Memorandum

Environmental Resources Management

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To: John Glass – South Carolina Department of Health and Environmental Control (SCDHEC)

From: Richard Hamel – Environmental Resources Management (ERM)

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Subject: Proposed Workaround Related to Buoyant Line Source Implementation Issues in AERMOD

ERM presents this memorandum describing known issues with the implementation of buoyant line sources in AERMOD version 16216r related to the use of multiple buoyant line sources in the same model run, as well as the handling of NO_X to NO_2 conversion methodologies relative to buoyant line sources. This matter was discussed in a conference call between Nucor Steel Corporation - Darlington Plant, SCDHEC, EPA OAQPS, EPA Region 4, and ERM on November 8, 2017.

After describing the issues below, ERM presents a proposed workaround to these issues for use until the issues are corrected by EPA in a future version of AERMOD. Should this approach be found agreeable to all parties, ERM will, when completed, provide the code, user's guide, and evaluation test cases for the model utilities developed that address these issues in order to make it available to the wider modeling community.

ERM welcomes the opportunity to discuss this issue with SCDHEC and EPA.

DESCRIPTION OF BUOYANT LINE SOURCES

The original Buoyant Line and Point Source (BLP) model was developed to enhance the representation of sources typical of metallurgical facilities, such as smelters, pot rooms, monovents, and other sources with significant buoyancy not suitable for representation with AERMOD's POINT source option. These sources are typically housed in elongated buildings that have been shown[1] to be misrepresented within the BPIPPRIME algorithm. Additionally, these sources have large areas of

[1] Building Downwash – Problems, Solutions and Next Generation. R. Peterson, EPA 11th Modeling Conference, August 13, 2015. https://www3.epa.gov/ttn/scram/11thmodconf/presentations/3-6_Building_Downwash-CPP-11thMC.pdf

exhaust with significant thermal buoyancy associated with the emitted plumes. These sources are not well represented by either the POINT or VOLUME source types in AERMOD.

ISSUES WITH THE IMPLEMENTATION OF BUOYANT LINE SOURCES IN AERMOD

The BLP algorithm was first introduced into AERMOD version 15181 and is now part of the regulatory default model in version 16216r. However, at present there are two known, significant issues with its implementation in AERMOD:

Limit of one configuration of Buoyant Line Source per model run:

As presently implemented, the use of buoyant line sources is limited to a single group of sources that are described with identical characteristics (e.g., buoyancy parameter and vent length). If more than one line source with dissimilar characteristics or orientation is present, as is often the case at metallurgical facilities, they cannot be reasonably included in the same model run.

Buoyant Line Source Impacts are added to the Model Predicted Impacts from other sources after the NO_X-to-NO_2 Conversion procedures:

For NO_2 model runs, the code that adds the modeled impacts from the buoyant line source type to other modeled impacts was implemented after the NO_X-to-NO_2 conversion methodologies: ARM2, OLM, and PVMRM, are applied. As a result, 100% of the NO_X impacts from the buoyant line source are converted to NO_2 regardless of the conversion methodology used, and thus the conversion methodologies are compared to an incorrect NO_X concentration when the conversion is calculated. For example, the ARM2 function that looks up the appropriate NO_X to NO_2 conversation ratio on the ARM2 curve uses the NO_X concentration without the contribution of the buoyant line source factored in, potentially resulting in the wrong conversation ratio being selected.

PROPOSED WORKAROUND TO CORRECT BUOYANT LINE SOURCE ISSUES

ERM proposes the following solution, to be available until such time as the implementation of buoyant line sources in AERMOD is refined by

EPA. For those scenarios where there are multiple dissimilar buoyant line sources at a facility being modeled, the following steps would be taken:

1. For each buoyant line source, a separate AERMOD run will be executed. Non-source characteristic related model inputs: Pollutant, period, meteorological data set and years, receptors, etc., will be identical for each run. Non-buoyant line sources could be included in any of the separate runs.
2. For each run, the POSTFILE keyword would be used to generate an unformatted binary file of the hourly impacts at each receptor.
3. Once the binary files for each BLP source is generated, all the binary files for a given pollutant/averaging period run would be processed in a FORTRAN utility developed by ERM called BINSUM. This utility sums and merges all the individual binary into a single binary file (representing source group ALL) for final processing.
4. The next step of the post-processing procedure would be executed with a utility called AERPOST. This FORTRAN program is built entirely on the EPA-approved AERMOD (version 16216r), and will not alter any of its internal calculation algorithms. HRBINARY allows for the import of an AERMOD unformatted 1-hour binary file to be added to any modeling run in order to perform the averaging of ranked highs for all currently evaluated averaging periods.
5. (*Optional step*) If the model run is for NO_2, and the ARM2 NO_X-to-NO_2 conversion methodology is selected, the ARM2 code to look up the appropriate NO_X/NO_2 ratio and apply the ratio to the total NO_X concentration to yield the correct NO_2 concentration would be executed within AERPOST for every hour at each receptor. Note that this process could be used for any NO_2 model run that includes a buoyant line source in order to assure that the ARM2 method is properly accounted for.

HRBINARY will produce AERMOD results including standard AERMOD output and plotfile formats for review.

Limitations:

1. Because of the complexity of the Tier-3 NO_X-to-NO_2 conversion screening methods, OLM and PVMRM, they will not be available in the AERPOST program.

2. Individual sources/source group and their contributions to the total concentrations will not be available in the output binary concentrations file. Summary tables and plotfiles will be available only for source group ALL.

3. Binary files generated by AERMOD are very large. Thus, ample disk space to house the files is needed.

ERM has developed a version of the codes for testing and determined that the model-predicted concentrations generated by AERPOST are identical to those generated by AERMOD, as expected because no manipulation of the data other than merging the results, or ARM2 processing if applicable, is undertaken.

Should this approach be approved by EPA, ERM will provide all codes related to the development and testing of the program, the program itself, user's guide, and documentation describing their testing to EPA OAQPS to be distributed to regional EPA offices and state agencies as EPA OAQPS sees fit.

Enclosure: BLP Equivalency Test and Readme