because of an ambient breeze. The contractors corrected this by decreasing the size of the openings by about half at the end of the first day of testing. Once this was done, this upset condition did not occur again. EPA's recollection of this event is quite different. (3.1.2).

In spite of these deficiencies, EPA position was:

"As the analysis is an extrapolation of only two data runs and the enclosure was designed to Method 204 criteria, EPA believed that the actual uncaptured emissions are most likely smaller than estimated by our analysis. Therefore, no further adjustments were made to the loadout emissions from Plant D." (3.1.2)

This is a confusing argument. The citizens position is that EPA again biased the results by this action. EPA's estimate of this bias is of the order of 10% and this adjustment would have to be used to adjust the EPA and citizen numbers in Table 1, but this adjustment could easily be double this value, i.e. 20%, in our opinion.

c. *EPA's flat denial of errors in the report*

In the Introductory Section of our last response[10], reproduced in the current report as 1.1.1, we commented that we were dissatisfied with the report review process because EPA released draft reports that were not sufficiently finalized. We specifically referred to the following problems; incorrect references, missing and incorrectly referenced appendices and numerical and logical errors in the analysis. We were referring to the entire review process, not just the current cycle. Also, our point was that EPA should produce draft reports that are free from error and the review process should not become a search for a needle in a haystack if a large document is referred to without providing a page number. Further, once the responsibility for finding each mistake is entirely passed to the reviewers who are volunteering their time for the review, such mistakes will persist in the final report as such volunteer reviewers miss them. In their current response to comments[5], EPA responded on page 1:

> *"The comment with respect to numerical and calculational errors is unsubstantiated in that no instances of any numerical or calculational errors were provided by the commentors."*

This comment is not accurate. In the previous round of comments[8], such numerical and calculational errors were shown. These included averaging data over a period when there were no emissions because trucks were absent, and showing a wrong number as a maximum value. These mistakes were not caught by EPA'S auditor Research Triangle Institute (RTI). Although chances are that RTI's contract focused on data collection procedures and did not include an auditing of data reduction and data analysis, their role is being exaggerated in the final report. At industry's urging, EPA is including the following statement in the Final Report. "*For example, two scientific auditors from the Research Triangle Institute were employed to independently audit the test and reporting process.*" (1.4.38). If RTI is to be given credit for the audit process, they should also be assigned blame for its failures.

EPA did admit to problems with references and appendices but stated that the missing appendices were provided on October 6 (1.1.2) or October 3 (1.4.54). They fail to mention that this was over a month after the end of the comment period.

At Plant D, two citizen observers noted what appeared to be errors in protocol for sampling. Specifically, when the sampling train was rinsed to recover condensed organic matter, the observers saw that the entire tube was not being rinsed. When this issue was mentioned, EPA's denial was immediate and strong, even before the citizens had explained their observations.

Numerous logical errors and examples of bias were pointed in comment letters[8, 10], To this, EPA's response is, *"The information presented in the reports as drafted are (sic) unbiased."* (1.2.6). An example of an "unbiased" statement, we suppose, is the following from 2.4.6: *"The lack of data to substantiate the statement is not a reason to eliminate the statement".*

d. Unfounded Leaps of Faith

In 3.7.2, while criticizing the use of model compounds by others at a time when no data on the composition of asphalt fume was available[11], EPA defends its own use of model compounds when such data on composition of asphalt fume is available. Furthermore, this data clearly shows that the two substances selected by EPA as model compounds, docosane and tricosane, are not the major measured constituents of asphalt fume. Standard scientific practice would be to use the best information available for this purpose. When data is available on the major constituents of asphalt fume, EPA chose these two compounds purely for expediency when data shows otherwise. EPA states, *"The Antoine's coefficients for aliphatic hydrocarbons that come the closest to producing a working loss emission estimate of 32 pounds per million gallons of asphalt throughput for this approximate molecular weight are docosane and tricosane."* In other words, these compounds are chosen because they give the desired result.

A similar contradiction exists in 3.7.6. Here EPA admitted that reference 360 in Appendix B, a report of certain tests by Division of Air Quality, North Carolina Department of Environment and Natural Resources, 1998, was not evaluated critically but then EPA ignored the comments offered by the citizens. These comments had pointed out that the authors of the reference had selectively ignored high readings of ambient benzene concentrations and used only the low readings. Further, they had used questionable methodology to convert an ambient concentration to an emission rate. Nevertheless, EPA decided to retain this defective information in the final report stating: *"The reference was not read critically............... the results that were developed for truck load-out (*in this reference*) do provide limited support for the load-out emission estimates for benzene."* In other words, EPA will continue to use this faulty information because it, purely by accident, appears to provide limited support to an EPA-derived number.

e. Problems with witnessing tests

The citizens were permitted to witness the actual tests at Plant C and Plant D. One individual, Dr. Nadkarni, was allowed to be present at Plant C and up to 3 individuals, were allowed at Plant D. While there can be justifiable concerns about visitor safety and owner liability when visitors are allowed to wander unfettered around an operating industrial plant, the usefulness and limitations of allowing a single witness need to be discussed.

The first issue is what a single witness can see when data is being gathered using complex instruments or complex sampling trains in various places simultaneously. Second, when access is also prevented under the claim of confidentiality, much information is shielded from citizen observers and discrepancies are seen by the citizen observers only after the data has been published in a draft report. (See references 8 and 10 for details on the questions raised about the data.) In an industry where the manufacturing equipment is available from several competing firms who will provide all the necessary details in order to sell this equipment, and the product is produced to published customer specifications, our view is that there IS little proprietary content. If plant operating procedures are proprietary, they would be of interest only to another HMA manufacturer and access to these details would be obtained, as in other industries, by hiring away a plant operator. Yet, access to information was blocked on many occasions under the cloak of confidentiality. Following are specific incidents where there were differences between the observations by the citizen observer and the EPA.

i. Emissions from the downwind end of the tunnel: In the discussions leading up to the actual testing at Plant C, EPA asserted several times that they had not observed any fugitive emissions exiting the tunnel at Plant C. However, they agreed to use tracers to measure capture efficiency. When Dr. Nadkarni arrived at Plant C on the day before the first test, he was surprised to see visible emissions exiting from the tunnel. (Such emissions were seen during each day of the test, typically later in the day when the ambient breeze became stronger.) Several times when this phenomenon was pointed out to EPA staff, they ascribed these emissions to a plant malfunction. Since citizens could not take photographs but EPA could, he requested that this fume be photographed and several times his request to document this photographically was turned down because the fumes might not be visible in a photo. When the draft report was published, the capture efficiency numbers corroborated this observation that fume was escaping from the downwind side of the tunnel, contrary to EPA assertions during planning, but there is little photographic evidence. Yet, at Plant C, the EPA Project Director spent almost an entire day with a videographer hired by the industry association consulting him on what to videotape.

In case of Plant D, no tracers were employed because the specially constructed enclosure was presumed to meet Method 204 requirements. The shortcomings of method 204 were obvious to the citizen observers on the first day of testing. Two citizen observers noted that the streamers at the Natural Draft Openings on the downwind side (above and below the door) were pointing towards the outside showing that a breeze was counteracting the draft induced by the fan. Again, there is no photographic evidence. While this problem was corrected for days 2 and 3 by installing plywood to reduce the size of the openings by half, EPA claims that this observation was not communicated to them until much later. (See 3.1.2) Similarly, the citizens observed that the fume lingered for a long time inside the enclosure at Plant D and was not transferred to the measurement point, as was discussed earlier in Section 1.b. Again, the citizens could not document this because of the restriction against photography.

ii. Lack of information sharing and access to instrumentation: At Plant C, the control room was cleared of all observers several times. Therefore it was not possible to take actual readings to double check the readings taken by EPA contractors. (This is not to cast any aspersions on the contractors who took these readings. Our point is that it was not possible to double check these readings). EPA had information on the volatile content of asphalt prior to and during testing at both plants. This information was not shared until much later.

iii. Prejudging of final outcome: On the day before the start of testing at Plant C, the industry hosted a dinner attended by the senior EPA staff member and the citizen observer. The citizen observer was quite surprised when the industry was told by the EPA staff member that EPA had no intention of regulating fugitive emissions from their industry.

Conclusion

Citizens, industry and EPA-RTP have undergone a lengthy process during the last six years to examine fugitive emissions from asphalt plants. This process suggests that there are lessons to be learned regarding a number of aspects of this exercise.

1. An epidemiological study should be undertaken by the government to better understand the quantity and intensity of health problems caused by exposure to asphalt fume. In our very limited casual interaction with individuals across the country, we have had too many anecdotal histories come to our attention to ignore this public health problem. These histories include the deaths of otherwise healthy farm animals barned within several hundred yards of an asphalt plant in the northeast section of the country, rashes and difficulty breathing by humans all across the country, each living in close proximity to one of these facilities, and cancer clusters in proximity to asphalt storage tanks at terminals. It is hard to believe that each of these instances is due solely to uncaring plant operators lacking concern for the impact of their business on the surrounding neighborhood. Even if the cause is determined to be hypersensitivity by individuals to certain chemicals, this is an issue that should not be faced by each individual citizen as his or her "problem" but rather is a responsibility for society as a whole, as well as for the industry.

2. A number of the EPA's regional offices have extensive experience in working through environmental concerns in concert with citizens rather than in opposition to the public. Some of the citizens who are working with this problem of asphalt fume have heretofore had productive relations with their regional offices of EPA on other industrial concerns. It may be that EPA-RTP has not had reason to develop protocols for interaction with the public, possibly because more of its business is conducted with industrial representatives. Nevertheless, it may be appropriate that EPA-RTP review its approach to citizens to find ways of encouraging that dialogue with an emphasis on cooperation and mutual respect. It is important that the public understands that it IS no less a partner with government at every level than is industry.

3. Industry and state environmental departments place great reliance on AP-42 emissions factors during the process of local permitting. However, AP-42 contains averaged data collected under the best of circumstances and is a poor source to determine "worst case" environmental impact scenarios. Many of the factors representing these worst cases are not as clearly represented in that document as it could be. To avoid misuse, simple changes in the layout could be accomplished such that where appropriate, the limitations of factors are made more evident, without recourse to the introductory language of this lengthy government publication. Even a standard "warning" or notice attached to each table could begin to highlight this complexity.

4. Industrial proprietary information varies from industry to industry. While some industries' competition may involve truly cutting edge technology, methodology and technique, other industries' competition is based on non-technical non-proprietary factors such as location and market power. Restrictions on oversight by the public during EPA financed tests as were conducted may be appropriate in one instance, and in other instances may more reflect an attempt by industry to hinder open and frank discourse. We believe that Government should aggressively challenge, where appropriate, unsubstantiated demands for secrecy by industry which ultimately reflect negatively on both that industry and on the government.

5. Henry Nowick, Nowick Environmental Associates, Springfield MA

1. "Emissions Testing: July 9 - 11, 1996" AIRx Testing, Ventura Ca - Job # 1030.

2. E.G. Knox & E.A. Gilman, "**Hazard proximities of childhood cancers in Great Britain from 1953 -80**", *Journal of Epidemiology and Community Health*, 1997, **51**, 151-159.

3. Hansen ES, "**Cancer incidence in an occupational cohort exposed to bitumen fumes**". Scand J Work Environ Health 1989;**15**:101-5. Hansen ES. "**Mortality of mastic asphalt workers**". Scand J Work Environ Health 1991;**17**:20-4; Hansen ES, "**Author's reply**", **Scand. J. Work Environ. Health**,18: 135-41, (1992).

4. There are probably political reasons for this reluctance. After all, the asphalt industry is at the confluence of several large, powerful and politically active industries with a long reach into Washington DC. These include the oil industry who produces the asphalt during the refining of petroleum, the sand and gravel business which produces aggregate, the other component of hot mix, the highway lobby and the State Departments of Transportation or Highways who have a symbiotic relationship with the hot mix asphalt industry as the major customer for the product. The article by Sarah Gibson ("How OSHA Dealt with Asphalt Fume", New Solutions, 5- 1, 24 - 47, Fall 1994.) is essential reading for any one interested in learning how the industry dictated the final OSHA standards for occupational exposure to asphalt fume. The industry also conducted a vehement, coordinated attack on Dr. Hansen, the epidemiologist who has shown a significant relationship between exposure to asphalt fume and various cancers, at an ACGIH Satellite Meeting on "Developing Occupational Exposure Values from Toxicology and Epidemiology Studies" on March 6, 1998 in Seattle. Her use of statistics was vehemently challenged by a statistician as a part of an industry presentation by an employee of Ashland Oil. The industry also paid to bring other attackers to the meeting including an employee of a Scandinavian industry trade group and another Scandinavian researcher whose results are somewhat different from Dr. Hansen's.

6. "**Strengthening Science at the U.S. Environmental Protection Agency: Research Management and Peer Review Practices (2000)**", National Research Council, National Academy Press. http://www.nap.edu/openbook/030971275/html/

7. V.P. Puzinauskas & L.W. Corbett, of the Asphalt Institute, "**Report on Emissions from Asphalt Hot Mixes**", Paper presented at ACS Meeting, Chicago IL, August 1975.

8. Ravi Nadkarni, Comments on EPA Reports on Asphalt Fume Measurements, September 15, 1999.

9. "Hot Mix Asphalt Plants - Emissions Assessment Report" with Appendices A, B & C. EPA-454/R-00-019, December 2000.

10. Ravi Nadkarni & Lloyd Fillion, Comments on EPA reports relating to AP-42 Section 11.1, August 31, 2000

11. R. Nadkarni, written communication to Chief, Emission Factor and Methodologies Section, USEPA-RTP, November 7, 1994; R. Nadkarni, written communication to Mr. Ron Ryan of EPA of October 26, 1995 and November 16, 1995; and R. Nadkarni, written communication to Mr. David Mobley of July 5, 1996.