KG&E THE ELECTRIC COMPANY
KANSAS GAS AND ELECTRIC COMPANY

GLENN L. KOESTER
VICE PRESIDENT - NUCLEAR

June 30, 1981

RECEIVED
JUL 06 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

KMLNRC 81-094
Re: Docket Number STN 50-482
Ref: NRC Letter dated 6/2/81 from RLTedesco, NRC
to GLKoester, KG&E

Dear Mr. Denton:

The referenced letter requested additional information in the area of meteorology. Transmitted herewith are responses to questions in the referenced letter. This information will be formally incorporated into the Wolf Creek Generating Station, Unit No. 1 Final Safety Analysis Report in Revision 4. This information is hereby incorporated into the Wolf Creek Generating Station, Unit No. 1 Operating License Application.

Yours very truly,

Glenn L Koester

GLK:bb
Attach

cc: Dr. Gordon Edison (2)
Division of Project Management
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Thomas Vandel
Resident NRC Inspector
Box 311
Burlington, Kansas 66839

B001
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OATH OF AFFIRMATION

STATE OF KANSAS)
) SS:
COUNTY OF SEDGWICK)

I, Glenn L. Koester, of lawful age, being duly sworn upon oath, do depose, state and affirm that I am Vice President - Nuclear of Kansas Gas and Electric Company, Wichita, Kansas, that I have signed the foregoing letter of transmittal, know the contents thereof, and that all statements contained therein are true.

KANSAS GAS AND ELECTRIC COMPANY

ATTEST:

By Glenn L Koester
Glenn L. Koester
Vice President - Nuclear

W.B. Walker, Secretary

STATE OF KANSAS)
) SS:
COUNTY OF SEDGWICK)

BE IT REMEMBERED that on this 30th day of June, 1981, before me, Evelyn L. Fry, a Notary, personally appeared Glenn L. Koester, Vice President - Nuclear of Kansas Gas and Electric Company, Wichita, Kansas, who is personally known to me and who executed the foregoing instrument, and he duly acknowledged the execution of the same for and on behalf of and as the act and deed of said corporation.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my seal the date and year above written.

EVELYN L. FRY
NOTARY PUBLIC
STATE OF KANSAS

Evelyn L. Fry
Evelyn L. Fry, Notary

My Commission expires on August 15, 1981.

451.0 ACCIDENT EVALUATION BRANCH

Q451.01WC Please provide hour-by-hour meteorological data for the periods 6/1/73 - 5/31/75 and 3/5/79 - 3/4/80 on magnetic tape using the enclosed guidance on format and tape attributes.

R451.01 A data tape of WCGS meteorological data and in the prescribed format was forwarded to the NRC on 6/1/81.

Q451.02WC Describe the status of the onsite meteorological measurements program since 3/4/80 and provide additional data for the period 3/5/80 - 3/4/81, if available.

R451.02 Reduction of the raw meteorological data for the time period 3/5/80 to 3/4/81 is complete. Additional manipulations to prepare the data to the format of that requested in Question 451.01 have not yet been performed and the requested data is presently unavailable. Per the recommendations of Regulatory Guide 1.70 Section 2.3.3, three years of onsite meteorological measurements, including a one-year recent period, have already been provided to the NRC. We feel that this data should be adequate for the NRC's review of WCGS meteorology.

Q451.03WC Table 2.3-37 (Rev. 1, 2/81) of the FSAR indicates that extremely unstable (Pasquill Type A), moderately stable (Pasquill Type F), and extremely stable (Pasquill Type G) conditions have persisted for long durations (e.g., greater than 12 hours) at the WCGS site. Apparently, extremely unstable conditions persisted for a 24-hour period during the Phase 2 program. Persistence of these stability classes for periods greater than 12 hours in duration is very unusual. Discuss the causes of persistent stability conditions for periods greater than 12 hours for classes A, F, and G. Identify the synoptic conditions during the observed periods of persistent stability for periods greater than 12 hours and discuss the possibility of instrument malfunction.

R451.03 The 85-10m differential temperature was used as the primary parameter to determine stability at Wolf Creek. If the 85-10m data value was not available, then the 60-10m differential temperature value determined stability. Difficulties were encountered in getting valid data for these parameters for the Phase 2 program (see Response 451.04). This caused all valid data to come under intense scrutiny. Before data was allowed into the data base, all calibrations, site logs, and weather maps that were obtained from the U.S. Department of Commerce were checked against the analog strip chart. If the data could not be proved invalid, then the data was allowed into the data base.

For these data, stabilities A, F, and G occurring for greater than a 12-hour consecutive period were identified. These 16 time periods and stabilities are listed in Table 451.03-1.

All strip chart data and instrument calibration records for the 10 stable condition periods showed consistent and valid data. All 10 periods occurred during the night time hours under clear skies and high pressure conditions. Daytime temperatures varied from 10 to 30°F. Radiational cooling near the surface occurs under these conditions creating stable meteorological conditions. As the sun rises and adds heat to the surface layer, stable conditions weaken.

The first three unstable periods (3/7-8/79, 3/8/79, 3/8-9/79) can be attributed to low pressure systems and frontal movements across the area which were being maintained by a polar jetstream maximum located over the midsection of the U.S. The upper

R451.03 (continued)

air flow was strong out of the north bringing an influx of polar air.

The polar air continued to flow over the region at upper levels during the last three unstable periods (3/10/79, 3/11/79, 3/12/79). However, low humidity, high pressure and a southerly surface flow helped to keep skies clear and create surface heating for unstable conditions near the surface.

TABLE 451.03-1

OCCURRENCES OF A, F, AND G STABILITIES
PERSISTING GREATER THAN 12 HOURS

STABILITY	TIME PERIOD	NUMBER OF CONSECUTIVE HOURS
A	79030705 - 79030804	24
A	79030806 - 79030821	16
A	79030823 - 79030921	23
A	79031003 - 79031021	19
A	79031104 - 79031119	16
A	79031204 - 79031218	15
G	79091720 - 79091808	13
G	79092520 - 79092608	13
G	79100620 - 79100708	13
G	79102720 - 79102809	14
G	79111518 - 79111609	16
G	79111619 - 79111708	14
F	79120119 - 79120208	14
G	79120320 - 79120409	14
G	80011321 - 80011409	13
G	80021122 - 80021210	13

Q451.04WC Table 2.3-29 (Rev. 1, 2/81) of the FSAR indicates a lower data recovery for joint frequency distributions of wind speed and wind direction by atmospheric stability for the period 3/5/79 - 3/4/80 than for the previous two years of data collection (6/1/73 - 5/31/75) despite increased attention to the onsite meteorological program. The major difference between the Phase 1 (6/1/73 - 5/31/75) program and the Phase 2 program (3/5/79 - 3/4/80) appears to be the type of data recording system, with the Phase 2 system consisting solely of analog charts. Discuss the reasons for the lower data recovery and indicate whether complete reliance on an analog recording system could be a major factor in reduced data recovery. Identify periods of extended instrument outage (e.g., for 24 hours or more) during the Phase 2 program and the cause of the outage. Indicate the corrective measures taken to minimize extended outages in the future. Describe the data availability (e.g., remote display in the control room or elsewhere) and data reduction procedures to be used for the meteorological measurements program during plant operation.

R451.04 The problems encountered in the Phase 2 meteorology data collection program at Wolf Creek were caused primarily by meteorological instrumentation. Thus, the low data recovery would have occurred even if a redundant data recording system were used. As Table 451.04-1 shows, most of the lost data for Phase 2 occurred at the 10-meter dewpoint, 85-10 meter delta temperature, and 60-10 meter delta temperature sensors.

Instrumentation at the tower during Phase 2 is given in Table 2.3-47. The cooled mirror dewpoint system installed at the start of Phase 2 exhibited design and reliability problems to the extent that considerably less than 90 percent valid data were recovered for this instrument.

Technicians at the site performed numerous calibrations and maintenance on the system in an attempt to make the system more reliable. On December 18, 1979 the cooled mirror dewpoint system was replaced with a backup LiCl dewpoint system. KG&E realized at that time even though the LiCl system was not as sensitive as the cooled mirror dewpoint system, the LiCl system must be installed inorder to obtain a data recovery of greater than 50 percent. On April 24, 1981 an EG&G cooled mirror dewpoint system was installed

R451.04 (continued)

at the tower. This system has been collecting valid data since that time.

Another problem occurred with the 85-10m and 60-10m differential temperature (new RTD temperature systems installed in Phase 2 to obtain better long-term differential temperature accuracy). Occasionally the upper level sensors would cause the Delta-T pair to give meteorologically impossible differential temperature values such as highly negative and positive values. This problem persisted until KG&E discovered corroded cable connectors and installed new electrical cabling to the upper levels on September 26, 1979.

Both aspiration systems on the 85-meter and 60-meter tower level failed in December 1979 causing the temperature sensors to experience solar heating during daylight hours. KG&E immediately replaced the faulty aspiration system with replacements obtained from a vendor. The replacement aspirators, however, had too low an air flow, and consequently did not produce representative differential temperature measurements. Problems in obtaining acceptable replacement delayed acquisition of valid data from both systems until the end of January 1980.

Since low data recovery during the period 3/5/79 to 3/4/80 of Phase 2 was primarily the result of meteorological instrumentation problems, KG&E and Dames & Moore have not changed any procedures for meteorological data collection because of the loss of data in the Phase 2 year. Currently the tower is checked each work day by a KG&E technician. Analog strip charts are taken from the recorders every two weeks. KG&E then reviews the analog charts before sending them to Dames & Moore. At Dames & Moore the charts are again reviewed and, if problems are found, KG&E is immediately notified. By checking the tower frequently and by reviewing the analog strip charts twice, all problems are readily identified and the problems corrected in a timely manner. KG&E and Dames & Moore did everything practical to prevent data loss in Phase 2. Unfortunately, due to the instrumentation problems which occurred, a large amount of data loss did occur during the period 3/5/79 to 3/4/80. The second year of the Phase 2 data collection has been more successful with all parameters reporting a data recovery of greater than 95 percent (refer to Table 451.04-2).

R451.04 (continued)

With respect to the operational meteorological program, it is intended that the system and operating procedures will meet the recommendations of NUREG-0654 and Regulatory Guide 1.23. A description of data availability during plant operation is provided in Section 2.3.3.1 of the FSAR. A revised description of the operational program reflecting the requirements of NUREG-0654 and Regulatory Guide 1.23 will be provided by December 31, 1982.

TABLE 451.04-1

INVALID DATA PERIODS 24-HOURS OR GREATER
MARCH 5, 1979 - MARCH 4, 1980

10 M DEWPOINT	REASONS FOR VALIDATION
March 5, 1979 0100 to March 22, 1979 1500	Sensor not installed
April 3, 1979 0900 to April 4, 1979 1200	Excessive dewpoint oscillation
June 25, 1979 0900 to June 26, 1979 1100	Calibration
June 30, 1979 0600 to July 2, 1979 1600	Excessive dewpoint oscillation
September 15, 1979 0300 to September 16, 1979 0700	Excessive dewpoint oscillation
October 19, 1979 1400 to October 21, 1979 0400	Excessive dewpoint oscillation
October 22, 1979 0600 to October 24, 1979 1500	Excessive dewpoint oscillation

85-10 M DELTA TEMPERATURE	
March 13, 1979 1500 to March 28, 1979 1000	Data inconsistent with existing conditions
April 3, 1979 1100 to April 4, 1979 1100	Corroded resistance thermal detector connector
December 27, 1979 0900 to January 24, 1980 1600	Aspiration failure

60-10 M DELTA TEMPERATURE	
March 13, 1979 1500 to March 28, 1979 1000	Data inconsistent with existing conditions
April 3, 1979 1100 to April 4, 1979 1100	Corroded resistance thermal detector connector
July 6, 1979 0700 to July 7, 1979 0600	Data inconsistent with existing conditions
December 19, 1979 1600 to December 28, 1979 1400	Aspiration failure

TABLE 451.04-1 (continued)

35-10 M DELTA TEMPERATURE	REASONS FOR INVALIDATION
April 3, 1979 1100 to April 4, 1979 1100	Corroded resistance thermal detector connector
35 M WIND DIRECTION	
September 7, 1979 1700 to September 10, 1979 0800	Ink pen failure
February 15, 1980 1000 to February 20, 1980 1600	Sensor frozen by ice storm
60 M SIGMA	
January 1, 1980 0100 to January 2, 1980 1100	Chart jam
60 M WIND SPEED	
January 19, 1980 2100 to January 21, 1980 1100	Frozen sensor
January 30, 1980 0900 to January 31, 1980 1300	Frozen sensor
February 15, 1980 0300 to February 18, 1980 0900	Sensor frozen by ice storm
35 M WIND SPEED	
January 19, 1980 2100 to January 21, 1980 1000	Frozen sensor
February 15, 1980 0700 to February 18, 1980 0200	Sensor frozen by ice storm
35 M SIGMA	
February 15, 1980 1000 to February 18, 1980 0600	Sensor frozen by ice storm
10 M WIND SPEED	
February 15, 1980 0400 to February 18, 1980 0600	Sensor frozen by ice storm

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

IMAGE EVALUATION
TEST TARGET (MT-3)

TABLE 451.04-2

DATA RECOVERY STATISTICS

Data recovery statistics for the 15 monitored parameters from March 5, 1980 to March 4, 1981 are as follows:

Parameter	Data Recovery (%)
60m wind direction	97.9
60m wind speed	97.7
60m sigma	97.2
35m wind direction	99.6
35m wind speed	99.6
35m sigma	98.5
10m wind direction	99.0
10m wind speed	95.6
10m sigma	99.1
10m temperature	99.4
10m dewpoint	99.6
85-10m delta temperature	99.4
60-10m delta temperature	99.2
35-10m delta temperature	99.4
1.3 m precipitation	99.6

Q451.05WC Section 2.3.2.2 (Rev. 1, 2/81) of the FSAR (see also Revision 1, 4/81 to the Environmental Report section 5.1.4) presents an analysis of the atmospheric impacts of the heat dissipation facilities using the model FOGALL. This analysis replaces the previous analysis based on the model POND.

a. Describe the improvements in the analysis using FOGALL compared to the analysis using POND.

b. Describe the validation (or verification) of FOGALL for analyzing atmospheric impacts of a 5090 acre cooling lake.

c. Describe the meteorological measurements program to be used to evaluate actual meteorological impacts of the heat dissipation system once the cooling lake is filled and the plant is operational.

R451.05

a. The FOGALL model was developed as an alternative to POND model in 1980 by Dames & Moore. The objective was to develop a model which was more flexible than POND and to update both the physics and algorithms used. The basic differences between FOGALL and POND are listed below:

1. FOGALL uses a more recent formulation (Ryan, 1973)* for the calculation of the heat and moisture fluxes from the heated pond.

2. FOGALL utilizes a formal area source dispersion algorithm, while POND utilizes a more intuitive trajectory approach. The trajectory approach limits POND to 8 discrete wind directions. In FOGALL the wind varies continuously.

3. POND uses ambient 3-hour meteorological observations while FOGALL uses hourly data.

4. FOGALL stimulates the vertical dispersion of vapor and heat from each area source making up the lake by using a Gaussian distribution

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* Ryan, E. J. and D. R. F. Harleman, 1973, Analytical and Experimental Study of Transient Cooling Pond Behavior, Report No. 161, Department of Civil Engineering, Massachusetts Institute of Technology.

R451.05 (continued)

using Pasquill-Gifford parameters. POND uses a uniform distribution to simulate the vertical dispersion. Both water vapor and heat are uniformly distributed between the water surface and a height calculated from upwind fetch and stability class.

5. POND uses an 18 x 10 fixed cartesian grid as the basis for its calculations. This grid is used to define both area sources and receptor points. In FOGALL each receptor and each area source can be independently positioned. That is, neither receptor or sources are keyed to a cartesian grid. The receptor in FOGALL can also be positioned with a vertical coordinate. This permits receptors in a visibility analysis to be placed at eye level position along critical highways.

6. FOGALL utilizes an optimized subroutine to calculate σ_y and σ_z while POND does not.

7. Input water temperature can be a constant or it can be varied hourly, daily or monthly in FOGALL. In POND the input water temperature can not be varied as a function of time.

8. FOGALL produces frequency distribution of fog, icing, water vapor density, and induced temperature changes for baseline as well as plant induced conditions. The frequency distributions generated have more resolution than those generated in POND.

b. A complete copy of the FOGALL certification/users manual was provided in response to ER(OLS) Questions 450.3 and 450.4.

The procedure used to validate the FOGALL model is described in the certification/users manual provided in response to ER Question 450.3.

The verification of FOGALL was performed by executing two test cases and manually calculating the expected results. One test case utilized source water temperature constant with time and area. The second case varied the source water temperature over the source area each hour. In addition, hand calculations were performed to verify that the results of each subroutine conformed with the respective applied theoretical model or mathematical equation.

R451.05 (continued)

The model design is based upon accepted principals of atmospheric physics; computed values were hand verified; and the test cases were designed to detect fog, no fog, ice, and no ice conditions at defined receptors. The validation procedure, therefore, provides a high degree of confidence that the FOGALL results are representative of actual conditions.

c. A preoperational fog monitoring program is being planned. The purpose of the study is to document the frequency of occurrence of natural fog (as opposed to fogs induced by the operation of the cooling lake) along Highway 75 which is located from 0.5 miles to 2.0 miles west of the cooling lake.

Table 2.3-29 shows that the predominant frequency of light wind (less than 3 meters per second) is from the sectors southeast through south. This corresponds with the Dames & Moore Program FOGALL analyses which shows the maximum increase in cooling lake induced fogging frequency along Highway 75 to occur approximately 3 miles south through 2 miles north of New Strawn, Kansas.

While the details of the fog monitoring program are not completely defined at this time, it is anticipated that a transmissometer and continuous analog recorder will be installed along Highway 75 at a point within 2 to 3 miles of New Strawn, Kansas. The instrument will continuously monitor visibility at an elevation of 1.5 to 2 meters above ground level. Maximum visibility resolution will be at least 100 meters.

The fog monitoring program will be initiated in 1981 and will continue through plant start-up. An annual analysis will be performed to categorize fogging occurrences by visibility classes and to correlate fog occurrences with the meteorological data acquired at the WCGS meteorological tower.

A detailed description of the specific fog monitoring program will be provided in forthcoming revisions to the WCGS ER(OLS) and FSAR Addendum.

R451.05 (continued)

It is anticipated that the operational fog monitoring program would consist of a continuation of the preoperational program described above. However, details of the operational program will not be established until results of the preoperational fog monitoring program have been evaluated.

Q451.06WC Section 2.3.2.2 (Rev. 1, 2/81) of the FSAR also discusses the effect of the cooling lake on atmospheric transport and diffusion and concludes "for winds less than about 6 mph flowing from or into this sector [south-southwest to south-southeast] (and less than 2 mph in any sector over the lake) modifications in the atmospheric stability of the diffusion properties of the air may be expected." Winds less than about 6 mph blowing from or into the south-southwest to south-southeast sector occur about 13% of the time. Discuss the modifications to transport and dispersion characteristics during these conditions and indicate if the calculations in Sections 2.3.4 and 2.3.5 of the FSAR should be changed to reflect the modified dispersion conditions.

R451.06 The primary effect of the cooling lake will be to modify atmospheric stability in the local area of the lake due to different roughness parameters and surface temperatues between land and lake. To evaluate the cooling lake's impact on the WCGS x/O calculations of the FSAR Section 2.3.4 and 2.3.5, eight combinations of ambient atmospheric stability, air-water temperature differences, and type of release were studied. These cases are listed in Table 451.06-1.

Case 1

For the case of a stable ambient atmosphere, water temperature warmer than ambient air, and ground level release, the effect of the cooling lake will be to heat the two level atmosphere causing increased turbulence. Ground level releases would, therefore, be more dispersed. For this case, the FSAR analyses of Sections 2.3.4 and 2.3.5 are conservative.

Case 2

For an elevated release into a stable atmosphere traversing over warmer water, there will be a modification of ground level x/Q only if the lake-induced mixing reaches plume height within the distance that air flow is over the lake. G. S. Raynor et all, 1974 present a method for estimating the vertical extent of mixing due to the warmer lake surface:

$$H = \frac{u^*}{u} \left(\frac{F(T_A - T_w)}{-\Delta T/\Delta Z} \right)^{\frac{1}{2}} \qquad (1)$$

R451.06 (continued)

where

H = height of modified layer (m)

u^* = friction velocity over the water ($m\ sec^{-1}$)

$\bar{u}$ = mean wind speed ($m\ sec^{-1}$)

F = fetch over water (m)

T_A = low-level air temperature in source region (°C)

T_W = water temperature (°C)

$\Delta T/\Delta Z$ = lapse rate over the source region and above the inversion ($°Cm^{-1}$)

To estimate the maximum impact of a warmer cooling lake on a stable atmosphere, the inversion height (H) was calculated for:

u^* = .21 m/s (appropriate for smooth water surface; D.H. Slade, 1968)

$\bar{u}$ = 2 m/s

F = 5.5 km (wind from south or north)

$T_A - T_W$ = -50°C

$\Delta T/\Delta Z$ = .015°C/m (E stability)

Under the extreme assumptions, the mixing height will reach approximately 450 meters, sufficient height to cause plume fumigations. Since the fumigation will occur over water or within a short distance of the lake, this situation will cause a greater impact (with respect to present analyses) only within a short distance of the lake itself. χ/Q concentrations farther downwind may be lower due to the lake-induced mixing.

Case 3 and 4

For an elevated or ground release with a stable atmosphere traversing a cooler body of water, the effect of the cooling lake will be to increase the stability of the atmosphere, potentially creating a very shallow intensification of the

R451.06 (continued)

existing temperature inversion. Since this shallow temperature structure would likely be destroyed by mechanically-induced turbulence over the land surfaces, the lake does not have a significant effect in this case.

Case 5 and 6

For the case of an elevated or surface release into an unstable atmosphere traversing a warmer body of water, the effect of the cooling lake would be to increase the instability of the atmosphere producing greater dispersion of a ground level release. Greater dispersion of an elevated release would occur if the lake-induced turbulence extended to plume height. For these cases, the existing analyses are conservative for a ground release, and are likely somewhat conservative for an elevated release.

Case 7

For a ground level release into an unstable atmosphere traversing cooler water, the effect of the cooling lake will be to create a low-level temperature inversion which would restrict the dispersion of the low-level plume, tending to increase ground-level concentrations, until the inversion was destroyed by a rougher (or warmer) land surface.

Case 8

As with Case 7, a low-level inversion will be created over the lake surface. From Equation 1 with the following variables:

u^* = .21 m/s

$\bar{u}$ = 2 m/s

F = 5.5 Km

$T_A - T_W$ = 10°C

$\Delta T/\Delta Z$ = -.015°C/m (C stability)

The mixing depth (H) for this conservative case will not exceed approximately 20 meters. Since an elevated release from the 60-meter vent would not easily penetrate to ground level through this inversion layer, x/Q values would generally be lower than the present analyses.

R451.06 (continued)

Conclusion

Only for Cases 2 and 7 would an analysis which considers the presence of the cooling lake tend to be more conservative than the existing analysis of WCGS FSAR Sections 2.3.4 and 2.3.5. For Cases 1, 5, 8, and perhaps 6 the exisitng analysis should be more conservative.

Cases 2 and 7 will differ from the present analyses only in the immediate vicinity of the cooling lake and then only for wind directions which would produce the largest over-water fetch (i.e., N, S, NW, and SSE). From three years of onsite data at 10- and 60-meter wind levels (Tables 2.3-29 and 2.3-30) unstable stability classes (E, F, and G) occur approximately 20 percent of the time and stable classes (A, B, and C) occur approximately 9 percent of the time.

It is expected that over long averaging periods the effect of Cases 1 and 8 will tend to balance the effect of Cases 2 and 7. The short-term accident analyses presented in Tables 2.3-55 through 2.3-57 show strong stable cases resulting from Case 7. With respect to Case 2, it is expected that the resulting fumigation will not result in a $\bar{x}/Q$ value which exceeds the x/Q values of a ground-level release in a stable atmosphere.

Based upon the above discussion, we consider the existing analyses to be valid.

REFERENCES

Rayner, G. S., P. Michael, R. M. Brown, and S. Sethu Raman, 1974, preprint of Symposium on Atmospheric Diffusion and Air Pollution, Sept. 9-13, 1974, Santa Barbara, California, Sponsored by American Meteorological Society.

Slade, D. H. (ed.), 1968, Meteorology and Atomic Energy - 1968, TID-24190, National Technical Information Service, Springfield, VA.

TABLE 451.06-1

CASES TO BE INVESTIGATED TO ASSESS EFFECTS OF COOLING LAKE ON ATMOSPHERIC TRANSPORT AND DIFFUSION

CASE	STABILITY	T water - T Land	RELEASE
1	Stable	+	Ground
2	Stable	+	Elevated
3	Stable	-	Ground
4	Stable	-	Elevated
5	Unstable	+	Ground
6	Unstable	+	Elevated
7	Unstable	-	Ground
8	Unstable	-	Elevated

Q451.07WC Tables 2.3-59 and 2.3-60 of the FSAR (Rev. 1, 2/81) present terrain/recirculation correction factors to be applied to a straight-line Gaussian dispersion model to better characterize temporal variations in meteorological conditions. These correction factors were estimated based on the results of a variable-trajectory puff advection model using one year of hour-by-hour meteorological data from the Wolf Creek site. Substantial reductions (up to a factor of 100 lower than the straight-line model) are suggested for distances approaching 80 km. For several directions, correction factors of zero are suggested, implying that no release from the site would affect a particular receptor location. Discuss the reasonableness and appropriateness of correction factors for receptors greater than 8 km from the source developed by use of a variable trajectory model with only a single source of meteorological data as input. Indicate the merit of a correction factor calculated to be zero.

R451.07 Dames & Moore's variable-trajectory puff advection model, PUFF, was used, along with a straight-line model, in the derivation of terrain/recirculation correction factors (TCFs). PUFF tracks the advection and dispersion of up to 500 Gaussian puffs across the study area. New puffs are emitted continuously at 20-minute intervals throughout the year. Puffs are discarded when they leave the study area, or when they have become so attenuated that they no longer have a significant impact at any receptor location. The criterion for discarding an attenuated puff is comparison of the puff center x/Q to a user-specified cutoff x/Q value. In the original analysis, this cutoff was inadvertently set to an inappropriately high value. The result was that puffs were discarded too quickly, before they could reach the more distant receptor locations.

The PUFF model analysis has been repeated for ground-level release using a more appropriate x/Q cutoff value. Revised TCFs are presented in Table 451.07-1 for the 10 receptor ring distances used in the PUFF analysis. As this table indicates, the strong systematic under-prediction of PUFF model results in relation to straight-line model results for large source-receptor distances is no longer present.

The mild overall decrease in TCF values at large downwind distances may be attributed to plume meander, accounted for in PUFF but not in the

R451.07 (continued)

straight-line model. With wind directions varying hourly, plume elements in PUFF actually cover a greater distance before arriving at a given receptor than is assumed in the straight-line model. They are, therefore, more attenuated on arrival at the receptor than the straight-line model algorithm would indicate.

Revised TCFs will be computed for the mixed-mode case as well as the ground-level case. The revised TCFs will be logarithmically interpolated to provide TCFs for all downwind distances of interest. This complete set of TCFs will be applied to all straight-line model results presented in the FSAR by September 1, 1981.

Use of a single meteorological station as the data source for the PUFF analysis is justified by the absence of severe terrain within the region of interest and by the fact that only long-term average relative concentrations are evaluated. Absence of severe terrain implies that deviations from straight-line flow that do occur are not strongly systematic. Effects of random plume meander and mesoscale recirculation on annual average x/Q values are adequately represented via PUFF simulations with single-station onsite meteorological input.

TABLE 451.07-1

TERRAIN/RECIRCULATION CORRECTION FACTORS AT TEN STANDARD DISTANCES (GROUND RELEASE) BASED ON JUNE 1, 1973 to MAY 31, 1974 ONSITE DATA

DISTANCE (KILOMETERS)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
0.4	1.14	0.96	0.96	1.10	0.98	0.95	1.08	0.95	1.02	0.99	1.29	1.08	1.04	0.99	1.00	1.02
1.2	1.00	1.05	0.94	1.02	1.09	0.91	1.06	0.97	1.04	0.96	1.24	1.28	1.02	1.05	1.02	0.97
2.4	1.08	1.07	1.04	0.99	1.05	0.98	1.07	0.91	1.05	0.97	1.17	1.13	1.03	1.05	1.01	0.95
4.0	1.07	1.01	0.97	1.03	1.16	0.93	1.19	1.01	1.09	0.89	1.28	1.03	1.17	1.01	1.03	0.95
5.6	1.12	0.82	0.88	0.84	1.07	0.80	1.11	1.01	1.22	0.96	1.25	1.11	1.14	0.98	1.05	1.00
8.0	1.08	0.91	0.71	0.81	1.10	0.80	1.09	1.06	1.05	0.98	1.31	1.17	1.17	0.98	1.09	0.92
16.0	0.80	1.00	0.60	0.69	1.05	0.75	0.99	1.14	1.12	0.77	1.31	1.09	1.11	0.94	0.98	1.00
32.0	0.76	0.88	0.58	0.59	0.74	0.70	0.86	0.80	1.00	0.75	1.09	0.93	1.03	0.87	1.02	0.93
56.0	0.73	0.44	0.29	0.63	0.83	0.49	0.65	0.75	0.91	0.55	0.82	0.69	0.84	0.68	0.61	0.87
80.0	0.57	0.28	0.24	0.35	0.55	0.31	0.50	0.61	0.75	0.43	0.56	0.60	0.75	0.55	0.51	0.70

Q451.08WC The expected number of lightning strikes to ground per year in a square mile area surrounding the site could be as high as 46 (p. 2.3-8 of the FSAR). Provide seasonal and annual estimates of lightning strikes to safety-related structures at the site, considering the "attractive area" of the structures. A suggested reference for this type of analysis is J. L. Marshall, Lightning Protection, 1973.

R451.08 The frequency of lightning strike t an area is related to the number of thunderstorm days in that area. In order to characterize the expected frequency of lightning strikes in the area of the Wolf Creek plant, data from Topeka, Kansas regarding the average number of thunderstorm days over a 31-year period were used. These data were presented in Table 2.3-4 of the FSAR and are summarized below.

SEASON	THUNDERSTORM DAYS
Winter (January through March)	3
Spring (April through June)	26
Summer (July through September)	23
Fall (October through December)	5
ANNUAL TOTAL	57

The following discussion, which estimates the number of lightning strikes to safety-related structures at the site, was developed following the methodology presented by J. L. Marshall in Lightning Protection published in 1973.

The "attractive area" of the structures was determined for a lightning strike with an electrical current magnitude of 20,000 amperes, which corresponds to the current magnitude of 50 percent of lighting flashes. The attractive area (A) of a structure is:

$$A = Lw + 4H \quad (w+L + \pi H), \text{ where}$$

L = structure length, meters
w = structure width, meters
H = structure height, meters

The grouping of safety-related structures which maximizes the attractive area is composed of six structures: reactor building, control building, auxiliary building, diesel generator building, fuel building, and refueling water storage tank.

R451.08 (continued)

For simplicity, this grouping has been assumed to have the following dimensions:

L = 96.4 m
w = 86.5 m
H = 62.5 m

These dimensions yield an attractive area of 0.103 km^2. The number of lightning strikes to earth per thunderstorm day per square kilometer (N_e) is given by:

$$N_e = (0.1 + 0.35 \sin z) \quad (0.40 + 0.20) \text{ where}$$

z = the geographical latitude

Using the approximate plant latitude of 38° 14', the value of N_e calculated from the above equation is N_e = 0.190. Thus, the number of lightning strikes per square kilometer per year equals:

$$N_e \times 57 \frac{\text{thunderstorm days}}{\text{year}} = 10.83 \frac{\text{strikes}}{\text{km}^2 \text{ year}}$$

Since the safety-related structures of interest have an attractive area of 0.103 km^2, the number of lightning strikes per year to safety-related structures at the site is estimated to be:

$$10.83 \frac{\text{strikes}}{\text{km}^2 \text{ yr}} \times 0.103 \text{ km}^2 = 1.12 \frac{\text{strikes}}{\text{year}}$$

or one lightning strike every 0.89 years (324 days).

From data in Section 2.3.1.2.5 it was seen that the number of strikes to ground per square mile per year is between 0.05 and 0.8 times the number of thunderstorm days per year. This results in between 3 and 46 lightning strikes per square kilometer per year, which includes the number previously calculated of 10.83 lightning strikes per square kilometer per year.

The seasonal estimate of lightning strikes to safety-related structures is presented below:

R451.08 (continued)

SEASON	STRIKES PER SEASON
Winter	0.06
Spring	0.51
Summer	0.45
Fall	0.10
ANNUAL	1.12

Reference: Lightning Protection, Marshall, J. L., 1973.

Q451.09WC The tornado statistics presented in Section 2.3.1.2.6 are based on a regional data base that ended in 1971. Identify any tornadoes that have occurred in the vicinity of the site since 1971, and provide estimates of the intensity (maximum wind speed) and path area of each.

R451.09 The publication Storm Data, published by the National Oceanic and Atmospheric Administration (NOAA) was consulted to obtain information concerning tornado strikes in the vicinity of the site in the years 1972 thrugh 1980. The area comprising Coffey County and the seven county area surrounding Coffey County were evaluated. The counties investigated are Allen, Anderson, Coffey, Franklin, Greenwood, Lyon, Osage, and Woodson Counties.

The tornadoes recorded in these counties are shown below along with an estimate of the path area of each. No estimate of the maximum wind speed that occurred was available from this source. In order to provide some indications as to the intensity of the tornado, an estimate of property and crop damage is included which has also been obtained from the NOAA Publication.

LOCATION (COUNTY)	DATE	PATH LENGTH (MILES)	PATH WIDTH (YARDS)	ESTIMATED DAMAGE[1] PROPERTY	CROPS
Greenwood, Wilson	4/19/72	20	100	4	0
Osage	7/2/72	Brief Touchdown		0	0
Lyon	3/13/73	8.5	220	4	0
Lyon	4/13/73	9 to 10	440	3	0
Greenwood	6/4/73	5	300	5	5
Allen	6/4/73	2	200	4	0
Coffey	11/20/73	1	176	5	0
Greenwood, Chase & Butler	5/30/74	28	500	6	4
Lyon, Osage & Shawnee	6/8/74	38	2640	7	4
Allen	3/11/77	0.5	75	5	0
Allen	5/4/77	0.25	50	3	0
Greenwood	5/11/78	7 yds.	3	4	0
Osage	5/23/78	4	30	5	0
Franklin	6/17/78	Brief Touchdown		0	0
Osage	6/17/78	8	150	5	0
Greenwood	9/17/78	2	7	4	0

R451.09 (continued)

Note 1 - Storm damages are placed in categories varying from 0 to 9 as follows:

0) No damage
1) Less than $50
2) $50 to $500
3) $500 to $5,000
4) $5,000 to $50,000
5) $50,000 to $500,000
6) $500,000 to $5 million
7) $5 million to $50 million
8) $50 million to $500 million
9) $500 million to $5 billion

Q451.10WC

a. Describe the procedures used for determining "the worst temperature period" and "the worst evaporation period" (Table 2.3-9 A and B) used for the analysis of the ultimate heat sink.

b. Regulatory Guide 1.27 (Rev. 2) recommends that the meteorological conditions used for analysis of the ultimate heat sink be selected from a recent 30-year period. Only 16 years of data from Chanute Flight Service Station were used in this evaluation (p. 2.3-12). Explain why 16 years of data (1949 through 1964) is considered representative of regional climatological conditions for analysis of the ultimate heat sink.

R451.10

a. See Section 9.2.5.3

b. The long-term meteorological data collected at Chanute, Kansas are considered to be the most representative data for the WCGS as discussed in Section 2.?.2. However, only 16 years of data were recorded (1949-1964) by the U.S. National Climatic Center at Chanute, Kansas.

These 16 years of data represent regional climatological conditions for analysis for the UHS because included in this 16-year period of record is the worst recorded drought which occurred during 1952 through 1957 and has an estimated recurrence interval of 50 years. This drought also occurred in many states in the midwest including Illinois and Texas. For example, the 1952-1955 drought in Illinois was considered to have a recurrence interval of 83 years by Illinois State Water Survey (Reference 1). Also, in Texas this drought was considered to be the worst on record since 1890 (Reference 2). To date these droughts for Illinois and Texas are considered to be the worst on record. Therefore, the 16 years of Chanute meteorological data for the Ultimate Heat Sink (UHS) Analysis for WCGS includes the most severe regional climatological period on record to date.

R451.10 (continued)

The worst 30-day evaporation and temperature periods were selected from this 16-year meteorological data for use in the UHS analysis. These two 30-day periods occurred close to or within the one-in-fifty year drought (maximum 30-day evaporation period occurred from June 24, 1954 to July 23, 1954; maximum temperature period occurred from July 16, 1951 to August 15, 1951). Note that this worst evaporation period for the WCGS UHS analysis occurred within the one-in-fifty year drought and the worst temperature period occurred close to the one-in-fifty year drought. Analysis of Illinois weather data for 28 years (1948 to 1976) for an UHS located in Illinois developed similar trends, i.e., the worst 30-day evaporation and temperature periods also occurred close to or within the one-in-fifty year drought.

By this analogy, the 16 years of Chanute meteorological data used for WCGS UHS analysis are representative of the regional climatological conditions and contain the worst case drought, evaporation, and temperature periods.

Table 9.2-4 will be revised to indicate that 16 years of data from Chanute, Kansas were used as the meteorological conditions for the design of the WCGS UHS.

REFERENCES

1. Hudson, H. E. Jr., and W. J. Roberts, 1955, 1952-1955 Illinois Drought with Special Reference to Impounding Reservoir Design - Bulletin No. 43, State Water Survey Division, State of Illinois.

2. Lowry, Jr., R. L., 1959. A Study of Droughts in Texas, Bulletin 5914, Texas Board of Water Engineers.