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Environmental Health Section

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Mr. Jim Keating
BP/Amoco
MC 7081C
801 Warrenville Road
Lisle, IL 60532-4323

Dear Mr. Keating:

This letter constitutes a formal response to your proposed modeling protocol for the BP/Amoco Refinery in Mandan, North Dakota. The proposed protocol is outlined in the report "SO_2 Air Quality Modeling Analysis Protocol for Demonstrating Compliance with the National Ambient Air Quality Standards" (RTP Environmental Associates, July 1999). The main feature of this protocol is the proposed use of the AERMOD model, which is not currently recommended (guideline) by EPA. However, AERMOD reflects an improved treatment of physics with respect to current "guideline" models, and its inclusion as a recommended model is expected with the next guideline revision.

BP/Amoco is proposing the use of AERMOD, because AERMOD appears to perform better than the "guideline" model ISCST3 for conditions in the vicinity of Mandan Refinery. AERMOD predictions appear to correlate better with observations at monitoring sites located west and southeast of the Refinery. The Department (North Dakota Department of Health) was also concerned about significant ISCST3 underpredictions at the southeast monitoring site. Modeling tests conducted by both BP/Amoco (September 1999) and the Department confirm the improved performance of AERMOD over ISCST3. However, available monitoring/emissions data for the Refinery are not comprehensive enough to support the conventional performance evaluation necessary to justify the use of a nonguideline model.

As you are aware, BP/Amoco, U.S. EPA Region 8, and the Department have held several discussions regarding modeling protocol for the Mandan Refinery since submittal of the July 1999 report. The protocol was discussed most recently in an April 28, 2000 meeting among BP/Amoco, MDU, and Department representatives. Kevin Golden (U.S. EPA) expressed concern that approval of AERMOD for the Mandan Refinery modeling problem, without a rigorous performance evaluation, would set an undesirable precedent for use of the nonguideline model in Region 8 States. The Department also had some reservations regarding the use of AERMOD.

Based on observations from three monitoring sites, it was concluded that design (maximum) SO_2 concentrations would likely occur in relatively level terrain southeast of the Refinery. But the "guideline" ISCST3 model was tending to overpredict in complex terrain west and north of the Refinery. Therefore, a hybrid modeling procedure was proposed including application of ISCST3 for simple terrain receptors, and either AERMOD or CTSCREEN for complex terrain receptors (both were tested). But the hybrid approach was found to be unworkable. Again, ISCST3 was significantly understating SO_2 concentrations southeast of the refinery.

Given the unworkability of the hybrid modeling option, Kevin Golden was again approached regarding exclusive use of AERMOD. Though the Department had some reservations regarding AERMOD, primarily regarding proper settings for subjective input conditions, it was clear that AERMOD was still outperforming ISCST3 for the Mandan Refinery. To avoid setting the undesirable precedent EPA was concerned about, it was proposed that AERMOD be applied in a conservative manner, with subjective input conditions set to produce maximum design concentrations. In response, Mr. Golden indicated exclusive use of AERMOD for the Mandan Refinery problem would be acceptable with the understanding that:

- the alternative model (AERMOD) provides higher design concentrations than the preferred model (ISCST3), where design concentration is based on the cumulative impact of all sources.

- subjective input conditions for AERMET/AERMOD (surface characteristics) are set to values which maximize design concentrations, and

- approval to use AERMOD applies to this analysis only; any future request for use of AERMOD in the vicinity of the Mandan Refinery will be considered on a case-by-case basis.

BP/Amoco and the Department subsequently discussed and agreed to these stipulations.

With exceptions as noted below, therefore, the modeling protocol proposed by BP/Amoco (July 1999) is acceptable. The protocol is summarized as follows.

- Model - AERMOD Version 98314

- Meteorological data - five years (1987-1991) of Bismarck Airport (NWS) surface and upper-air data processed with AERMET (The Department will verify BP/Amoco results using its own TD-6201 upper-air and CD-144 surface data processed using conventional AERMET guidance.)

- Anemometer height - 6.1 meters

- Surface characteristics - Surface albedo = 0.3, Bowen ratio = 0.9, Surface roughness length = 0.10 meters (Sensitivity testing conducted by the Department indicates that use of these annual-average values, as suggested by BP/Amoco, should maximize design concentrations relative to the range of plausible values for surface characteristics in the vicinity of the Refinery.)

- Receptors - The receptor grid proposed in the July 1999 report is acceptable, but because of slight discrepancies in terrain elevations generated by BP/Amoco and the Department, use of the AERMAP receptor file developed by the Department and provided to BP/Amoco is preferred.

- Emissions Inventory - As discussed at the April 28, 2000 meeting, emission scenarios reflecting normal (full load, reduced load) and upset (flaring) operation should be addressed. Nearby sources, as listed in Table 3-2 of the July 1999 Report, should be explicitly modeled. The adjacent Heskett Power Station should be modeled using the allowable emissions rates (Table 3-2).

- Background concentrations - The following SO_2 background concentrations, based on Department monitoring analysis, should be added to model results for the Mandan Refinery:

  3-hour = 11 $\mu g/m^3$
  24-hour = 9 $\mu g/m^3$
  Annual = 3 $\mu g/m^3$

- Building wake effects - Treatment as described in Section 3.1 of the July 1999 Report is acceptable. The Department notes that the July 1998 survey resulted in a significant change in some building dimensions, particularly for dominant building tiers. An explanation of these changes, as well as any available updated plot plans or building blueprints, should be provided with the modeling analysis.

- Other model options - rural, regulatory default

Also, please provide copies of all AERMOD input and output files on CD or diskette.

Despite the improved performance of AERMOD over ISCST3, AERMOD appears biased toward underprediction of maximum observed 24-hour concentrations southeast of the refinery (based on comparisons documented in October 1998 and July 1999 reports prepared by RTP Environmental Associates). The underprediction occurs even with the

use of conservative input assumptions (surface characteristics), and interpretation of predictions and observations as unpaired in space and time. The underprediction tendency is consistent with the results seen in AERMOD performance evaluations, where the range of modeled to observed robust highest concentrations varied from 0.72 to 1.02 for 24-hour averages in simple terrain (RTP Environmental Associates, September 1999). Because SO_2 concentrations approaching the 24-hour NAAQS have been observed at the south Refinery monitoring site, this underprediction tendency remains a concern.

Given the consequences of monitored exceedances of NAAQS (as discussed at the April 28 meeting), the Department had recommended application of a 10% safety factor to AERMOD results for Mandan Refinery to address concerns regarding model underprediction. BP/Amoco alternatively proposed that some margin of safety could be achieved by specifying conservative stack parameter values for each emission scenario, including:

- maximum emission rate (maximum sulfur content in fuel, etc.),
- low end of the range of plausible stack gas exit velocity, and
- low end of the range of sampled stack gas exit temperature for BP/Amoco stacks.

The Department agrees that use of these stack parameter values for AERMOD input would constitute some measure of safety (through testing of AERMOD for the Mandan Refinery, the Department has verified an inverse relationship between stack gas exit velocity/temperature and model predictions). Documentation regarding development of stack parameter values should be provided.

If you have any questions regarding the modeling protocol outlined here, please contact Steve Weber at 701-328-5188.

Sincerely,

Jeffrey L. Burgess, P.E.
Director, Division of
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