Koerber

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

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SUBJECT: Model Evaluation Study for
Koch Refining Company
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The Koch Refining Company has proposed a model evaluation study to determine which of two USEPA guideline models are more appropriate for its facility near Pine Bend, Minnesota. The purposes of this memorandum are to summarize the study, present Region V's position, and request comments from the Model Clearinghouse.

Background

Koch Refining Company owns and operates a petroleum refinery near Pine Bend, Minnesota. Although the refinery is located in a rural area (as defined by Section 8.2.8 of the "Guideline on Air Quality Models (Revised)", July, 1986), the State of Minnesota has applied the RAM-urban model to develop emission limitations for this source. This is because several preliminary model-monitor comparison studies have shown that: (1) models with the rural dispersion coefficients (i.e., RAM-rural, MPTER,ISC) severely underpredict high monitored concentrations, and (2) RAM-urban is a better predictor of high monitored concentrations. To determine better the model that most accurately estimates concentrations in the area of interest, Koch has proposed a more rigorous model evaluation study.

Study

I. Preliminary Analysis

A. Regulatory Aspects of the Application - The basic issue is attainment and maintenance of the SO_2 National Ambient Air Quality Standards (NAAQS). Previous modeling and monitoring data have shown that the 24-hour standard is constraining.

B. Source and Source Environment - A map of the Pine Bend area is included as Figure 1. Several comments on this figure should be noted: (1) terrain in the area is generally flat in the immediate vicinity of Koch, although the elevations decrease further to the east, (2) a large portion of Koch property has been fenced to preclude public access, (3) interaction with other nearby sources, especially those along the prevailing NW-SE wind direction axis, is expected.

It should also be noted that based on visual observations, building wake effects appear to significant (i.e., plumes are brought down to ground-level in the immediate vicinity of the plant - see attached photo #1). Although there are no well-defined structures which would indicate such downwash, the cluster of structures at the refinery appear to be acting together to create this effect. The available monitoring data support the "downwash" theory (i.e., maximum concentrations occur near plant fenceline and occur under medium-high wind speed, neutral stability conditions). Thus, to simulate this effect, the dispersion model must account for enhanced vertical dispersion, either by the use of urban dispersion coefficients or downwash-modified rural dispersion coefficients.

C. Models to be Evaluated - RAM (urban, UNAMAP Version 6) and ISCST (rural, UNAMAP Version 6) will be evaluated. As noted previously, RAM has been the model of choice by the regulatory agencies in order to ensure attainment of the NAAQS. ISCST has been proposed by Koch based on the rural characteristics of the Pine Bend area and the apparent downwash at the refinery.

D. Preliminary Estimates - The Minnesota Pollution Control Agency (MPCA) performed modeling using ISCST and RAM with 1982-1986 Minneapolis/St. Cloud meteorological data, a comprehensive receptor grid (terrain elevations accounted for with ISCST), and three emission inventories (average daily emissions, maximum daily emissions, and the proposed revised SIP emissions). A copy of the State's analysis is included in Attachment #1.

Koch also performed a preliminary modeling analysis. The results of this analysis, included in Attachment #2, are similar to those produced by MPCA.

These two analyses were used to help design the ambient monitoring network, and to determine the objectives of the modeling protocol.

E. Technical Comparison of Models - MPCA performed a technical comparison of RAM and ISCST for the Pine Bend area (see Attachment #3). The major differences between these two guideline models (i.e., dispersion coefficients and consideration of building wake effects) are obvious. MPCA concluded that on a purely theoretical basis, ISCST is preferable. This conclusion will be taken into account in the event of a tie between the two candidate models.

II. Protocol for Performance Evaluation - The protocol for the model evaluation study is contained in Attachment #4.

A. Performance Evaluation Objectives - The primary objective is to ensure that the peak (highest and highest second high) SO_2 concentrations are predicted accurately. Since compliance with the short-term SO_2 NAAQS are based on the highest second high concentrations, more emphasis will be placed on these concentrations. Based on the preliminary modeling analyses which showed that the 24-hour average concentrations are constraining, more emphasis will be placed on this averaging time.

Other secondary objectives are to ensure that the overall concentration frequency distribution is predicted accurately and to ensure consistency between the meteorological conditions associated with high modeled and high monitored concentrations. The first of these objectives was proposed by Koch based on their belief that the best model should accurately predict all concentrations, not just those at the upper end of the frequency distribution. The second was proposed by Region V in order that the high concentrations are predicted for the right reasons.

B. Data Sets, Performance Measures, Weighting, Scoring - In developing the performance evaluation scheme, MPCA and Koch tried to rely on the previous model evaluation studies (as summarized in "Interim Prodcedures for Evaluating Air Quality Models: Experience with Implementation", July 1985), while focusing on the regulatory issues most relevant to the Pine Bend situation.

The data sets were chosen to address the objectives of ensuring accurate peak (first high, second high, 25-highest) and accurate overall (all data) concentration predictions. Averaging times considered included annual, 24-hour, 3-hour (averaging time of the NAAQS) and 1-hour (building block for model concentration estimates). The performance measures for these data sets are those used commonly in previous studies and include consideration of meteorological cases in common to address the other objective. The weighting scheme placed most emphasis on the short-term NAAQS, especially the 24-hour standard, and on the peak concentration objective, since these are most relevant in setting emission limitations.

The scoring scheme was patterned after previous studies and accounted for underprediction by awarding less points (by a factor of 1.5) for modeled concentrations below the monitored concentrations, than for modeled concentrations above the monitored concentration.

The model with the most number of points will be selected as the winning model. In the event of a tie, the protocol suggests subjective consideration of some additional performance measures (i.e., frequency distribution for top 25 concentrations, extreme value statistics, and additional evaluation of meteorological cases in common), for the pupose of further ensuring that the winning model does not underpredict the regulatory concentrations of concern.

III. Data Bases for Performance Evaluation

A. Ambient SO_2 Data - The proposed monitoring network is outlined in Attachment #5. As noted in the attachment, the number of monitors (six) is significantly less than the number used in previous model evaluation studies. Region V believes that is this consistent with the guidance in the December 2, 1986, memorandum entitled "Urban/Rural Determinations" from the Model Clearinghouse (i.e., spatial coverage of monitors may not necessarily be as rigorous in addressing urban/rural issues). Koch still needs to provide a quality assurance plan for collection of these data.

B. Meteorological Data - Wind speed, wind direction, and temperature will be measured at Site KRC 1, with Site MPCA as a back-up. Stability class will be determined using the Turner method, with on-site wind speed and cloud cover/ceiling height from the Minneapolis NWS station. Mixing height will be determined from the St. Cloud NWS data. Koch has stated that on-site data will meet USEPA's quality assurance requirements for Prevention of Significant Deterioration monitoring, but has failed to provide a quality assurance plan. Region V recommends that Koch and MPCA follow USEPA's "On-Site Meteorological Program Guidance for Regulatory Modeling Applications", June 1987.

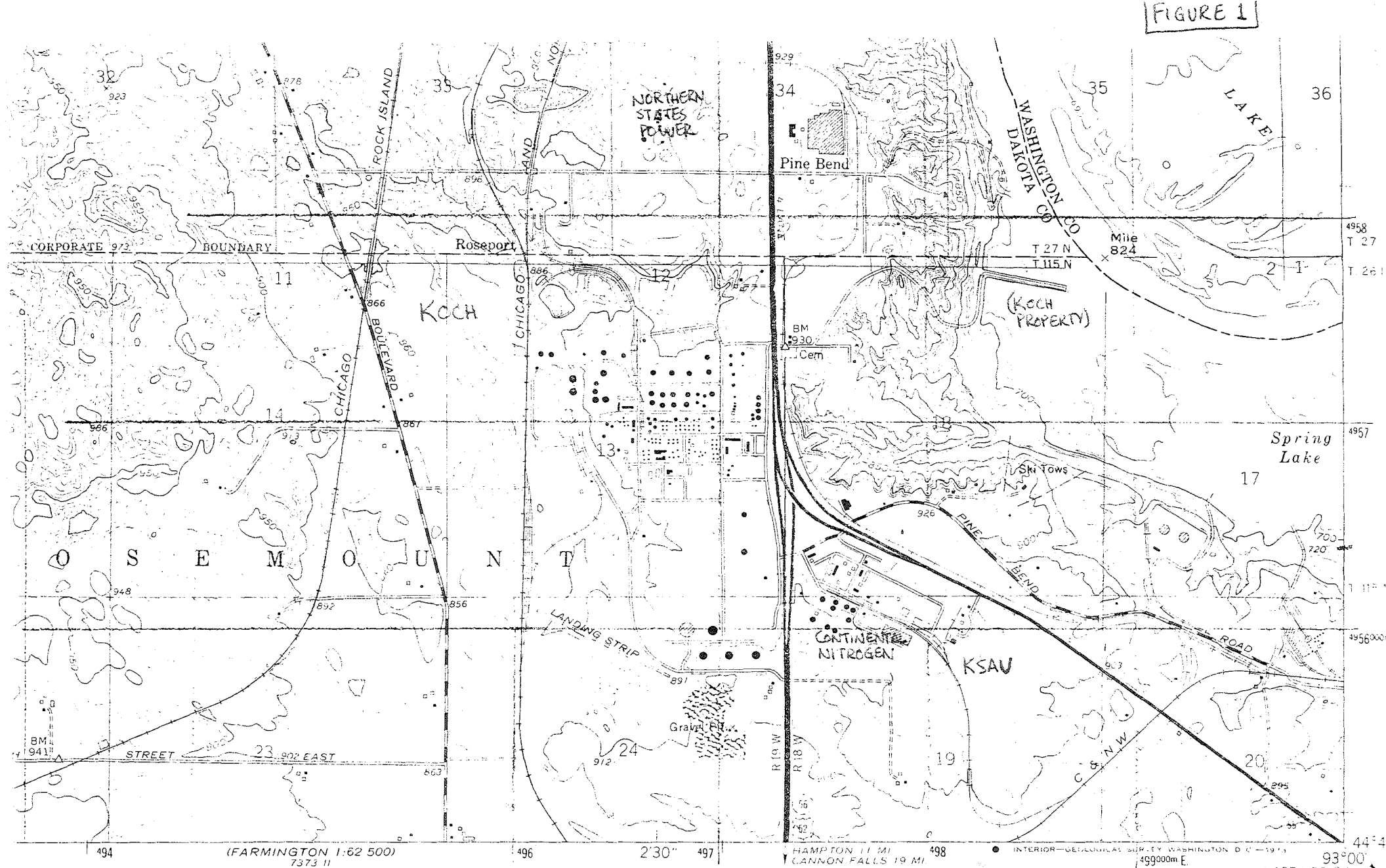
C. Emissions Data - Koch's proposal for collecting emissions inventory data is contained in Attachment #6. For Koch sources, emission rates will be determined from continuous emissions monitoring systems, stack analyzers, hourly/daily fuel oil consumption and sulfur content, fuel gas consumption records, and a daily refinery energy balance. Stack exit parameters will be determined based on unit throughput, fuel consumption, and available stack temperature data. Considering the complex nature of the refinery, Koch should provide inventories for a few days to verify the reliability of the proposed emissions tracking plan. In addition, back-up methods should be specified.

   For other Pine Bend sources, emissions data will be obtained as follows: KSAU - continuous monitoring system, Continental Nitrogen - records of fuel use and sulfur content, NSP - records of fuel use and sulfur content. Further specifics on the collection of data for these sources is necessary.

Summary

Koch Refining Company, with the assistance of the Minnesota Pollution Control Agency, has proposed a model evaluation study to determine whether ISCST (rural) or RAM (urban) more accurately estimates concentrations in the Pine Bend area. Region V has reviewed the proposed study relative to the "Interim Procedures for Evaluating Air Quality Models (Revised)", September 1984 and believes that the study is generally acceptable (see Attachment #7). The following portions of the study still require clarification: quality assurance plan for collection of ambient monitoring and meteorological data, actual emission inventories to justify the proposed emissions tracking plan, back-up procedures for collecting emissions data for Koch sources, and emissions tracking plan for non-Koch sources.

FIGURE 1



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