STATE OF NEW MEXICO
ENVIRONMENTAL IMPROVEMENT BOARD

IN THE MATTER OF THE APPEAL PETITION FOR HEARING ON AIR QUALITY PERMIT NO. 8585. **No. EIB 21-48**

Earth Care New Mexico
By Miguel Acosta Munoz, Co-Director
and Linda Marianiello, as an individual;
Petitioners.
v.

New Mexico Environment Department

v.

Associated Asphalt and Materials, LLC
Applicant.

Written Report of Dr. Ranajit (Ron) Sahu

I. Biographical Material

A copy of my resume is provided in Attachment A to this report. Briefly, I am a Mechanical Engineer with over 30 years of experience in engineering, energy, and environmental consulting, including over 30 years in consulting on all aspects of air quality in the US and abroad. In that time my clients have included a wide range of private industrial entities, non-governmental and public interest groups, as well as various state government entities, the US EPA and the US Department of Justice. I have provided both consulting and testifying expertise to the EPA and DoJ. My resume in Attachment A contains a list of my expert witness experience.

II. Scope

In this report, I have been asked to address two aspects pertaining to the current matter of permitting of the AAM asphalt manufacturing facility. In the interest of brevity, I am not providing introductory material which is readily available in the record.

The two areas are:

(1) the incorrect and misplaced reliance by the Applicant and the Department on EPA's AP-42 Compilation of Emission Factors. The Applicant used these factors in estimating almost all of the emissions of air pollutants that will be generated from the various identified sources at the permitted AAM facility, resulting in grossly unreliable and vastly underestimated emissions

ascribed to this facility's operations; This is important because the estimated emissions from operations and activities are a critical input into the dispersion modeling air quality analysis which has been used in this permitting matter to make conclusions about AAM's air quality impacts and whether or not these impacts are likely to be in compliance with applicable standards including National Ambient Air Quality Standards (NAAQS). As a result of the unreliability and undoubtedly underestimated emissions, all of the subsequent conclusions regarding this source's ambient air impacts are also incorrect.

(ii) confusion relating to how the Department defines and considers what is "ambient air" in the analysis as both a conceptual and a practical matter. This is important because it could result in the Department inappropriately ignoring NAAQS exceedances resulting from the AAM operation.

III Summary of Opinions

For the reasons that I discuss in the report, it is my opinion, based on over 30+ years of experience in air quality matters and to a very high degree of confidence that:

(i) The calculations made by the Applicant to estimate the emissions and approved by the Department, including the maximum or potential to emit emissions as used in the analysis in this matter, rely substantially on the use of EPA's AP-42 compilation of emission factors;

(ii) The use of AP-42 factors in the present instance was improper for multiple reasons including the express unsuitability for calculating such emissions given the inaccuracy of the factors, as reflected in the poor ratings of almost all of the emission factors used, and the fact that the AAM facility is already in existence, meaning the actual emissions of the facility, as it operates in real time, are readily available;
(iii) The accuracy of the emissions estimate is an especially important consideration in the present instance given the lack of any margin between the predicted emissions estimates and the compliance with certain NAAQS. Thus, all conclusions about compliance with the NAAQS, as asserted by NMED, are simply unsupported and, more than likely, completely wrong.
(iv) The Department's definition of ambient air as it has been used in addressing the modeled impacts of the permitted source outside its property fence line is confusing at best; and
(ii) The record simply does not provide adequate explanation or detail regarding how the Department's described "ambient air" adjustment(s) may have been made in order to arrive at final modeled impacts from AAM, making it unlikely the Department can adequately predict the impacts of AAM's expected emissions.

Based on the above and based on the criticality of the emissions input into the analyses, it is my opinion that the results and conclusions of the modeling analysis conducted in this matter should be set aside and no weight should be given to them.

IV. Inappropriate Use of AP-42 Emission Factors.

IV.1 Importance of Emissions Calculations

Although it should be obvious, I begin by noting the importance of accurate emission calculations in the permitting analysis for this matter simply by pointing to the NMED's own statements on this topic:

(i) As part of its publicly available FAQs, the NMED responds as follows to the following question:

"How does the Air Quality Bureau ensure the health of citizens is protected from the proposed impacts on the ambient air from a facility?

> [Response:] The Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED) have established health-based ambient air quality standards for pollutants. These health-based standards take into account our most sensitive populations, such as children and the elderly. Emissions calculations and computer-based ambient air modeling analyses are used to determine if a facility will meet or exceed these standards. A facility is required to demonstrate through modeling that it will meet all state and federal ambient standards before the Department will issue an air quality permit. If the permit is issued, it will contain conditions to ensure that the facility will operate as represented by the company in the application and in compliance with all applicable state and federal regulations and ambient air quality standards."[1] (emphasis added)

(ii) Similarly, the NMED responds to another question about the status of the permit in this matter as follows:

"Has the State of NM basically already approved the air quality permit for AAM's Santa Fe Facility?

> [Response:] The AQB is completing a technical review of this application. The facility, as represented in the application, demonstrates compliance with all federal and state regulations. The facility's operations, as represented in this application, do not cause nor significantly contribute to any exceedances of applicable air quality standards. These results are based on the modeling analysis and emissions calculations for asphalt fumes, Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Particulate Matter 10 micrometers or less in aerodynamic diameter (PM10), Particulate Matter (2.5 microns or less) (PM2.5), and Sulfur Dioxide (SO2)."[2] (emphasis added)

[1] NMED 002636, 002658
[2] NMED 002639

Thus, based on both responses, it is clear that not only are correct emissions calculations vital to ensuring that the AAM facility complies with applicable air quality standards and that the health of neighboring communities is protected, but also that NMED recognizes how important compliance modeling is..

IV.2 Summary of NMED's Predicted Impacts

The table below summarizes the predicted impacts of various criteria pollutants from the project ("Facility Concentration") as well as Total Modeled Concentration, Background Concentration, Cumulative Concentration, and a comparison of these concentrations with various standards including Federal NAAQS, New Mexico NAAQS, the Significant Impact Level (as used in New Source Review/Prevention of Significant Deterioration), as applicable.

Pollutant	Period	Facility Concentration (µg/m3)	Total Modeled Concentration (µg/m3)	Total Modeled Concentration (PPM)	Background Concentration	Cumulative Concentration	Standard	Value of Standard	Units of Standard, Background, and Total	Percent of Standard
Asphalt Fumes	8 Hour	25.5	25.5	---	---	---	20.2.72.502	50	µg/m^3	51.0
NOx	1 Hour	59.7	59.7	---	85.1	144.8	NAAQS	188.03	µg/m^3	77.0
NOx	Annual	6.2	6.2	---	19.6	25.8	NMAAQS	94.02	µg/m^3	27.4
CO	1 Hour	665.9	---	---	---	---	SIL	2000	µg/m^3	33.3
CO	8 Hour	499.5	---	---	---	---	SIL	500	µg/m^3	99.9
SO_2	1 Hour	8.8	8.8	---	8.84	17.6	NAAQS	196.4	µg/m^3	9.0
$PM_{2.5}$	24 Hour	1.87	25.0	---	9.45	34.5	NAAQS	35	µg/m^3	98.6
$PM_{2.5}$	Annual	0.44	7.27	---	4.32	11.59	NAAQS	12	µg/m^3	96.6
PM_{10}	24 Hour	6.2	92.8	---	23.0	115.8	NAAQS	150	µg/m^3	77.2

[3]

I have highlighted, via red box in the last column, examples of instances where the model's predicted impacts are very close to the respective standards. I note that this is the NMED's and Applicant's analysis. Thus, for example, the PM2.5 impacts (both 24-hour average and annual) are barely below the NAAQS, allowing for little to no room for error in any calculations. The CO 8-hour impact is basically at the SIL but for lack of rounding. And the 1-hour NOx and 24-hour PM10 impacts are also close to 80% of their respective standards.

The key point is that **any underestimation of emissions that were input to this modeling analysis will likely result in the exceedance of the respective standards**. I will show in the following discussions that, because of NMED's uncritical reliance on AP-42 emission factors and methods, which have known and express shortcomings, it is without question that this underestimation of AAM's emissions, and likely dramatic underestimation of the emissions, is assured. Thus, conclusions by NMED that the AAM operation will meet the various standards,

[3] NMED 000299

based on the summary above and with the lack of margin as indicated in the last column, are simply wrong and misleading.

IV.3 Background and Context Regarding AP-42

Before discussing the specifics of the use of AP-42 emission factors in this case, which I will show was not incidental but endemic in the emissions calculations for AAM, I will first discuss some pertinent details about AP-42, taken from AP-42 itself. These cautions and limitations were well known, or should have been, to the Applicant and the NMED. They are not new. They have been part of the language included in AP-42 for decades.

First, as the U.S. EPA itself readily and explicitly acknowledges, there are many flaws and shortcomings inherent to the use of AP-42. Consequently, the EPA accordingly cautions users to take those flaws into account if they decide to use AP-42 factors to calculate an operation's expected emissions. These caveats, however, are neither recognized nor respected in the present instance by either the Applicant, who used AP-42 liberally, despite having actual operational data readily available, nor the NMED who reviewed the applicant's calculations.

Second, the primary limitation on the use of AP-42 for emission calculations (typically potential-to-emit, PTE or maximum) is that its factors are designed only to approximate average emission rates, not the maximum emission rate necessary to appropriately calculate expected emissions (and resulting worst-case modeling) necessary for permitting purposes. As stated by U.S. EPA:

> "In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average)."[4] (emphasis added)
>
> "Emission factor ratings in AP-42…provide indications of the robustness, or appropriateness, of emission factors for estimating average emissions for a source activity."[5] (emphasis added)
>
> "Emission factors in AP-42 are neither EPA-recommended emission limits . . . nor standards. . . Use of these factors as source-specific permit limits and/or as emission regulation compliance determination is not recommended by EPA. Because emission factors essentially represent an average of a range of emission rates, approximately half of the subject sources will have emission rates greater than the emission factor and the other half will have emission rates less than the factor."[6] (emphasis added)

And additionally:

[4] AP-42 Introduction, p. 1. Available at https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors
[5] *Id.*, p. 2.
[6] *Id.*, p. 2.

> "Average emissions differ significantly from source to source and, therefore, emission factors frequently may not provide adequate estimates of the average emissions for a specific source. The extent of between-source variability that exists, even among similar individual sources, can be large depending on process, control system, and pollutant. . . As a result, some emission factors are derived from tests that may vary by an order of magnitude or more. Even when the major process variables are accounted for, the emission factors developed may be the result of averaging source tests that differ by factors of five or more."[7]

Based on the above, it is clear that AP-42 emission factors are inappropriate for developing emission estimates, especially PTE, because the AP-42 emission factors represent "average" and not maximum emissions.

Third, the variability noted by EPA also means that AP-42 factors should not blindly be used for representing the emissions from an activity of a single source, without regard to how its operations and emissions differ from or are similar to the sources and activities that were measured as the basis for the AP-42 factor. There is absolutely no such comparison to or even discussion about this issue in the current record. Instead, the Applicant uses, and the Department approved of the use of every single AP-42 factor without any discussion of its appropriateness for use in determining the emissions from AAM's operations.

Fourth, the record simply does not consider or even mention the rating of any of the AP-42 factors used in the emission calculations. This is a critical and fatal error because the reliability of any AP-42 emission factor is reflected in its rating. In an attempt to inform (and caution) users, AP-42 uses a rating system, quoted below, to provide the user with context about the accuracy of any particular emission factor:

> "Each AP-42 emission factor is given a rating from A through E, with A being the best. A factor's rating is a general indication of the reliability, or robustness, of that factor. This rating is assigned based on the estimated reliability of the tests used to develop the factor and on both the amount and the representative characteristics of those data. In general, factors based on many observations, or on more widely accepted test procedures, are assigned higher rankings. Conversely, a factor based on a single observation of questionable quality, or one extrapolated from another factor for a similar process, would probably be rated much lower….
>
> The AP-42 emission factor rating is an overall assessment of how good a factor is, based on both the quality of the test(s) or information that is the source of the factor and on how well the factor represents the emission source. Higher ratings are for factors based on many unbiased observations, or on widely accepted test procedures. For example, ten or more source tests on different randomly selected plants would likely be assigned an "A" rating if all tests are conducted using a single valid reference measurement method. Likewise, a single observation based on

[7] *Id.*, p. 3.

questionable methods of testing would be assigned an "E", and a factor extrapolated from higher-rated factors for similar processes would be assigned a "D" or an "E".

AP-42 emission factor quality ratings are thus assigned:

A — Excellent. Factor is developed from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category population is sufficiently specific to minimize variability.

B — Above average. Factor is developed from A- or B-rated test data from a "reasonable number" of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with an A rating, the source category population is sufficiently specific to minimize variability.

C — Average. Factor is developed from A-, B-, and/or C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.

D — Below average. Factor is developed from A-, B- and/or C-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source population.

E — Poor. Factor is developed from C- and D-rated test data, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population."[8]

Note, in particular, the very poor reliabilities of "D" and "E" rated factors. As I will show in the examples below, the current record and the emission calculations in this case have predominantly used unreliable D and E rated factors in order to estimate emissions.

IV.4 EPA's November 2019 AP-42 Enforcement Alert

While the discussion in the previous section above is well known and has been part of AP-42 for decades, due to its widespread misuse by industry applicants and state environmental agencies in determining emission calculations for permitting, EPA, in November 2020, promulgated an Enforcement Alert called "EPA Reminder About Inappropriate Use of AP-42 Emission Factors"[9]

[8] *Id.*, p. 8-10.
[9] https://www.epa.gov/sites/default/files/2021-01/documents/ap42-enforcementalert.pdf

("Alert") in which it notes and warns about all of the deficiencies of AP-42 including those I note above and below. The Alert specifically noted that it is for permitting. An Alert is not an enforcement tool.

Specifically, I excerpt several directly applicable provisions below from this Enforcement Alert. I note that this Alert was available through much of the time that this matter was under consideration by the Applicant and the NMED.

(i) As to the purpose of the Alert "[T]his (sic) purpose of this Enforcement Alert is to remind permitting agencies, consultants, and regulated entities that improperly using AP-42 emission factors can be costly to their businesses, inefficient, and in some circumstances, can subject regulated entities to enforcement and penalties. The Environmental Protection Agency (EPA) is concerned that some permitting agencies, consultants, and regulated entities may incorrectly be using AP-42 emission factors in place of more representative source-specific emission values for Clean Air Act permitting and compliance demonstration purposes." (emphasis added)

The Alert specifically applies to permitting actions as is the present matter. It also applies to the NMED, the applicant and its permitting consultant.

(ii) EPA states, quoting AP-42 itself that even when an AP-42 factor may be higher rated like A or B, it is still inappropriate for use as representing the emissions for any one specific source: "[P]ermitting agencies, consultants, and regulated entities should be aware that even emission factors with more highly rated AP-42 grades of "A" or "B" are only based on averages of data from multiple, albeit similar, sources (*See* the Attachment for an overview of the history of AP-42 emission factors and the AP-42 emission factor rating system). Accordingly, these factors are not likely to be accurate predictors of emissions from any one specific source, except in very limited scenarios…."

Not only is there nothing in the record to indicate that this is a special source to which EPA's Enforcement Alert guidance should not apply, and, in fact, is a source that currently exists meaning the applicant could base its emissions calculations on actual emissions measured from the operating plant, as I will show next, the vast majority of the emission factors used in the emission calculations in this permit are rated D and E with only a few that are better than these two bottom-most ratings. Therefore there is simply no reason to rely on these factors. To the extent that the NMED has pled that "everyone" uses AP-42 factors, that is not a defense to using these rank inappropriate and unreliable factors. Of course NMED compounds its problem by then asserting that its analyses relying on these factors are somehow infallible and accurate and that compliance with air quality standards is demonstrated. That is an unsupported and false assertion.

IV.5 AAM's Emission Calculation and Use of AP-42

In this section I will show, via numerous examples that (a) AAM and NMED relied on AP-42 for the vast majority of their emission calculations; and (b) that, with rare exceptions, these emission factors were rated E or D, with a few that were C, making all of them unreliable to varying degrees. I excerpt relevant assertions from the record and show the corresponding AP-42 emission factor's ratings. On occasion, as warranted, I also make related observations.

IV.5.1 Aggregate Crushing/Screening Plant and Scalping Screen Plant

First, the excerpt below, with my red box highlights shows how the calculations rely exclusively on various AP-42 factors.

Aggregate Crushing/Screening Plant and Scalping Screen Plant

Pre-Control Particulate Emission Rates

Material Handling ($PM_{2.5}$, PM_{10}, and PM)

To estimate material handling pre-control particulate emissions rates for crushing, screening, and conveyor transfer operations, emission factors were obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Aug. 2004, Section 11.19.2, Table 11.19.2-2. To determine missing $PM_{2.5}$ emission factors the ratio of 0.35/0.053 from $PM_{10}/PM_{2.5}$ *k* factors found in AP-42 Section 13.2.4 (11/2006) were used.

To estimate material handling pre-control particulate emission rates for aggregate handling operations (mining/aggregate piles/ loading feed bins), an emission equation was obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, Section 13.2.4 (11/2004), where the k (PM = 0.74, PM_{10} = 0.35, $PM_{2.5}$ = 0.053), wind speed for determining the maximum hourly emission rate is the NMED default of 11 MPH and for determining annual emission rate is based on the average wind speed for Santa Fe for the years of 1996 through 2006 of 9.5 mph, and the NMED default moisture content of 2 percent.

[10]

Next, the excerpt below shows the specific emission factors and their source, as used in the calculations.

[10] NMED 000041

AP-42 Section 11.19.2 Table 11.19.2-2 Emission Factors:

All Bin Unloading and Conveyor Transfers = Uncontrolled Conveyor Transfer Point Emission Factor
Crushing = Uncontrolled Tertiary Crushing Emission Factor
Screening = Uncontrolled Screening Emission Factor

Material Handling Emission Factors:

Process Unit	PM Emission Factor (lbs/ton)	PM_{10} Emission Factor (lbs/ton)	$PM_{2.5}$ Emission Factor (lbs/ton)
Uncontrolled Crushing	0.00540	0.00240	0.00036
Uncontrolled Screening	0.02500	0.00870	0.00132
Feed Bin Unloading, and Conveyor Transfers	0.00300	0.00110	0.00017
Uncontrolled Hourly Aggregate Storage Piles, Aggregate Feeder Loading	0.00660	0.00312	0.00047
Uncontrolled Annual Aggregate Storage Piles, Aggregate Feeder Loading	0.00545	0.00258	0.00039

[11]

I excerpt below the referenced AP-42 Table 11.19.2-2. I have also highlighted the various emission factor ratings. Note that every single total PM emission factor is rated E. Note also that there are no A- or B-rated factors at all in this entire table. Note finally that there are no factors at all for primary and secondary crushing.

[11] NMED 000042

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

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Comparing the AP-42 ratings of the various factors to the emission factors actually used from this table in the calculations, as excerpted earlier, it is simply obvious as to the ratings of the factors used by AAM/NMED, by source type:

(i) Uncontrolled Crushing: PM EF 0.0054 – rated E; PM10 EF 0.0024 – rated C;

(ii) Uncontrolled Screening: PM EF 0.025 – rated E; PM10 EF 0.0087- rated C;

(iii) Feed Bin Unloading and Conveyor Transfers: PM EF 0.00300 – rated E; PM10 EF 0.00110 – rated D; and

[12] AP-42 Section 11.19.2

(iv) Emission factors for the last two lines used in the calculations, although noted as being from this AP-42 table, are simply not listed in the referenced Table 11.19.2-2. Their origin or how they may have been derived from some of the other data in this table is not transparent and unknown.

Next, I excerpt below the Applicant's discussion relating to control efficiencies used in the analysis. Note that none of the estimated control efficiencies are reliable because they are premised on unreliable data in the form of AP-42 Emissions Factors, which I discuss in greater detail below.

Controlled Material Handling ($PM_{2.5}$, PM_{10}, and PM)

No fugitive dust controls or emission reductions are proposed for the aggregate storage piles or loading of the aggregate feed bins with the exception of limiting annual production rates.

Fugitive dust control for unloading the aggregate feed bins onto conveyors will be controlled, as needed, with enclosures and/or water sprays at the exit of the feed bins. Fugitive dust control for the transfer conveyors will be controlled with material moisture content and/or enclosure. It is estimated that these methods will control to an efficiency of 95.3 percent per AP-42 Section 11.19.2, Table 11.19.2-2. Additional emission reductions include limiting annual production rates.

Fugitive dust control from the plant crusher will be controlled, as needed, with enclosures and/or water sprays. It is estimated that these methods will control to an efficiency of 77.8 percent for crushing operations per AP42 Section 11.19.2, Table 11.19.2-2. Additional emission reductions include limiting annual production rates.

Fugitive dust control from the plant screens will be controlled, as needed, with enclosures and/or water sprays. It is estimated that these methods will control to an efficiency of 91.2 percent for screening operations per AP42 Section 11.19.2, Table 11.19.2-2. Additional emission reductions include limiting annual production rates.

Fugitive dust control for the stacker conveyor transfer to storage piles will be controlled with material moisture content and/or enclosure. It is estimated that the additional moisture during processing will increase the moisture content from the default of 2% to the high moisture content value found in footnote b of AP-42 Table 11.19.2-2 of 2.88%. This will control fugitive emissions to an efficiency of 40 percent. Additional emission reductions include limiting annual production rates.

[13]

I start with the first, which is for conveyor transfer points. The relevant emission factors are shown from Table 11.19.2-2 below

Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E

For the transfer conveyors, even though the control efficiencies were mathematically calculated by AAM as (0.003 – 0.00014)/(0.003) = 95.3%, this is meaningless because both the controlled and uncontrolled factors are rated E, the lowest and most unreliable rating.

Next, let us examine crushing, for which I excerpt the relevant factors from Table 11.19.2-2 below.

[13] NMED 000046

Tertiary Crushing (SCC 3-050030-03)	0.0054[d]		E	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]		E	

However, here for the plant crusher, it appears that the AP-42 values for tertiary crushing were used. I note that this is not the same as primary crushing or even secondary crushing for which the referenced table above simply provides "No Data". Thus the control efficiency was estimated mathematically using the only available, i.e., tertiary crushing data as (0.0054 – 0.0012)/(0.0054) = 77.8%, even though AAM's crushing operation is not limited to tertiary crushing. Even if it did apply, the calculated control efficiency is still meaningless because both the controlled and uncontrolled factors used in its derivation are rated E.

Next, turning to screening, whose emission factors are excerpted from Table 11.19.2-2 below, it is clear that the pattern repeats.

Screening (SCC 3-05-020-02, 03)	0.025[c]		E	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]		E	

Like in the previous instances, for the plant screens, even though the control efficiencies were mathematically calculated as (0.025 – 0.0022)/(0.025) = 91.2%, this is meaningless because both the controlled and uncontrolled factors are rated E.

Finally, although the control efficiency for stacker conveyor to storage pile is noted in the excerpt above as being 40%, relying on Table 11.19.2-2, I could not determine how AAM or NMED arrived at this control efficiency.

In addition to the reliance on Table 11.19.2-2, the material handling emissions also rely on AP-42 Section 13.2.4 per the excerpt, which I have reproduced again below for ease of reference.

Aggregate Crushing/Screening Plant and Scalping Screen Plant

Pre-Control Particulate Emission Rates

Material Handling ($PM_{2.5}$, PM_{10}, and PM)

To estimate material handling pre-control particulate emissions rates for crushing, screening, and conveyor transfer operations, emission factors were obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Aug. 2004, Section 11.19.2, Table 11.19.2-2. To determine missing $PM_{2.5}$ emission factors the ratio of 0.35/0.053 from $PM_{10}/PM_{2.5}$ *k* factors found in AP-42 Section 13.2.4 (11/2006) were used.

To estimate material handling pre-control particulate emission rates for aggregate handling operations (mining/aggregate piles/ loading feed bins), an emission equation was obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, Section 13.2.4 (11/2004), where the k (PM = 0.74, PM_{10} = 0.35, $PM_{2.5}$ = 0.053), wind speed for determining the maximum hourly emission rate is the NMED default of 11 MPH and for determining annual emission rate is based on the average wind speed for Santa Fe for the years of 1996 through 2006 of 9.5 mph, and the NMED default moisture content of 2 percent.

This section contains the so-called drop equation, which I show below, provided in two different units This equation calculates the emission factor ("E") when materials "drop" from a certain height, for example from one conveyor to a different conveyor segment or from a conveyor to a pile, etc. Per the equation, the emission factor depends on the wind speed ("U"), the moisture content of the material("M") and a constant ("k"), which is different depending on the size of the PM (i.e., k varies if the equation is intended to apply to total PM, PM10, or PM2.5). This equation was used in this instance to calculate the quantity of particulate emissions coming from the AAM Aggregate Crushing/Screening Plant and Scalping Screen Plant.

The quantity of particulate emissions generated by either type of drop operation, per kilogram (kg) (ton) of material transferred, may be estimated, with a rating of A, using the following empirical expression:[11]

$$E = k(0.0016)\ \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\ \text{(kg/megagram [Mg])}$$

$$E = k(0.0032)\ \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\ \text{(pound [lb]/ton)}$$

14

[14] AP-42 Section 13.2.4, Drop Equation (1)

As to the Section 13.2.4 use of the drop equation, this is one area for which actual test data are available to demonstrate the reliability, or lack thereof, of the use of the equation. I provide a copy of a PowerPoint presentation containing test data summaries conducted in Florida in 2008 as Attachment B to this report. These tests were done with the express purpose of comparing AP-42's drop equation above with actual field measurements of emissions.

As the results in Attachment B confirm, the actual field test emissions were dramatically higher than those predicted by the drop-equation – ranging from over 8 times to as much as almost 400 times. The study concluded that "**AP-42 Continuous Drop Equation Grossly Underestimates PM emissions up to Several Orders of Magnitude**."

Thus, taken as a whole, the emissions calculated from the Aggregate Crushing/Screening Plant and Scalping Screen Plant are grossly underestimated. Since the emissions determined by the use of this equation are used as inputs to the model, the results of the model also underestimated expected emissions.

IV.5.2 Hot Mix Asphalt Plant #2 (and Plant #5)

In this section, I will use excerpts from calculations that are provided by AAM for Hot Mix Asphalt Plant #2. However since identical emission factors were also used for Plant #5, and in an effort to not repeat my criticisms twice, my comments below are for Plant #2 and they apply equally also for Plant #5 which uses similar calculations.

I start with the excerpt from AAM's calculation of emissions below, with my red boxes confirming the widespread and almost exclusive used of AP-42 for sources in Plants #2 and #5.

Hot Mix Asphalt Plant #2

Pre-Control Particulate Emission Rates

Material Handling ($PM_{2.5}$, PM_{10}, and PM)

To estimate material handling pre-control particulate emissions rates for conveyor transfer operations, emission factors were obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Aug. 2004, Section 11.19.2, Table 11.19.2-2. To determine missing $PM_{2.5}$ emission factors the ratio of 0.35/0.053 from $PM_{10}/PM_{2.5}$ *k* factors found in AP-42 Section 13.2.4 (11/2006) were used.

To estimate material handling pre-control particulate emission rates for aggregate handling operations (aggregate piles/ loading cold feed bins), an emission equation was obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, Section 13.2.4 (11/2004), where the k (PM = 0.74, PM_{10} = 0.35, $PM_{2.5}$ = 0.053), wind speed for determining the maximum hourly emission rate is the NMED default of 11 MPH and for determining annual emission rate is based on the average wind speed for Santa Fe for the years of 1996 through 2006 of 9.5 mph, and the NMED default moisture content of 2 percent.

The asphalt will contain 1.5% mineral filler. Pre-control particulate emissions rates for mineral filler silo loading was obtained from EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, Section 11.12 (06/06), Table 11.12-2 "Cement Unloading to Elevated Storage Silo". To determine missing $PM_{2.5}$ emission factors the ratio of 5.90/0.38 from $PM/PM_{2.5}$ uncontrolled k factors found in AP-42 Section 11.12 (06/06), Table 11.12-4 "Central Mix Operation" was used.

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The actual emission factors used in the calculations from the AP-42 sections are summarized in the record as excerpted below.

[15] NMED 000065

Material Handling Emission Factors:

Process Unit	PM Emission Factor (lbs/ton)	PM_{10} Emission Factor (lbs/ton)	$PM_{2.5}$ Emission Factor (lbs/ton)
Uncontrolled Feed Bin Unloading, and Conveyor Transfers	0.00300	0.00110	0.00017
Uncontrolled Aggregate Storage Piles, Cold Aggregate Feeder Loading Max Hourly	0.00660	0.00312	0.00047
Uncontrolled Aggregate Storage Piles, Cold Aggregate Feeder Loading Annual	0.00545	0.00258	0.00039

AP-42 Section 11.12 Table 11.12-2 Uncontrolled Emission Factors:

Process Unit	PM Emission Factor (lbs/ton)	PM_{10} Emission Factor (lbs/ton)	$PM_{2.5}$ Emission Factor (lbs/ton)
Mineral Filler Silo Loading	0.73	0.47	0.047

[16]

First, I note that some of the calculations here also use the emission factors from AP-42 Table 11.19.2-2 which I discuss in Section IV.5.1. Thus, since the deficiencies in the references to Table 11.19.2-2 have been previously discussed, I will skip over them and not repeat them. I will note, however, that of the three sets of PM/PM10/PM2.5 factors supposedly used from this Table for these calculations at Plant #2 and Plant #5, two could not be found at all in the Table 11.19.2-2. Nor does the record describe how they may have been derived from other information provided in this table, making it impossible to know how the Applicant determined these emissions factors.

Second, and similar to above, I have also discussed the significant and gross underestimation of using the drop equation from Section 13.2.4 referenced in these calculations above.

Third, as noted in the excerpt, some of the calculations for Plant #2 and Plant #5 are drawn from AP-42 Section 11.12, and specifically Table 11.12-2 for the uncontrolled mineral filler silo loading PM/PM10/PM2.5 EFs of 0.73/0.47/0.047 lb/ton respectively. I have excerpted that portion of this AP-42 table below.

[16] NMED 000065

11.12-6

TABLE 11.12-2 (ENGLISH UNITS)
EMISSION FACTORS FOR CONCRETE BATCHING [a]

Source (SCC)	Uncontrolled				Controlled			
	Total PM	Emission Factor Rating	Total PM_{10}	Emission Factor Rating	Total PM	Emission Factor Rating	Total PM_{10}	Emission Factor Rating
Aggregate transfer [b] (3-05-011-04,-21,23)	0.0069	D	0.0033	D	ND		ND	
Sand transfer [b] (3-05-011-05,22,24)	0.0021	D	0.00099	D	ND		ND	
Cement unloading to elevated storage silo (pneumatic)[c] (3-05-011-07)	0.73	E	0.47	E	0.00099	D	0.00034	D

It shows a rating for each of the PM and PM10 factors of E. It is pointless to therefore critique the PM2.5 factor which was derived from the E-rated PM factor and a ratio taken from Table 11.12-4. Even if this ratio is assumed to be accurate, the base PM factor with a rating of E is so inaccurate that it makes the PM2.5 factor similarly inaccurate and simply unreliable.

Next, I show the calculations pertaining for the Drum Mix portion of Plant #2 below

Drum Mix Hot Mix Asphalt Plant

Drum mix hot mix asphalt plant uncontrolled emissions were estimated using AP-42, Section 11.1 "Hot Mix Asphalt Plants" (revised 03/04), tables 11.1-1, -2, -5, -6 and -14 emission equations. The drum dryer will be permitted to combust natural gas. Hourly emission rates are based on maximum hourly asphalt production (150 tph) and maximum annual emission rates are based on operating 8760 hours per year. To determine missing $PM_{2.5}$ emission factor the sum of uncontrolled filterable from Table 11.1-4 plus uncontrolled organic and inorganic condensable in Table 11.1-1 was used. Silo filling and plant loadout emission factors were calculated using the default value of –0.5 for asphalt volatility and a tank temperature setting of 325° F for HMA mix temperature. Yard emissions were found in AP-42 Section 11.1.2.5. TOC emission equation is 0.0015 lbs/ton of asphalt produced and CO is equal to the TOC emission rate times 0.32.

Emissions of VOCs (TOCs) from the asphalt cement storage tanks were determined with EPA's TANK 4.0.9d program and the procedures found in EPA's "Emission Factor Documentation for AP-42 Section 11.1 (12/2000) Section 4.4.5" for input to the TANK program.

AP-42 Section 11.1 Table 11.1-1, 5, 6, and 14 Uncontrolled Emission Factors:

Process Unit	Pollutant	Emission Factor (lbs/ton)
Drum Mixer	NO_X	0.025
	CO	0.40
	SO_2	0.0046
	VOC	0.0082
	TOC	0.015
	PM	32.0
	PM_{10}	4.5
	$PM_{2.5}$	0.287
Asphalt Mixer Loadout	CO	0.001349240
	TOC	0.004158948
	PM	0.000521937
	PM_{10}	0.000521937
	$PM_{2.5}$	0.000521937
Yard	CO	0.000352
	TOC	0.0011

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[17] NMED 000071

These calculations rely on AP-42 Section 11.1 and the various tables noted in the excerpt above. I begin first with an excerpt from Table 11.1-1 below showing that the uncontrolled PM factors used in the calculation and taken from this table are all rated E, the lowest rated of all AP-42 factors.

11.1-11

Table 11.1-1. PARTICULATE MATTER EMISSION FACTORS FOR BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	Filterable PM				Condensable PM[b]				Total PM			
	PM[c]	EMISSION FACTOR RATING	PM-10[d]	EMISSION FACTOR RATING	Inorganic	EMISSION FACTOR RATING	Organic	EMISSION FACTOR RATING	PM[e]	EMISSION FACTOR RATING	PM-10[f]	EMISSION FACTOR RATING
Dryer, hot screens, mixer[g] (SCC 3-05-002-45, -46, -47)												
Uncontrolled	32[h]	E	4.5	E	0.013[j]	E	0.0041[j]	E	32	E	4.5	E
Venturi or wet scrubber	0.12[k]	C	ND	NA	0.013[m]	B	0.0041[n]	B	0.14	C	ND	NA
Fabric filter	0.025[p]	A	0.0098	C	0.013[m]	A	0.0041[n]	A	0.042	B	0.027	C

E

Next, I show below the referenced Table 11.1-2 used in the calculations. The entire table's values are all rated E.

Table 11.1-2. SUMMARY OF PARTICLE SIZE DISTRIBUTION FOR BATCH MIX DRYERS, HOT SCREENS, AND MIXERS[a]

EMISSION FACTOR RATING: E

Particle Size, µm[b]	Cumulative Mass Less Than or Equal to Stated Size (%)[c]		Emission Factors, lb/ton	
	Uncontrolled[d]	Fabric Filter	Uncontrolled[d]	Fabric Filter
1.0	ND	30[e]	ND	0.0075[e]
2.5	0.83	33[e]	0.27	0.0083[e]
5.0	3.5	36[e]	1.1	0.0090[e]
10.0	14	39[f]	4.5	0.0098[f]
15.0	23	47[e]	7.4	0.012[e]

Following this, the calculations next reference Table 11.1-5. Since the dryer will be natural gas fired, I excerpt that portion of the Table below. As I have highlighted, the ratings for NOx, CO, and SO2, taken from this table are all C, D, and E.

Table 11.1-5. EMISSION FACTORS FOR CO, CO_2, NO_x, AND SO_2 FROM BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	CO[b]	EMISSION FACTOR RATING	CO_2[c]	EMISSION FACTOR RATING	NO_x	EMISSION FACTOR RATING	SO_2[c]	EMISSION FACTOR RATING
Natural gas-fired dryer, hot screens, and mixer (SCC 3-05-002-45)	0.40	C	37[d]	A	0.025[e]	D	0.0046[f]	E

Finally, I turn to the referenced Table 11.1-6, with the relevant portion for natural gas excerpted below. The factors for TOC and VOC are rated D.

Table 11.1-6. EMISSION FACTORS FOR TOC, METHANE, AND VOC FROM BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	TOC[b]	EMISSION FACTOR RATING	CH_4[c]	EMISSION FACTOR RATING	VOC[d]	EMISSION FACTOR RATING
Natural gas-fired dryer, hot screens, and mixer (SCC 3-05-002-45)	0.015[e]	D	0.0074	D	0.0082	D

Thus, every one of the emission factors for the drum mixer in Plants #2 and #5 used in the calculations has rating of C or worse, with most of them being D and/or E.

The calculations also rely on Table 11.1-14 as the source of the Asphalt Mixer Loadout emission factors. I excerpt that table below.

Table 11.1-14. PREDICTIVE EMISSION FACTOR EQUATIONS FOR LOAD-OUT AND SILO FILLING OPERATIONS[a]

EMISSION FACTOR RATING: C

Source	Pollutant	Equation
Drum mix or batch mix plant load-out (SCC 3-05-002-14)	Total PM[b]	$EF = 0.000181 + 0.00141(-V)e^{((0.0251)(T + 460) - 20.43)}$
	Organic PM[c]	$EF = 0.00141(-V)e^{((0.0251)(T + 460) - 20.43)}$
	TOC[d]	$EF = 0.0172(-V)e^{((0.0251)(T + 460) - 20.43)}$
	CO	$EF = 0.00558(-V)e^{((0.0251)(T + 460) - 20.43)}$
Silo filling (SCC 3-05-002-13)	Total PM[b]	$EF = 0.000332 + 0.00105(-V)e^{((0.0251)(T + 460) - 20.43)}$
	Organic PM[c]	$EF = 0.00105(-V)e^{((0.0251)(T + 460) - 20.43)}$
	TOC[d]	$EF = 0.0504(-V)e^{((0.0251)(T + 460) - 20.43)}$
	CO	$EF = 0.00488(-V)e^{((0.0251)(T + 460) - 20.43)}$

All of the equations are rated C.

Finally, the emissions calculations for the Yard TOC and CO emissions reference AP-42 Section 11.1.2.5, which I excerpt below.

> Vapors from the HMA loaded into transport trucks continue following load-out operations. The TOC emissions for the 8-minute period immediately following load-out (yard emissions) can be estimated using an emission factor of 0.00055 kg/Mg (0.0011 lb/ton) of asphalt loaded. This factor is assigned a rating of E. The derivation of this emission factor is described in Reference 1. Carbon monoxide emissions can be estimated by multiplying the TOC emissions by 0.32 (the ratio of truck load-out CO emissions to truck load-out THC emissions).

It confirms that the TOC factor is rated E and therefore the CO factor which is derived by simply multiplying the TOC factor by 0.32, cannot be any more accurate – i.e., it is also rated E.

The record provides the following discussion regarding control efficiencies used in the calculations. The excerpt below discusses how the applied control efficiencies were derived.

Controlled Material Handling ($PM_{2.5}$, PM_{10}, and PM)

No fugitive dust controls or emission reductions are proposed for the aggregate storage piles (P2HMAP) or loading of the cold aggregate feed bins (P2HMABIN) with the exception of limiting annual production rates.

Fugitive dust control for unloading the cold aggregate feed bins onto the cold aggregate feed bin conveyor (P2HMATP1), feed bin conveyor to transfer conveyor (P2HMATP2), and transfer conveyor to sling conveyor (P2HMATP3) will be controlled, as needed, with enclosures and/or water sprays at the exit of the feed bins. It is estimated that these methods will control to an efficiency of 95.3 percent per AP42 Section 11.19.2, Table 11.19.2-2. Additional emission reductions include limiting annual production rates.

Particulate emissions from loading the mineral filler silo (P2HMAFIL) will be controlled with a baghouse dust collector on the exhaust vent. This dust collector consists of filter bags and is passive with no fan. It functions only when material is loaded into the silo. The filter bags are cleaned by air pulses at set intervals. Baghouse fines are dumped back into the silo. It is estimated that this method will control to an efficiency of 99 percent or greater based on information from filter bag specifications. To determine missing $PM_{2.5}$ emission factors the ratio of 0.19/0.03 from $PM/PM_{2.5}$ controlled k factors found in AP-42 Section 11.12 (06/06), Table 11.12-4 "Central Mix Operation" was used. Additional emission reductions include limiting annual production rates.

Particulate emissions from the drum dryer/mixer (P2HMASTK) will be controlled with a baghouse dust collector (P2HMASTK) on the exhaust vent. It is estimated that this method will control to an efficiency of 99.87 percent per AP42 Section 11.1, Table 11.1-1 "controlled emission factor vs. uncontrolled emission factor". Baghouse fines are sent to a dust box. Additional emission reductions include limiting annual production rates.

18

Earlier, in Section IV.5.1, I have discussed the basis for the 95.3% efficiency relying on AP-42 Table 11.19.2-2 showing that it is worthless, having being derived from two E-rated factors.

As far as the assumption of the baghouse control efficiencies noted for the mineral filler silo in the excerpt above (i.e., 99% or greater, relying on "bag filter specifications,") this is also improper because specifications are expectations and do not dictate actual performance. They are by no means guarantees of what the actual manufacturer of the equipment may or may not provide. Of course, equipment efficiencies depend on the age of the equipment and how well they are maintained. Without any discussion of equipment age and its conditions, simply assuming a high control efficiency makes no sense.

As to the last in the excerpt above, i.e., the assumed efficiency for the drum dryer/mixer of 99.87%, derived by relying on AP-42 Table 11.1-1, i.e., comparing the controlled versus the uncontrolled emission factors in that Table, it cannot be accurate at all since the uncontrolled factors themselves are all rated E as I have previously noted.

The clear conclusion from the discussion above that **the entire set of emission calculations for all sources from Plant#2 and Plant #5 and, indeed, from the entire project** that rely predominantly on extremely poorly-rated AP-42 emission factors, **are completely unreliable and cannot and should not be relied upon with any assurances of accuracy, much less support a**

[18] NMED 000073

claim by the NMED that using these useless factors in the emissions calculations, followed by dispersion modeling using these emissions inputs, will protect any air quality standards including NAAQS. This is a particularly egregious conclusion when the NMED's own analysis, as I noted in the very beginning, shows that for several pollutants such as NOx, PM2.5, PM10, and CO, there are very small margins between the standards and the estimated impacts.

IV.5.3 Calculations for Hazardous Air Pollutants (HAPs)

Just like for the criteria pollutants above, it is also easy to show that all of the calculations for HAPs contained in the record for this permit are grossly inaccurate. Below, as an example, I excerpt several tables from the record containing HAP calculations.

Table 6-25: HAPs Emission Rates from the Drum Dryer/Mixer (P2HMASTK)
EPA HAPS Emissions Drum Mixer Hot Mix Asphalt Plant with Fabric Filter

Average Hourly Production Rate:	150	tons per hour
Yearly Production Rate:	375000	tons per year

Type of Fuel:	Natural Gas
Emission Factors	AP-42 Section 11.1 Tables 11.1-9, 11.1-11

Non-PAH HAPS	CAS#		Emission Factor (lbs/ton)	Emission Rate (lbs/hr)	Emission Rate (ton/yr)
Acetaldehyde	75-07-0		3.2E-04	0.048000	0.030400
Benzene	71-43-2		2.8E-04	0.042000	0.026600
Ethylbenzene	100-41-4		2.2E-03	0.330000	0.209000
Formaldehyde	50-00-0		7.4E-04	0.111000	0.070300
Quinone	106-51-4		2.7E-04	0.040500	0.025650
Toluene	108-88-3		1.0E-03	0.150000	0.095000
Xylene	1330-20-7		2.7E-03	0.405000	0.256500
		Total Non-PAH HAPS	7.5E-03	1.126500	0.713450

PAH HAPS	CAS#		Emission Factor (lbs/ton)	Emission Rate (lbs/hr)	Emission Rate (ton/yr)
2-Methylnaphthalene	91-57-6		7.1E-05	0.010650	0.006745
Acenaphthene	83-32-9		9.0E-07	0.000135	0.000086
Acenaphthylene	208-96-8		5.8E-07	0.000087	0.000055
Anthracene	120-12-7		2.1E-07	0.000032	0.000020
Benzo(a)anthracene	56-55-3		4.6E-09	0.000001	0.000000
Benzo(a)pyrene	50-32-8		3.1E-10	0.000000	0.000000
Benzo(b)fluoranthene	205-99-2		9.4E-09	0.000001	0.000001
Benzo(g,h,i)perylene	191-24-2		5.0E-10	0.000000	0.000000
Benzo(k)fluoranthene	207-08-9		1.3E-08	0.000002	0.000001
Chrysene	218-01-9		3.8E-09	0.000001	0.000000
Dibenz(a,h)anthracene	53-70-3		9.5E-11	0.000000	0.000000
Fluoranthene	206-44-0		1.6E-07	0.000024	0.000015
Fluorene	86-73-7		1.6E-06	0.000240	0.000152
Indeno(1,2,3-cd)pyrene	193-39-5		3.0E-10	0.000000	0.000000
Naphthalene	91-20-3		3.6E-05	0.005400	0.003420
Phenanthrene	85-01-8		2.6E-06	0.000390	0.000247
Pyrene	129-00-0		6.2E-08	0.000009	0.000006
		Total PAH HAPS	1.1E-04	0.016972	0.010749

[19]

[19] NMED 000088

HAPS Metals		Emission Factor (lbs/ton)	Emission Rate (lbs/hr)	Emission Rate (ton/yr)
Arsenic		4.6E-07	0.000069	0.000044
Beryllium		1.5E-07	0.000023	0.000014
Cadmium		6.1E-07	0.000092	0.000058
Chromium		5.7E-07	0.000086	0.000054
Hexavalent Chromium		4.8E-08	0.000007	0.000005
Lead		8.9E-07	0.000134	0.000085
Manganese		6.9E-06	0.001035	0.000656
Mercury		4.1E-07	0.000062	0.000039
Nickel		3.0E-06	0.000450	0.000285
Selenium		4.9E-07	0.000074	0.000047
	Total Metals HAPS	1.4E-05	0.002029	0.001285
	Total HAPS		**1.15**	**0.73**

The source of the non-PAH and PAH HAPs in the tables above are shown below, i.e., AP-42 Table 11.1-9. All of the emission factors are either rated D or E.

[20] NMED 000089

Table 11.1-9. EMISSION FACTORS FOR ORGANIC POLLUTANT EMISSIONS FROM BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. Nos.
	CASRN	Name			
Natural gas- or No. 2 fuel oil-fired dryer, hot screens, and mixer with fabric filter (SCC 3-05-002-45,-46)	Non-PAH Hazardous Air Pollutants[b]				
	75-07-0	Acetaldehyde	0.00032	E	24,34
	71-43-2	Benzene	0.00028	D	24,34,46, 382
	100-41-4	Ethylbenzene	0.0022	D	24,46,47,49
	50-00-0	Formaldehyde	0.00074	D	24,34,46,47,49,226,382
	106-51-4	Quinone	0.00027	E	24
	108-88-3	Toluene	0.0010	D	24,34,46,47
	1330-20-7	Xylene	0.0027	D	24,46,47,49
		Total non-PAH HAPs	0.0075		
	PAH HAPs				
	91-57-6	2-Methylnaphthalene[c]	7.1×10^{-5}	D	24,47,49
	83-32-9	Acenaphthene[c]	9.0×10^{-7}	D	34,46,226
	208-96-8	Acenaphthylene[c]	5.8×10^{-7}	D	34,46,226
	120-12-7	Anthracene[c]	2.1×10^{-7}	D	34,46,226
	56-55-3	Benzo(a)anthracene[c]	4.6×10^{-9}	E	46,226
	50-32-8	Benzo(a)pyrene[c]	3.1×10^{-10}	E	226
	205-99-2	Benzo(b)fluoranthene[c]	9.4×10^{-9}	D	34,46,226
	191-24-2	Benzo(g,h,i)perylene[c]	5.0×10^{-10}	E	226
	207-08-9	Benzo(k)fluoranthene[c]	1.3×10^{-8}	E	34,226
	218-01-9	Chrysene[c]	3.8×10^{-9}	E	46,226
	53-70-3	Dibenz(a,h)anthracene[c]	9.5×10^{-11}	E	226
	206-44-0	Fluoranthene[c]	1.6×10^{-7}	D	34,46,47,226
	86-73-7	Fluorene[c]	1.6×10^{-6}	D	34,46,47,226
	193-39-5	Indeno(1,2,3-cd)pyrene[c]	3.0×10^{-10}	E	226
	91-20-3	Naphthalene	3.6×10^{-5}	D	34,46,47,49,226
	85-01-8	Phenanthrene[c]	2.6×10^{-6}	D	34,46,47,226
	129-00-0	Pyrene[c]	6.2×10^{-8}	D	34,46,226
		Total PAH HAPs	0.00011		
		Total HAPs	0.0076		

As for the metal HAPs, the excerpt below from Table 11.1-11 is shown below.

Table 11.1-11. EMISSION FACTORS FOR METAL EMISSIONS FROM BATCH MIX HOT MIX ASPHALT PLANTS[a]

Process	Pollutant	Emission Factor, lb/ton	Emission Factor Rating	Reference Numbers
Dryer, hot screens, and mixer[b] (SCC 3-05-002-45,-46,-47)	Arsenic[c]	4.6×10^{-7}	D	34, 40, 226
	Barium	1.5×10^{-6}	E	24
	Beryllium[c]	1.5×10^{-7}	E	34, 226
	Cadmium[c]	6.1×10^{-7}	D	24, 34, 226
	Chromium[c]	5.7×10^{-7}	D	24, 34, 226
	Hexavalent chromium[c]	4.8×10^{-8}	E	34, 226
	Copper	2.8×10^{-6}	D	24, 34, 226
	Lead[c]	8.9×10^{-7}	D	24, 34, 226
	Manganese[c]	6.9×10^{-6}	D	24, 34, 226
	Mercury[c]	4.1×10^{-7}	E	34, 226
	Nickel[c]	3.0×10^{-6}	D	24, 34, 226
	Selenium[c]	4.9×10^{-7}	E	34, 226
	Zinc	6.8×10^{-6}	D	24, 34, 226

Again, it is clear that every factor is either D- or E-rated.

Thus, the reliability of the HAPs calculations are no better than the reliability of the criteria pollutant calculations. The vast majority, as shown above, use emission factors that are D- and E-rated.

In summary, the entire set of emission calculations, both for criteria pollutants and HAPs, are simply unreliable. In addition, it is more than likely that emissions are underestimates. AAM and NMED do not even note much less comment on any of the ratings of the AP-42 factors used. And, neither NMED nor AAM has any discussion on how the emission factors from AP-42 can represent emissions not just from normal operations but also during startup and shutdown or during malfunctions.

For all of the reasons stated above, it is my opinion that the emission calculations, a critical input into the modeling, are incorrect and underestimate emissions from this facility. Therefore the conclusions from dispersion modeling that rely on these emissions calculations are also incorrect. **There is no reason to believe that NMED's conclusions that this facility will not adversely impact relevant and applicable air quality standards is correct whatsoever. Given the already thin, and in some instances, non-existent margins between predicted impacts and the applicable standard, NMED's statement was already ludicrous**. The fact that the emissions used in the analysis are of such poor quality makes that conclusion not just unreasonable, but simply wrong. This is all the more egregious because AAM is an existing facility whose emissions can be determined by testing under any and all operating conditions. Instead of using AP-42 factors, all of which are rated at the very bottom and are therefore completely unreliable, NMED

had every opportunity to obtain representative emissions data and derive representative emission factors from AAM's various sources but chose not to, so as not to "bully" industry partners.[21]

V. Ambient Air

I briefly address the issue of ambient air in this section. I stress strongly that this discussion is likely to be moot if the emissions calculations are properly performed using representative emissions data in lieu of AP-42 as I have pointed out in the previous discussions. If proper emissions are estimated, there is no doubt that for many of the criteria pollutants there would be significant exceedances of the NAAQS, eliminating the need for considering background pollution concentration data and without the need for considering the nuances of the locations of these exceedances and "ambient air."

It is clear that the air outside of the fence line of the facility receiving the permit, in this case, AAM, to which the public has access is considered ambient air, meaning that the permitted facility cannot contribute to a NAAQS violation in that area. This follows long-standing EPA policy and guidance. The NMED, as far as I can tell, does not dispute this.[22]

In this instance, however, some portions of the air outside of AAM's facility boundary are within the boundaries of other industrial or private operations that also emit many of the same pollutants that are emitted by AAM, such as various sizes of PM. Though the general public likely does not have access to these facilities, that is not established in the record per se. For example, visitors, contractors, suppliers and others may have access to these other facilities and may be subject to impacts from the emissions from AAM, making that area "ambient air" for the purposes of AAM's emissions and requiring AAM change operations in such a way that would reduce emissions in order to avoid contributing to a NAAQS exceedance in the area.

Nonetheless, the record relating to how "ambient air" has been defined and accounted for in the modeling analysis leaves a muddled and confusing picture of what NAAQS exceedances may occur as a result of AAM's operation for the following reasons:

(i) In applying the definition of ambient air to the specific analysis here, the NMED states:

> "[T]he definition of ambient air applies to each facility. It is evident from the definition that the contribution of each facility may be subtracted from the concentrations within its own nonambient air property. When a source is modeling the impacts within a neighbor's fenced and restricted property, they must consider all contributions except those produced by that neighbor."[23] (emphasis added)

The NMED then provides summary conclusions about how this adjustment was done.

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[21] 03-24-21 TR at 535: 16-25.

[22] See NMED Exhibit 11, p. 11. "What is the definition of ambient air? Answer: The EPA defines "ambient air" at 40 CFR Part 50.1 (e) as "that portion of the atmosphere, external to buildings, to which the general public has access."

[23] NMED Exhibit 11, p. 11.

> "An annual concentration of 12.766 ug/m^3 PM2.5 was predicted at one point in the modeling, which would be above the air quality standard. Visual inspection of Google Earth imagery of the location showed that the receptor in question was inside the same fence as a modeled source with an emission rate of 4.08 lb/hr PM2.5. However, further inspection revealed that the source with the large emission rate was not the cause of the predicted violation of annual PM2.5 standards. Corrections to inaccurate emission rates for a different source, LM Concrete Pumping - Santa Fe Location, lowered the annual concentration at the receptor in question to below the PM2.5 annual NAAQS without excluding emissions from any facility. The corrections or refinements to the surrounding sources are described in email with index number 186 and Bates number 001729. The modeling files for the annual modeling of this receptor are contained in the email with index number 187 and Bates number 001730."[24]

I have reviewed the documents with Bates number 001729 and 001730 cited by the NMED in its response above. NMED asserts that the "corrections or refinements to the surrounding sources and described in email….[at] Bates number 001729…" That is simply not true. I have excerpted the relevant portion of Bates 001729 below and highlighted where the consultant for AAM states that he has reduced the emission rate from 4.08 lb/hour to 0.85 lb/hr but no details are provided.

From: Paul Wade
To: Peters, Eric, NMENV
Subject: [EXT] Re: Permit 3435
Date: Monday, January 27, 2020 3:44:21 PM
Attachments: AAMSantaFePM24CIAS10v1.BST
AAMSantaFePM24CIAS10v1_2016_PM2.5.DTA
AAMSantaFePM24CIAS10v1_2016_PM2.5.GRF
AAMSantaFePM24CIAS10v1_2016_PM2.5.LST

Eric
I have completed the revised AERMOD PM2.5 modeling for AAM's Santa Fe Facility using Scenario 10 of the original modeling. The revised modeling includes changing the emission rate for LM Concrete Pumping - Santa Fe Location, GCP5-3534 from 4.08 lbs/hr to 0.85 lbs/hr as we discussed. This will account for the fact that it is a small GCP-5 facility limited to 360 cubic yards per day instead of 24oo cubic yards per day.

The results of the revised modeling shows exceedances within the boundaries of Eker Bros - 300TPH Crusher No2410 & 2712, Montano Crushing Plant No. 3167, and Vulcan Materials-Santa Fe HMAP NSR 0324. Both when each neighboring source contribution is removed from the analysis all exceedances are eliminated.

These email and the next will contain the results of this modeling. Let me know what else you need from me for your review.

To the extent that the explanation relies on the fact that the production rate reduction from 2400 cubic yards per day to 360 cubic yards per day may explain the "revision", that does not seem to be consistent. This production reduction is (360/2400) or a ratio of 0.15. The reduction of the emission rate from 4.08 to 0.85 lb/hr is (0.85/4.08) or 0.208. More important the basis for either of these emission rates, other than production, such as any emission factors that may have been

[24] NMED Exhibit 11, p. 12.

used are not provided in this email. Nor is that information contained in any location in the record that I could find.

The other referenced document in NMED's response, i.e., Bates no. 001730 is also unhelpful since it is a transmittal email with some attachments which appear to be modeling files. No explanation is provided in that email, i.e., explanation of why this reduced emission rate was used in the modeling is not likely to be explained in the modeling files themselves.

Based on this, I ask that the NMED provide a complete and detailed explanation of its adjustment for this adjacent facility including a complete analysis of the basis of the 0.85 lb/hr emission rate used. Without this explanation, simply reducing the emission rate from 4.08 lb/hr to 0.85 lb/hr, i.e., a reduction of almost 80% with no basis is not only not transparent, but also simply arbitrary and designed to "pass" the modeling purpose and avoid addressing issues with NAAQS exceedances potentially occurring in ambient air and impacting the public.

(ii) compounding this lack of transparency, NMED's following assertion during Day 1 of the Hearing is confusing:[25]

16 Q. So the applicant in this case can exclude its
17 own emissions from what would be another facility's
18 nonambient air. Is that what you're saying?
19 A. Yes. And the neighboring facility can't
20 prohibit a neighbor from installing close to them by --
21 by -- without -- by using the nonambient air against
22 them if they were using nonambient air for their own
23 facility to get their permit"

The NMED should explain the exchange noted above and clarify its position regarding ambient air and how it applies conceptually in this instance and, as noted above, how the NMED applied it as a practical matter. The NMED should also clarify if its policy on ambient air differs in any way at all from EPA' policy on ambient air and if so, to explain the differences and their rationale for those differences.

VI. Conclusion

Based on all of the discussion in this report, my final conclusions are that:

(1) use of AP-42 and its worst-ranked emission factors to estimate emissions from an existing source like AAM whose emissions can and should be tested and measured is regulatory malpractice;

(2) use of AP-42 without any reference to the ratings of the emission factors is inexcusable;

[25] Hearing Transcript, Day 1, p. 258.

(3) as a result of the use of AP-42 factors, the estimated emissions from AAM are not only unreliable, but they are also underestimated as I have demonstrated;

(4) as a result of the use of these emission factors and emission estimates, the modeling conclusions are wrong. This is especially important given that NMED's modeling shows little to no margin for several pollutants as compared to their respective standards such as NAAQS, making it highly likely that a proper modeling analysis would show NAAQS exceedances; and

(5) NMED and AAM's adjustments to the definition of "ambient air" to account for NAAQS exceedances in the vicinity of AAM is opaque, at best, and this lack of transparency has no place in the public record.

Attachment A

RANAJIT (RON) SAHU, Ph.D, QEP, CEM (Nevada)

CONSULTANT, ENVIRONMENTAL AND ENERGY ISSUES

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EXPERIENCE SUMMARY

Dr. Sahu has over thirty one years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment for a wide range of emissions sources including stationary and mobile sources; soils and groundwater remediation including landfills as remedy; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

He has over twenty eight years of project management experience and has successfully managed and executed numerous projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public.

He has provided consulting services to numerous private sector, public sector and public interest group clients. His major clients over the past twenty six years include various trade associations as well as individual companies such as steel mills, petroleum refineries, chemical plants, cement manufacturers, aerospace companies, power generation facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, land development companies, and various entities in the public sector including EPA, the US Dept. of Justice, several states (including Oregon, New Mexico, Pennsylvania, and others), various agencies such as the California DTSC, and various municipalities. Dr. Sahu has performed projects in all 50 states, numerous local jurisdictions and internationally.

In addition to consulting, for approximately twenty years, Dr. Sahu taught numerous courses in several Southern California universities including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management). He also taught at Caltech, his alma mater (various engineering courses), at the University of Southern California (air pollution controls) and at California State University, Fullerton (transportation and air quality).

Dr. Sahu has and continues to provide expert witness services in a number of environmental areas discussed above in both state and Federal courts as well as before administrative bodies (please see Annex A).

EXPERIENCE RECORD

2000-present **Independent Consultant.** Providing a variety of private sector (industrial companies, land development companies, law firms, etc.), public sector (such as the US Department of Justice), and public interest group clients with project management, environmental consulting, project management, as well as regulatory and engineering support consulting services.

1995-2000 Parsons ES, **Associate, Senior Project Manager and Department Manager for** Air Quality/Geosciences/Hazardous Waste Groups, Pasadena. Responsible for the management of a group of approximately 24 air quality and environmental professionals, 15 geoscience, and 10 hazardous waste professionals providing full-service consulting, project management, regulatory compliance and A/E design assistance in all areas.

Parsons ES, **Manager for Air Source Testing Services**. Responsible for the management of 8 individuals in the area of air source testing and air regulatory permitting projects located in Bakersfield, California.

1992-1995 Engineering-Science, Inc. **Principal Engineer and Senior Project Manager** in the air quality department. Responsibilities included multimedia regulatory compliance and permitting (including hazardous and nuclear materials), air pollution engineering (emissions from stationary and mobile sources, control of criteria and air toxics, dispersion modeling, risk assessment, visibility analysis, odor analysis), supervisory functions and project management.

1990-1992 Engineering-Science, Inc. **Principal Engineer and Project Manager** in the air quality department. Responsibilities included permitting, tracking regulatory issues, technical analysis, and supervisory functions on numerous air, water, and hazardous waste projects. Responsibilities also include client and agency interfacing, project cost and schedule control, and reporting to internal and external upper management regarding project status.

1989-1990 Kinetics Technology International, Corp. **Development Engineer.** Involved in thermal engineering R&D and project work related to low-NOx ceramic radiant burners, fired heater NOx reduction, SCR design, and fired heater retrofitting.

1988-1989 Heat Transfer Research, Inc. **Research Engineer**. Involved in the design of fired heaters, heat exchangers, air coolers, and other non-fired equipment. Also did research in the area of heat exchanger tube vibrations.

EDUCATION

1984-1988 Ph.D., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1984 M. S., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1978-1983 B. Tech (Honors), Mechanical Engineering, Indian Institute of Technology (IIT) Kharagpur, India

TEACHING EXPERIENCE

Caltech

"Thermodynamics," Teaching Assistant, California Institute of Technology, 1983, 1987.

"Air Pollution Control," Teaching Assistant, California Institute of Technology, 1985.

"Caltech Secondary and High School Saturday Program," - taught various mathematics (algebra through calculus) and science (physics and chemistry) courses to high school students, 1983-1989.

"Heat Transfer," - taught this course in the Fall and Winter terms of 1994-1995 in the Division of Engineering and Applied Science.

“Thermodynamics and Heat Transfer,” Fall and Winter Terms of 1996-1997.

U.C. Riverside, Extension

"Toxic and Hazardous Air Contaminants," University of California Extension Program, Riverside, California. Various years since 1992.

"Prevention and Management of Accidental Air Emissions," University of California Extension Program, Riverside, California. Various years since 1992.

"Air Pollution Control Systems and Strategies," University of California Extension Program, Riverside, California, Summer 1992-93, Summer 1993-1994.

"Air Pollution Calculations," University of California Extension Program, Riverside, California, Fall 1993-94, Winter 1993-94, Fall 1994-95.

"Process Safety Management," University of California Extension Program, Riverside, California. Various years since 1992-2010.

"Process Safety Management," University of California Extension Program, Riverside, California, at SCAQMD, Spring 1993-94.

"Advanced Hazard Analysis - A Special Course for LEPCs," University of California Extension Program, Riverside, California, taught at San Diego, California, Spring 1993-1994.

"Advanced Hazardous Waste Management" University of California Extension Program, Riverside, California. 2005.

Loyola Marymount University

"Fundamentals of Air Pollution - Regulations, Controls and Engineering," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1993.

"Air Pollution Control," Loyola Marymount University, Dept. of Civil Engineering, Fall 1994.

"Environmental Risk Assessment," Loyola Marymount University, Dept. of Civil Engineering. Various years since 1998.

"Hazardous Waste Remediation" Loyola Marymount University, Dept. of Civil Engineering. Various years since 2006.

University of Southern California

"Air Pollution Controls," University of Southern California, Dept. of Civil Engineering, Fall 1993, Fall 1994.

"Air Pollution Fundamentals," University of Southern California, Dept. of Civil Engineering, Winter 1994.

University of California, Los Angeles

"Air Pollution Fundamentals," University of California, Los Angeles, Dept. of Civil and Environmental Engineering, Spring 1994, Spring 1999, Spring 2000, Spring 2003, Spring 2006, Spring 2007, Spring 2008, Spring 2009.

International Programs

"Environmental Planning and Management," 5 week program for visiting Chinese delegation, 1994.

"Environmental Planning and Management," 1 day program for visiting Russian delegation, 1995.

"Air Pollution Planning and Management," IEP, UCR, Spring 1996.

"Environmental Issues and Air Pollution," IEP, UCR, October 1996.

PROFESSIONAL AFFILIATIONS AND HONORS

President of India Gold Medal, IIT Kharagpur, India, 1983.

Member of the Alternatives Assessment Committee of the Grand Canyon Visibility Transport Commission, established by the Clean Air Act Amendments of 1990, 1992.

American Society of Mechanical Engineers: Los Angeles Section Executive Committee, Heat Transfer Division, and Fuels and Combustion Technology Division, 1987-mid-1990s.

Air and Waste Management Association, West Coast Section, 1989-mid-2000s.

PROFESSIONAL CERTIFICATIONS

EIT, California (#XE088305), 1993.

REA I, California (#07438), 2000.

Certified Permitting Professional, South Coast AQMD (#C8320), since 1993.

QEP, Institute of Professional Environmental Practice, since 2000.

CEM, State of Nevada (#EM-1699). Expiration 10/07/2021.

PUBLICATIONS (PARTIAL LIST)

"Physical Properties and Oxidation Rates of Chars from Bituminous Coals," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **67**, 275-283 (1988).

"Char Combustion: Measurement and Analysis of Particle Temperature Histories," with R.C. Flagan, G.R. Gavalas and P.S. Northrop, *Comb. Sci. Tech.* **60**, 215-230 (1988).

"On the Combustion of Bituminous Coal Chars," PhD Thesis, California Institute of Technology (1988).

"Optical Pyrometry: A Powerful Tool for Coal Combustion Diagnostics," *J. Coal Quality*, **8**, 17-22 (1989).

"Post-Ignition Transients in the Combustion of Single Char Particles," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **68**, 849-855 (1989).

"A Model for Single Particle Combustion of Bituminous Coal Char." Proc. ASME National Heat Transfer Conference, Philadelphia, **HTD-Vol. 106**, 505-513 (1989).

"Discrete Simulation of Cenospheric Coal-Char Combustion," with R.C. Flagan and G.R. Gavalas, *Combust. Flame*, **77**, 337-346 (1989).

"Particle Measurements in Coal Combustion," with R.C. Flagan, in "**Combustion Measurements**" (ed. N. Chigier), Hemisphere Publishing Corp. (1991).

"Cross Linking in Pore Structures and Its Effect on Reactivity," with G.R. Gavalas in preparation.

"Natural Frequencies and Mode Shapes of Straight Tubes," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Optimal Tube Layouts for Kamui SL-Series Exchangers," with K. Ishihara, Proprietary Report for Kamui Company Limited, Tokyo, Japan (1990).

"HTRI Process Heater Conceptual Design," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Asymptotic Theory of Transonic Wind Tunnel Wall Interference," with N.D. Malmuth and others, Arnold Engineering Development Center, Air Force Systems Command, USAF (1990).

"Gas Radiation in a Fired Heater Convection Section," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1990).

"Heat Transfer and Pressure Drop in NTIW Heat Exchangers," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1991).

"NOx Control and Thermal Design," Thermal Engineering Tech Briefs, (1994).

“From Purchase of Landmark Environmental Insurance to Remediation: Case Study in Henderson, Nevada,” with Robin E. Bain and Jill Quillin, presented at the AQMA Annual Meeting, Florida, 2001.

“The Jones Act Contribution to Global Warming, Acid Rain and Toxic Air Contaminants,” with Charles W. Botsford, presented at the AQMA Annual Meeting, Florida, 2001.

PRESENTATIONS (PARTIAL LIST)

"Pore Structure and Combustion Kinetics - Interpretation of Single Particle Temperature-Time Histories," with P.S. Northrop, R.C. Flagan and G.R. Gavalas, presented at the AIChE Annual Meeting, New York (1987).

"Measurement of Temperature-Time Histories of Burning Single Coal Char Particles," with R.C. Flagan, presented at the American Flame Research Committee Fall International Symposium, Pittsburgh, (1988).

"Physical Characterization of a Cenospheric Coal Char Burned at High Temperatures," with R.C. Flagan and G.R. Gavalas, presented at the Fall Meeting of the Western States Section of the Combustion Institute, Laguna Beach, California (1988).

"Control of Nitrogen Oxide Emissions in Gas Fired Heaters - The Retrofit Experience," with G. P. Croce and R. Patel, presented at the International Conference on Environmental Control of Combustion Processes (Jointly sponsored by the American Flame Research Committee and the Japan Flame Research Committee), Honolulu, Hawaii (1991).

"Air Toxics - Past, Present and the Future," presented at the Joint AIChE/AAEE Breakfast Meeting at the AIChE 1991 Annual Meeting, Los Angeles, California, November 17-22 (1991).

"Air Toxics Emissions and Risk Impacts from Automobiles Using Reformulated Gasolines," presented at the Third Annual Current Issues in Air Toxics Conference, Sacramento, California, November 9-10 (1992).

"Air Toxics from Mobile Sources," presented at the Environmental Health Sciences (ESE) Seminar Series, UCLA, Los Angeles, California, November 12, (1992).

"Kilns, Ovens, and Dryers - Present and Future," presented at the Gas Company Air Quality Permit Assistance Seminar, Industry Hills Sheraton, California, November 20, (1992).

"The Design and Implementation of Vehicle Scrapping Programs," presented at the 86th Annual Meeting of the Air and Waste Management Association, Denver, Colorado, June 12, 1993.

"Air Quality Planning and Control in Beijing, China," presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, Ohio, June 19-24, 1994.

Annex A

Expert Litigation Support

A. Occasions where Dr. Sahu has provided Written or Oral testimony before Congress:

1. In July 2012, provided expert written and oral testimony to the House Subcommittee on Energy and the Environment, Committee on Science, Space, and Technology at a Hearing entitled "Hitting the Ethanol Blend Wall – Examining the Science on E15."

B. Matters for which Dr. Sahu has provided affidavits and expert reports include:

2. Affidavit for Rocky Mountain Steel Mills, Inc. located in Pueblo Colorado – dealing with the technical uncertainties associated with night-time opacity measurements in general and at this steel mini-mill.
3. Expert reports and depositions (2/28/2002 and 3/1/2002; 12/2/2003 and 12/3/2003; 5/24/2004) on behalf of the United States in connection with the Ohio Edison NSR Cases. *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).
4. Expert reports and depositions (5/23/2002 and 5/24/2002) on behalf of the United States in connection with the Illinois Power NSR Case. *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).
5. Expert reports and depositions (11/25/2002 and 11/26/2002) on behalf of the United States in connection with the Duke Power NSR Case. *United States, et al. v. Duke Energy Corp.*, 1:00-CV-1262 (Middle District of North Carolina).
6. Expert reports and depositions (10/6/2004 and 10/7/2004; 7/10/2006) on behalf of the United States in connection with the American Electric Power NSR Cases. *United States, et al. v. American Electric Power Service Corp., et al.*, C2-99-1182, C2-99-1250 (Southern District of Ohio).
7. Affidavit (March 2005) on behalf of the Minnesota Center for Environmental Advocacy and others in the matter of the Application of Heron Lake BioEnergy LLC to construct and operate an ethanol production facility – submitted to the Minnesota Pollution Control Agency.
8. Expert Report and Deposition (10/31/2005 and 11/1/2005) on behalf of the United States in connection with the East Kentucky Power Cooperative NSR Case. *United States v. East Kentucky Power Cooperative, Inc*., 5:04-cv-00034-KSF (Eastern District of Kentucky).
9. Affidavits and deposition on behalf of Basic Management Inc. (BMI) Companies in connection with the BMI vs. USA remediation cost recovery Case.
10. Expert Report on behalf of Penn Future and others in the Cambria Coke plant permit challenge in Pennsylvania.
11. Expert Report on behalf of the Appalachian Center for the Economy and the Environment and others in the Western Greenbrier permit challenge in West Virginia.
12. Expert Report, deposition (via telephone on January 26, 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark Fork Coalition (CFC)) in the Thompson River Cogeneration LLC Permit No. 3175-04 challenge.

13. Expert Report and deposition (2/2/07) on behalf of the Texas Clean Air Cities Coalition at the Texas State Office of Administrative Hearings (SOAH) in the matter of the permit challenges to TXU Project Apollo's eight new proposed PRB-fired PC boilers located at seven TX sites.

14. Expert Testimony (July 2007) on behalf of the Izaak Walton League of America and others in connection with the acquisition of power by Xcel Energy from the proposed Gascoyne Power Plant – at the State of Minnesota, Office of Administrative Hearings for the Minnesota PUC (MPUC No. E002/CN-06-1518; OAH No. 12-2500-17857-2).

15. Affidavit (July 2007) Comments on the Big Cajun I Draft Permit on behalf of the Sierra Club – submitted to the Louisiana DEQ.

16. Expert Report and Deposition (12/13/2007) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case. *Plaintiffs v. Allegheny Energy Inc., et al.,* 2:05cv0885 (Western District of Pennsylvania).

17. Expert Reports and Pre-filed Testimony before the Utah Air Quality Board on behalf of Sierra Club in the Sevier Power Plant permit challenge.

18. Expert Report and Deposition (October 2007) on behalf of MTD Products Inc., in connection with *General Power Products, LLC v MTD Products Inc*., 1:06 CVA 0143 (Southern District of Ohio, Western Division) .

19. Expert Report and Deposition (June 2008) on behalf of Sierra Club and others in the matter of permit challenges (Title V: 28.0801-29 and PSD: 28.0803-PSD) for the Big Stone II unit, proposed to be located near Milbank, South Dakota.

20. Expert Reports, Affidavit, and Deposition (August 15, 2008) on behalf of Earthjustice in the matter of air permit challenge (CT-4631) for the Basin Electric Dry Fork station, under construction near Gillette, Wyoming before the Environmental Quality Council of the State of Wyoming.

21. Affidavits (May 2010/June 2010 in the Office of Administrative Hearings))/Declaration and Expert Report (November 2009 in the Office of Administrative Hearings) on behalf of NRDC and the Southern Environmental Law Center in the matter of the air permit challenge for Duke Cliffside Unit 6. Office of Administrative Hearing Matters 08 EHR 0771, 0835 and 0836 and 09 HER 3102, 3174, and 3176 (consolidated).

22. Declaration (August 2008), Expert Report (January 2009), and Declaration (May 2009) on behalf of Southern Alliance for Clean Energy in the matter of the air permit challenge for Duke Cliffside Unit 6. *Southern Alliance for Clean Energy et al., v. Duke Energy Carolinas, LLC*, Case No. 1:08-cv-00318-LHT-DLH (Western District of North Carolina, Asheville Division).

23. Declaration (August 2008) on behalf of the Sierra Club in the matter of Dominion Wise County plant MACT.us

24. Expert Report (June 2008) on behalf of Sierra Club for the Green Energy Resource Recovery Project, MACT Analysis.

25. Expert Report (February 2009) on behalf of Sierra Club and the Environmental Integrity Project in the matter of the air permit challenge for NRG Limestone's proposed Unit 3 in Texas.

26. Expert Report (June 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al.*

27. Expert Report (August 2009) on behalf of Sierra Club and the Southern Environmental Law Center in the matter of the air permit challenge for Santee Cooper's proposed Pee Dee plant in South Carolina).

28. Statements (May 2008 and September 2009) on behalf of the Minnesota Center for Environmental Advocacy to the Minnesota Pollution Control Agency in the matter of the Minnesota Haze State Implementation Plans.

29. Expert Report (August 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

30. Expert Report and Rebuttal Report (September 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

31. Expert Report (December 2009) and Rebuttal reports (May 2010 and June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

32. Pre-filed Testimony (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

33. Pre-filed Testimony (July 2010) and Written Rebuttal Testimony (August 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions*, No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

34. Expert Report (August 2010) and Rebuttal Expert Report (October 2010) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana) – Liability Phase.

35. Declaration (August 2010), Reply Declaration (November 2010), Expert Report (April 2011), Supplemental and Rebuttal Expert Report (July 2011) on behalf of the United States in the matter of DTE Energy Company and Detroit Edison Company (Monroe Unit 2). *United States of America v. DTE Energy Company and Detroit Edison Company*, Civil Action No. 2:10-cv-13101-BAF-RSW (Eastern District of Michigan).

36. Expert Report and Deposition (August 2010) as well as Affidavit (September 2010) on behalf of Kentucky Waterways Alliance, Sierra Club, and Valley Watch in the matter of challenges to the NPDES permit issued for the Trimble County power plant by the Kentucky Energy and Environment Cabinet to Louisville Gas and Electric, File No. DOW-41106-047.

37. Expert Report (August 2010), Rebuttal Expert Report (September 2010), Supplemental Expert Report (September 2011), and Declaration (November 2011) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (District of Colorado).

38. Written Direct Expert Testimony (August 2010) and Affidavit (February 2012) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

39. Deposition (August 2010) on behalf of Environmental Defense, in the matter of the remanded permit challenge to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

40. Expert Report, Supplemental/Rebuttal Expert Report, and Declarations (October 2010, November 2010, September 2012) on behalf of New Mexico Environment Department (Plaintiff-Intervenor), Grand Canyon Trust and Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. Public Service Company of New Mexico* (PNM), Civil No. 1:02-CV-0552 BB/ATC (ACE) (District of New Mexico).

41. Expert Report (October 2010) and Rebuttal Expert Report (November 2010) (BART Determinations for PSCo Hayden and CSU Martin Drake units) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

42. Expert Report (November 2010) (BART Determinations for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

43. Declaration (November 2010) on behalf of the Sierra Club in connection with the Martin Lake Station Units 1, 2, and 3. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Case No. 5:10-cv-00156-DF-CMC (Eastern District of Texas, Texarkana Division).

44. Pre-Filed Testimony (January 2011) and Declaration (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf

Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

45. Declaration (February 2011) in the matter of the Draft Title V Permit for RRI Energy MidAtlantic Power Holdings LLC Shawville Generating Station (Pennsylvania), ID No. 17-00001 on behalf of the Sierra Club.

46. Expert Report (March 2011), Rebuttal Expert Report (June 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

47. Declaration (April 2011) and Expert Report (July 16, 2012) in the matter of the Lower Colorado River Authority (LCRA)'s Fayette (Sam Seymour) Power Plant on behalf of the Texas Campaign for the Environment. *Texas Campaign for the Environment v. Lower Colorado River Authority*, Civil Action No. 4:11-cv-00791 (Southern District of Texas, Houston Division).

48. Declaration (June 2011) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

49. Expert Report (June 2011) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

50. Declaration (August 2011) in the matter of the Sandy Creek Energy Associates L.P. Sandy Creek Power Plant on behalf of Sierra Club and Public Citizen. *Sierra Club, Inc. and Public Citizen, Inc. v. Sandy Creek Energy Associates, L.P.*, Civil Action No. A-08-CA-648-LY (Western District of Texas, Austin Division).

51. Expert Report (October 2011) on behalf of the Defendants in the matter of *John Quiles and Jeanette Quiles et al. v. Bradford-White Corporation, MTD Products, Inc., Kohler Co., et al.*, Case No. 3:10-cv-747 (TJM/DEP) (Northern District of New York).

52. Declaration (October 2011) on behalf of the Plaintiffs in the matter of *American Nurses Association et. al. (Plaintiffs), v. US EPA (Defendant)*, Case No. 1:08-cv-02198-RMC (US District Court for the District of Columbia).

53. Declaration (February 2012) and Second Declaration (February 2012) in the matter of *Washington Environmental Council and Sierra Club Washington State Chapter v. Washington State Department of Ecology and Western States Petroleum Association*, Case No. 11-417-MJP (Western District of Washington).

54. Expert Report (March 2012) and Supplemental Expert Report (November 2013) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v. ExxonMobil Corporation et al.*, Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

55. Declaration (March 2012) in the matter of *Center for Biological Diversity, et al. v. United States Environmental Protection Agency*, Case No. 11-1101 (consolidated with 11-1285, 11-1328 and 11-1336) (US Court of Appeals for the District of Columbia Circuit).

56. Declaration (March 2012) in the matter of *Sierra Club v. The Kansas Department of Health and Environment*, Case No. 11-105,493-AS (Holcomb power plant) (Supreme Court of the State of Kansas).

57. Declaration (March 2012) in the matter of the Las Brisas Energy Center *Environmental Defense Fund et al., v. Texas Commission on Environmental Quality*, Cause No. D-1-GN-11-001364 (District Court of Travis County, Texas, 261st Judicial District).

58. Expert Report (April 2012), Supplemental and Rebuttal Expert Report (July 2012), and Supplemental Rebuttal Expert Report (August 2012) on behalf of the states of New Jersey and Connecticut in the matter of the Portland Power plant *State of New Jersey and State of Connecticut (Intervenor-Plaintiff) v. RRI Energy Mid-Atlantic Power Holdings et al.*, Civil Action No. 07-CV-5298 (JKG) (Eastern District of Pennsylvania).

59. Declaration (April 2012) in the matter of the EPA's EGU MATS Rule, on behalf of the Environmental Integrity Project.

60. Expert Report (August 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana) – Harm Phase.

61. Declaration (September 2012) in the Matter of the Application of *Energy Answers Incinerator, Inc.* for a Certificate of Public Convenience and Necessity to Construct a 120 MW Generating Facility in Baltimore City, Maryland, before the Public Service Commission of Maryland, Case No. 9199.

62. Expert Report (October 2012) on behalf of the Appellants (Robert Concilus and Leah Humes) in the matter of Robert Concilus and Leah Humes v. Commonwealth of Pennsylvania Department of Environmental Protection and Crawford Renewable Energy, before the Commonwealth of Pennsylvania Environmental Hearing Board, Docket No. 2011-167-R.

63. Expert Report (October 2012), Supplemental Expert Report (January 2013), and Affidavit (June 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

64. Pre-filed Testimony (October 2012) on behalf of No-Sag in the matter of the North Springfield Sustainable Energy Project before the State of Vermont, Public Service Board.

65. Pre-filed Testimony (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

66. Expert Report (February 2013) on behalf of Petitioners in the matter of Credence Crematory, Cause No. 12-A-J-4538 before the Indiana Office of Environmental Adjudication.

67. Expert Report (April 2013), Rebuttal report (July 2013), and Declarations (October 2013, November 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

68. Declaration (April 2013) on behalf of Petitioners in the matter of *Sierra Club, et al., (Petitioners) v Environmental Protection Agency et al. (Resppondents)*, Case No., 13-1112, (Court of Appeals, District of Columbia Circuit).

69. Expert Report (May 2013) and Rebuttal Expert Report (July 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

70. Declaration (August 2013) on behalf of A. J. Acosta Company, Inc., in the matter of *A. J. Acosta Company, Inc., v. County of San Bernardino*, Case No. CIVSS803651.

71. Comments (October 2013) on behalf of the Washington Environmental Council and the Sierra Club in the matter of the Washington State Oil Refinery RACT (for Greenhouse Gases), submitted to the Washington State Department of Ecology, the Northwest Clean Air Agency, and the Puget Sound Clean Air Agency.

72. Statement (November 2013) on behalf of various Environmental Organizations in the matter of the Boswell Energy Center (BEC) Unit 4 Environmental Retrofit Project, to the Minnesota Public Utilities Commission, Docket No. E-015/M-12-920.

73. Expert Report (December 2013) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

74. Expert Testimony (December 2013) on behalf of the Sierra Club in the matter of Public Service Company of New Hampshire Merrimack Station Scrubber Project and Cost Recovery, Docket No. DE 11-250, to the State of New Hampshire Public Utilities Commission.

75. Expert Report (January 2014) on behalf of Baja, Inc., in *Baja, Inc., v. Automotive Testing and Development Services, Inc. et. al*, Civil Action No. 8:13-CV-02057-GRA (District of South Carolina, Anderson/Greenwood Division).

76. Declaration (March 2014) on behalf of the Center for International Environmental Law, Chesapeake Climate Action Network, Friends of the Earth, Pacific Environment, and the Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. the Export-Import Bank (Ex-Im Bank) of the United States*, Civil Action No. 13-1820 RC (District Court for the District of Columbia).

77. Declaration (April 2014) on behalf of Respondent-Intervenors in the matter of *Mexichem Specialty Resins Inc., et al., (Petitioners) v Environmental Protection Agency et al.,* Case No., 12-1260 (and Consolidated Case Nos. 12-1263, 12-1265, 12-1266, and 12-1267), (Court of Appeals, District of Columbia Circuit).

78. Direct Prefiled Testimony (June 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17319 (Michigan Public Service Commission).

79. Expert Report (June 2014) on behalf of ECM Biofilms in the matter of the US Federal Trade Commission (FTC) v. ECM Biofilms (FTC Docket #9358).

80. Direct Prefiled Testimony (August 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of Consumers Energy Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17317 (Michigan Public Service Commission).

81. Declaration (July 2014) on behalf of Public Health Intervenors in the matter of *EME Homer City Generation v. US EPA* (Case No. 11-1302 and consolidated cases) relating to the lifting of the stay entered by the Court on December 30, 2011 (US Court of Appeals for the District of Columbia).

82. Expert Report (September 2014), Rebuttal Expert Report (December 2014) and Supplemental Expert Report (March 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland General Electric Company, Northwestern Corporation, and Pacificorp (Defendants),* Civil Action No. CV 13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

83. Expert Report (November 2014) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

84. *Declaration (January 2015) relating to Startup/Shutdown in the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.*

85. Pre-filed Direct Testimony (March 2015), Supplemental Testimony (May 2015), and Surrebuttal Testimony (December 2015) on behalf of Friends of the Columbia Gorge in the matter of the Application for a Site Certificate for the Troutdale Energy Center before the Oregon Energy Facility Siting Council.

86. Brief of Amici Curiae Experts in Air Pollution Control and Air Quality Regulation in Support of the Respondents, On Writs of Certiorari to the US Court of Appeals for the District of Columbia, No. 14-46, 47, 48. *Michigan et. al., (Petitioners) v. EPA et. al., Utility Air Regulatory Group (Petitioners) v. EPA et. al., National Mining Association et. al., (Petitioner) v. EPA et. al.,* (Supreme Court of the United States).

87. Expert Report (March 2015) and Rebuttal Expert Report (January 2016) on behalf of Plaintiffs in the matter of *Conservation Law Foundation v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants),* Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

88. Declaration (April 2015) relating to various Technical Corrections for the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.

89. Direct Prefiled Testimony (May 2015) on behalf of the Michigan Environmental Council, the Natural Resources Defense Council, and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Increase its Rates, Amend its Rate Schedules and Rules Governing the Distribution and Supply of Electric Energy and for Miscellaneous Accounting Authority, Case No. U-17767 (Michigan Public Service Commission).

90. Expert Report (July 2015) and Rebuttal Expert Report (July 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

91. Declaration (August 2015, Docket No. 1570376) in support of "Opposition of Respondent-Intervenors American Lung Association, et. al., to Tri-State Generation's Emergency Motion;" Declaration (September 2015, Docket No. 1574820) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors for Remand Without Vacatur;" Declaration (October 2015) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors to State and Certain Industry Petitioners' Motion to Govern, *White Stallion Energy Center, LLC v. US EPA*, Case No. 12-1100 (US Court of Appeals for the District of Columbia).

92. Declaration (September 2015) in support of the Draft Title V Permit for Dickerson Generating Station (Proposed Permit No 24-031-0019) on behalf of the Environmental Integrity Project.

93. Expert Report (Liability Phase) (December 2015) and Rebuttal Expert Report (February 2016) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., Environmental Law and Policy Center, and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

94. Declaration (December 2015) in support of the Petition to Object to the Title V Permit for Morgantown Generating Station (Proposed Permit No 24-017-0014) on behalf of the Environmental Integrity Project.

95. Expert Report (November 2015) on behalf of Appellants in the matter of *Sierra Club, et al. v. Craig W. Butler, Director of Ohio Environmental Protection Agency et al.*, ERAC Case No. 14-256814.

96. Affidavit (January 2016) on behalf of Bridgewatch Detroit in the matter of *Bridgewatch Detroit v. Waterfront Petroleum Terminal Co., and Waterfront Terminal Holdings, LLC.*, in the Circuit Court for the County of Wayne, State of Michigan.

97. Expert Report (February 2016) and Rebuttal Expert Report (July 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

98. Direct Testimony (May 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

99. Declaration (June 2016) relating to deficiencies in air quality analysis for the proposed Millenium Bulk Terminal, Port of Longview, Washington.

100. Declaration (December 2016) relating to EPA's refusal to set limits on PM emissions from coal-fired power plants that reflect pollution reductions achievable with fabric filters on behalf of Environmental Integrity Project, Clean Air Council, Chesapeake Climate Action Network, Downwinders at Risk represented by Earthjustice in the matter of *ARIPPA v EPA, Case No. 15-1180.* (D.C. Circuit Court of Appeals).

101. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

102. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Backus Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

103. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Drakulic Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

104. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Deutsch Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

105. Affidavit (February 2017) pertaining to deficiencies water discharge compliance issues at the Wood River Refinery in the matter of *People of the State of Illinois (Plaintiff) v. Phillips 66 Company, ConocoPhillips Company, WRB Refining LP (Defendants)*, Case No. 16-CH-656, (Circuit Court for the Third Judicial Circuit, Madison County, Illinois).

106. Expert Report (March 2017) on behalf of the Plaintiff pertaining to non-degradation analysis for waste water discharges from a power plant in the matter of *Sierra Club (Plaintiff) v. Pennsylvania Department of Environmental Protection (PADEP) and Lackawanna Energy Center*, Docket No. 2016-047-L (consolidated), (Pennsylvania Environmental Hearing Board).

107. Expert Report (March 2017) on behalf of the Plaintiff pertaining to air emissions from the Heritage incinerator in East Liverpool, Ohio in the matter of *Save our County (Plaintiff) v. Heritage Thermal Services, Inc. (Defendant), Case No. 4:16-CV-1544-BYP*, (US District Court for the Northern District of Ohio, Eastern Division).

108. Rebuttal Expert Report (June 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight (Plaintiffs) v Coyote Creek Mining Company LLC (Defendant),* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

109. Expert Affidavit (August 2017) and Penalty/Remedy Expert Affidavit (October 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant,)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

110. Expert Report (August 2017) on behalf of Appellant in the matter of *Patricia Ann Troiano (Appellant) v. Upper Burrell Township Zoning Hearing Board (Appellee)*, Court of Common Pleas of Westmoreland County, Pennsylvania, Civil Division.

111. Expert Report (October 2017), Supplemental Expert Report (October 2017), and Rebuttal Expert Report (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

112. Declaration (December 2017) on behalf of the Environmental Integrity Project in the matter of permit issuance for ATI Flat Rolled Products Holdings, Breckenridge, PA to the Allegheny County Health Department.

113. Expert Report (Harm Phase) (January 2018), Rebuttal Expert Report (Harm Phase) (May 2018) and Supplemental Expert Report (Harm Phase) (April 2019) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

114. Declaration (February 2018) on behalf of the Chesapeake Bay Foundation, et. al., in the matter of the Section 126 Petition filed by the state of Maryland in *State of Maryland v. Pruitt (Defendant)*, Civil Action No. JKB-17-2939 (Consolidated with No. JKB-17-2873) (US District Court for the District of Maryland).

115. Direct Pre-filed Testimony (March 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of *NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC,* PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

116. Expert Affidavit (April 2018) and Second Expert Affidavit (May 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

117. Direct Pre-filed Testimony and Affidavit (December 2018) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

118. Expert Report (February 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

119. Declaration (March 2019) on behalf of Earthjustice in the matter of comments on the renewal of the Title V Federal Operating Permit for Valero Houston refinery.

120. Expert Report (March 2019) on behalf of Plaintiffs for Class Certification in the matter of *Resendez et al v Precision Castparts Corporation* in the Circuit Court for the State of Oregon, County of Multnomah, Case No. 16cv16164.

121. Expert Report (June 2019), Affidavit (July 2019) and Rebuttal Expert Report (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellants) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

122. Affidavit/Expert Report (August 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

123. Expert Report (October 2019) relating to the appeal of air permit (Plan Approval) on behalf of Appellants in the matter of *Clean Air Council and Environmental Integrity Project (Appellants) v. Commonwealth of Pennsylvania Department of Environmental Protection and Sunoco Partners Marketing and Terminals L.P.*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-057-L.

124. Expert Report (December 2019), Affidavit (March 2020), Supplemental Expert Report (July 2020), and Declaration (February 2021) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

125. Affidavit (December 2019) on behalf of Plaintiff-Intervenor (Surfrider Foundation) in the matter of *United States and the State of Indiana (Plaintiffs), Surfrider Foundation (Plaintiff-Intervenor), and City of Chicago (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant),* Civil Action No. 2:18-cv-00127 (US District Court for the Northern District of Indiana, Hammond Division).

126. Declarations (January 2020, February 2020, May 2020, July 2020, and August 2020) and Pre-filed Testimony (April 2021) in support of Petitioner's Motion for Stay of PSCAA NOC Order of Approval No. 11386 in the matter of the *Puyallup Tribe of Indians v. Puget Sound Clean Air Agency (PSCAA) and Puget Sound Energy (PSE),* before the State of Washington Pollution Control Hearings Board, PCHB No. P19-088.

127. Expert Report (April 2020) on behalf of the plaintiff in the matter of Orion Engineered Carbons, GmbH (Plaintiff) vs. Evonik Operations, GmbH (formerly Evonik Degussa GmbH) (Respondent), before the German Arbitration Institute, Case No. DIS-SV-2019-00216.

128. Expert Independent Evaluation Report (June 2020) for *PacifiCorp's Decommissioning Costs Study Reports dated January 15, 2020 and March 13, 2020 relating to the closures of the Hunter, Huntington, Dave Johnston, Jim Bridger, Naughton, Wyodak, Hayden, and Colstrip (Units 3&4) plants*, prepared for the Oregon Public Utility Commission (Oregon PUC).

129. Direct Pre-filed Testimony (July 2020) on behalf of the Sierra Club in the matter of *the Application of the Ohio State University for a certificate of Environmental Compatibility and Public Need to Construct a Combined Heat and Power Facility in Franklin County, Ohio*, before the Ohio Power Siting Board, Case No. 19-1641-EL-BGN.

130. Expert Report (August 2020) and Rebuttal Expert Report (September 2020) on behalf of WildEarth Guardians (petitioners) in the matter of *the Appeals of the Air Quality Permit No. 7482-M1 Issued to 3 Bear Delaware Operating – NM LLC (EIB No. 20-21(A) and Registrations Nos. 8729, 8730, and 8733 under General Construction Permit for Oil and Gas Facilities (EIB No. 20-33 (A)*, before the State of New Mexico, Environmental Improvement Board.

131. Expert Report (July 2020) on the *Initial Economic Impact Analysis (EIA) for A Proposal To* Regulate *NOx Emissions from Natural Gas Fired Rich-Burn Natural Gas Reciprocating Internal Combustion Engines (RICE) Greater Than 100 Horsepower* prepared on behalf of Earthjustice and the National Parks Conservation Association in the matter of Regulation Number 7, Alternate Rules before the Colorado Air Quality Control Commission.

132. Expert Report (August 2020) and Supplemental Expert Report (February 2021) on the Potential Remedies to Avoid Adverse Thermal Impacts from the Merrimack Station on behalf of Plaintiffs in the matter of *Sierra Club Inc. and the* Conservation *Law Foundation (Plaintiffs) v. Granite Shore Power, LLC et. al., (Defendants)*, Civil Action No. 19-cv-216-JL (US District Court for the District of New Hampshire.)

133. Expert Report (August 2020) and Supplemental Expert Report (December 2020) on behalf of Plaintiffs in the matter of *PennEnvironment Inc., and Clean Air Council (Plaintiffs) and Allegheny County Health Department (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant)*, Civil Action No. 2-19-cv-00484-MJH (US District Court for the Western District of Pennsylvania.)

134. Pre-filed Direct Testimony (October 2020) and Sur-rebuttal Testimony (November 2020) on behalf of petitioners (Ten Persons Group, including citizens, the Town of Braintree, the Town of Hingham, and the City of Quincy) in the matter of Algonquin Gas Transmission LLC, Weymouth MA, No. X266786 Air Quality Plan Approval, before the Commonwealth of Massachusetts, Department of Environmental Protection, the Office of Appeals and Dispute Resolution, OADR Docket Nos. 2019-008, 2019-009, 2019010, 2019-011, 2019-012 and 2019-013.

135. Expert Report (November 2020) on behalf of Protect PT in the matter of *Protect PT v. Commonwealth of Pennsylvania Department of Environmental Protection and Apex Energy (PA) LLC*, before the Commonwealth of Pennsylvania Environmental Hearing Board, Docket No. 2018-080-R (consolidated with 2019-101-R)(the "Drakulic Appeal").

136. Expert Report (December 2020) on behalf of Plaintiffs in the matter of *Sierra Club Inc. (Plaintiff) v. GenOn Power Midwest LP (Defendants)*, Civil Action No. 2-19-cv-01284-WSS (US District Court for the Western District of Pennsylvania.)

137. Pre-filed Testimony (January 2021) on behalf of the Plaintiffs (Shrimpers and Fishermen of the Rio Grande Valley represented by Texas RioGrande Legal Aid, Inc.) in the matter of the Appeal of Texas Commission on Environmental Quality (TCEQ) Permit Nos. 147681, PSDTX1522, GHGPSDTX172 for the Jupiter Brownsville Heavy Condensate Upgrader Facility, Cameron County, before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-21-0111, TCEQ Docket No. 2020-1080-AIR.

138. Expert Report (June 2021) and Declarations (May 2021 and June 2021) on behalf of Plaintiffs in the matter of *Sierra Club (Plaintiff) v. Woodville Pellets, LLC (Defendant)*, Civil Action No. 9:20-cv-00178-MJT (US District Court for the Eastern District of Texas, Lufkin Division.)

139. Declaration (July 2021) on behalf of Plaintiffs in the matter of *Stephanie Mackey and Nick Migliore, on behalf of themselves and all others similarly situated (Plaintiffs) v. Chemtool Inc. and Lubrizol Corporation (Defendants)*, Case No. 2021-L-0000165, State of Illinois, Circuit Court of the 17th Judicial Circuit, Winnebago County.

140. Expert Report (April 2021) and Sur-Rebuttal Report (June 2021) on behalf of the Plaintiffs in the matter of *Modern Holdings, LLC, et al. (Plaintiffs) v. Corning Inc., et al. (Defendants)*, Civil Action No. 5:13-cv-00405-GFVT, (US District Court for the Eastern District of Kentucky, Central Division at Lexington).

141. Expert Witness Disclosure (June 2021) on behalf of the Plaintiffs in the matter of *Jay Burdick, et. al., (Plaintiffs) v. Tanoga Inc. (d/b/a Taconic) (Defendant)*, Index No. 253835, (State of New York Supreme Court, County of Rensselaer).

142. Expert Report (June 2021) on behalf of Appellants in the matter of *PennEnvironment and Earthworks (Appellants) v. Commonwealth of Pennsylvania Department of Environmental Protection (Appellee) and MarkWest Liberty Midstream and resource, LLC (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2020-002-R.

143. Expert Reports (March 2021 and May 2021) regarding the Aries Newark LLC Sludge Processing Facility, Application No. CPB 20-74, Central Planning Board, City of Newark, New Jersey.

144. Expert Report (April 2021) for *Charles Johnson Jr. (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:20-CV-01329. (US District Court for the Eastern District of Louisiana, New Orleans Division).

145. Expert Report (April 2021) for *Floyd Ruffin (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:20-cv-00334-CJB-JCW (US District Court for the Eastern District of Louisiana, New Orleans Division).

146. Expert Report (May 2021) for *Clifford Osmer (Plaintiff) v. BP Exploration and Production Inc., et. al., (Defendants)* related to No. 2:19-CV-10331 (US District Court for the Eastern District of Louisiana, New Orleans Division).

147. Expert Report (June 2021) for *Antonia Saavedra-Vargas (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:18-CV-11461 (US District Court for the Eastern District of Louisiana, New Orleans Division).

148. Affidavit (June 2021) for Lourdes Rubi in the matter of *Lourdes Rubi (Plaintiff) v. BP Exploration and Production Inc., et. al., (Defendants),* related to 12-968 BELO in MDL No. 2179 (US District Court for the Eastern District of Louisiana, New Orleans Division).

149. Expert Report (May 2021) for *James Noel (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 1:19-CV-00694 (US District Court for the Southern District of Alabama, Mobile Division).

150. Expert Report (June 2021) for *Wallace Smitht (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:19-CV-12880 (US District Court for the Eastern District of Louisiana, New Orleans Division).

C. Occasions where Dr. Sahu has provided oral testimony <u>in depositions, at trial or in similar proceedings</u> include the following:

151. Deposition on behalf of Rocky Mountain Steel Mills, Inc. located in Pueblo, Colorado – dealing with the manufacture of steel in mini-mills including methods of air pollution control and BACT in steel mini-mills and opacity issues at this steel mini-mill.

152. Trial Testimony (February 2002) on behalf of Rocky Mountain Steel Mills, Inc. in Denver District Court.

153. Trial Testimony (February 2003) on behalf of the United States in the Ohio Edison NSR Cases, *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).

154. Trial Testimony (June 2003) on behalf of the United States in the Illinois Power NSR Case, *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).

155. Deposition (10/20/2005) on behalf of the United States in connection with the Cinergy NSR Case. *United States, et* al. *v. Cinergy Corp., et al.*, IP 99-1693-C-M/S (Southern District of Indiana).

156. Oral Testimony (August 2006) on behalf of the Appalachian Center for the Economy and the Environment re. the Western Greenbrier plant, WV before the West Virginia DEP.

157. Oral Testimony (May 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark Fork Coalition (CFC)) re. the Thompson River Cogeneration plant before the Montana Board of Environmental Review.

158. Oral Testimony (October 2007) on behalf of the Sierra Club re. the Sevier Power Plant before the Utah Air Quality Board.

159. Oral Testimony (August 2008) on behalf of the Sierra Club and Clean Water re. Big Stone Unit II before the South Dakota Board of Minerals and the Environment.

160. Oral Testimony (February 2009) on behalf of the Sierra Club and the Southern Environmental Law Center re. Santee Cooper Pee Dee units before the South Carolina Board of Health and Environmental Control.

161. Oral Testimony (February 2009) on behalf of the Sierra Club and the Environmental Integrity Project re. NRG Limestone Unit 3 before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

162. Deposition (July 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al*.

163. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Coleto Creek coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

164. Deposition (October 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

165. Deposition (October 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

166. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Tenaska coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH). (April 2010).

167. Oral Testimony (November 2009) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

168. Deposition (December 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

169. Oral Testimony (February 2010) on behalf of the Environmental Defense Fund re. the White Stallion Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

170. Deposition (June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

171. Trial Testimony (September 2010) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, State of Maryland, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case in US District Court in the Western District of Pennsylvania. *Plaintiffs v. Allegheny Energy Inc., et al.,* 2:05cv0885 (Western District of Pennsylvania).

172. Oral Direct and Rebuttal Testimony (September 2010) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

173. Oral Testimony (September 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions*, No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

174. Oral Testimony (October 2010) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

175. Oral Testimony (November 2010) regarding BART for PSCo Hayden, CSU Martin Drake units before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

176. Oral Testimony (December 2010) regarding BART for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

177. Deposition (December 2010) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC,* 09-CV100-RET-CN (Middle District of Louisiana).

178. Deposition (February 2011 and January 2012) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (D. Colo.).

179. Oral Testimony (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

180. Deposition (August 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

181. Deposition (July 2011) and Oral Testimony at Hearing (February 2012) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

182. Oral Testimony at Hearing (March 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana).

183. Oral Testimony at Hearing (April 2012) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

184. Oral Testimony at Hearing (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

185. Deposition (March 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

186. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

187. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

188. Deposition (February 2014) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

189. Trial Testimony (February 2014) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v. ExxonMobil Corporation et al.*, Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

190. Trial Testimony (February 2014) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

191. Deposition (June 2014) and Trial (August 2014) on behalf of ECM Biofilms in the matter of the *US Federal Trade Commission (FTC) v. ECM Biofilms* (FTC Docket #9358).

192. Deposition (February 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland General Electric Company, Northwestern Corporation, and Pacificorp (Defendants)*, Civil Action No. CV 13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

193. Oral Testimony at Hearing (April 2015) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department

of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

194. Deposition (August 2015) on behalf of Plaintiff in the matter of *Conservation Law Foundation (Plaintiff) v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants)*, Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

195. Testimony at Hearing (August 2015) on behalf of the Sierra Club in the matter of *Amendments to 35 Illinois Administrative Code Parts 214, 217, and 225* before the Illinois Pollution Control Board, R15-21.

196. Deposition (May 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

197. Trial Testimony (October 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

198. Deposition (April 2016) on behalf of the Plaintiffs in *UNatural Resources Defense Council, Respiratory Health Association, and Sierra Club (Plaintiffs) v. Illinois Power Resources LLC and Illinois Power Resources Generation LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (Central District of Illinois, Peoria Division).

199. Trial Testimony at Hearing (July 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

200. Trial Testimony (December 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

201. Trial Testimony (July-August 2016) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

202. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

203. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Backus Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

204. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Drakulic Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

205. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Deutsch Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

206. Deposition Testimony (July 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight v Coyote Creek Mining Company LLC (Defendant)* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

207. Deposition Testimony (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

208. Deposition Testimony (December 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

209. Deposition Testimony (January 2018) in the matter of National Parks Conservation Association (NPCA) v. State of Washington Department of Ecology and British Petroleum (BP) before the Washington Pollution Control Hearing Board, Case No. 17-055.

210. Trial Testimony (January 2018) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

211. Trial Testimony (April 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC, PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

212. Deposition (June 2018) (harm Phase) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

213. Trial Testimony (July 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

214. Deposition (January 2019) and Trial Testimony (January 2019) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

215. Deposition (February 2019) and Trial Testimony (March 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

216. Deposition (June 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

217. Deposition (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellants) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

218. Deposition (December 2019) on behalf of the Plaintiffs in the matter of David Kovac, individually and on behalf of wrongful death class of Irene Kovac v. BP Corporation North America Inc., Circuit Court of Jackson County, Missouri (Independence), Case No. 1816-CV12417.

219. Deposition (February 2020, virtual) and testimony at Hearing (August 2020, virtual) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

220. Hearing (July 14-15, 2020, virtual) on behalf of the Sierra Club in the matter of *the Application of the Ohio State University for a certificate of Environmental Compatibility and Public Need to Construct a Combined Heat and Power Facility in Franklin County, Ohio*, before the Ohio Power Siting Board, Case No. 19-1641-EL-BGN.

221. Hearing (September 2020, virtual) on behalf of WildEarth Guardians (petitioners) in the matter of *the Appeals of the Air Quality Permit No. 7482-M1 Issued to 3 Bear Delaware* Operating – *NM LLC (EIB No. 20-21(A)*

and Registrations Nos. 8729, 8730, and 8733 under General Construction Permit for Oil and Gas Facilities (EIB No. 20-33 (A), before the State of New Mexico, Environmental Improvement Board.

222. Deposition (December 2020, March 4-5, 2021, all virtual) and Hearing (April 2021, virtual) in support of Petitioner's Motion for Stay of PSCAA NOC Order of Approval No. 11386 in the matter of the *Puyallup Tribe of Indians v. Puget Sound Clean Air Agency (PSCAA) and Puget Sound Energy (PSE)*, before the State of Washington Pollution Control Hearings Board, PCHB No. P19-088.

223. Hearing (September 2020, virtual) on the *Initial Economic Impact Analysis (EIA) for A Proposal To* Regulate *NOx Emissions from Natural Gas Fired Rich-Burn Natural Gas Reciprocating Internal Combustion Engines (RICE) Greater Than 100 Horsepower* prepared on behalf of Earthjustice and the National Parks Conservation Association in the matter of Regulation Number 7, Alternate Rules before the Colorado Air Quality Control Commission.

224. Deposition (December 2020, virtual and Hearing February 2021, virtual) on behalf of the Plaintiffs (Shrimpers and Fishermen of the Rio Grande Valley represented by Texas RioGrande Legal Aid, Inc.) in the matter of the Appeal of Texas Commission on Environmental Quality (TCEQ) Permit Nos. 147681, PSDTX1522, GHGPSDTX172 for the Jupiter Brownsville Heavy Condensate Upgrader Facility, Cameron County, before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-21-0111, TCEQ Docket No. 2020-1080-AIR.

225. Deposition (January 2021, virtual) on behalf of Plaintiffs in the matter of *PennEnvironment Inc., and Clean Air Council (Plaintiffs) and Allegheny County Health Department (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant)*, Civil Action No. 2-19-cv-00484-MJH (US District Court for the Western District of Pennsylvania.)

226. Deposition (February 2021, virtual) on behalf of Plaintiffs in the matter of *Sierra Club Inc. (Plaintiff) v. GenOn Power Midwest LP (*Defendants*)*, Civil Action No. 2-19-cv-01284-WSS (US District Court for the Western District of Pennsylvania.)

227. Deposition (April 2021, virtual) on the Potential Remedies to Avoid Adverse Thermal Impacts from the Merrimack Station on behalf of Plaintiffs in the matter of *Sierra Club Inc. and the* Conservation *Law Foundation (Plaintiffs) v. Granite Shore Power, LLC et. al., (Defendants)*, Civil Action No. 19-cv-216-JL (US District Court for the District of New Hampshire.)

228. Deposition (June 2021, virtual) on behalf of Plaintiffs in the matter of *Sierra Club (Plaintiff) v. Woodville Pellets, LLC (Defendant)*, Civil Action No. 9:20-cv-00178-MJT (US District Court for the Eastern District of Texas, Lufkin Division).

229. Deposition (June 2021, virtual) on behalf of the Plaintiffs in the matter of *Modern Holdings, LLC, et al. (Plaintiffs) v. Corning Inc., et al. (Defendants)*, Civil Action No. 5:13-cv-00405-GFVT, (US District Court for the Eastern District of Kentucky, Central Division at Lexington).

230. Testimony (June 2021, virtual) regarding the Aries Newark LLC Sludge Processing Facility, Application No. CPB 20-74, Central Planning Board, City of Newark, New Jersey.

Attachment B

Community EIB Exhibit 3

"AP-42 Continuous Drop Equation vs Stack Testing"

Material Handler's Workshop
Tampa, Florida
December 11, 2008

Sterlin Woodard, P.E.
EPC-Hillsborough County

EPC
Material Handler's Workshop

Agenda

1 PM	*Welcome & Introduction-Sterlin Woodard*
1:10 PM	*Exemption Presentation by Diana Lee*
2 PM	*AP-42 Continuous Drop Equation Vs Stack Tests*
2:50 PM	*Open Discussion/Industry Topics*
3:30 PM	*Adjourn*

AP-42 Continuous Drop Equation vs Stack Testing

- Why Is It Important?
  - Hillsborough County
    - 7 Largest Bulk Material Port in United States
    - Rule 62-296.711, F.A.C (PM-RACT for Materials Handling limits PM to 5% opacity, or if vented to stack 0.03 gr/dscf)
    - Rule 62-296.320(4)(c),F.A.C.-requires the use of reasonable precautions to control unconfined PM emissions (use of hoods and fans to capture and/or vent PM emissions)
  - Title V/PSD Applicability & Exemptions -PTE & Actual Emissions
    - Rule 62-210(242)"Potential to Emit", F.A.C.-the maximum capacity of an emission unit or facility to emit a pollutant under its physical and operational design. Any physical or operational or operational limitation on the capacity of the emission unit or facility to emit a pollutant, including air pollution control equipment and restrictions on hours of operation or on the type or amount of material combusted, stored, or processed, shall be treated as part of its design if the limitation or the effect it would have on emissions is federally enforceable.
    - Rule 62-212.400(3)(b),F.A.C.- Don't consider fugitives in PTE unless emitted from SIC Group 28 Sources

AP-42 Continuous Drop Equation vs Stack Testing

- *Why Is It Important?*
  - *Title V/PSD Applicability & Exemptions -PTE & Actual Emissions*
    - *Material Handling transfer points are not fugitive emissions*
      - *Fugitive Emissions-Rule 62-210.200(147),F.A.C. defines them as emissions which could not reasonably pass through a stack, chimney or vent.*
      - *Unconfined Emissions-Rule 62-210.200(318),F.A.C. defines them as emissions which escape and become airborne or which are emitted into the atmosphere without being conducted through a stack.*
  - *Title V/PSD Applicability & Exemptions-PTE & Actual Emissions*

    Rule 62-210.370, F.A.C. requires the use of the most accurate method:
    - *CEM*
    - *Mass Balance*
    - *EF based upon site-specific Stack Testing (eg. lb/ton)*
    - *Published EF directly applicable to the process*
    - *EF based upon a similar, but different process*

AP-42 Continuous Drop Equation vs Stack Testing

- *Started in 2000 with Permit 0570094-003-AC @ IMC Big Bend Facility in Hillsborough County*
  - *PM EF=0.00387 lb/ton using M=0.5%; U=1.3 mph from AP-42, Section 13.2.4 (AP-42 Continuous Drop Equation)*
  - *EPC Proposed PM EF=0.06 lb/ton from AP-42, Table 8.5.3-1 & EAT Stack Test PM EF=0.05 lb/ton*

AP-42 Continuous Drop Equation vs Stack Testing

- IMC agreed to PM Stack Test in June 2000
- GTSP @ TP #3
- Results:
  - BH CE of 99%
  - PM EF of 0.01lb/ton for oiled GTSP
  - PM EF of 0.05 lb/ton for un-oiled GTSP using 80% CE for Chemical Suppression from AP-42, Table B.2-3 & AWMA Air Pollution Engineering Manual, 2nd Edition Table 3
  - Permit 0570094-003-AC issued with an Uncontrolled 0.05 lb/ton un-oiled PM EF for each Transfer Point

AP-42 Continuous Drop Equation vs Stack Testing

- Continuous Drop Equation:
  AP-42, Section 13.2.4, Equation 1

$$PM = \frac{k(0.0032)(U/5)^{1.3}}{(M/2)^{1.4}} (lb/ton)$$

U= wind speed (1.3-15 mph)

M= moisture content (0.25-4.8%)

k=particle size multiplier (0.74 < 30 μm)

Silt Content Range:0.44-19%

  - Predictive EF based upon dispersion modeling and ambient TSP monitoring. Only Measures up to PM_{30}

AP-42 Continuous Drop Equation vs Stack Testing

- Continuous Drop Equation:
  - Silt Content Missing From Continuous Drop Equation
  - No correlation with PM emissions or EPA Method 5
  - 200 Mesh Screen (ASTM-C-136) <= 75 µm
  - Typical Silt Content (AP-42 Table 13.2.4-1):
    - Limestone- 1.3%-1.9%
    - Coal-0.6%-4.8%
    - Fly Ash-78%-81%

AP-42 Continuous Drop Equation vs Stack Testing

- Stack Tests:
  - Based Upon EPA Method 1,2,4 and 5
  - Measures PM
  - Permanent/Temporary Stack Sampling Platform
  - Usually Conducted On Stacks With Well Designed Permanent Ventilation & Capture System
    - Adequate Hood Capture Velocities-200-500 fpm (ACGIH Industrial Ventilation Manual, 16th Edition, Table 4-1, & AWMA Air Pollution Engineering Manual, 2nd Edition, Table 1 & 6)
    - Well Designed Capture Systems
      - Enclosure of Source
      - Source within 1 Duct Diameter of Hood Face
    - Adequate Duct Transport Velocities >3500 fpm (ACGIH Industrial Ventilation Manual,16th Edition, Table 4-2 & AWMA Air Pollution Engineering Manual, 2nd Edition, Table 12)

AP-42 Continuous Drop Equation vs Stack Testing Results

I. Phosphate Rock

A. AP-42, Section 13.2.4, Equation 1

$$PM = \frac{k(0.0032)(U/5)^{1.3}}{(M/2)^{1.4}} \text{ (lb/ton)}$$

U= wind speed

M= moisture content

$$PM = \frac{0.74(0.0032)(8.4/5)^{1.3}}{(3/2)^{1.4}} = 0.0026 \text{ lb/ton}$$

B. CSX Ship Loading #7 BH, 11/15/97 Stack Test On 67 BPL Rock

$$PM = \frac{(6.07 \text{ lb/hr})}{(2500 \text{ tons/hr})} = 0.0024 \text{ lb/ton (controlled)}$$

PM = 0.24 lb/ton (uncontrolled) using 99% BH CE

Scale Factor = 92

*PM PTE @ 1,000,000 tpy = 1.3 tpy vs 120 tpy

AP-42 Continuous Drop Equation vs Stack Testing Results

II. GTSP

A. AP-42, Section 13.2.4, Equation 1

$$PM = \frac{k(0.0032)(U/5)^{1.3}}{(M/2)^{1.4}} \text{ (lb/ton)}$$

U= wind speed

M= moisture content

$$PM = \frac{0.74(0.0032)(8.4/5)^{1.3}}{(1.7/2)^{1.4}} = 0.006 \text{ lb/ton}$$

B. IMC Big Bend TP #3, 6/17-19/2000 Stack Test On GTSP

PM = 0.01 lb/ton (BH inlet controlled with DS)

PM = 0.05 lb/ton (uncontrolled) using 80% DS CE

Scale Factor = 8.3

*PM PTE @ 1,000,000 tpy = 3 tpy vs 25 tpy

AP-42 Continuous Drop Equation vs Stack Testing Results

III. DAP

A. AP-42, Section 13.2.4, Equation 1

$$PM = \frac{k(0.0032)(U/5)^{1.3}}{(M/2)^{1.4}} \text{ (lb/ton)}$$

U= wind speed

M= moisture content

$$PM = \frac{0.74(0.0032)(8.4/5)^{1.3}}{(1.7/2)^{1.4}} = 0.006 \text{ lb/ton}$$

B. CSX Ship Loading #7 BH, 5/22/03 Stack Test On DAP

$$PM = \frac{(0.23 \text{ lb/hr})}{(1815 \text{ tons/hr})} = 0.00013 \text{ lb/ton (controlled)}$$

PM = 0.065 lb/ton (uncontrolled) using 99% BH CE & 80% DS CE

Scale Factor = 10.8

*PM PTE @ 1,000,000 tpy = 3 tpy vs 32.5 tpy

AP-42 Continuous Drop Equation vs Stack Testing Results

IV. AFI (Mono & Dicalcium Phosphate-Triple Super Phosphate)

A. AP-42, Section 13.2.4, Equation 1

$$PM = \frac{k(0.0032)(U/5)^{1.3}}{(M/2)^{1.4}} \text{ (lb/ton)}$$

U= wind speed

M= moisture content

$$PM = \frac{0.74(0.0032)(8.4/5)^{1.3}}{(12/2)^{1.4}} = 0.00037 \text{ lb/ton}$$

B. Kinder Morgan-IMC Pt Sutton, 2/22/05 Stack Test On AFI

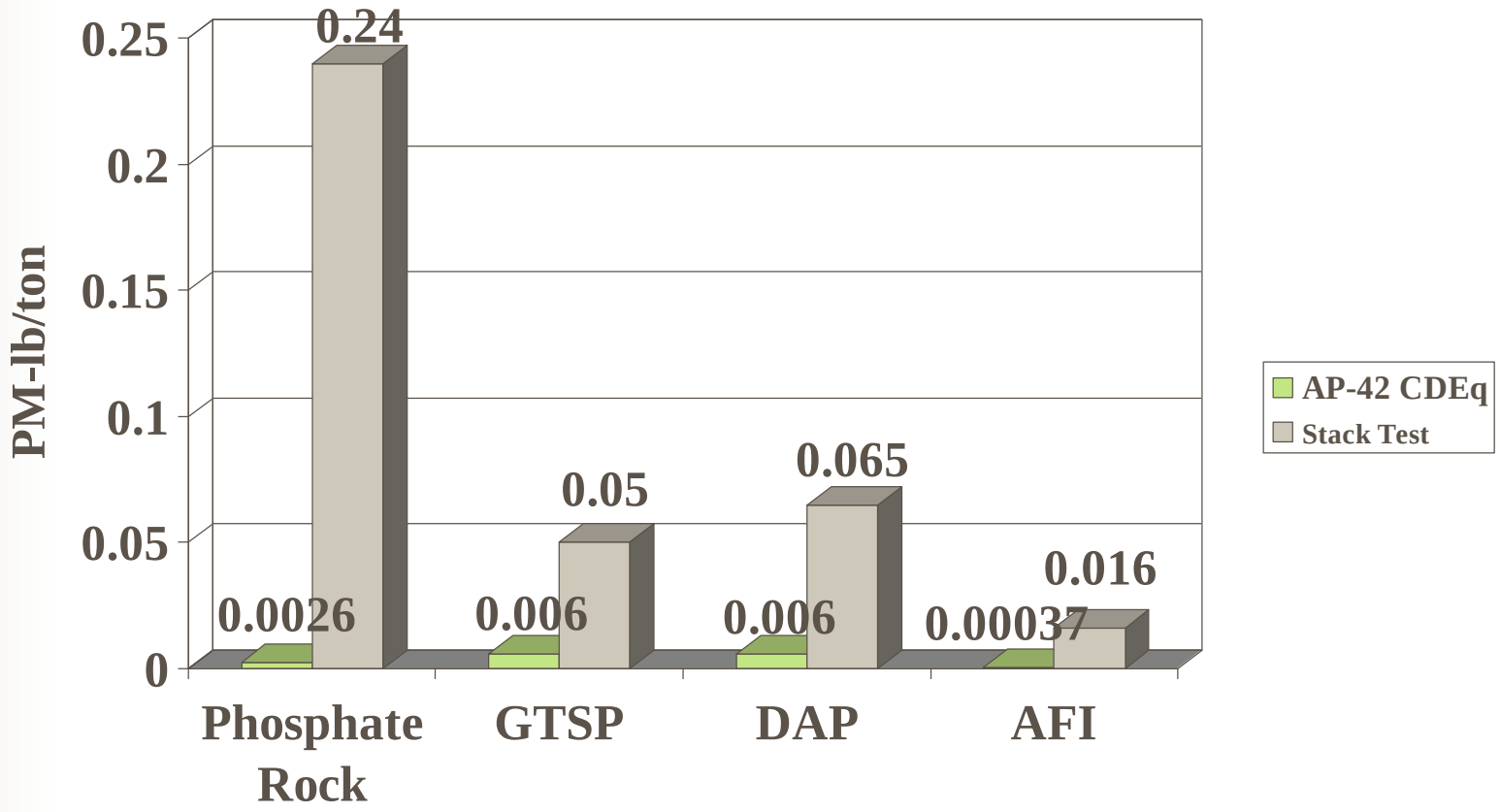
$$PM = \frac{(0.11 \text{ lb/hr})}{(684.9 \text{ tons/hr})} = 0.00016 \text{ lb/ton (controlled)}$$

PM = 0.016 lb/ton (uncontrolled) using 99% BH CE

Scale Factor = 43

*PM PTE @ 1,000,000 tpy = 0.2 tpy vs 8 tpy

AP-42 Continuous Drop Equation vs Stack Testing Results



AP-42 Continuous Drop Equation vs Stack Testing

- Not All Stack Tests Are Created Equal:
  - If Ventilation and Capture Systems Not Properly Designed, It Negatively Biases PM Results
    - Small 6-12 in Ducts
    - Usually S-Type Pitot Tube vs Required Standard Pitot Tube for Small Ducts (<12 inched in Diameter)
    - Vertical Traverses
    - Inadequate Hood Design
    - Low Hood Capture Velocities
    - Low Duct Transport Velocities

AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-CEMEX
  - AP-42 Continuous Drop Equation=0.0011 lb/ton (U=5, M=2)
  - In response to an RAI, Conducted Stack Test @ Inglis
  - Based upon EPA Method 5 using Temporary Ventilation & Capture System (0.00087 lb/ton PM EF; M=7, S=0.7)
    - Small 6 in Ducts
    - S-Type Pitot Tube
    - Vertical Traverses
    - Inadequate Hood Design
    - Low Duct Transport Velocities < 1000 fpm
    - No VEs

AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-CEMEX

Figure 6. Sampling Equipment and Flexible Vent Line

Figure 5. Conveyors, Hopper and Shroud

AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-CEMEX
  - Permit Issued-EPC Used Worst Case PM EF of 0.31 lb/ton* (Uncontrolled AP-42 EF from Table 11.6-4 assuming 99% CE for BH & 90% CE for atomized water sprays from AP-42, Table B.2-3 & AWMA Air Pollution Engineering Manual, 2nd Edition Table 3)

    *Scale Factor=28

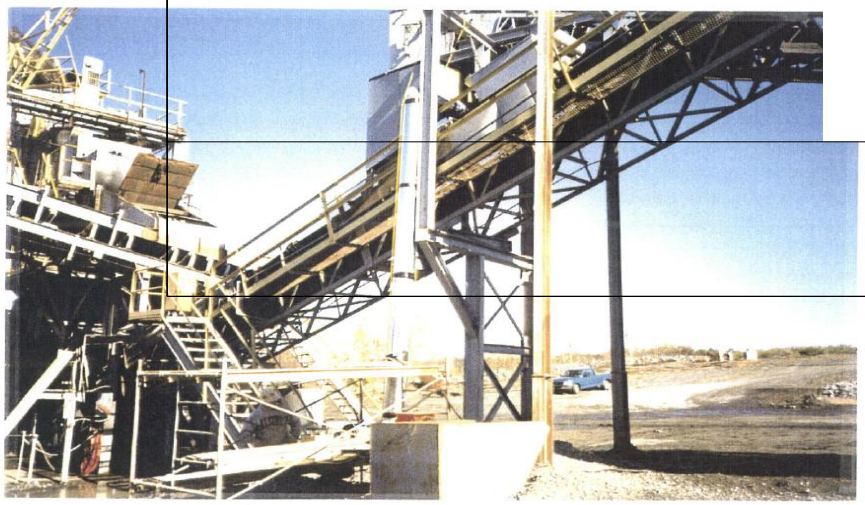
AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-Martin Marietta
  - Used AP-42, Table 11.19.2-2 for Crushed Stone 0.00014 lb/ton PM EF
  - AP-42 Continuous Drop Equation=0.0034 lb/ton (U=8.4, M=2.5)
  - Based upon EPA Method 201A/5 using Temporary Ventilation & Capture System @ MM North Carolina Facilities in mid 1990s
    - Small 6 -12 in Ducts
    - S-Type Pitot Tube
    - Vertical Traverses
    - Inadequate Hood Design
    - Low Duct Transport Velocities < 1000 fpm
    - No VEs

AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-Martin Marietta

Photograph 6. Vibrating Screen, Track-Mounted Hood System, Structural Steel I Beam and Stone Flow Prevent Sampling in Upper 4 Feet of Vibrating Screen



Photograph 10. Transfer Point 12 Inch Outlet Duct Proceeding to Sample Location and Blower Below

AP-42 Continuous Drop Equation vs Stack Testing

- Case Study-Martin Marietta
  - Permit Denial/Issued-EPC Suggested Worst Case PM EF of 0.055 lb/ton* (@ 600 tph and M =0.29%) for Granite with 90% CE for atomized water sprays (AP-42, Table B.2-3 & AWMA Air Pollution Engineering Manual, 2nd Edition Table 3)

    *Scale Factor=393

AP-42 Continuous Drop Equation vs Stack Testing

- Conclusions:
  - AP-42 Continuous Drop Equation Grossly Underestimates PM emissions up to Several Orders of Magnitude
  - Previously Permitted Minor Sources May be Title V and/or PSD if throughputs are > 1,000,000 tpy
  - Developer of Continuous Drop Equation-High throughputs=Major Source

- Recommendations:
  - PTEs should be calculated using federally enforceable worst case type of material
  - State-wide Consistency
    - Critically review the reasonableness of all EFs submitted in application
    - Compare EF vs Stack Test Data
    - Review Stack Test
    - Review the Ventilation & Capture System Design as part of PTE
  - Industry or State Sponsored Stack Testing
  - TAWG

AP-42 Continuous Drop Equation vs Stack Testing

- *Final Thoughts-AP-42 Continuous Drop Equation doesn't predict this*
  - *Bauxite PM EF= 1.1 lb/ton (AP-42, Table 11.24-2)*