



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

AUG 01 2016

MEMORANDUM

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

SUBJECT: Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Montana-Dakota Utility Company's R.M. Heskett Station Modeling Demonstration

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INTRODUCTION

In response to your June 29, 2016 concurrence request memorandum, the Model Clearinghouse has reviewed Region 8's technical report and recommendation for approving the use of the ADJ_U* Beta option in the AERMET meteorological processor (version 15181) for the Montana-Dakota Utilities Company's R.M. Heskett Station (Heskett) facility located about 10 km northwest of Bismarck, North Dakota. As documented in our February 10, 2016 concurrence response memorandum to Region 10 regarding the Donlin Mine Compliance Demonstration¹, in our April 29, 2015 concurrence response memorandum to Region 1 regarding the Schiller Station Modeling Demonstration (Schiller)², and in our June 20, 2016 concurrence response memorandum to Region 3 regarding the Herbert A. Wagner Generating Station Modeling Demonstration (Wagner)³, the ADJ_U* Beta option was incorporated in AERMET to address concerns regarding potential underprediction of the surface friction velocity (u^*) during low-wind/stable conditions that could contribute to overprediction of ambient air impacts by the AERMOD dispersion model (version 15181) for some applications. In the case of the Heskett facility, excessive 1-hour SO_2 concentrations on terrain (Crown Butte) approximately 15 km from the source at elevations above the lowest effective stack height were predicted by the regulatory default version of the AERMOD Modeling System, specifically during low-wind/stable conditions when u^* values were relatively small. This parallels similar excessive 1-

¹ <http://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=16-X-01>

² <https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=16-I-01>

³ <https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=16-III-01>

hour SO₂ concentrations predicted on distant terrain during similar low wind/stable conditions for the Region 1 Schiller and Region 3 Wagner situations. Given this model response, the Region 8 technical report and associated alternative model justification package from the North Dakota Department of Health (NDDH), and our similar concurrences of ADJ_U* for a nearly identical circumstances that were also appropriately justified, we agree that it was appropriate for the ADJ_U* Beta option in AERMET to be considered for this regulatory modeling demonstration at the Heskett facility.

MODEL CLEARINGHOUSE RESPONSE

Application of ADJ_U* Beta Option in AERMET

Appendix W, Section 3.2.2 provides three different conditions for which an alternative model is approvable. These three conditions are briefly summarized as:

- 1) The alternative and preferred model provide equivalent estimates;
- 2) The alternative model outperforms the preferred model when comparing the results to actual air quality data; or
- 3) The preferred model is less appropriate or there is no preferred model for the given scenario.

In reviewing the June 29, 2016 concurrence request memorandum package from Region 8 and the attached alternative model justification package from the NDDH, it is noted that Region 8 and NDDH followed the second condition⁴ for the basis of this alternative model approval. The Model Clearinghouse concurs that a well-reasoned justification was thoroughly documented and demonstrates that the ADJ_U* Beta option in AERMET selected for the Heskett facility modeling demonstration performs better than the default regulatory version of AERMET for the given application, *i.e.*, a tall stack located near complex terrain, where high modeled concentrations are likely to occur under low wind, stable conditions. In this case, the terrain feature of interest, Crown Butte, is located about 15 km west-northwest from the Heskett facility with a peak elevation approximately 150-175 m above the stack base or around 50-75 m above the stack height. The highest concentration impacts at receptors on Crown Butte occurred only during periods of low wind, stable conditions.

The Region 8 technical report and NDDH alternative model justification package appropriately highlight the evaluation databases, namely the Lovett⁵ and Mercer County, ND⁶, which most directly represent the Heskett facility and surrounding terrain circumstances. From the NDDH alternative model justification package, there was a predominant focus on comparison to the Mercer County, ND evaluation database. While this is completely reasonable considering the

⁴ Appendix W to 40 CFR, Part 51, Section 3.2.2.b(2).

⁵ EPA's Addendum: User's Guide for the AMS/EPA Regulatory Model – AERMOD. September 2004, updated June 2015. EPA-454/B-03-001. Appendix F. Evaluation of Low Wind Beta Options.

⁶ Paine, R., O. Samani, M. Kaplan, E. Knipping and N. Kumar. 2015. Evaluation of low wind modeling approaches for two tall-stack databases", Journal of the Air & Waste Management Association, 65:11, 1341-1353, DOI: 10.1080/10962247.2015.1085924.

relatively close proximity and almost identical climate and terrain features surrounding the Heskett facility to that of the Mercy County study, we appreciate that the Region 8 technical report also included a comparative discussion with respect to the Lovett evaluation study. Although the Heskett facility is located at further distances from the higher terrain features than in the Lovett evaluation, we feel that the comparisons with respect to the application of the ADJ_U* Beta option are more than adequate for this circumstance and bring a more comprehensive evaluation database into consideration for the alternative model approval. In both cases, the Lovett and Mercer County, ND evaluations demonstrate a significant improvement of the modeled concentrations with the use of the ADJ_U* Beta option for a facility with tall stacks located near complex terrain, particularly during low wind, stable conditions. Combined with appropriate references to the foundational peer reviewed scientific work of Qian and Venkatram⁷ and the Luhar and Rayner⁸ that provide a scientific basis for the adjustment to u^* , there is a reasonable justification for the application of the ADJ_U* Beta option in the Heskett facility modeling demonstration.

The NDDH alternative model justification package also included a source specific model sensitivity that is worth noting in our concurrence memorandum. As with the previously referenced Region 1 Schiller and Region 3 Wagner alternative model concurrences, a model sensitivity analysis was performed to demonstrate the appropriateness and applicability of the ADJ_U* Beta option in this modeling demonstration for the Heskett facility. The sensitivity analysis indicated that the most critical impacts occurred at receptors on Crown Butte and specifically during hours when the u^* values were substantially low, which is indicative of low wind, stable conditions. These receptors were all at or above the emissions release height at the Heskett facility, as noted above. The application of the ADJ_U* Beta option resulted in comparable increases in the u^* values and reductions to the concentrations at these receptors, as demonstrated in the representative Lovett and Mercer County evaluation studies. For the nearby controlling receptors, the critical impacts were occurring at times of much higher u^* values. With the application of the ADJ_U* Beta option, the u^* values and concentrations were relatively unchanged for these nearby receptors, which many were also at or above the emissions release height at the Heskett facility. Therefore, we support that the model sensitivity analysis is providing further evidence of the relevance and appropriateness of the ADJ_U* Beta option for the Heskett facility modeling demonstration.

Lastly, there was indication in our aforementioned Regions 1, 3, and 10 concurrence response memorandums that EPA has concerns that the use of the ADJ_U* Beta option in combination with site-specific meteorological data that includes the sigma-theta and/or sigma-w turbulence parameters may introduce a bias toward concentration underprediction. We continue to evaluate the potential for this concentration underprediction bias and caution anyone considering the use of both the ADJ_U* Beta option and meteorological data that includes the derived sigma-theta and/or sigma-w turbulence parameters in regulatory applications without consultation and

⁷ Qian, W. and A. Venkatram. 2010. "Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions." *Boundary-Layer Meteorology* (2011) 138:475–491 DOI 10.1007/s10546-010-9565-1. Published online December 3, 2010. Accessed August 24, 2015.

⁸ Luhar AK and Rayner KN. 2009. "Methods to Estimate Surface Fluxes of Momentum and Heat from Routine Weather Observations for Dispersion Applications under Stable Stratification." *Boundary-Layer Meteorology*. 132:437-454. DOI 10.1007/s10546-009-9409-z.

approval from the appropriate permitting authority and the respective EPA Regional Office. However, it is noted that the meteorological data used in the Heskett facility modeling demonstration were not site-specific and did not include any derived sigma-theta or sigma-w turbulence information. So, the underprediction bias concern is not a factor in this case.

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