

Amec Foster Wheeler - Response to SMT Comments

RE: Review and Analyses of the Kuparuk, Alaska Drill Rig 1-hour NO₂ Monitoring Study Data
(Draft Version, Dated February 8, 2016)

Page 2: Inserted John Bunyak 3/17/2016 2:25:00 PM

CAK general questions:

- How many hours of data did AMEC use in its final AERMOD input files?

As the report describes, there are two sets of modeling files, differentiated by the method used to determine background ozone.

Method 1 (no2_impacts_only) limited the dataset to only those hours for which there is an NO₂ impact on the "downwind" monitor and used the O₃ value from the "upwind" monitor as the background O₃ value for each hour. This yielded 1328 hours of data.

Method 2 (max_o3_background) compared the O₃ value from both monitors each hour, and took the higher of the two values as the background value for the hour. This assumes the lower value always resulted from background ozone scavenging and preserves hours when the plume did not impact the monitor for model evaluation. This yielded 2549 hours of data.

- Do we have a file that shows all the raw data and indicates which hours were used and how stack parameters were determined?

A file with these characteristics has not been generated. Stack parameters (assumed and calculated values) are discussed in the report. Calculations were performed using R on the retained records and the abbreviated datasets were exported to comma-delimited text files.

- What percent of those hours does AMEC still think are suspect? Why?

While it is known there are suspect hours in the generated input files, an assessment to identify those records has not been performed. A first priority communicated by the SMT was to complete the processing scripts that would format the data properly for input to AERMET and AERMOD. These scripts could then serve as a base that can be updated as additional analyses are performed and the methods for processing the data are refined.

- Has AMEC cross-referenced the hours from the ADEC report that failed QA/QC used in the final model input files (if ADEC report is that specific)?

The ADEC report is not that specific. It reports general statistics but does not identify specific hours or time periods.

Page 3: Deleted John Bunyak 3/17/2016 2:36:00 PM

y

The information conveyed in the parentheses was updated, rather than deleted, to clarify why this data was not considered for input to AERMOD. During the cursory review of the Alaska dataset, Amec Foster Wheeler questioned the lack of documentation for this data, and we received the following response from the SMT on 6/9/2015:

"The WS/WD at DS2N was never intended to be PSD quality, just to help us understand short-term events and aid in the pollutant data QA process. The DS2N wind data should be used with extreme caution as it could have been influenced by nearby structures and activities such as when the drill rig itself was at the well nearest the station and any time other equipment was nearby. It could have easily been within the wake of major obstructions. That is why the data at DSF1 was collected."

The wind data and instrumentation are not documented in the audit reports and calibration records were not provided. Amec Foster Wheeler assumes the instruments were not calibrated or audited prior to or during the study.

Also pertaining to the strikeout text above:

Page 3: Commented [D1] Doug 2/17/2016 7:21:00 PM

- What is deficient in QA/QC? (Referring to the wind data collected at the downwind monitor at DS2N)

QA/QC records were not included in the data package and these data were not documented in the audit reports.

- What parameters were measured and at what elevation? (Referring to the wind data collected at the downwind monitor at DS2N)

Wind speed, wind direction, and sigma theta were collected at the downwind monitor on DS2N. The wind data and instrumentation are not documented in the audit reports, and the height of the wind instruments at DS2N was not provided.

- I would not discount the downwind met, because the ambient turbulence may in result of the rig structure.

The report text has been updated to reflect that this data was collected to aid in the pollutant QA process, but should be used with caution as communicated to Amec Foster Wheeler by the SMT.

Deleted: (1-minute and 1-hour wind data collected at DS2N were also included, but we understand from the SMT strict quality assurance procedures were not followed during the data collection of these parameters and they were not intended to be used in the stud

Deleted:)

Page 4: Commented [D2] Doug 2/17/2016 7:21:00 PM

- Add fuel type and sulfur level

Fuel type and sulfur content were added to the text further below this table for the equipment for which we have data. Nabors did not provide fuel type for the 3412 engine since it was a "move engine" and was not monitored.

Page 6: Commented [D3] Doug 2/17/2016 7:21:00 PM

- Confirm that this is above grade and not above the floor of the drilling platform.

Confirmed, email from John Neason on 10/1/2015.

Page 6: Commented [D4] Doug 2/17/2016 7:21:00 PM

- What is a triangular diffuser?

The text was updated to indicate this is a non-restrictive rain diffuser. I contacted John Neason at Nabors for clarification who confirmed that the diffuser is a rain diffuser to keep rain, snow, and debris out of the stack. He also confirmed that this diffuser is not supposed to restrict flow or alter the exit velocity. I also confirmed this with a senior air engineer within Amec Foster Wheeler who is familiar with these devices.

Page 6: Commented [D5] Doug 3/5/2016 3:26:00 PM

- Provide sulfur levels of the 2 fuels

The report text was updated to include the sulfur levels of the two fuels.

Page 6: Commented [D6] Doug 3/5/2016 3:27:00 PM

- List make and model of monitoring equipment

A monitoring equipment list is provided in Attachment F of the ConocoPhillips Field Study Design Monitoring plan which is part of the original Kuparuk data package included as electronic Attachment 01 with the memorandum report. The report was updated to include a reference to the monitoring plan for an equipment list.

Page 7: Commented [D7] Doug 2/17/2016 7:21:00 PM

- Windrose from or toward?

Figure caption has been updated to indicate wind rose illustrates the direction from which the wind is blowing.

Page 8: Commented [D8] Doug 3/5/2016 3:30:00 PM

- Provide a listing of make and model of monitoring equipment.

A monitoring equipment list is provided in Attachment F of the ConocoPhillips Field Study Design Monitoring plan which is part of the original Kugaruk data package included as electronic Attachment 01 with the memorandum report. The report was updated to include a reference to the monitoring plan for an equipment list.

Page 8: Commented [D9] Doug 3/5/2016 3:32:00 PM

- State elevation and equipment type.

This comment refers to the wind instruments at the downwind ambient pollutant monitoring station on DS2N. This information was not provided in the data package. The wind data collected at the downwind site was not mentioned in either of the audit reports and calibration records were not provided.

Page 8: Commented [D10] Doug 2/17/2016 7:21:00 PM

- Need to provide a table that indicates the dates of drilling for each well, when the rig was operating on line power, the distance from the well bore and the angle between the well bore and the downwind monitor.

A new table was added (Table 3 in final report) that lists dates and times the rig was operating from the power of the engines. Table 12 in the final (Table 11 in draft) provides the drilling schedule, modified from the schedule provided by ConocoPhillips (Table 11 in final), which accounts for the time the rig was moving between wells.

The distance from the well bore has not been included, but the distance from the actual emission sources is provided in Table 14 in the final.

Page 8: Commented [D11] Doug 3/5/2016 3:34:00 PM

- Distance between DSF1 and DSF2?

No data were provided for this study from DSF2. Met data was collected at DSF1. CEMS data ambient pollutant data were collected during drilling operations at DS2N. The distance between DS2N and DSF1 is included in the report.

- Elevation of met sensors at DSF2 are needed.

No data were provided for this study from DSF2. Elevation of met sensors at DS2N were not included in the Kugaruk data package. To our understanding, calibrations were not performed on wind sensors at DS2N and the wind data at DS2N was not included in the audit reports. The ConocoPhillips monitoring plan states the wind sensors at DS2N

are at approximately 3 meters. The list of wind parameters collected at DS2N were updated to indicate wind data was collected at 3 meters. The list of wind parameters collected at DSF1 was updated to indicate wind data was collected at 10 meters.

- Make and model

A monitoring equipment list is provided in Attachment F of the ConocoPhillips Field Study Design Monitoring plan which is part of the original Kuparuk data package included as electronic Attachment 01 with the memorandum report. The report was updated to include a reference to the monitoring plan for an equipment list.

- Add ozone to this table

Ozone was not collected at DSF1.

Page 9: Commented [D12] Doug 2/17/2016 7:21:00 PM

- Absolute or corrected? (Referring to barometric pressure.)

Report was updated to indicate reported pressure values are station barometric pressure.

Page 9: Inserted Doug 3/5/2016 3:34:00 PM

- All air quality monitoring data were conducted using EPA Reference or Equivalent methods.

Added.

Page 9: Commented [D13] Doug 3/5/2016 3:34:00 PM

- We need to state if both ozone analyzers were FRM or not.

Both ozone monitors are FEM; however, the "upwind" monitor was not deployed and operated under the conditions specified and linked to the EPA equivalency designation. This is stated in SLR's pre-study and post-study ozone correlation assessments which are included in the original Kuparuk dataset (Attachment 01). The report was updated with language from the correlation assessments to indicate the "upwind" monitor was not operated under the conditions specified in the EPA equivalency designation. Footnotes were added to identify the correlation assessments and a reference to Attachment 01 was added to the text.

Note: *The decision was made during a weekly call with the SMT that Amec Foster Wheeler would not perform additional QA on the data and the data would be accepted as-is unless an issue was encountered while analyzing or formatting the data that warranted additional QA to resolve the issue.*

Page 9: Commented [D14] Doug 3/5/2016 3:36:00 PM

- Why is this needed? (Referring to discussion of the convention used to average the data.)

This discussion could be important to the AERMOD Evaluation teams or others who wish to correlate the 1-minute and 1-hour data. Commonly, met data follows an hour-ending convention, but this is not always the case and cannot be assumed. AERMET uses an hour-ending convention when supplementing with ASOS 1-minute data. I think it is correct to say that EPA's AQS system states that 1-hr averaged data follows the hour-beginning convention.

Page 10: Inserted Doug 2/17/2016 5:07:00 PM

- and NO₂ (Referring to the contents of the hourly emissions file formatted for input to AERMOD.)

This change was not accepted. The formatted hourly emissions file that is input to AERMOD includes only NO_x emission values as required by AERMOD. AERMOD provides a separate means to specify the NO₂/NO_x in-stack ratio as a single value to represent all stacks modeled or a separate value for each stack.

Page 10: Inserted Doug 2/17/2016 5:08:00 PM

- NO₂ (Referring to the contents of the hourly emissions file formatted for input to AERMOD.)

See comment immediately above.

Page 10: Commented [JB15] John Bunyak 3/17/2016 2:49:00 PM

- Cathe comment: Dry?

Report was updated to indicate concentrations are reported in ppm by dry volume.

Page 13: Commented [D16] Doug 3/5/2016 3:43:00 PM

- CAT data provides stack temp as a function of load

Acknowledged.

Page 13: Commented [JB17] John Bunyak 3/17/2016 2:50:00 PM

- Cathe Comment: Should state the basis for assumption.

Report was updated to indicate the 0.1 assumed moisture content was estimated based on professional experience in lieu actual stack testing data.

- Bunyak comment: Cathe provided some additional information that shows the calculated stack moisture content for the various units ranges from 1.9% to 8.8%.(see attached file) Please incorporate these data into your calculations and include the data as an attachment to the report.

Incorporating this data will require additional effort beyond the scope of finalizing the report to reflect the work completed by Amec Foster Wheeler under the recent contract with WESTAR.

Page 14: Commented [JB18] John Bunyak 3/10/2016 11:29:00 AM

- Clint: I suggest that you indicate which electronic attachment includes the calculated mass emission rates and emission exit velocities, as modified in subsequent discussions.

The file list for the electronic attachments was added to the end of the report. File names highlighted in yellow indicate files that include or used as their data source the calculated mass emission rates and/or exit velocities.

Page 14: Commented [D19] Doug 3/5/2016 3:43:00 PM

- Be specific when this occurred (*Referring to when the rig was on line power versus powered by the generators.*)

New Table 3 was added using the schedule from ConocoPhillips presentation that lists the hours by engine and well number that the rig was powered by one or more of the engines. Note: As the text and table footnote states, this schedule of rig engine use does not indicate or suggest that the engines were running only during the hours listed. Fuel data indicates the engines were often running when the rig was on line power.

Page 15: Commented [D20] Doug 3/5/2016 4:07:00 PM

- Add hourly average to the following graphs. (*Referring to Figures 4-8 in the draft report.*)

I assume the intent was to add the 1-hour fuel use to the graph for comparison with the 1-minute fuel use. The 1hour fuel use is the sum (rather than the average) of the 1-minute fuel use across the hour. Figures were regenerated to include the 1-hour fuel use.

- If you compare 1 min fuel use averaged over an hour how close is it to the hourly average?

I assume the intent in this comment is to calculate the 1-hour sum from the 1-minute average rather than a 1-hour average. This analyses has not been performed and would require additional effort to compute the 1-hour sum from the 1-minute data and compare the results. However, a quick spot check on random hours suggests they are identical.

Page 15: Commented [D21] Doug 2/17/2016 7:21:00 PM

- Do we believe that the short instantaneous decreases in fuel is real?

We have no way of verifying whether these instantaneous decreases in fuel use are real, but we have confirmed with SLR and ConocoPhillips that boiler #1 cycled on and off frequently during a given hour during the first half of the study until the seasonal ambient temperature dropped and there was more demand for heat. The data are in agreement with this statement.

Page 19: Commented [JB22] John Bunyak 3/17/2016 3:14:00 PM

- Cathe Comment: This statement is not clear to me.

Statement has been removed.

Page 19: Inserted Doug 3/6/2016 10:51:00 AM

- It is important to place the CEM issues into proper perspective. AERMOD and many other models have a time step of 1 hour. This means that 1-hour average emissions and meteorological data are input into the model which computes 1-hour average predicted concentrations. Thus, the accuracy of average 1-hour emissions is important. The 1 minute emission data are the building block for the hourly average, but some of the uncertainty in the 1-minute data is averaged out through the calculation of a 1-hour average. The attached Earth System Sciences (ESS) memo indicates for boiler 2 very good agreement between calculation of emissions using a derived emission factor based on all CEM data (lbs/gallon of fuel consumed) and fuel usage.

Text was added and ESS memo was included with final as electronic Attachment 11.

Page 19: Commented [D23] Doug 3/6/2016 11:00:00 AM

- For this case 20.7 % O₂ is ambient conditions and consistent with the emission data. (Referring to the data in Table 4 of the draft report.)

Yes, the O₂ and NO_x are in agreement, but the purpose of this table is to illustrate from the raw (or original data files) that the reported fuel use for a given minute is not always consistent with the reported O₂ and NO_x values.

- This data is not in the hourly emission file so it is not possible to check CEM with the average emission factor approach.

Two methods were used to determine the hours of data that were extracted for the hourly emissions and background ozone file as described above and discussed in the report. The methods differed base on how the background ozone was determined. Amec Foster Wheeler was given direction by the technical advisor and the SMT to construct a dataset using each of the methods for determining background ozone. One method (no₂_impacts_only) limited the hours to only those that NO₂ impacted the downwind monitor. The second method (max_o₃_background) retained those hours for which there was an ozone value from both the upwind and downwind monitors and

selected the max value as the background ozone value. The hour (hour 22 on 10/29/2014) represented by the 1-minute data in the original Table 4 (draft report) was retained using the max_o3_background method but was not retained using the no2_impacts_only method.

- What happened to the hourly data?

See response immediately above.

Page 19: Inserted Doug 2/17/2016 8:00:00 PM

- Earth System Sciences, LLC, "Analysis and Comments of Kugaruk, AK Database

Footnote added.

Page 20: Commented [D24] Doug 2/17/2016 7:42:00 PM

- Wouldn't this be the same as a difference in clock settings?

Report has been updated to clarify the difference in the two possible ways the data from the two data loggers could be offset or paired incorrectly. One possibility is that the clock times were not in sync, so when the data were integrated or combined, matching time stamps did not represent the same period of actual time. Another possibility is programmatic or mechanical error when integrating the data. In the latter case, the clocks may be in sync, but the data are incorrectly integrated together.

Page 20: Commented [D25] Doug 2/17/2016 7:53:00 PM (Referring to QC of CEMS measurements in ADEC's review of the CEMS data.)

- Can you be more specific?

Cathe provided updates to reflect additional information provided by COP to ADEC.

- What parameters and by how much?

Cathe provided updates to reflect additional information provided by COP to ADEC.

Page 20: Commented [JB26] John Bunyak 3/17/2016 3:34:00 PM

- Cathe Comment: Was this due to failure of daily span checks? What specific QA requirements were not met? Do we have the specific hours?
- CAK update – revised to reflect some additional info that COP had provide to ADEC

Revision accepted.

Page 20: Commented [JB27] John Bunyak 3/17/2016 3:43:00 PM

- Cathe Comment: Restate the issue.

Sentence was updated to restate the issue.

Page 21: Commented [D28] Doug 3/6/2016 11:03:00 AM

- If the fuel is summed over the hour, my calculation method for Boiler 1 has an emission rate of 0.14 lbs/hr and CEM has 0.04. A difference of 0.10 lbs/hr. This seems quite reasonable.

Noted.

Page 23: Commented [D29] Doug 3/5/2016 6:45:00 PM

- It would be desirable to provide a table that represents the hourly averages expressed in terms of lbs/hr.

These examples are presented from the raw data prior to calculating the mass emission rates, to illustrate the issues Amec Foster Wheeler encountered with the data. These issues led to the different methods that Amec Foster Wheeler was directed to explore and use by SMT to generate the datasets that accompanied the report.

Page 23: Commented [D30] Doug 3/6/2016 11:02:00 AM

- This event can be corrected by calculating the average emission rate from the valid data. (For Boiler 2 calculate the average emission rate in terms of fuel usage, lbs/gal). The average emission factor can then be used to calculate emissions for this hour. I believe that this will provide accurate emission estimates. See my memo for results.
- My approach results in an hourly emission of 0.14 lbs/hr.

This is the approach used by Amec Foster Wheeler, as directed by the SMT, to substitute or fill records for which the emission rate could not be computed using Method 19. (See Attachment_04_R_Scripts\formatted_max_o3_backgrnd\cems_1hr_alt_abbr.csv). Our version yielded 0.17 lbs/hr using the "good" data from the extracted records (based on well schedule and background ozone determination) rather than the full set of raw data. In the report, refer to the section "CEMS Data Treatment Approach 2 - Apply Average Emission Factor and O₂ for Data Fill."

Page 23: Commented [D31] Doug 3/6/2016 11:06:00 AM

- The emission data should be checked by calculating a fuel based emission factor for all data for a given source, computing emissions and compare to CEM data.

Noted. This will require additional effort to generate the comparison and present the results. This is beyond the scope of finalizing the report to reflect the work that Amec Foster Wheeler completed under the recent contract.

Page 23: Commented [JB32] John Bunyak 3/17/2016 3:53:00 PM

- Cathe Comment: I don't see the point of this discussion. Do we trust the fuel meter? If so, then the O2 CEMS reading is obviously an error and not valid.

We believe the fuel data to be accurate, though we have no way of confirming the accuracy of the fuel data. This discussion is part of an earlier summary Amec Foster Wheeler was directed by the SMT to generate to fully document the issues we encountered when we started working with the data to calculate the mass emission rates and velocities. The summary was submitted to the SMT for review and we were subsequently directed to include the summary in the memorandum. This part of the discussion demonstrates the impossible stack values that result using Method 19 without additional treatment of the data and the need for an alternative method to derive the mass emission rates and exit velocities.

Page 23: Commented [JB33] John Bunyak 3/10/2016 11:35:00 AM

- Clint: you indicated that there were initially some errors in your emission calculations. Just checking to make sure that the values reported here are based on the corrected emission and velocity calculations.

Confirmed. The values reported were taken from the corrected files.

Page 23: Commented [D34] Doug 3/6/2016 11:09:00 AM

- Obviously, the NOx and O2 are not valid. Emissions can be calculated as stated above. The velocity can be calculated based on the representative emissions.

This discussion is part of an earlier summary Amec Foster Wheeler was directed by the SMT to generate to fully document the issues we encountered when we started working with the data to calculate the mass emission rates and velocities. The summary was submitted to the SMT for review and we were subsequently directed to include the summary in the memorandum. This part of the discussion demonstrates the impossible stack values that result using Method 19 and the need for an alternative method to derive the mass emission rates and exit velocities.

- Velocities for boilers and heaters should can be recalculated based derived emission factor and compared to the AMEC values.

See comment immediately above. Subsequent sections discuss two alternative approaches Amec Foster Wheeler was directed by the SMT to explore. One was using the regression analysis provided by the SMT for Boiler #1 and the second approach preserved the emission rates and velocities derived from the monitored data for those hours that are not suspect. Those hours were then used to compute a source-specific average emission factor (lbs/gal) and in-stack O₂ (%). These averages were, in turn, used to compute an hourly mass emission rate and exit velocity for those records in which the monitored NO_x, O₂, and fuel values are inconsistent with each other, as in the examples discussed previously. This second approach was ultimately used for all 5

emission sources and is reflected in the formatted emissions file included in Attachment 07.

- For engines CAT data provides estimate of stack temp and vel based on load. These should be incorporated into the database and confirm the reported values.

This should be considered for future work and is beyond the scope of updating the final to reflect the work completed by Amec Foster Wheeler under the recent contract.

Page 24: Commented [D35] Doug 2/17/2016 8:21:00 PM

- My suggested approach of using fuel data and average emission factor is a third approach.

Amec Foster Wheeler acknowledges a third approach has been documented via the ESS memo. Since it has not yet been thoroughly reviewed, it is unclear how it differs from the second approach Amec Foster Wheeler was directed by the SMT to investigate and the approach reflected in the formatted emissions file included in Attachment 07.

Page 24: Commented [D36] Doug 3/6/2016 11:10:00 AM

- The derived emission factor approach is much better than this. This can be left in the report but should be downplayed. *(Referring to the regression analysis provided to Amec Foster Wheeler by the SMT.)*

Amec Foster Wheeler was directed by the SMT to apply the regression analysis provided by the SMT to the Boiler #1 CEMS data. The report documents the effort by Amec Foster Wheeler. This was one of two methods described in an earlier comment that Amec Foster Wheeler was directed by the SMT to explore.

Page 25: Commented [D37] Doug 3/6/2016 11:11:00 AM

- Replace with figure in ESS memo

The purpose of the memorandum is to fully document the work completed by Amec Foster Wheeler under the recent contract with WESTAR. The figure reflects work we performed. The analysis performed by ESS was conducted after our contract with WESTAR expired and was provided to Amec Foster Wheeler along with the comments on the draft report. The ESS memo has been added as an attachment and referenced in final memorandum.

Page 26: Commented [D38] Doug 3/6/2016 11:13:00 AM

- Use information in the ESS memo

The purpose of the memorandum is to fully document the work completed by Amec Foster Wheeler under the recent contract with WESTAR. The discussion reflects the work we performed under contract, directed by the SMT. The analysis performed by ESS was conducted after our contract with WESTAR expired and was provided to Amec Foster Wheeler along with the comments on the draft report. The ESS memo has been added as an attachment and referenced in final memorandum.

Page 26: Commented [JB39] John Bunyak 3/17/2016 3:56:00 PM

- Cathe Comment: An example of this would have been helpful.

Report was updated to include more description and an example for Boiler #1.

Page 26: Commented [JB40] John Bunyak 3/17/2016 4:00:00 PM

- Cathe Comment: What would have been more interesting to me is how the two approaches compare. Just looking at the data for the one hour, the emissions rate is about the same but stack velocities are significantly different.

Noted. The two methods were not compared in detail.

Page 27: Commented [D41] Doug 3/6/2016 11:14:00 AM

- Delete figures related to AP-42. This do not have any value at this time.

AP-42 figures and discussion have been deleted and replaced with a figure comparing the calculated emissions rates for Boiler #1 using the two methods. A figure showing the emission rates for all five sources using the average emission factor approach was also added

Page 27: Commented [JB42] John Bunyak 3/17/2016 4:02:00 PM

- **Cathe Comment:** What is the purpose of comparing the calculations to an AP-42 factor?

AP-42 figures and discussion have been deleted and replaced with a figure comparing the calculated emissions rates for Boiler #1 using the two methods. A figure showing the emission rates for all five sources using the average emission factor approach was also added

Page 29: Commented [D43] Doug 2/17/2016 8:32:00 PM

- This figure would be better if it was done in terms of mass emission rate. (Referring to Figure 17 in the draft report.)

In the draft this figure was incorrectly labeled and captioned as 1-hour data but it was actually generated from the 1-minute data. The figure has been replaced with a new plot generated from the processed 1-hour data and NOx emissions are now in units of lb/hr.

Page 29: Commented [D44] Doug 3/6/2016 11:15:00 AM

- Present this figure in terms of lbs/hr (Referring to Figure 17 in the draft report.)

In the draft this figure was incorrectly labeled and captioned as 1-hour data but it was actually generated from the 1-minute data. The figure has been replaced with a new plot generated from the processed 1-hour data and NOx emissions are now in units of lb/hr.

Page 29: Commented [JB45] John Bunyak 3/17/2016 4:04:00 PM

- Cathe Comment: Maybe this paragraph is better at the front of the section. (Referring to the discussion on the uncertainty of the CEMS data.)

Since the content of this paragraph as it is written relies on the previous discussion of the issues in the CEMS data and it references the figures above it and the method used to compute the mass emission rates, it was retained in its original place in the report. The related graph was also updated to present the comparison of emission rates, by source, in units of lb/hr.

The front of the section was updated to reference the later section on uncertainty. A sentence was added to the front section that summarizes the uncertainty in the boiler #1 data and that its contribution to the downwind ambient concentrations at the monitor are likely negligible.

Page 30: Commented [D46] Doug 3/6/2016 11:23:00 AM

- Why not delete this table as it has no value.

This table was retained for transparency in how Amec Foster Wheeler derived the final well schedule used to omit those from the final datasets when we are fairly certain the rig was in transit between wells and the exact location of the sources was not known. There was not a definitive schedule of when the rig was in motion so we were given general guidance from Nabors on how to adapt the original Rig Accept/Rig Release schedule, as the report discusses. Some or even all of the emission sources may have been operating at times while the rig was in transit.

Page 31: Commented [D47] Doug 3/6/2016 11:27:00 AM

- Need to create a table providing schedule of well location, when all sources were operational and when just boilers and heater were operational. Also include the distance from the well to the monitor.

While not difficult to accomplish, to create an additional table providing a schedule by well location when all sources were operational and when just the boilers were operational would require additional effort to extract and compile that information from the database. The data would also have to be coordinated with the well schedule to eliminate those hours the rig was in between wells. This is beyond the scope of updating the report to reflect the work Amec Foster Wheeler completed under the recent contract.

Page 31: Commented [JB48] John Bunyak 3/21/2016 10:09:00 AM

- Follow-up Comment from Doug: John:
I have an additional comment on the AMEC report. I feel that a table should be included in the report that lists the 7 (equivalent to the 98% tile) highest monitored NO₂ concentrations and the associated NO_x concentrations. This table is necessary because regardless of modeling issues, the monitored data provide actual data on NO₂ impacts from the rig. The table should also present associated well bore (distance to the monitor) and meteorological conditions (wind speed and direction from downwind met station). Doug

While this table would be beneficial, it would require significant additional effort to compile this information from the data. This is beyond the scope of updating the report to reflect the work Amec Foster Wheeler completed under the recent contract.

Page 31: Commented [D49] Doug 3/6/2016 11:27:00 AM

- Provide azimuth between sources and monitor for each well.

A table was added (Table 15) that lists the azimuth between each source and both monitoring stations, by well.

Page 41: Commented [JB50] John Bunyak 3/18/2016 2:25:00 PM

- Cathe Comment: Is this a different approach than was described earlier in the report?

Amec Foster Wheeler has not thoroughly reviewed the ESS memo, and it is not clear how the approach described differs from the approach employed by Amec Foster Wheeler as directed by the SMT.

Page 41: Commented [JB51] John Bunyak 3/18/2016 2:26:00 PM

- Cathe Comment: What are some specific reasons for remaining suspect data? I'm trying to understand which suspect data issues were addressed and which were not.

Text was updated to clarify why there are still suspect records in the emissions files. During processing, various criteria were applied to each CEMS record to identify discrepancies between the measured NOX, O2, and fuel use. These criteria may need to be updated/refined to be more stringent or catch conditions that were not anticipated. The criteria are listed in the section titled, " Task 3: Format Hourly Kuparuk Data for AERMOD Model Evaluation" under "Step 2: Process CEMS - Mass Emission Rate and Exit Velocity Calculations."

Page 42: Commented [JB52] John Bunyak 3/10/2016 11:52:00 AM

- Clint: please include the Table of Contents of the files that you prepared separately. Also, since calculating the mass emission rates and exit velocities was a specific task that required a significant amount of your time, I suggest you specifically indicate in the listed files and in the Table of Contents which electronic file contains these data.

The file list for the electronic attachments was added to the end of the report. File names highlighted in yellow indicate files that include or used as their data source the calculated mass emission rates and/or exit velocities.

Additional Updates

In addition to addressing comments from the SMT, Amec Foster Wheeler completed the following miscellaneous updates:

- Refined met processing - AERMET-ready onsite data file now includes all hours of met data for the entire study period. Originally, the hours included in the formatted input file were limited to those hours in the AERMOD-ready hourly emissions and background ozone files. AERMET needs the early morning hours to initialize the boundary layer. The AERMET output files are then synchronized with the hourly emissions and background ozone files using the program CUTMET.
- Standard Deviation of the Vertical Wind Speed was added to the formatted AERMET input file and added to list of fields read and used by AERMET in the test control files. This is not a required data element, but should be included for the evaluation of AERMOD.
- The R-scripts that process the data and generate the formatted files for input to AERMET and AERMOD were updated to alter the order of processing to maintain consistency between the different methods that were investigated for filling inconsistent data records.