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March 19, 1999

Mr. Pat Hanrahan
Oregon Department of Environmental Quality
Northwest Region
Air Quality Program
2020 SW Fourth Ave., Suite 400
Portland, Oregon 97201-4987

Dear Mr. Hanrahan,

As we discussed in our conference call of March 18, 1999, we are requesting concurrence of the Oregon Department of Environmental Quality for the use of "AERMOD" (AMS/EPA Regulatory Model) at our proposed Rainier facility. We are making this request because of the unusual topographical and meteorological circumstances at the site.

It is our understanding that "AERMOD" has been proposed as an addition to the Guideline for Air Quality Modeling (40 CFR Part 51, Appendix W). Further, it is expected that this addition to the Guideline will be finalized in the near future.

Please let me know if you wish to discuss this request further. I can be reached at (312) 606-3770 or (312) 606-4484 by fax.

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Frank P. May
Director, Environmental
& Manufacturing Services

cc: #156, R. J. Haszel
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This section of the modeling report includes various documentation demonstrating the equivalency of Trinity's BREEZE AERMOD SUITE software package with the U.S. EPA's current AERMOD executable program, as well as justification for utilizing AERMOD in lieu of an "official" U.S. EPA guideline model (ISCST3, for example) for this project. A detailed consequence analysis comparing the results of AERMOD to ISCST3 when several modeling parameters are varied slightly is also provided for reference. The information contained in this section is intended to facilitate both ODEQ and U.S. EPA Region X review (and subsequent approval) of AERMOD model performance in this type of modeling situation.

13.1 AERMOD EQUIVALENCY DEMONSTRATION

The latest version of Trinity's BREEZE AERMOD SUITE software package (Version 3.1.4) is employed to determine off-property pollutant impacts surrounding the proposed Northwest Plant. BREEZE AERMOD SUITE combines the most-recent version (dated 98314) of the U.S. EPA's AERMOD executable program with a Windows interface to assist in the development of model input files and the interpretation of modeling results. The original U.S. EPA executable program is only slightly modified from the version publicly available in order to be built into BREEZE AERMOD SUITE, with no changes to the model's computational algorithms. As such, modeling results generated by BREEZE AERMOD SUITE should be identical to those produced by the U.S. EPA's AERMOD executable program when an identical input file is modeled.

The 1995 PM_{10} significance modeling file (PS95.DAT) is selected for use in this equivalency demonstration. This input file is modeled using both BREEZE AERMOD SUITE and the U.S. EPA's AERMOD program in order to compare the two sets of results. The diskettes in Appendix E include a copy of the BREEZE AERMOD SUITE and U.S. EPA AERMOD input (.DAT) and output (.LST) files generated in the equivalency demonstration. As can be seen in the output files, the results of the two runs are identical to the third (and in most cases, to the fourth) decimal place; thus, equivalency between the two model versions is demonstrated.

13.2 AERMOD TECHNICAL APPLICABILITY

The initial goal of developing a new generation regulatory model (AERMOD, in this case) was to create a model that combines the functionality and flexibility of an ISC model with algorithms based upon the most up-to-date atmospheric dispersion science.[24] In general, AERMOD contains many improvements over the algorithms currently used in ISCST3. For example, instead of determining atmospheric stability based on the Pasquill-Gifford stability class, AERMOD employs the stability measures of Monin-Obukhov length (a measure of both mechanical and buoyant effects on atmospheric turbulence) and friction velocity (a measure of mechanical effects alone), which allows for a more-accurate simulation of

[24] United States Environmental Protection Agency, *AERMOD – Description of Model Formulation (Draft)*, December 15, 1998.

plume behavior.[25] Also, AERMOD allows for the input of an expanded set of meteorological parameters over ISCST3 so that vertical profiles of wind, turbulence, and temperature can be used in model computations instead of a single meteorology layer.[26] Lastly, AERMOD's approach to handling different terrain regimes (simple, intermediate, and complex) is significantly improved over the ISCST3 method. In ISCST3, separate algorithms are employed to compute concentrations in simple and complex terrain, with the higher of the two being selected when intermediate terrain is encountered. AERMOD models the plume as either impacting or following the terrain regardless of terrain classification, which allows for a consistent, non-discontinuous treatment of all terrain types.[27]

The Northwest Plant will be located at the bottom of a steep river valley, with high bluffs (complex terrain) present on both sides of the river. Traditional (i.e., ISCST3) modeling of these types of situations has proved difficult due to the impact of the complex terrain on both local meteorology and plume dispersion. AERMOD has two considerable advantages over ISCST3 for modeling of the Northwest Plant: 1) AERMOD is able to incorporate vertical profiles of meteorology into the model calculations, which allows for better characterization of the local meteorology near the Northwest Plant, and 2) AERMOD's improved method of handling the abundant intermediate and complex terrain that surrounds the Northwest Plant allows for more-accurate computation of off-property concentrations that fall within these terrain regimes. Based on these advantages, it is clear that AERMOD is the better model for determining Northwest Plant pollutant impacts.

13.3 AERMOD PERFORMANCE SUMMARY

The U.S. EPA sponsored an extensive field study in order to assist in the development of AERMOD and to evaluate its performance. This field study is thoroughly documented in the U.S. EPA report "Model Evaluation Results for AERMOD", dated December 17, 1998. The study included SO_2 comparison data from five different sites in various geographic locations and terrain regimes for model development evaluation and five additional sites for model performance assessment. Of these sites, five of them (Lovett, Clifty Creek, Martins Creek, Westvaco, and Tracy) were located in rural areas that included either moderate or complex terrain, and four of these (Clifty Creek [Ohio], Martins Creek [Delaware], Westvaco [Potomac], and Tracy [Truckee]) involved facilities sited at the bottom of river valleys. Among this group, the Martins Creek study site is most similar to the Northwest Plant since the facility has several different stacks, some of which release at heights that are comparable to those planned at the Northwest Plant (approximately 60 m). In any case, dispersion conditions at all four river valley locations can be considered to be generally similar to those found at USG's proposed site.

The U.S. EPA field study shows that the modeled robust highest concentrations (RHCs) predicted by AERMOD are typically much closer to monitor-observed RHCs than results produced by ISCST3 (or CTDMPLUS) for the averaging periods of interest in this modeling analysis (24-hour and annual). Table 13-1 compares the AERMOD and ISCST3 (or CTDMPLUS) ratios of modeled RHCs to observed RHCs

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[25] R.F. Lee, A. Goodman, and A. Heinerikson, *Comparison between AERMOD and ISCST3 using data from Three Industrial Plants*, Trinity Consultants, for presentation at the 92nd Air & Waste Management Association annual meeting, 99-536.

[26] United States Environmental Protection Agency, *AERMOD – Description of Model Formulation (Draft)*, December 15, 1998.

[27] *Ibid.*

(where a ratio of 1.0 indicates perfect agreement between model and monitor) for the four river valley study sites.

TABLE 13-1. AERMOD/ISCST3 RATIOS OF MODELED RHCS TO OBSERVED RHCS IN U.S. EPA AERMOD FIELD STUDY.

Site	Averaging Period	Ratio of Modeled/Observed RHCs AERMOD	ISCST3
Clifty Creek	24-hour	0.72	0.67
	Annual	0.54	0.31
Martins Creek	24-hour	1.72	8.88
	Annual	0.74	3.37
Westvaco	24-hour	1.14	1.54*
	Annual	1.64	0.93*
Tracy	1-hour	1.07	0.77*

*CTDMPLUS model results.

These results demonstrate that AERMOD generally performs better than other dispersion models (ISCST3 and CTDMPLUS) in locations that are similar to the Northwest Plant site, namely river valleys surrounded by moderate or complex terrain.

A recent study performed by Trinity for the upcoming Air & Waste Management Association annual meeting in St. Louis compares 24-hour highest, fourth-high and annual average PM_{10} results from AERMOD and ISCST3 at a Portland cement plant located in a rural, hilly terrain region.[28] This type of facility is extremely similar to the Northwest Plant in both the pollutant emitted (PM_{10}), source of emissions (mineral processing), and nature of the releases (many low-level sources close to large buildings). The results of the Trinity study found that AERMOD predicted a 24-hour highest, fourth-high PM_{10} concentration that was approximately 21% higher than that calculated by ISCST3 and in a slightly different location. Annual average results between the two models showed almost perfect agreement, but were also in slightly different locations.

13.4 AERMOD/ISCST3 CONSEQUENCE ANALYSIS

Per U.S. EPA Region X request, a brief consequence analysis is performed to determine the effects of slight changes in model input values on overall results of both AERMOD and the most recent version of ISCST3 (dated 98356). As with the equivalency demonstration, the 1995 PM_{10} significance modeling file (PS95.DAT) is selected as the base file for use in the consequence analysis. The base file is

[28] R.F. Lee, A. Goodman, and A. Heinerikson, *Comparison between AERMOD and ISCST3 using data from Three Industrial Plants*, Trinity Consultants, for presentation at the 92nd Air & Waste Management Association annual meeting, 99-536.

modified to include only a single stack (1.0 g/s emission rate, 88 ft height, 600 °F temperature, 38.2 ft/s velocity, 2.67 ft diameter) located in the center of a single building (140 m long × 87 m wide × 15.24 m tall), which is sited in the middle of the proposed Northwest Plant property. The receptor grid utilized is a smaller version of the grid used in the other analyses (9 rings versus 22 rings) and includes worst-case terrain elevations (as described in Section 10). actual

Table 13-2 summarizes the findings of the consequence analysis for AERMOD and ISCST3. The listed values are overall maximum 24-hour and annual average concentrations (and respective locations) as predicted by each model under different circumstances. Model inputs examined include emission rate, stack parameters, stack location, building dimensions, and receptor locations/elevations. Note that only one parameter is varied from the base case at any given time.

The consequence analysis shows that AERMOD and ISCST3 behave similarly when model inputs are slightly varied. Neither model produces a significantly-different result when small changes are made. The complete set of AERMOD/ISCST3 model input (.DAT) and output (.LST) files from this analysis are included on diskette in Appendix E for reference.

Source UTMs → 502.310 km E
5105.465 N

USG source

TABLE 13-2. SUMMARY OF AERMOD/ISCST3 CONSEQUENCE ANALYSIS RESULTS.

Scenario	Modeling File	Model	24-Hour Results Maximum Conc. ($\mu g/m^3$)	24-Hour Results Location UTM East (km)	24-Hour Results Location UTM North (km)	Annual Results Maximum Conc. ($\mu g/m^3$)	Annual Results Location UTM East (km)	Annual Results Location UTM North (km)
Base Case								
	BASEA	AERMOD	11.787	501.963	5,105.373	1.661	502.090	5,105.294
	BASEI	ISCST3	24.013	501.658	5,105.828	4.057	501.471	5,105.314
Emission Rate Case – Increase Emission Rate by 10% (to 1.1 g/s)								
	EMISA	AERMOD	12.966	501.963	5,105.373	1.827	502.090	5,105.294
	EMISI	ISCST3	26.414	501.658	5,105.828	4.462	501.471	5,105.314
Stack Height Case – Reduce Stack Height by 2.0 ft (to 86 ft)								
	STHTA	AERMOD	12.044	502.005	5,105.347	1.722	502.090	5,105.294
	STHTI	ISCST3	24.251	501.658	5,105.828	4.098	501.471	5,105.314
Stack Temperature Case – Reduce Stack Temperature by 50% (to 300 °F)								
	TEMPA	AERMOD	12.853	502.005	5,105.347	2.023	502.090	5,105.294
	TEMPI	ISCST3	25.305	501.658	5,105.828	4.426	501.471	5,105.314
Stack Velocity Case – Increase Stack Velocity by 1.0 ft/s (to 39.2 ft/s)								
	VELOA	AERMOD	11.735	501.963	5,105.373	1.641	502.090	5,105.294
	VELOI	ISCST3	23.943	501.658	5,105.828	4.034	501.471	5,105.314
Stack Diameter Case – Reduce Stack Diameter by 0.2 ft (to 2.47 ft)								
	DIAMA	AERMOD	12.155	502.005	5,105.347	1.788	502.090	5,105.294
	DIAMI	ISCST3	24.432	501.658	5,105.828	4.185	501.471	5,105.314
Stack Location Case – Move Stack 2.0 m South and 2.0 m East								
	STLOA	AERMOD	11.840	502.005	5,105.347	1.667	502.090	5,105.294
	STLOI	ISCST3	23.913	501.658	5,105.828	4.045	501.471	5,105.314
Building Size Case – Increase Building Length & Width by 1.0 m (to 141 m × 88 m)								
	BLSZA	AERMOD	11.787	501.963	5,105.373	1.661	502.090	5,105.294
	BLSZI	ISCST3	24.013	501.658	5,105.828	4.057	501.471	5,105.314
Building Height Case – Increase Building Height by 1.0 m (to 16.24 m)								
	BLHTA	AERMOD	11.788	501.963	5,105.373	1.689	502.090	5,105.294
	BLHTI	ISCST3	24.015	501.658	5,105.828	4.057	501.471	5,105.314
Receptor Location Case – Move All Receptor Locations 1.0 m North and 1.0 m West								
	RCLOA	AERMOD	11.788	501.962	5,105.374	1.664	502.089	5,105.295
	RCLOI	ISCST3	23.963	501.657	5,105.829	4.051	501.470	5,105.315
Receptor Elevation Case – Reduce All Receptor Elevations by 1.0 m								
	RCHTA	AERMOD	11.787	501.963	5,105.373	1.664	502.090	5,105.294
	RCHTI	ISCST3	24.065	501.658	5,105.828	4.062	501.471	5,105.314