KANSAS GAS AND ELECTRIC COMPANY

GLENN L KOESTER
VICE PRESIDENT NUCLEAR

RECEIVED JUN 08 1981 U.S. NUCLEAR REGULATORY COMMISSION

June 5, 1981

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

KMLNRC 81-082
Re: Docket Number STN 50-482
Ref: NRC Letter dated 5/12/81 from RLTedesco, NRC, to GLKoester, KG&E

Dear Mr. Denton:

The referenced letter requested additional information concerning the Wolf Creek Generating Station, Unit No. 1 Environmental Report - Operating License Stage. Transmitted herewith are responses to questions in the referenced letter. The remaining outstanding responses will be forwarded to you in August, 1981. This information will be formally incorporated into the Wolf Creek Generating Station Unit No. 1 Environmental Report - Operating License Stage in Revision 2. This information is hereby incorporated into the Wolf Creek Generating Station Operating License Application.

Yours very truly,

Glenn L Koester

GLK:bb
Attach

8106080315

C

cc: Gordon Edison
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

Bernard Jaroslow
Argonne National Laboratory
Building 10
9700 South Cass Avenue
Argonne, Illinois 60439

Maurice Messier
Environmental Review Coordinator
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

# 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 5th 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
SEDGWICK CO. KANS.

Evelyn L. Fry
Evelyn L. Fry, Notary

My Commission expires on August 15, 1981.

NRC Question 240.1(ER)(3.3)

ER-OL, p. 3.3-2, Sec. 3.3.6. Please indicate the makeup water rates used in simulating the Wolf Creek cooling lake drawdown during the 16-year (1948-1964) design weather period.

Response:

The makeup rate for the 16-year cooling lake analysis was divided into three makeup schedules given as follows:

> For the predrought, January 1, 1949 to July 31, 1952, the makeup rate varied from 0 to 120 cfs; during the drought, August 1, 1952 to May 31, 1957, the makeup rate was fixed at a constant 40 cfs; and for the post drought, June 1, 1957 to December 13, 1964, the makeup rate varied from 0 to 120 cfs.

In the predrought and post drought periods where the makeup varied from 0 to 120 cfs, the LAKET program calculated the amount of makeup required to maintain a constant cooling lake elevation of 1087 feet MSL. The attached tables list the average monthly makeup flow rates for the 16-year cooling lake analysis for Unit 1 and Units 1 and 2 respectively.

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TABLE 240.1 -1

Kansas Gas & Electric Company

Wolf Creek Station - Unit 1

Monthly Average Cooling Lake

Makeup Flow Rate, cfs, From 1949 to 1964

| Month/ Year | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN | 0 | 26.07 | 24.37 | 18.14 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 58.64 | 62.99 | 50.03 | 67.50 | 38.27 | 61.44 | 63.24 |
| FEB | 0 | 23.55 | 9.18 | 20.94 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 54.27 | 59.34 | 44.75 | 51.99 | 43.21 | 59.20 | 65.46 |
| MARCH | 0 | 34,67 | 20.85 | .40 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 5.70 | 69.26 | 20.66 | 37.48 | 40.50 | 47.76 | 73.74 |
| APRIL | 0 | 44.57 | 9.43 | 0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 46.27 | 67.04 | 52.52 | 31.33 | 78.74 | 96.34 | 43.85 |
| MAY | 0 | 16.67 | 0 | 35.03 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 53.05 | 43.40 | 54.56 | 0 | 103.56 | 89.63 | 79.21 |
| JUNE | 0 | 18.04 | 0 | 81.65 | 40.0 | 40.0 | 40.0 | 40.0 | 0 | 52.64 | 87.42 | 83.83 | 36.02 | 25.74 | 84.55 | 46.78 |
| JULY | 14.07 | 0 | 0 | 63.25 | 40.0 | 40.0 | 40.0 | 40.0 | 57.71 | 11.28 | 32.91 | 79.61 | 93.95 | 93.55 | 108.55 | 119.02 |
| AUG | 62.04 | 0 | 0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 118.33 | 85.36 | 96.66 | 76.76 | 92.31 | 108.52 | 117.54 | 92.53 |
| SEPT | 25.05 | 0 | 0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 79.25 | 54.96 | 103.25 | 115.36 | 10.72 | 12.04 | 102.06 | 95.69 |
| OCT | 33.94 | 24.40 | 0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 63.34 | 93.90 | 12.60 | 48.60 | 59.44 | 75.35 | 107.42 | 95.0 |
| NOV | 48.76 | 51.54 | 0 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 54.28 | 73.87 | 78.92 | 75.36 | 54.08 | 64.31 | 80.44 | 83.68 |
| DEC | 23.56 | 28.83 | .94 | 40.0 | 40.0 | 40.0 | 40.0 | 40.0 | 57.71 | 59.98 | 58.39 | 65.89 | 58.43 | 66.84 | 72.53 | 65.04 |

POOR ORIGINAL

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CHICAGO, ILLINOIS



TABLE 240.1-2

Kansas Gas & Electric Company

Wolf Creek Station - Units 1 & 2

Monthly Average Cooling Lake

Makeup Flow Rate, cfs, From 1949 to 1964

| Month/ Year | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN | .55 | 37.58 | 36.74 | 29.31 | 40 | 40 | 40 | 40 | 40 | 120 | 73.68 | 60.42 | 78.39 | 46.46 | 70.30 | 74.68 |
| FEB | 0 | 34.70 | 13.42 | 34.31 | 40 | 40 | 40 | 40 | 40 | 120 | 70.45 | 56.65 | 63.40 | 57.92 | 71.92 | 78.93 |
| MARCH | 0 | 48.27 | 39.94 | 3.45 | 40 | 40 | 40 | 40 | 40 | 120 | 83.65 | 31.33 | 51.64 | 52.95 | 62.05 | 87.15 |
| APRIL | 10.82 | 59.0 | 24.58 | 10.62 | 40 | 40 | 40 | 40 | 40 | 120 | 82.40 | 69.02 | 44.16 | 93.98 | 112.02 | 58.21 |
| MAY | 24.04 | 31.51 | 0 | 68.84 | 40 | 40 | 40 | 40 | 40 | 120 | 61.40 | 71.85 | 0 | 115.61 | 107.94 | 92.96 |
| JUNE | 45.68 | 39.17 | 0 | 100.27 | 40 | 40 | 40 | 40 | 120 | 120 | 101.67 | 101.18 | 74.30 | 49.97 | 101.11 | 68.83 |
| JULY | 36.15 | 4.94 | 0 | 84.38 | 40 | 40 | 40 | 40 | 120 | 70.28 | 56.06 | 99.02 | 110.62 | 111.69 | 120 | 120 |
| AUG | 82.67 | 0 | 0 | 40 | 40 | 40 | 40 | 40 | 120 | 108.92 | 116.13 | 97.21 | 112.78 | 113.71 | 120 | 120 |
| SEPT | 42.37 | 16.87 | 0 | 40 | 40 | 40 | 40 | 40 | 120 | 80.37 | 119.59 | 119.33 | 26.27 | 42.20 | 120 | 118.50 |
| OCT | 51.07 | 75.16 | 0 | 40 | 40 | 40 | 40 | 40 | 120 | 110.86 | 29.33 | 76.68 | 78.09 | 94.83 | 120 | 111.58 |
| NOV | 61.83 | 64.67 | 9.72 | 40 | 40 | 40 | 40 | 40 | 120 | 87.80 | 91.89 | 90.19 | 67.15 | 76.10 | 120 | 98.74 |
| DEC | 35.0 | 39.48 | 39.18 | 40 | 40 | 40 | 40 | 40 | 120 | 70.01 | 70.34 | 76.93 | 69.45 | 79.59 | 86.29 | 74.92 |

Q240.2 (ER) (3.4) ER-OL, p. 3.4-1, Sec. 3.4.1. For one 1150 MWe unit operating at a 100-percent average annual load factor, will the circulating water heat rejection rate be $8.1 \times 10^9$ Btu/hr as stated in Sec. 3.4.1 or $7.87 \times 10^9$ Btu/hr as indicated in Sec. 3.4.4?

R240.2 The circulating water heat rejection rate for one 1150 MWe unit operating at 100 percent average annual load factor is $7.87 \times 10^9$ Btu/hr.

The $8.1 \times 10^9$ Btu/hr heat rejection rate mentioned in Section 3.4.1 should be $8.0 \times 10^9$ Btu/hr and represents the heat rejection rate for the circulating water system plus $0.13 \times 10^9$ Btu/hr heat rejection rate for the service water system.

NRC Question 240.3(ER)(3.4)

ER-OL, p. 3.4-3, Sec. 3.4.3.2. The calculated velocities of the water approaching and within the circulating water intake structure do not seem to be accurate. The staff has presented in the FES-CP, Table 3.1 the various intake velocities for a total flow rate of 1256 cfs. Please prepare the similar table for the modified intake structure and the revised flow rate of 1204 cfs.

Response:

The fourth and fifth paragraphs of ER(OLS) Section 3.4.3.2 (original text) will be revised for clarification as follows:

> "The Circulating Water Screenhouse sump floor is located at an elevation of 1058 feet MSL. A steel plate is provided at the sump inlet of the Screenhouse as a weather protection device (Figure 3.4-9). This steel plate extends from elevation 1075 feet MSL, upwards to the operating floor, 1092 feet MSL. The velocities of circulating water and service water flow downstream of the steel plate are essentially independent of cooling lake water level."
>
> "Based on a total (circulating water and service water combined) flow rate of 1204 cfs for one unit, the average inlet water velocities are calculated to be:

| | |
|---|---|
| Approach velocity to the Screenhouse: | 0.87 feet per second |
| Velocity through the bar grill: | 1.06 feet per second |
| Approach velocity to the traveling screens: | 1.06 feet per second |
| Velocity through the traveling screens: | 1.95 feet per second" |

The water intake velocities listed above replace the Table 3.1 of the FES-CP.

Q240.4 (ER) (3.4) ER-OL, p. 3.4-3, Section 3.4.3.2. Please provide an engineering drawing showing the width of the modified circulating water discharge chute, and also indicate the discharge velocity for a total flow rate of 1204 cfs.

R240.4 The width of the modified circulating water discharge chute is 75 feet as shown in the plan view of the attached drawing S-500.

The discharge velocities below the circulating water discharge chute for a total flow rate of 1204 cfs are calculated to be 1.15 ft/sec and 1.5 ft/sec for the lake levels of 1087.0 ft (normal operating level) and 1085.0 ft (low water level for 1-unit) respectively.

NRC QUESTION 240.5 (ER) (3.4):

ER-OL, p. 3.4-4, Sec. 3.4.4 Please indicate the service water temperature rise and the combined circulating and service water temperature rise for the station operating at full load.

Response:

The service water temperature rise and the combined circulating and service water temperature rise for one unit operating at 100% load are given as follows:

| | | |
|---|---|---|
| Service water temperature rise | = | 6.4°F |
| Plant temperature rise (Combination of circulating and service water) | = | 29.6°F |
| Circulating water temperature rise | = | 31.5°F |

NRC Question 240.6 (ERO (3.4):

ER-OL, p. 3.4-4, Sec. 3.4.4 Please provide a copy of the manual describing the LAKET computer model used to calculate the cooling lake temperature distribution.

Response:

The LAKET program is proprietary so that only the LAKET program abstract is attached for your review. The LAKET user's manual is available in Sargent & Lundy offices for NRC's inspection.

Q 240.6

# PROGRAM ABSTRACT

| | |
|---|---|
| TITLE: | LAKET - One-Dimensional Lake Thermal Prediction Program |
| PROGRAM NO.: | 09.5.072-5.0 |
| AUTHOR: | R. J. Slezak |
| PROGRAM SCOPE: | LAKET analyzes the transient thermal performance of one-dimensional lakes, rivers, and channels. Varying plant flow rate and rise temperature are treated. Lake TDS and turbine back-pressure may be computed. Runs may switch between open and closed cycle, and between constant level and varying level. |
| INPUT: | Lake configuration, meteorological conditions, and plant operational data. |
| OUTPUT: | Lake temperatures, elevation, and water balance components. Full statistical monthly, seasonal, yearly, and total summaries for all variables. Computer-generated plots of all calculated variables versus time are available with the LAKPLOT (09.5.115-1.0) post processor. |
| COMPUTATIONAL APPROACH: | A LaGrangian formulation of the mass and energy conservation equations is implemented. Plug flow is assumed through the channel. A 3-hour time step is used for all variables. |
| ESTIMATED RUNNING TIME: | One CPU minute per year of simulation. |
| MACHINE: | UNIVAC 1106<br>Core size ≅ 22k words |

NRC Question 240.7(ER)(2.4)

Describe the effects of plant consumptive water use on existing and projected downstream water users under low flow conditions up to and including the 2 percent chance drought. The description should include current information on water use and current projections of future use.

Response:

A discussion of the effects of plant consumptive water use on downstream water users during the period of record drought of 1952-1957 was discussed by the NRC staff in the Supplemental Testimony, dated January 6, 1976, on contention I-1 during the Atomic Safety and Licensing Board hearings. This period-of-record drought is estimated to have a recurrence interval of fifty years (2% chance drought). The NRC staff in their discussion concluded that even if all the water rights, senior to Kansas Water Resources Board's right to John Redmond Reservoir storage, set out in Kansas Department of Agriculture list, are included as downstream users, there is sufficient storage available in John Redmond Reservoir to provide 41 cfs to the WCGS and to satisfy rights of the downstream users through the period-of-record drought.

NRC Question 240.8(ER)(2.4)

Provide a flow-duration curve for the Neosho River at Wolf Creek reflecting regulation by the John Redmond Reservoir. Also, provide an estimate of the 7 consecutive day once in 10 year low flow for the river at Wolf Creek under the same conditions. Discuss the effect of plant operation on these parameters. Provide in your discussion your assumptions regarding reservoir release rates and plant withdrawals used in your analysis.

Response:

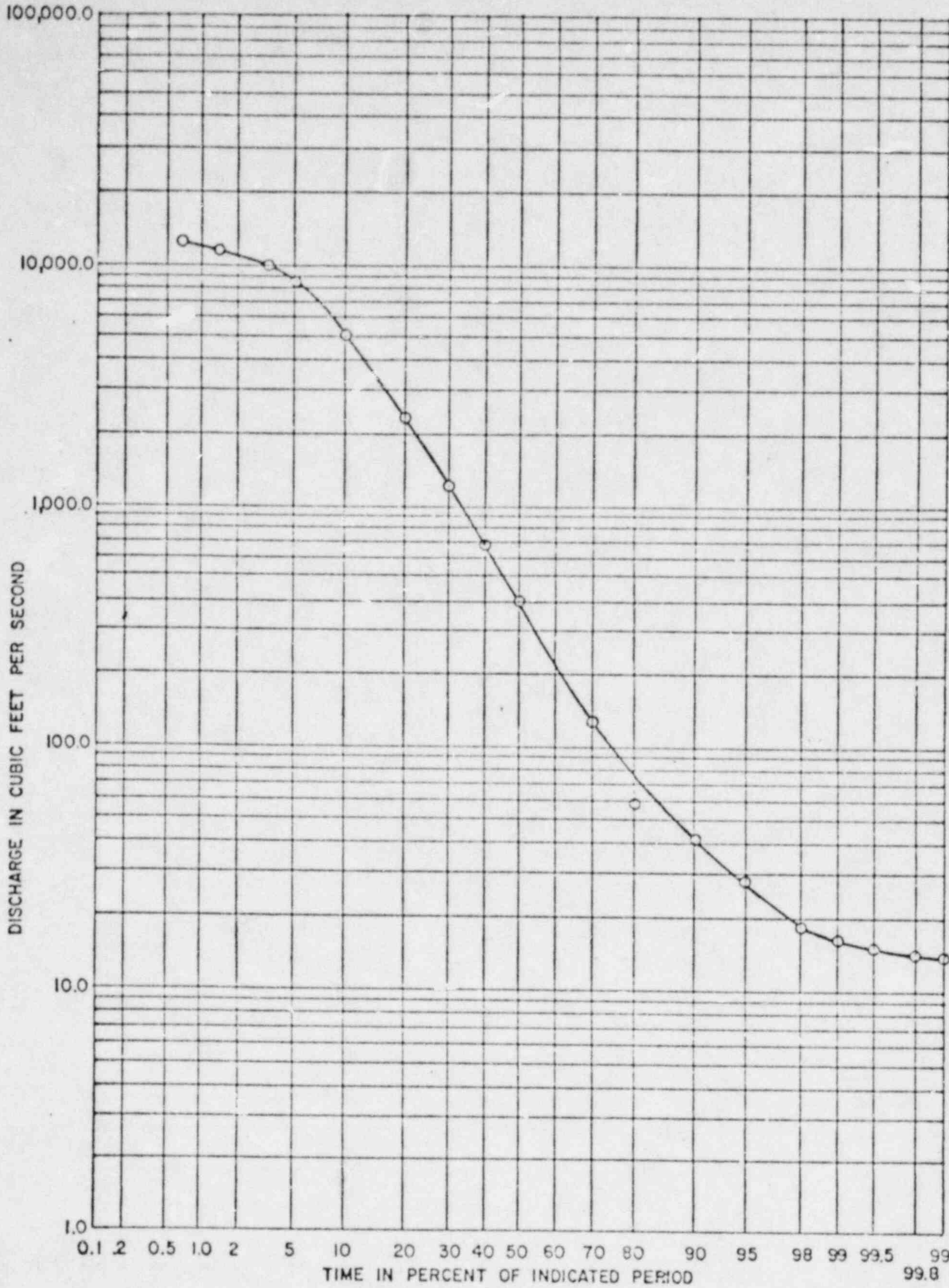
The nearest U.S. Geological Survey gaging station on the Neosho River downstream of John Redmond Reservoir and near the confluence of Neosho River and Wolf Creek is at Burlington, Kansas. This gaging station at Burlington, Kansas, is approximately five miles downstream of John Redmond Reservoir and the confluence of Neosho River and Wolf Creek is approximately 4 miles downstream of this gaging station. The flow-duration information for Neosho River at Burlington, Kansas, for the period October 1964 to September 1979 is presented in Figure 1. The 7-day 10-year low flow for the same period is 17.3 cfs.

During low flows, the flows in Neosho River below John Redmond Reservoir would constitute the releases from the reservoir for water rights and water quality purposes. Even with plant operation at WCGS, the releases for water rights and water quality will be made from the Reservoir and, hence, the flow-duration for the low-flow range would not be affected at Burlington nor at Wolf Creek.

The Attachment M to the supplemental testimony by NRC staff dated January 6, 1976 on contention I-1 during Atomic Safety Licensing Board hearings (Construction Permit Stage) gives average monthly flows in the Neosho River below John Redmond Reservoir with WCGS operation for the period 1951-1959.

Attachments A and B to the above testimony tabulate the water quality and water rights releases below John Redmond Reservoir. The plant makeup water rates (withdrawal from John Redmond Reservoir) are discussed in Section 3.3.6 of WCGS, ER(OLS). See response to Question 240.7 regarding the effects of plant consumptive water use on existing and projected downstream water users under low flow conditions.

(Q40.8)




PERIOD OF RECORD:
OCT. 1964 - SEP. 1979

Q240.8

FIGURE
FLOW-DURATION CURVE -
DAILY FLOW OF NEOSHO RIVER
AT BURLINGTON

NRC Question 240.9(ER)(2.4)

Provide the dates of the minimum daily flows shown in Table 2.4.3 of the ER. If these low flows were a result of reservoir filling, provide minimum daily flows (and dates) for the period after the reservoir began normal operation.

Response:

A revised Table 2.4-3 listing dates of minimum daily flows for the period September 1, 1964 through September 30, 1977 is attached. Regulated storage of John Redmond Reservoir began on September 1, 1964.

Q240.9



TABLE 2.4-3

REGULATED STREAM FLOWS OF THE NEOSHO RIVER

FROM 1964 TO 1977

(All Values in Cubic Feet per Second)

| | RECORDED DISCHARGES AT BURLINGTON, KANSAS (RM 338.4) | | | | RECORDED DISCHARGES AT IOLA, KANSAS (RM 284.4) | | | |
|---|---|---|---|---|---|---|---|---|
| Month | Monthly Average | Maximum Daily | Minimum Daily | Date of Min.Flow | Monthly Average | Maximum Daily | Minimum Daily | Date of Min.Flow |
| Oct. | 1,774 | 13,400 | 2.8 | 10/2/74 | 2,284 | 29,500 | 25 | 10/16/66 |
| Nov. | 1,397 | 13,400 | 29 | 11/30/66 | 1,897 | 24,900 | 27 | 11/2/66 |
| Dec. | 1,005 | 6,240 | 14 | 12/31/66 | 1,316 | 15,200 | 21 | 12/31/66 |
| Jan. | 951 | 7,180 | 14 | 1/10/67 | 1,339 | 12,800 | 14 | 1/12/67 13 |
| Feb. | 1,024 | 12,400 | 21 | 2/11/67 | 1,299 | 14,200 | 18 | 2/24/67 25 |
| Mar. | 1,461 | 15,100 | 20 | 3/18/67 | 2,035 | 22,100 | 15 | 3/16/67 17 |
| Apr. | 2,002 | 14,000 | 30 | 4/2/67 | 2,633 | 30,200 | 38 | 4/12/77 |
| May | 2,433 | 12,200 | 21 | 5/24/70 | 2,758 | 15,100 | 40 | 5/23-28/67 |
| June | 4,080 | 14,700 | 31 | 6/22/70 | 5,314 | 26,100 | 68 | 6/30/66 |
| July | 2,884 | 13,000 | 18 | 7/19/73 | 3,412 | 29,500 | 37 | 7/15/66 |
| Aug | 532 | 9,750 | 2.0 | 8/31/76 | 698 | 11,100 | 31 | 8/31/66 |
| Sep | 930 | 11,900 | 5.9 | 9/30/74 | 1,495 | 24,100 | 19 | 9/4/76 |

Sources: U.S. Geological Survey (1969) and U.S. Department of the Interior (1966-1977).

Note: Period of record is from September 1, 1964 through September 30, 1977. Regulated storage of the John Redmond Reservoir began on September 1, 1964; flow at the Burlington gauge has been completely regulated by the reservoir since 1963; flow at the gauge near Iola has reflected considerable regulation since 1963.

NRC QUESTION 240.10 (ER)(2.4)

Provide a description of the analysis used to determine the runoff into Wolf Creek Cooling Lake for the cooling lake simulation study. Describe the gaged basins used to extrapolate flows for Wolf Creek including location, size period of record, whether the streams are effluent or influent, and any adjustments made other than for drainage area.

Response:

Since Wolf Creek is ungaged, no records of stream flows are available. Streamflow data for the Wolf Creek were synthesized from the U.S. Geological Survey records for the following gaging stations:

| Gaging Station | Drainage Area (sq. mi.) | Period of Record Used |
|---|---|---|
| 1. Neosho River at Council Grove, Ks. | 250 | 1938-1977 |
| 2. Neosho River at Americus, Ks. | 622 | 1963-1977 |
| 3. Neosho River at Strawn, Ks. | 3015 | 1922-1963 |
| 4. Neosho River at Burlington, Ks. | 3042 | 1962-1977 |
| 5. Neosho River at Iola, Ks. | 3818 | 1917-1977 |
| 6. Virdigris River at Madison, Ks. | 181 | 1955-1976 |

All the above stations are located adjacent to the Wolf Creek drainage area and the available data is adjusted to correlate with the creek's drainage area. The average intensity of streamflow at the gaging stations was applied to the drainage area of Wolf Creek to obtain the runoff into Wolf Creek cooling lake. No adjustments are made other than for drainage area.

The Neosho River and Wolf Creek are characterised as effluent streams in ER(OLS) Section 2.4.1.2.

NRC Question 240.11 (ER)(3.3):

Justify the conservatism of the estimates of Wolf Creek Cooling Lake seepage, evaporation, and inflow that have been used as input to the consumptive water use analysis and cooling lake drawdown studies.

Response:

Seepage

The maximum seepage estimated from the cooling lake and through the cooling lake dam is 0.102 cfs, when the lake level is at the normal operating level of 1087.0 feet MSL. (See Section 2.4.2.4.2 and Table 2.4-10 of ER(OLS) and Section 2.5.6.6.1 of FSAR.) A seepage of 3.5 cfs at the lake level of 1087.0 feet MSL was used in the cooling lake analysis. The use of the higher seepage of 3.5 cfs is conservative because, during drought conditions (August 1952 through May 1957), the higher seepage would force the cooling lake to operate at more severe conditions, greater lake drawdown and higher lake temperatures.

Evaporation

The evaporation predicted by LAKET are based on the most accurate predicted method available from published sources and experimental studies listed below.

Patrick Ryan and Donald Harleman, "An Analytical and Experimental Study of Transient Cooling Pond Behavior," MIT Report No. 161, 1973.

D. K. Brady, W. L. Graves and J. C. Geyer, "Surface Heat Exchange at Power Plant Cooling Lakes", Cooling Water Studies for Edison Electric Institute, Report No. 5, John Hopkins University, November 1969.

B. A. Tichenor and A. G. Christianson, "Cooling Pond Temperature vs. Size and Water Loss", presented at ASCE National Water Resources Engineering Meeting, Phoenix, Arizona, January 1971.

Inflows

The inflows into Wolf Creek cooling lake are estimated as described in response to Q240.10 (2.4). The estimated flows are shown in Table 2.4-22 of the FSAR.

During the historic drought period of 1952-1957, for a period of six consecutive months (September 1956 to February 1957), the flows are negligibly small. Also for the 7 month period, from August 1953 to February 1954, the flow is less than 0.2 cfs. Therefore, it can be concluded that the inflows used in the analysis are conservative.

Q240.12 (ER) (2.4) Provide detailed stratigraphic sections used for seepage calculations along the seepage sectors shown on Figure 2.4-17. These sections should clearly identify the various stratigraphic members, their length, thickness, and elevations; and the location of wells or streams intersecting these members in the vicinity of the plant. Photo copies of sections plotted for Table 2.4-10 calculations are acceptable.

R240.12 The detailed stratigraphic sections are attached. The same stratigraphic sections, as well as other supporting technical information, were previously provided as written testimony on Contention I-2 during the earlier environmental hearings (Construction Permit Stage).

Q240.13 (ER) (7.1) Calculate the radiological consequences of a liquid pathway release from a postulated core melt accident. The analysis should assume, unless otherwise justified, that there has been a penetration of the reactor basemat by the molten core mass, and that a substantial portion of radioactively contaminated sump water was released to the ground. Doses should be compared to those calculated in the Liquid Pathway Generic Study (NUREG-0440, 1978). Provide a summary of your analysis procedures and the values of parameters used (such as permeabilities, gradients, populations affected, water use). It is suggested that meetings with the staff of the Hydrologic Engineering Section be arranged so that we may share with you the body of information necessary to perform this analysis.

R240.13 The requested analysis to calculate the radiological consequences of a liquid pathway release from a postulated core melt accident will be performed. The analysis will be conducted in accordance with guidance received from the NRC staff. The results of the analysis will be provided to the NRC in the form of a revision to the Environmental Report (OLS) in the near future.

## NRC Questions 240.14(ER)(2.4) and 240.15(ER)(5.7)

### Question 240.14

Descriptions of floodplains, as required by Executive Order 11988, Floodplain Management, have not been provided. The definition used in the Executive Order is:

Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including at a minimum that area subject to a one percent or greater chance of flooding in any given year.

(a) Provide descriptions of the floodplains adjoining the Neosho River, Wolf Creek and Wolf Creek Cooling Lake adjacent to the site. On a suitable scale map(s) provide delineations of those areas that will be flooded during the one percent (100 year) and .2 percent (500 year) chance floods both before and after plant construction.

(b) Provide details of the methods used to determine the floodplains in response to a. above. Include your assumptions of and bases for the pertinent parameters used in the computation of the one percent flood flow and water elevation. If studies approved by the Federal Insurance Administration (FIA) are available for the site and adjoining area, the details of the analysis used in the reports need not be supplied. You can instead provide the reports from which you obtained the floodplain information.

(c) Identify, locate on a map and describe all structures and topographic alterations in the floodplains.

### Question 240.15

(a) Discuss the hydrologic effects of all items identified in response to question 14c. Discuss the alteration in flood flows in Wolf Creek below Wolf Creek Cooling Lake. Determine the effect of the cooling lake on the 50, 10, 1, and .2 percent chance floods (2 year, 10 year, 100 year, and 500 year floods) in Wolf Creek below the cooling lake. Expected reservoir water level and storage and the time of the storm should be taken into account.

(b) Provide details of your analysis used in response to a. above.

### Response:

These two Questions (240.14 and 240.15) are interrelated. Therefore, a common response is provided. A description of the Neosho River basin and Wolf Creek watershed is given in Section 2.4.1.2 of the ER(OLS) and Section 2.4.1.2 of the FSAR for the Wolf Creek Generating Station (WCGS).

The flood prone area, the area flooded due to a 100-year flood, in the vicinity of the site prior to the construction of the WCGS and its facilities is shown in Figure 1. The flood prone area is taken from Flood Hazard Boundary Maps for Coffey County, developed by the Federal Insurance Administration, U.S. Department of Housing and Urban Development, dated August 1977. Maps showing the area flooded by a 500-year flood are not developed by the FIA and, hence, are not available. However, a Standard Project Flood (SPF) was developed for the Wolf Creek cooling lake and is presented below.

The facilities for WCGS, which may potentially alter the flood plains of the streams in the site area are the cooling lake dam, the makeup water screenhouse on the Neosho river below John Redmond dam, the circulating water screenhouse and discharge structure, the makeup discharge structure and the offsite roads and railroad track. All these facilities are identified in Figure 2. The circulating water screenhouse, discharge structure and the makeup discharge structure are built along the shoreline of the cooling lake and will have negligible effect on the Wolf Creek floodplain. A description of other facilities and their potential effects on the flood plains of the streams is given below.

Floods in Cooling Lake

A cooling lake was developed for WCGS by constructing a dam across Wolf Creek. The 100-year flood level in the cooling lake is estimated to be 1089.8 MSL. The flood prone areas above the dam due to a 100-year flood before and after the construction of the dam are shown in Figure 2. The boundaries of the property owned by the applicant are also shown in Figure 2. The area covered by the 100-year flood in the cooling lake is well within the property boundaries (Figure 2). Beyond the property boundary in the upper reaches of Wolf Creek, the 100-year flood in the cooling lake does not affect the flood prone area which existed prior to construction of the main dam.

The 500-year flood was not generated for the Wolf Creek cooling lake. However, a standard project flood (SPF) was developed for WCGS and is discussed in Section 2.4 of the FSAR. The cooling lake level during a SPF is estimated to be at an elevation of 1091.7 feet MSL and the area potentially flooded due to SPF would be within the property boundaries.

The complete description of the development of flood hydrographs (100-year flood, and SPF) with and without the cooling lake is given in Section 2.4 of the FSAR. These flood hydrographs are presented in Figures 2.4-17 and 2.4-19 of the FSAR.

Floods in Wolf Creek Below Cooling Lake Dam

The peak flood flows in Wolf Creek below the cooling lake will be considerably smaller, compared to the peak flood flows prior to the construction of the cooling lake due to the storage capacity of the cooling lake available above the lake normal operating level of 1087.0 feet MSL. The peak flood flows in Wolf Creek below the cooling lake for 2-year, 10-year, 100-year and standard project floods were obtained by routing the respective flood hydrographs through the cooling lake and over the service and auxiliary spillways. The description of the spillways and the flood routing procedure are described in detail in Section 2.4 of the FSAR. The starting elevation in the cooling lake was assumed to be at the service spillway crest level of 1088.0 feet MSL though a part of the flood could be absorbed by the storage capacity available between the normal operating level of 1087.0 feet MSL and spillway crest level. Table 1 presents the peak flood flows in Wolf Creek downstream of the cooling lake dam together with peak flows during preconstruction condition without the cooling lake. The table clearly shows that the post-construction peak flood flows are much lower than the corresponding preconstruction flood peaks. Hence, the flooding of the areas below Wolf Creek dam due to Wolf Creek flood flows is much reduced after the construction of the cooling lake.

Makeup Screenhouse

The makeup screenhouse was built downstream of the stilling basin for John Redmond dam spillway, and on the east bank of the discharge channel. Figures 3.4-4, 3.4-5, and 3.4-6 (ER(OLS)) show the general arrangement and location of the makeup screenhouse. The screenhouse is built on the east bank of the discharge channel and as can be seen from Figure 2, its encroachment into 100-year flood zone is very little. Hence, the additional flooding in the Neosho River below the John Redmond dam, due to the makeup screenhouse, is negligible.

Offsite Roads and Railroad Track

The offsite roads and railroad track are shown in Figure 2. The offsite railroad track crosses Long Creek, Scott Creek, Crooked Creek and Taucket Creek. Suitable bridge and culvert openings are provided wherever the roads and track cross the creeks.

Q 240.14/240.15

TABLE I

PEAK FLOOD FLOWS IN WOLF CREEK

(Below Cooling Lake Dam)

| No. | Recurrence Interval (Years) | Peak Flow (Natural Condition) (cfs) | Peak Flow (With cooling lake) (cfs) | Maximum Cooling Lake Water Level (feet M.S.L.) |
|---|---|---|---|---|
| 1 | 2 | 3,725 | 290 | 1088.78 |
| 2 | 10 | 5,941 | 497 | 1089.31 |
| 3 | 100 | 8,363 | 928 | 1089.80 |
| 4 | SPF | 20,000 | 4,188 | 1091.70 |

290.0 ENVIRONMENTAL ENGINEERING BRANCH

Q290.1 (ER) (3.9) Describe any changes in the routing of the transmission line corridors since the ER-OL (Sec. 3.9). What is the current state of completion (ER-OL Sec. 3.9)?

R290.1 Wolf Creek-Rose Hill Transmission line (345-kV) -- No changes to route, to be completed in 1983.

Wolf Creek-Craig Transmission line (345 kV) -- The Wolf Creek-Craig line has been changed and will terminate at a new substation -- West Gardner. The La Cygne-Craig transmission line will be intercepted and brought through the West Gardner substation where a ring bus arrangement will be used to connect these lines to the Wolf Creek 345 kV line. The West Gardner Substation will have three 345 kV lines (Wolf Creek-West Gardner, West Gardner-Craig, and West Gardner-La Cygne). Terminating the 345 kV Wolf Creek line at West Gardner will result in saving approximately 14 miles of 345 kV line. The transmission line corridor from Wolf Creek to West Gardner has not changed. Wolf Creek-West Gardner is to be completed in 1983.

Wolf Creek-Benton transmission line - no change. Completed in 1976.

Wolf Creek-La Cygne transmission line - no change. Completed in 1976.

Wolf Creek tap of Athens-Burlington transmission line - no change. Completed in 1975.

Wolf Creek to Coffey County REC transmission line - no change. Completed.

Q290.2 (ER) (3.9) Give details on the present status of the railroad spur routing and have there been any changes since the FES-CP Sec. 3.9?

R290.2

a. Railroad Spur Route: The route of the completed railroad spur is shown on drawing S-300.

b. Changes since FES-CP Section 3.9: The right-of-way for the offsite railroad spur varies from a width of 60 feet to 180 feet.

Q290.3 (ER) (3.9) Has the water pipeline been completed and have there been any changes in the proposed route (FES-CP Sec. 3.9)?

R290.3

a. The construction of the makeup water pipeline is complete.

b. The route of the existing pipeline varies from the proposed route shown in FES-CP Section 3.9 at the makeup water screen house (Corps of Engineers property) and at the makeup water discharge structure (KG&E property). The existing route of the pipeline is shown on drawings S-1, M-84, M-85, M-86 and M-87.

Q290.4 (ER) (3.9) What are the current plans for recreational and agricultural land use on site when WCGS becomes operational?

R290.4 No changes will result in recreational land use when WCGS becomes operational because there are no plans to open the lake for public recreational use as described in Section 2.8.

Land owned by the applicants is presently being utilized for agricultural purposes. It is the applicants' policy to lease such lands when such leasing is consistent with prior commitments and does not interfere with the future operation of WCGS. No change from this policy is anticipated when WCGS goes into operation. Section 2.8 also describes this land use policy for land adjacent to the cooling lake and inside the WCGS site boundary.

Q290.5 (ER) What mitigative measures will be taken by the applicant (or other agencies) for the protection of bald and golden eagles that may be attracted to the cooling lake? This is in regards to both protection from plant operation and structures and from recreational users of the cooling lake.

R290.5 Because the construction of the WCGS cooling lake will create habitat favorable for wintering Bald Eagles, mitigative measures have been taken for the protection of these endangered raptors. The Golden Eagle, since it occurs only rarely in this part of the state (Schwilling, Pers. Comm) would be of lesser concern.

Management considerations and their corresponding mitigative measures for Bald Eagles include:

1. Potential Hazards

   A. Human disturbance - The WCGS cooling lake is closed to the public and therefore human disturbance of Bald Eagles roosting or feeding on the cooling lake will be minimized.

   B. Shooting - Shooting is the most prevalent single cause of death among Bald Eagles (Coon et al. 1970). Restriction of public access will minimize the incidence of eagle shootings on the WCGS cooling lake.

   C. Electrocution - Electrocutions occur when an eagle, or other bird, with a wide wing span makes simultaneous contact with any two phase conductors or with a phase conductor and a ground wire. Powerlines with electrical ratings over 69 kv do not present a hazard because of wide line spacing. On powerlines with ratings of 69 kv or less, crossarm type distribution poles are the most likely to be involved with electrocutions (Ansell et al. 1980). The distribution poles used on the 69 kv line near the WCGS cooling lake are not the crossarm type.

2. Food Supply

   Wintering Bald Eagles feed primarily on crippled or healthy waterfowl and winter-killed or live fish. They also feed on other waterbirds, upland game and small mammals. All of these food sources are available on or near the WCGS cooling lake.

3. Vegetative Habitats - Wintering Bald Eagles usually perch in large trees that are adjacent to foraging areas and provide protection from the wind (Griffin et al. 1980, Steenhoff et al. 1980). Modifications of the initial cooling lake basin clearing plan were made to increase the amount of standing timber left in the upper portions of the lake. Such areas will probably be utilized as perch sites. In addition, small stands of trees left at various locations around the lake will also provide excellent perch sites. It is also quite likely that Baffle Dikes A and B will be utilized for perching and foraging. This variety of potential perch sites should reduce usage of power poles for perching.

4. Avifauna Surveys - Surveys of the WCGS cooling lake have been initiated by the Applicant to determine the amount of Bald Eagle usage and identify any developing problems. Surveys are conducted on a semi-monthly basis during the months of January-April and September-December. Three ground surveys (each at a different time of day) are conducted during each half-month period. Aerial surveys of both the WCGS cooling lake and John Redmond Reservoir will be conducted on a monthly basis beginning in September, 1981.

## REFERENCES

Ansell, A. R., and W. E. Smith, 1980, Raptor Protection Activities of the Idaho Power Company in Workshop on Raptors and Energy Developments, R. H. Howard and J. F. Gore, ed. p. 56-70.

Coon, N. C., L. N. Locke, E. Cromartie and W. L. Reichel, 1970, Causes of Bald Eagle Mortality, J. Wildl. Dis. 6(1):70-76.

Griffin, C. R., T. S. Baskett and T. S. Sparrowe, 1980, Bald Eagles and the Management Program at Swan Lake National Wildlife Refuge in Trans. 45th North Am. Wild. and Nat. Resources Conf.

Schwilling, M., Non-game, Threatened and Endangered Project Leader, Kansas Fish and Game, 1981, Personal Communication.

Steenhoff, K., S. S. Berlinger and L. H. Fredrickson, 1980, Habitat Use by Wintering Bald Eagles in South Dakota, J. Wildl. Manage. 44(4):798-805.

Q290.6 (ER) Was the crawfish frog observed in the area to be inundated by the cooling lake mudflat area? If so, are there other preferred habitat areas within the area that currently maintain a localized population of this species?

R290.6 Records exist which document the occurrence of the northern crayfish frog (Rana areolata) for twelve eastern Kansas counties, including Coffey County. Although there was a single observation of this species in 1976 on the mudflats of John Redmond Reservoir, there have been no observations made of the crayfish frog on the WCGS site. While the lack of observations for this species on site does not entirely rule out the possibility of their occurrence, it does indicate that no large colonies, similar to those referenced by Collins (1974), exist on site.

REFERENCE

Collins, J. T., 1974, Amphibians and Reptiles in Kansas, Univ. of Kans. Museum of Natl. Hist., Publ. Ed. Ser. No. 1, 283 p.

Q290.7 (ER) Has the baseline terrestrial ecology been done for the proposed ROWs? Please provide the data.

R290.7 No baseline terrestrial ecology data has been collected for the transmission line right-of-ways. During the ER(CPS) no commitments were made by the Applicant and no recommendations were made by the Commission in the WCGS Final Environmental Statement to perform such monitoring. Consequently, there are no plans to perform ROW monitoring.

Q290.8 (ER) Have there been any changes in the site boundaries? Where are they?

R290.8 The site boundary was changed in a few minor ways between that described in the Environmental Report Construction Permit Stage (ER[CPS]) and the Environmental Report-Operating License Stage (ER[OLS]). Figure 2.1-8 of the ER(CPS) and 2.1-6 of the ER(OLS) should be compared to show the changes. The changes resulted in less property being purchased for WCGS proper. The nominal acreage within the site boundary in the ER(CPS) was 10,500 acres and the actual amount purchased was 9,818 acres. The specific changes are:

- Sections 13 and 24, T21S-R15E -- Boundary moved east to section line;
- Section 30, T21S-R16E -- Boundary moved north to half-section line (See revised ER(OLS) Figure 2.1-6);
- Section 17, T21S-R16E -- Boundary excludes NW 40 acres (See revised ER(OLS) Figure 2.1-6);
- Section 9, T21S-R16E -- Boundary moved west to section line; and
- Section 36, T20S-R15E -- Boundary moved west to follow lake contour.

Q290.9 (ER) How many hectares on site are grazed prairie and how many are old farmland?

R290.9 In answering this question, grazed prairie was understood to be grasslands in which the sod has never been tilled, and old farmland was interpreted as land that was once cultivated and has since been returned to grass. There are an estimated 626 hectares of grazed prairie and 72 hectares of old farmland that are above elevation 1087 and within the site boundary. Information concerning demography of land below elevation 1087 is given in Section 4.1.1 of the ER (CPS).

Q290.10 (ER) (2.1.3) Provide a Table similar to Table 3.9-1 indicating the percentage of prime and unique farmlands onsite.

R290.10

TABLE 290.10-1

PRIME AND UNIQUE FARMLANDS ON WCGS S.TE

| | Prime Farmland | Unique Farmland | Total Acres | Percent Prime & Unique |
|---|---|---|---|---|
| Onsite | 7,756 acres* | 0 acres | 9,818 | 79% |

* The total acreage is based on field inspection sheets and is an estimate. Exact acreage of prime farmland can be supplied upon issuance of the US Soil Conservation Service Master Soil Map of Coffey County.

Q290.11 (ER) (2.2.1) Provide an update of the listing of Rare and Endangered Species.

R290.11 One species, the Bald Eagle, named on the official list of threatened and endangered species for the United States (U.S. Dept. of Interior, 1979) and classified as endangered by the state of Kansas, was observed on a near the WCGS site. No other species on the federal list has been observed during monitoring activities.

One species listed on the state of Kansas endangered species list, the Neosho madtom (Noturus placidus), has been collected during monitoring activities at WCGS. It has been collected consistently at two Neosho River locations since 1978.

Two bird, one fish, and one amphibian species classified as threatened by the state of Kansas have been collected or observed near WCGS. The prairie falcon was observed in 1979 and again in 1981 as a winter resident. The least tern was observed at John Redmond Reservoir (JRR) in 1977. The blue sucker has consistently been collected at several Neosho River locations since 1978. This species has been collected at JRR (Location 1) most frequently. The northern crayfish frog has been observed only once on the JRR mudflats in 1976.

The bobcat, a species previously listed as endangered (federally), has been observed by tracks in the north floodplain area in 1977 during monitoring and in 1980 as an incidental siting by site personnel.

The following list includes those species classified as endangered or threatened by the state of Kansas.

ENDANGERED WILDLIFE IN KANSAS

| | | |
|---|---|---|
| 1. | Black-footed Ferret | Mustela nigripes |
| 2. | Gray Bat | Myotis grisescens |
| 3. | Peregrine Falcon | Falco peregrimus |
| 4. | Whooping Crane | Grus americana |
| 5. | Eskimo Curlew | Numenius borealis |
| 6. | Bald Eagle * | Haliaeetus leucocephalus |
| 7. | Neosho Madtom * | Noturus placidus |
| 8. | Pallid Sturgeon | Scaphirhynchus albus |
| 9. | Sicklefin Chub | Hybopsis meeki |
| 10. | Central Newt | Notophtalmus viridescens louisianensis |

| | | |
|---|---|---|
| 11. | Grotto Salamander | Typhlotriton spelaeus |
| 12. | Gray-bellied Salamander | Eurycea multiplicata griseogaster |
| 13. | Cave Salamander | Eurycea lucifuga |
| 14. | Small Amphibious Snail | Pomatiopsis lapidaria |
| 15. | Warty-backed Mussel | Quadrula nodulata |
| 16. | Heel-splitter Mussel | Anodonta suborbiculata |

THREATENED WILDLIFE IN KANSAS

| | | |
|---|---|---|
| 1. | Prairie Falcon * | Falco mexicanus |
| 2. | Least Tern * | Sterna albifrons |
| 3. | Blue Sucker * | Cycleptus elongatus |
| 4. | Arkansas Darter | Estheostoma cragini |
| 5. | Topeka Shiner | Notropis topeka |
| 6. | Alligator Snapping Turtle | Macroclemys temmincki |
| 7. | Northern Crawfish Frog * | Rana areolata circulosa |
| 8. | Riffle Beetle | Optioservus phaeus |

* Found on or near WCGS site

Q290.12 (ER) (5.5) Provide a discussion on the potential short-term and long-term effects of electric fields on humans and describe the grounding procedures to be utilized to prevent primary and secondary shocks.

R290.12 Electric utilities commonly employ various grounding practices and techniques as simple and highly effective methods for keeping induced voltages and currents from having harmful effects. All transmission lines associated with Wolf Creek are 345 kV or less. Transmission at these voltages is called EHV (extra high voltage) transmission. When electric utilities began building UHV (ultra high voltage) transmission lines (greater than 500 kV) in the 1960's the potential for increased effect on humans was recognized and studied.

One study conducted by American Electric Power during 1962-1972 with the assistance of the John Hopkins medical group studied electrostatic field effects on the human body (Scherer, et al. undated). One of the objectives of the study was to determine if the electric field could cause either short or long-term effects on human health.

Medical examination was made on 11 linemen who performed live line maintenance at 345 kV using both barehand and hot-stick methods. The medical study consisted of opthamological, otolarynogological, urological, and neuro-psychiatrial as well as physical and laboratory examinations. The nine year continuous study revealed no effects in their health resulting from exposure to high voltage lines. No evidence of any malignancy, or changes in physical, mental, or emotional states were found.

Numerous other studies have also been completed or are ongoing. EPRI collected and reviewed this information and published two reports summarizing the biological effects of high-voltage electric fields (EPRI RP381, 1975; EPRI EA-1123, 1979). The 1975 report concluded and the 1979 report confirms the conclusion that it is highly improbable that electric fields from transmission lines have any significant biological effects on healthy individuals who encounter such fields in a normal way under normal conditions. However, the reports also relate that there may be subtle and as yet undetected effects of such electric fields. Further studies to determine if other effects exist are presently being conducted.

Years of operating experience have indicated that with proper grounding EHV and UHV transmission lines pose no hazard to the health and well being of humans. Grounding techniques employed by KG&E and KCPL include for 345 kV lines:

1. Static wires overhead of the lines;
2. Ground wires on wooden structures;
3. Ground rods on wooden or steel structures, if required, to limit ground resistance to 10 ohms or less;
4. Fences grounded at 1/4 mile intervals that run parallel to the line or within 200 feet of the center line;
5. Fences that cross the line grounded 50 feet on each side of the center line for KG&E and 80 feet for KCPL; and
6. Minimum ground clearance of 30 feet in open country and higher elsewhere.

These features limit the potential shock hazard to secondary or imperceptible shocks well below the painful shock or let-go shock threshold.

REFERENCES

EPRI RP 381, 1975, Biological Effects of High-Voltage Electric Fields.

EPRI EA-1123, 1979, Biological Effects of High Voltage Electric Fields: An Update.

Scherer, Jr., H. N., and B. J. Ware, Undated, Environmental Effects of High Voltage Transmission, American Electric Power Service Corporation.

Q290.13 (ER) (5.5) Provide a discussion of the potential problems of seasonal waterfowl impacting the proposed transmission lines bordering the Wolf Creek Cooling Lake.

R290.13 There is no doubt that birds collide with transmission lines and that populations utilizing Wolf Creek Cooling Lake (WCCL) will be susceptible to such collisions. However, the potential for such collisions can be greatly reduced through a wide variety of mitigative measures (Thompson, 1978). Preventive measures taken by the Applicant to reduce the potential for transmission line collisions include siting of lines, tower design and prevention of fright/flight collision potential.

1. <u>Initial siting of lines</u>

Only a small percentage of the existing 345 and 69 kV transmission lines pass over WCCL. In the areas where crossings occur standing timber should help to reduce the potential hazard. Standing timber will reduce the clearance between lines and the land configuration, thereby channeling the birds over the lines. In some cases, existing lines paralleled each other thereby clustering the corridors to reduce collision potential.

Two additional 345 kV lines are to be constructed to transmit power from WCGS. Both enter the area from the east, with one traveling to the West Gardner substation in a NNE direction and the other going down the east side of WCCL then west to the Rose Hill substation. The Wolf Creek-Rose Hill line is positioned close to the existing 69 kV line. Paralleling these lines should reduce collision potential.

2. <u>Tower Design</u>

By reducing the number of horizontal planes formed by powerlines, the collisions involving flocks flying through the lines will be reduced. The existing 345 kV lines at WCGS have both two plane and three plane sections. The new 345 lines will have two horizontal planes.

3. Prevention of Fright/Flight Reactions

The WCGS cooling lake is closed to public access. By restricting human disturbance and hunting, mortality due to collisions when birds are startled or distracted will be minimized.

4. Surveys

Surveys of the WCGS cooling lake have been initiated by the Applicant in order to determine the amount of waterfowl usage and identify any developing trends. Surveys are conducted on a semi-monthly basis during the months of January-April and September-December. Three ground surveys (each at a different time of day) are conducted during each half-month period. Aerial surveys of both the WCGS cooling lake and John Redmond Reservoir will be conducted on a monthly basis beginning in September, 1981.

291.0 ENVIRONMENTAL ENGINEERING BRANCH

Q291.1 (ER) Provide the following information on the lime sludge pond:

a. Location on the station site, including the distance from the pond wall to the cooling lake;

b. Major diversions;

c. Materials of construction;

d. Need for and frequency of clearout and ultimate disposal of wastes removed;

e. Estimated seepage rate from the pond into the groundwater;

f. Estimated composition and flow rate of effluent from the pond into the cooling lake.

R291.1

a. The lime sludge pond is located north of the switch yard and west of the meteorological tower (see Figure 2.4-14). With the cooling lake at normal operating pool level (elevation 1987.0 ft), the distance from the base of the lime sludge pond to the cooling lake will be approximately 50 feet.

b. The lime sludge pond has two diversions, a sluice structure and an emergency spillway. The spill height for the sluice structure is at elevation 2003'5" and for the emergency spillway at 2004'.

c. The lime sludge pond is unlined and has been constructed by excavating the existing grade of the pond area to a maximum height for the bottom of 1997.5' elevation. The excavated soil (inorganic cohesive soil) was used to build the dikes around the pond. The dike slopes are 3:1, vertical to horizontal. Dike slopes are covered with either four inches of seeded topsoil or twelve inches of filter type II covered by twelve inches of riprap class facin_.

d. The lime sludge pond is sized to contain all the influent from the lime softener blowdown, carbon and sand filter backwash, and regenerative waste for 2 units in operation and 40 years of plant life. The resulting lime sludge pond size is 180 acre-ft with an average depth of 7.8 ft and corresponding surface area of 1 million square feet.

R291.1 Cont'd

e. The seepage rate from the lime sludge pond is expected to be less than 10 gpm assuming upper bound permeability values for underlying soil and rock formations and will probably be less than 1 gpm. The runoff into the lime sludge pond will be negligibly small due to dikes on three sides and a intercepting drainage ditch on the fourth side.

f. At the end of 40 years of plant operation, the sludge accumulated in the lime sludge pond for 2 units in operation is estimated to be 19 acre-ft and approximately 1 ft deep (for the influent values listed in Figure 3.3-1 of the ER(OLS); values are doubled for 2 units in operation). The remainder of the lime sludge pond (161 acre-ft and 6.8 ft depth) at the end of 40 years will still have sufficient capacity to accommodate the worst rainfall. The 100 year-24 hour rainfall in the vicinity of the Wolf Creek Station is only 8 inches (U.S. Commerce Weather Bureau, Technical Paper No. 40). Also, the lime sludge pond volume will have sufficient capacity to accommodate the worst recorded wet years (from the Chanute, Kansas weather data used in the LAKET analysis) from 1949 to 1951 (typically, on an annual average basis, the precipitation rate in the Wolf Creek Station area is lower than the natural evaporation rate). These three consecutive wet years would increase the sludge pond water level by only 2.5 ft, leaving 4.3 ft margin in the lime sludge pond (the 1 ft sludge accumulation included).

The spillway in the lime sludge pond was originally designed for use during heavy rainfalls. However, with reduced demineralized makeup water design demand and thus, the corresponding reduction in pretreatment and demineralizer wastes (reduced lime softeners blowdown, carbon and sand filter backwash, and regenerative waste), the spillway is no longer required even during the heaviest of rainfalls as discussed previously.

NRC Question 291.2(ER)(3.6)

(a) Provide a complete description of the model used to calculate the allowable blowdown limits;

(b) Indicate the values used for the diffusion parameters and flow velocities in these calculations. Describe the model assumptions made in these calculations;

(c) The data given in the OL-ER imply that the concentrations of TDS, $SO_4^=$ and $Cl^-$ in the blowdown are the same as those in the cooling lake. However, such factors as incomplete diffusion or mixing of solutes or concentration stratification in the cooling lake might make the blowdown solute concentration different from that of the lake as a whole. Indicate whether such factors have been considered and, if so, what analysis has been made.

(d) Provide the basis of or the source(s) for the criteria for TDS, $SO_4^=$ and $Cl^-$ cited for the Neosho River.

Response (a,b):

The following is a brief description of the analysis and results for the dispersion of blowdown discharge from Wolf Creek lake in the Neosho River.

The TDS concentration distribution in the Neosho River is analyzed with a steady state dispersion model assuming the effluent discharge as a point continuous source on one of the banks of the river. The dispersion in the vertical and transverse directions of the river is considered. The longitudinal dispersion is neglected as it will be lower in comparison with the convection due to the ambient velocity of the river. The velocity in the river cross-section is assumed constant and an equivalent rectangular cross-section of the river is assumed for computation.

The following equation is used to find the concentration under steady state conditions:

$$C = \frac{C_o Q_o}{4\pi \sqrt{D_y D_z}\, X} \quad \exp\left[-\frac{U}{4X}\left(\frac{Y^2}{D_y} + \frac{Z^2}{D_z}\right)\right] \qquad \text{Equation 1}$$

in which:

| | |
|---|---|
| $C$ | = Concentration at any point in the river |
| $C_o$ | = Effluent concentration |
| $Q_o$ | = Rate of flow of effluent |
| $U$ | = Average velocity of flow in the cross-section |
| $D_y, D_z$ | = Dispersion coefficients in the y and z directions |
| $X$ | = Longitudinal distance |
| $Y$ | = Lateral distance |

$Z$ = Vertical distance

As the model is for unbounded channel, the effect of boundaries of the channel are taken care of by using method of images.

The dispersion coefficients were calculated from the following empirical equations developed for natural streams (Ref. 1).

$$\log\left(\frac{D_y}{UH}\right) = -3.547 + 1.378 \log\left(\frac{B}{H}\right) \qquad \text{Equation 2}$$

$$\log\left(\frac{D_z}{\nu}\right) = -8.1 + 1.558 \log\left(\frac{UH}{\nu}\right) \qquad \text{Equation 3}$$

in which:

$B$ = Top width of flow in river

$H$ = Hydraulic depth of flow

$\nu$ = Kinematic viscosity of water

Different combinations of Neosho River discharge, blowdown discharge and initial effluent TDS concentration are used in the computations. Figure 1 is a summary of the results. The maximum flow area in the cross-section along the length of the river which is having a concentration $\geq$ 500 mg/l (includes 400 mg/l Neosho River ambient TDS concentration) is computed and plotted against the blowdown discharge with $C_o$ as a variable. From these curves the blowdown discharges and $C_o$ values corresponding to the maximum flow area equal to 25% of the total flow cross-section are picked and plotted on Figure 1 with the Neosno River discharge as a variable. The 25% flow area is designated as a mixing zone according to Kansas Water Quality Criteria for interstate and intrastate waters of Kansas.

The following is used as input for the dispersion calculations:

1. An average section of the two surveyed cross-sections, one at the confluence with Wolf Creek and the other 600 feet downstream, is assumed downstream of the confluence of Wolf Creek with Neosho River. The rectangularized cross-section adopted for computation has a width of 92 feet and depth of 9.0 feet for a discharge of 1335 cfs.

2. The average velocity through the river for a discharge of 1335 cfs is computed as 1.6 ft/sec. The bottom slope of the river is obtained from the USGS (Burlington and Leroy Quadrangle Sheets, 7.5 minute series) topographic maps. A Manning's 'n' of 0.05 is assumed in the velocity computations.

3. The concentrations are computed at intervals of distances both laterally and vertically.

4. The point of injection for this computation is assumed to be at 5 feet from the bottom.

5. The values of dispersion coefficients used for a river discharge of 1335 cfs are calculated from equations (2) and (3) and they are:

$$D_y = 0.101 \text{ ft}^2/\text{sec}$$

$$D_z = 0.00031 \text{ ft}^2/\text{sec}$$

Response (c):

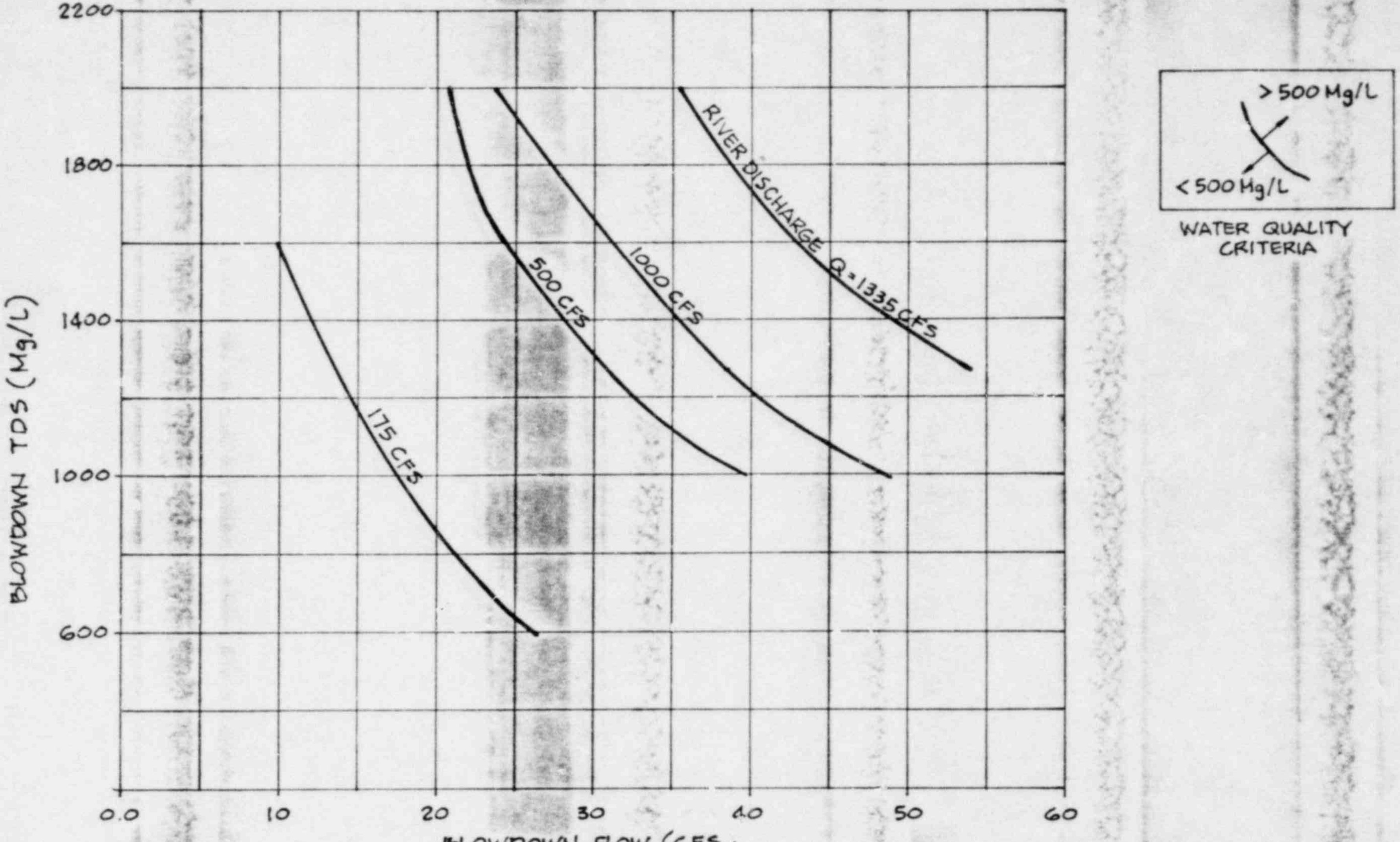
The cooling lake water quality calculations were based on complete mixing in the cooling lake. This issue of using complete mixing in the cooling lake water quality calculations has been discussed previously during the Atomic Safety and Licensing Board hearings (Construction Permit Stage). In this testimony, the NRC staff agreed that the use of complete mixing in the water quality calculations was valid.

Response (d):

The Kansas Water Quality Criteria for interstate and intrastate waters of Kansas, approved by Environmental Protection Agency August 1978, is used to establish criteria for TDS, $SO_4^{=}$ and $Cl^-$ (see ER(OLS) Section 3.6.2.2).

REFERENCE

1. Bansel, M. K., "Dispersion in Natural Streams," Journal of the Hydraulics Division, ASCE, Vol. 97, No. Hyll, Proc. Paper 8540, November 1971, pp. 1867-1886.




TDS LIMITED BLOWDOWN
Figure 1
Q 291.2

ng16

MR. RIDDLE: Yes, sir.

MR. CHARNOFF: Yes, sir.

CHAIRMAN JENSCH: Very well. The request of the Regulatory Staff counsel is granted and the previously prepared statement by Charles R. Boston consisting of five pages may be physically incorporated within the transcript and then shall constitute testimony in evidence on behalf of the Regulatory Staff.

(Testimony follows)

POOR ORIGINAL

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

| | |
|---|---|
| In the Matter of | ) |
| | ) |
| KANSAS GAS AND ELECTRIC COMPANY | ) |
| & KANSAS CITY POWER AND LIGHT | ) Docket No. 50-482 |
| COMPANY | ) |
| | ) |
| (Wolf Creek Generating Station | ) |
| Unit No. 1 | ) |

SUPPLEMENTAL TESTIMONY OF
CHARLES R. BOSTON
IN RESPONSE TO BOARD QUESTIONS
DEALING WITH COOLING LAKE WATER QUALITY

POOR ORIGINAL

The value for maximum TDS in the cooling lake which appears in the FES, Table 3.8 is the applicant's estimate as indicated in footnote "e". The staff considered this to be a reasonable estimate and using this value (1200 ppm) and the highest value of Neosho River TDS measured by the applicant during the sampling period (326 ppm, 9-11/73, Sampling Point No. 4, ER, Table 2.5 A-2), calculated a concentration factor of 3.7. This factor was then used to estimate the maximum concentration of other chemicals in the cooling lake. The calculation was considered to be reasonably conservative and non-critical to the overall assessment of impacts to either the cooling lake (FES, p. 5-34) or the Neosho River (FES, p. 5-27). Most organisms expected to exist in the cooling lake can tolerate TDS levels several times higher than the predicted 1200 ppm (FES, Table 5.23). Impacts to the Neosho River will also be acceptable regardless of TDS levels in the cooling lake since blowdown must meet State water quality criteria which the staff considers to be adequate.

At the request of Dr. Anderson, I have made an independent estimate of the maximum TDS expected in the cooling lake using the following assumptions:

- One unit operating at an annual average plant factor of 75%.
- Maximum TDS will occur near the end of the period or record drought (August 1952 to April 1957; 56 months).
- Zero blowdown during 56 month period (ER, Table 3.3-5).
- Average makeup during 56 month period of 46.6 cfs (ER, Table 3.3-1). TDS concentration assumed to be 326 mg/l.
- Volume of cooling lake will be 111,280 acre-ft.

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- Average makeup during 56 month period of 46.6 cfs (ER, Table 3.3-1). TDS concentration assumed to be 326 mg/1.
- Volume of cooling lake will be 111,280 acre-ft.

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3. Whereas the dominant driving force for the establishment of thermal stratification is density differences, the same forces actually oppose chemical stratification. The input of solar and plant waste heat at the surface promotes thermal stratification. On the other hand, the input of chemicals at the surface by direct additions and by evapo-concentration effects actually opposes the thermal stratification forces. The more concentrated, higher density solutions near the surface would tend to sink, thereby enhancing the mixing operation. If we were dealing with concentrated solutions rather than extremely dilute solutions it is conceivable that these forces could overshadow the thermal stratification forces.

4. Other effects such as diffusion would also reduce the likelihood of significant chemical concentration gradients.

For these reasons one can safely conclude that chemical stratification will occur to a much lesser extent than thermal stratification and since the phenomenon is seasonal and occurs over a relatively small portion of the lake, the effect on TDS calculations should not be significant.

Table 3.8. Increase in chemical concentration of effluent to Neosho River due to cooling lake concentration

| Chemical parameter | Maximum concentration in Neosho River[a] (mg/liter) | Maximum concentration in cooling lake[b] (mg/liter) | Incremental increase in Neosho River[c] (mg/liter) |
|---|---|---|---|
| Biological oxygen demand | 2.7 | 8.5 | 1.2 |
| Chemical oxygen demand | 24 | 77 | 11 |
| Dissolved oxygen | 14.1 | | |
| Sulfate | 56 | 787[d,e] | 146 |
| Chloride | 17.5 | 56 | 8 |
| Nitrate as N | 1.2 | 3.8 | 0.5 |
| Phosphate as P | 0.16 | 0.51 | 0.07 |
| Total dissolved solids (TDS) | 326 | 1200[e] | 174 |

[a]ER, Table 2.5A-2.

[b]Based on concentration cycle of 3.2.

[c]Based on minimum river flow of 32 cfs and 8 cfs blowdown which would be the maximum permissible to meet State standard of 500 mg/liter for TDS concentration in the river.

[d]Based on concentration cycle plus added $H_2SO_4$.

[e]ER, Table 3.6-3. Staff estimates maximum sulfate of 546 mg/liter and maximum TDS of 1600 mg/liter.

Affiant having been first duly sworn, on oath deposes and says: That the facts contained herein are true to the best of his knowledge and belief.

Charles K. Dieter

Subscribed and sworn to before me this 23rd day of March 1976.

Carl E. Woolf

My Commission Expires October 6, 1979

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NRC Question 291.3(ER)(2.4)

Outline the derivation of the concentrations given in Table 3.6-1. Are the values for the cooling lake averages over the whole lake - are they steady state values? Discuss why the normal values for the Redmond Reservoir are so much higher than those given in Table 2.4-11.

Response:

Table 3.6-1 lists the chemical constituents of the water in the John Redmond Reservoir and the Wolf Creek cooling lake (for one and two units in operation) covering a period of 1949 through 1964 which includes a 2% chance drought. Since the regulated storage of the John Redmond Reservoir did not begin until September 1, 1964, the John Redmond Reservoir water quality data in Table 3.6-1 were developed on the basis of published Neosho River water quality data (obtained from "Water Resources Data for Kansas," U.S. Geological Survey and Kansas State Board of Health, Division of Sanitation). With these Neosho River data as input, the LAKET program was used to predict the total dissolved solids (TDS) levels in the John Redmond Reservoir. The predicted TDS levels in the reservoir provided data for the calculation of the cycles of concentration (the cycles of concentration is defined as the ratio of the concentration of TDS in the circulating water to that in the makeup water and represents the effect of evaporation on the concentration of dissolved minerals). The concentrations of the other constituents in the water, listed in Table 3.6-1, were then determined by simply increasing these constituents concentrations for the Neosho River by the cycles of concentration, i.e., cycles of concentration times the concentration of the constituents.

The cooling lake water quality data listed in Table 3.6-1 were developed in a similar fashion. The John Redmond Reservoir water quality data were used as input into LAKET to predict the TDS levels in the cooling lake. The cycles of concentration were then determined which was used to cycle up the other water quality constituents. However, the cooling lake data includes sulfuric acid addition (for scale control in the condenser). This means that, with the added acid, the TDS and sulfate levels are increased by more than the cycles of concentration value, while the alkalinity is reduced due to a lower pH. The effects of acid addition are described in ER(OLS) Section 3.6.2.

The Wolf Creek cooling lake water quality data tabulated in Table 3.6-1 were predicted by the LAKET program based on the conservation of total dissolved solids and water as a function of time. For a given time interval, the cooling lake water quality is assumed constant over the entire lake (i.e., complete mixing).

The John Redmond Reservoir water quality data given in Table 3.6-1 are different than those given in Table 2.4-11 because the water quality data in Table 3.6-1 are based on a longer time interval (the TDS data are for a period of 1949 to 1964) than just the three years tabulated in Table 2.4-11. This difference in data base results in higher water quality data values for the John Redmond Reservoir and represents the record period of water quality data. For the cooling lake design, a record period of water quality data is essential and the use of these higher values are conservative.

Q291.4 (ER) Indicate whether essential service water is withdrawn continuously or only during an accident or shutdown?

R291.4 Essential service water (ESW) is not withdrawn continuously or used during shutdown. ESW is used during accident conditions and for testing.

NRC Question 291.5(ER)

Provide estimates of the maximum total residual chlorine concentration (including that combined as chloramines ahd chloro-organics) to be expected at the circulating water discharge outlet to the cooling lake.

Response:

Chlorination of the condenser cooling water is designed for three 30-minute applications per day. The chlorine dosage will be varied to maintain a free residual chlorine between 0.1 and 0.5 mg/l at the condenser outlet during each chlorination period. The total chlorine residual (including chlorine combined as chloramines and chloro-ogranics) will depend on the chlorine demand of water. However, during Atomic Safety Licensing Board hearings (Construction Permit Stage) in 1976, it was reported that the total chlorine residual would range between 0.68 mg/l and 1.08 mg/l at the circulating water discharge outlet to the cooling lake.

Q291.6 (ER) Where is the service water discharged? Is sulfuric acid added to the service water? If so, how much is added?

R291.6 The service water is discharged into the circulating water (CW) system downstream of the condensers prior to CW system leaving the power block. Sulfuric acid is not added to the service water system.

The principle expected corrosion products from water passage through the circulating and service water systems will be from the piping and heat exchangers. The concentrations of these corrosion products will be low, on the order of ppb or less. The potential chemical species are summarized below:

Carbon Steel - $Fe_2O_3$, $Fe_3O_4$, $Fe(OH)_3$, $Fe_2O_3 \cdot 3H_2O$

90-10 Cupronickel - $Cu_2O$, $CuO$, $NiCuO_2$, $Ni_3O_4$

Stainless Steel - $Fe_2O_3$, $Fe_3O_4$, $Fe(OH)_3$, $Fe_2O_3 \cdot 3H_2O$, $NiFe_2O_4$, $Cr_2FeO_4$, $NiCr_2O_4$, $Ni_3O_4$, $Cr_3O_4$

The concentration of the species will depend upon the ratios of metals present in the system, temperature and chemical composition of the water. The underground service water piping will have cathodic protection which will reduce corrosion in this pipe.

Q291.7 (ER) According to the OLER, Ammonia, Hydrazine, Potassium Chromate, and Turco Decon 4521 and 4520 are used in the power block system. Provide estimates of the usage of these chemicals. Also discuss the ultimate fate of these chemicals. Identify the pathways to the environment from the plant and indicate the amount and concentrations of these chemicals in the pathways.

R291.7

Ammonia

Expected blowdown from normal operations should not exceed .25 ppm $NH_3$ (See FSAR Table 10.3-4). The blowdown from Hot Standby is less than 10 ppm. All other conditions should have $NH_3$ concentration of less-than-or-equal-to .5 ppm.

Hydrazine

FSAR Table 10.3-4 shows hydrazine concentration as 75-100 ppm during cold hydro and cold wet layup. Otherwise the hydrazine content should not exceed the $0_2$ by 5 ppb. The maximum $0_2$ concentration in blowdown and feedwater is less than 100 ppm.

The pathway to the environment for $NH_3$ and hydrazine would be from condenser tube leakage to the circulating water.

Potassium Chromate

Potassium Dichromate is used in the component cooling water system. Pathways to the environment would be from heat exchanger leakage to the service water system.

Normal operational levels of $K_2Cr0_4$ in the CCW are 175-225 ppm ($Cr0_4$). Initial system conditioning will require 1000 ppm ($Cr0_4$) for the first week after filling the system.

The initial filling residue and any subsequent system drain down would be collected, tested and disposed of in an approved manner, e.g. wastes treated to bring the chromium concentrations to less than 5 ppm, or the waste would be removed to a disposal facility.

Turco Decon 4521 and 4502 (not 4520)

Turco Decon is used to decontaminate parts/equipment and its usage is dependent on the work being done. When used, Turco Decon 4521 is mixed with water, 8 oz to the gallon; and 2 lbs of Turco Decon 4502 is mixed with a gallon of water.

Turco Decon is disposed as drummed solid waste via the chemical waste tank.

Q291.8 (ER) Indicate the concentration and types of chemicals discharged in the rad·waste system effluent into the cooling lake.

R291.8 The reactor coolant system is the normal source of chemicals which may be discharged, after treatment by the liquid radwaste processing system, via the radwaste effluent to the lake.

Maximum releases are provided in Table 291.8-1. Each concentration is based on an average expected flow rate of 1,394 gals/day.

TABLE 291.8-1

TYPE AND CONCENTRATION OF CHEMICALS IN RADWASTE EFFLUENT TO COOLING WATER LAKE

| ITEM | OUTPUT CONCENTRATION |
|---|---|
| Boric Acid | 4 ppm |
| Chlorides | 0.15 ppm |
| Fluorides | 0.15 ppm |
| Suspended Solids | 1.0 ppm |
| pH Control Agent ($Li^7OH$) | 2.2 ppm (as Li) |
| Silica | 0.2 ppm |
| Aluminum | 0.05 ppm |
| Calcium | 0.05 ppm |
| Magnesium | 0.05 ppm |

Q291.9 (ER) (3.6) According to the OLER Section 3.6.3.2 each demineralizer train will be regenerated once every 26 days, and only one will be used at any given time with the other train kept as a spare. Explain why the relevant entries of Table 3.6-2 are calculated for twice the above regeneration rate.

R291.9 Section 3.6.3.2 will be changed to show that each demineralizer train will be regenerated once every 13 days instead of 26 days.

Q291.10 (ER) (3.6) According to Table 3.6-2 of the OLER about two mole equivalents of $H^+$ are used in regeneration of the demineralizers for each mole equivalent of $OH^-$. As a result, during each regeneration, one-half the acid is discharged unused into the alkaline lime sludge pond. Please verify or correct the above entries in the Table.

R291.10 Two corrections will be made to Table 3.6-2 for Sodium Hydroxide used to regenerate primary bed demineralizers. The dosage will be changed from 535 lb/regen to 625 lb/regen which causes the annual quantity to change from 15,020 to 17,548. This table provides the quantity of chemicals going into the primary and mixed bed demineralizers, but the effluent from the demineralizers may contain different proportions of $H^+$ and $OH^-$.

NRC Question 291.11(ER)(3.6)

Provide details on the derivation of the numbers given in Table 3.6-6 of the OLER.

Response:

Table 3.6-6 of the OLS-ER lists the impurities removed by one demineralizer train in the treatment of 216,000 gallons of makeup condensate. Based on the specified influent water quality and the design effluent water quality, the demineralizer manufacturer's guaranteed this removal of impurities.

Q291.12 (ER) Describe the program for monitoring TDS, $SO_4^=$, and $Cl^-$ concentrations in the Neosho River or in the blowdown to ensure that discharge criteria are met.

R291.12 Blowdown discharges from Wolf Creek Cooling Lake (WCCL) will comply with Kansas water quality criteria. The monitoring program which will document compliance with the criteria will be delineated by the requirements of the operating NPDES permit issued by the State of Kansas. At this time the NPDES permit has not been modified to cover WCCL discharges. See the response to Question 291.15 for additional discussion concerning the Wolf Creek NPDES permit.

Q291.13 (ER) Indicate whether discharged fluids, including oil spills in the transformer vault discharged through the oily waste separator system. If not, describe the discharge system where the effluents go and the amount of oily discharge to be expected. Describe the oily waste separator system and the fate of the separated oil and aqueous wastes after leaving the system.

R291.13 Any potentially oily waste, including oil spills in the transformer vaults, can be directed to the oily waste separator where oils and liquids are separated by their density differences. Should an oil spill be well contained, the oil could instead be cleaned up and drummed for reclaiming.

The attached drawing shows the site drainage plan and routing of piping to the oil separator. Table 3.6-7 gives a summary of oily waste discharge rates. Separated oil is reclaimed from the separator and aqueous wastes are routed to the cooling lake.

Q291.14 (ER) (3.4) Verify or correct the following changes in the OLER supplied during the site visit. Annual use of NaOCL for potable water disinfection 315 lbs/yr instead of 1315 lbs/yr (Table 3.6-2). Lime softener blowdown contains ferric hydroxide instead of ferrous hydroxide (page 3.6-5).

R291.14 Annual use of NaOCl for potable water disinfection should be 315 lbs/yr instead of 1,315 lbs/yr.

The lime softner blowdown contains ferric hydroxide instead of ferrous hydroxide.

Q291.15 (ER) Please supply a list, and copies if available, of all permits needed to discharge effluents during station operation. The OL-ER, Section 12, states that the discharge permit No. 1-NE07-R002 will be modified as WCGS becomes operational. Describe the expected modifications. If available give pollutant limits for the modifications. Identify and describe effluent discharges into the cooling lake or the lime sludge pond that will not be covered by a permit.

R291.15 A copy of the present NPDES permit (No. I-NE07-P001) issued by the Kansas Department of Health and Environment (KDHE) is attached. This permit controls effluents at three onsite locations:

- 001 Domestic waste treatment plant discharge
- 002 Stormwater runoff from the construction site
- 003 Concrete batch plant holding pond discharge

Since closure of the Wolf Creek Cooling Lake (WCCL) dam in November 1980, all plant effluents are being contained in the WCCL impoundment of water and there have been no discharges from Wolf Creek. Consequently, monitoring of the NPDES parameters is presently not required. The response to Question 291.17 discusses the range of time intervals which are projected to be required to fill the WCCL.

Prior to discharging from the lake the present NPDES permit will be modified to reflect the discharge point being the WCCL outlet. Discussions with KDHE personnel indicate that pollutant limits required in the present permit would be typical of those required to be in compliance with Kansas Water Quality Criteria if the operating NPDES permit were issued today.

All effluent discharges from Wolf Creek are either into the cooling lake or the lime sludge pond. (See Question 291.1 concerning discharges from the lime sludge pond.) All drainage in the vicinity of the plant is into the cooling lake so monitoring at the outlet of the cooling lake means that all effluent discharges will be covered by a permit.

*State of Kansas . . .* John Carlin, *Governor*

# DEPARTMENT OF HEALTH AND ENVIRONMENT

Joseph F. Harkins, *Secretary*

Forbes Field
Topeka, Kansas 66620
913 862 9360

March 21, 1980

Kansas Gas & Electric Co. - Wolf Creek Station
201 North Market
P.O. Box 208
Wichita, Kansas 67201

RECEIVED MAR 1980 NUCLEAR DEPT.

Re: Kansas Water Pollution Control
Permit No. I-NE07-P001

Gentlemen:

This is to inform you that you have fulfilled all filing requirements for a Kansas Water Pollution Control Permit and Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES). We are pleased to forward your new permit. While it is permissible to make as many copies as needed for monitoring and reporting purposes, you need to retain the original permit for your files.

We suggest you carefully read the terms and conditions of your permit and that you understand that these terms and conditions are enforceable under both State and Federal law.

We look forward to working with you in the achievement and maintenance of high quality water for the State of Kansas.

Sincerely yours,

Gerald A. Stoltenberg

Gerald Stoltenberg, P.E.
Director
Division of Environment

GS:am4Q1
Enclosure
cc: Southeast District

Kansas Permit Number: I-NE07-P001

Federal Permit Number: KS-0079057

# KANSAS WATER POLLUTION CONTROL PERMIT AND AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Pursuant to the provisions of Kansas Statutes Annotated 65-164 and 65-165, the Federal Water Pollution Control Act as amended, (33 U.S.C. 1251 et seq; the "Act"),

Owner: The Kansas Gas and Electric Company

Owner's Address: 201 North Market, P.O. Box 208
Wichita, Kansas 67201

Facility Name: Wolf Creek Station

Facility Location: Burlington, Kansas 66839
Coffey County

Receiving Stream & Basin: Neosho River via Wolf Creek Impoundment
Neosho River Basin

is authorized to discharge from the waste treatment facility described herein, in accordance with effluent limitations and monitoring requirements as set forth herein.

This permit shall become effective March 21, 1980, will supersede all previous permits and/or agreements in effect between the Kansas Department of Health and Environment and the permittee, and will expire April 30, 1983.

FACILITY DESCRIPTION:

Discharge consists of package plant effluent from domestic wastes, stormwater runoff from the plant site, and overflow from sediment control holding ponds treating process water from a concrete batch plant.

Secretary, Kansas Department of Health and Environment

21 March 1980
Date

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A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

The permittee is authorized to discharge from outfall(s) with serial number(s) as specified in the application for this permit. The effluent limitations shall become effective on the dates specified herein. Such discharges shall be controlled, limited, and monitored by the permittee as specified. The initial reporting period shall begin in April 1980 and end in June 1980 . Each consecutive three month period thereafter shall constitute a reporting period. There shall be no discharge of floating solids or visible foam in other than trace amounts.

| Effective Date / Outfall Number and Effluent Parameter(s) | EFFLUENT LIMITATIONS: Final Limitations Upon Issuance | MONITORING REQUIREMENTS: Measurement Frequency | Sample Type |
|---|---|---|---|
| **001 - Domestic Waste Treatment Plant into Wolf Creek** | | | |
| Flow - MGD (Base Flow = 0.03 MGD) | ---- | Weekly | |
| Biochemical Oxygen Demand (5-Day) | | Weekly | grab |
| Daily Average-mg/l(lbs/day) | 30( 7.5) | | |
| Daily Maximum-mg/l(lbs/day) | 45(11.3) | | |
| Total Suspended Solids | | Weekly | grab |
| Daily Average-mg/l | 30( 7.5) | | |
| Daily Maximum-mg/l | 45(11.3) | | |
| Free Available Chlorine | | Weekly | grab |
| Daily Maximum-mg/l | 1.0 | | |
| pH - Standard Units | 6.0-9.0 | Weekly | grab |

002 - Stormwater runoff from construction site

During the period beginning on the effective date and lasting through the date of expiration the permittee is authorized to discharge from outfall(s) serial number(s) 002

Such discharges shall be limited and monitored by the permittee as specified below:

Monitoring of the effluent will not be required unless there is a significant change in the quality or quantity of the subject discharge. The Water Quality Criteria for Interstate and Intrastate Waters of Kansas as formulated by the Kansas Department of Health and Environment, Regulation 28-16-28, will be applicable.

1. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units.
2. The discharge shall be essentially free of visible oil or grease and in no circumstances result in deterioration of the receiving water's quality.
3. Control of excessive suspended solids shall be undertaken as necessary to prevent receiving water deterioration.

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4. There shall be no sludge banks or deposition of solids downstream from the outfall.

5. There shall be no discharge of floating solids or visible foam in other than trace amounts.

Any violation of the above referenced Water Quality Criteria shall be reported immediately to the Kansas Department of Health and Environment, Bureau of Water Pollution Control, in Topeka, Kansas.

003 - Discharge from sediment control holding pond receiving process water from the concrete batch plant

| | | | |
|---|---|---|---|
| Total Suspended Solids | | | |
| Daily Maximum-mg/l | 50 | Monthly | grab |
| pH-Standard Units | 6.0-9.0 | Monthly | grab |

B. STANDARD CONDITIONS

In addition to the specified conditions stated herein, the permittee shall comply with the attached Part I Standard Conditions dated May 1, 1979.

C. SCHEDULE OF COMPLIANCE

None

D. SUPPLEMENTAL CONDITIONS

1. This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301 (b)(2), (C), and (D), 304 (b)(2), and 307 (a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

   a. Contains different conditions or is otherwise more stringent than any effluent limitation in the permit, or

   b. Controls any pollutant not limited in the permit.

   The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

Effective May 1, 1979

STANDARD CONDITIONS FOR
KANSAS WATER POLLUTION CONTROL AND
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
PERMITS

PART I - GENERAL CONDITIONS

1. Representative Sampling

A. Samples and measurements taken as required herein shall be representative of the nature and volume of the monitored discharge. All samples shall be taken at the locations designated in this permit, and unless specified, at the outfall(s) before the effluent joins or is diluted by any other body of water or substance.

B. Monitoring results shall be recorded and reported on forms acceptable to the Division and postmarked no later than the 28th day of the month following the completed reporting period. Signed copies of these, and all other reports required herein, shall be submitted to:

Kansas Department of Health & Environment
Division of Environment
Water Pollution Control Section
Topeka, Kansas 66620
(913) 862-9360

2. Schedule of Compliance: No later than 14 calendar days following each date identified in the "Schedule of Compliance", the permittee shall submit to the above address, either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next schedule requirements, or, if there are no more schedule requirements, when such noncompliance will be corrected.

3. Definitions

A. The "daily average" discharge means either the total discharge by weight during a calendar month divided by the number of days in the month that the facility was operating, or the average concentration for the month. The daily average discharge shall be determined by the summation of all measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made, or by the summation of all concentrations determined during the calendar month divided by the number of samples collected and analyzed.

B. The "daily maximum" discharge means the total discharge by weight or average concentration during a 24 hour period.

C. The "monthly average", other than for fecal coliform bacteria, is the arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days. The monthly average for fecal coliform bacteria is the geometric mean of the value of the effluent samples collected in a period of 30 consecutive days.

D. The "weekly average", other than for fecal coliform bacteria, is the arithmetic mean of the values for effluent samples collected in a period of seven consecutive days. The weekly average for fecal coliform bacteria is the geometric mean of the values for effluent samples collected in a period of seven consecutive days.

E. The "grab sample" is an individual sample collected in less than 15 minutes.

F. A "composite sample" is a combination of individual samples in which the volume of each individual sample is proportional to the discharge flow, or the sample frequency is proportioned to the flow rate over the sample period.

G. The "Act" means the Clean Water Act, Public Law 95-217.

H. "Division" means Division of Environment, Kansas Department of Health and Environment.

I. "Department" means the Kansas Department of Health and Environment.

4. Test Procedures: All analyses required by this permit shall conform to the requirements of Section 304(h) of the Act, and shall be conducted in a laboratory certified by the Department. For each measurement or sample the permittee shall record the exact place, date, and time of sampling; the date of the analyses; the analytical techniques or methods used; and, the results. If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved procedures, the results shall be included in the Discharge Monitoring Report form required in 1.B. above. Such increased frequency shall also be indicated.

5. Records Retention: All records and information resulting from the monitoring activities required by this permit, including all records of analyses and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation, shall be retained for a minimum of 3 years, or longer if requested by the Division.

6. Change in Discharge: All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant not authorized by this permit or of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any facility expansions, production or flow increases, or process modifications which will result in new, different, or increased discharges of pollutants shall be reported to the Division at least one hundred eighty (180) days before such changes.

7. Noncompliance Notifications: If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum or weekly average effluent limitation specified in this permit, the permittee shall provide the Department with the following information in writing within 5 days of becoming aware of such condition:

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A. a description of the discharge and cause of noncompliance, and
B. the period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

The above information shall be provided with the submittal of the regular Discharge Monitoring Report form for violations of monthly average of daily average effluent limitations.

8. Facilities Operation: The permittee shall at all times maintain in good working order and efficiently and effectively operate all treatment, collection, and control systems or facilities used to achieve compliance with the terms and conditions of this permit. Maintenance of treatment facilities which results in degradation of effluent quality shall be scheduled during non-critical water quality periods and shall be carried out in a manner approved in advance by the Division. The permittee shall take all necessary steps to minimize any adverse impact to waters of the State resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

9. Bypassing: Any diversion from or bypass of facilities necessary to maintain compliance with this permit is prohibited, except where necessary to prevent loss of human life or severe property damage; or where excessive storm drainage or runoff would damage any facilities necessary to comply with this permit. The permittee shall immediately notify the Division by telephone of each bypass and shall confirm the telephone notification with a letter explaining what caused the spill or bypass and what actions have been taken to prevent recurrence.

10. Removed Substances: Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner acceptable to the Division.

11. Power Failures: The permittee shall provide an alternate power source sufficient to operate and wastewater control facilities or halt or otherwise control production and all discharges upon the loss of the primary source of power to the wastewater control facilities.

12. Right of Entry: The permittee shall allow authorized representatives of the Division or the Environmental Protection Agency upon the presentation of credentials, to enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept by this permit, and at reasonable times to have access to and copy any records required to be kept by this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge from the facility and any waste or materials generated or stored on the premises.

13. Transfer of Ownership: The permittee shall notify the succeeding owner, controlling person, or operator of the existence of this permit by certified letter, a copy of which shall be forwarded to the Division.

14. Availability of Reports: Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department. Effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act and K.S.A. 65-170c.

15. Permit Modification: After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, violations of any terms or conditions of this permit; obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or, a change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

16. Toxic Pollutants: Notwithstanding Paragraph 15 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

17. Civil and Criminal Liability: Except as authorized by statute and Paragraph 9 "Bypassing", nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

18. Oil and Hazardous Substance Liability: Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject to under Section 311 of the Act, or K.S.A. 65-164 et seq. The municipal permittee shall promptly notify the Division by telephone upon discovering crude oil or other petroleum derivative in its sewer system or wastewater treatment facilities.

19. Industrial Users: The municipal permittee shall require any industrial user of the treatment works to comply with Sections 307 & 308 of the Act, and any industrial user of storm sewers to comply with Section 308 of the Act.

20. Property Rights: The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of or violation of federal, state or local laws or regulations.

21. Operator Certification: The permittee shall assure that his wastewater facilities are under the supervision of an operator certified by the Department. If the permittee does not have a certified operator, or loses its certified operator, he shall take the appropriate steps to obtain a certified operator as required by K.A.R. 28-16-29.

22. Property Rights: The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

23. Removal From Service: The permittee shall inform the Division at least 3 months before a pumping station or other waste treatment facility is to be removed from service, and shall make arrangements acceptable to the Division of decommissioning that will provide adequate protection for the public health, and ground and surface waters.

POOR ORIGINAL

Q291.16 (ER) Indicate the present status of Wolf Creek Cooling Lake (WCCL) with respect to completion of the Dam and filling.

R291.16 The Wolf Creek Cooling Lake (WCCL) construction was completed in late 1980. Filling began on November 13, 1980, and has continued intermittently until the present time. As of 5/28/81, WCCL level is 1060.55 and per Figure 2.4-20 (Cooling Lake Area - Capacity Curves) of the FSAR, the lake is at 23% of its normal capacity and 41% of its low level operating capacity.

Q291.17 (ER) Indicate the present prediction for completion of filling of Wolf Creek Cooling Lake (WCCL).

R291.17 The prediction for the filling of WCCL during the worst case drought at a 41 cfs fill rate is 23 months to the minimum operating level and 41 months to the normal operating level. However, the prediction for an average year at 120 cfs is 5 months to minimum operating level and 14 months to the normal operating level.

Q291.18 (ER) Please provide the results of aquatic biological surveys conducted to date relative to aquatic organisms in WCCL.

R291.18 Scheduled aquatic monitoring on WCCL has been accomplished in February and April of 1981. However data analyses has not been completed by consultants. Data will be submitted to KG&E in May of 1982 and will be available for review by the NRC at WCGS.

Q291.19 (ER) Provide details of the monitoring program on WCCL during filling and as planned after station operation begins. This should include information on icthyoplankton and young-of-the-year fishes, especially in the area of cooling water intake.

R291.19 The Applicants have initiated the lake filling phase environmental monitoring program on Wolf Creek Cooling Lake (WCCL). Cooling lake monitoring includes limnological and fishery studies designed to investigate the cooling lake as it fills. Lake monitoring will characterize the chemistry and biology of the cooling lake while providing information on the success of the fish stocking program. The sampling schedule for this phase of monitoring is outlined in Tables 291.19-2 and 291.19-3. Details of the lake filling phase are outlined as follows:

WATER QUALITY

Surface waters will be collected six times per year in the cooling lake at Locations 2 and 6 (Figure 6.1-1). Duplicate water samples will be collected from a depth of one meter using non-metallic water samplers with the exception of bacteriological and oil and grease samples which will be collected at the surface of the water.

Water quality parameters are presented in Table 291.19-1. Preservation and analytical methods for water quality appear in ER(OLS) Table 6.1-5.

PHYTOPLANKTON

Water samples for phytoplankton analysis will be collected six times per year at Locations 2 and 6 (Figure 6.1-1; Table 291.19-2). The samples will be stored in bottles containing $m^3$ preservative. The inverted microscope method will be used to determine phytoplankton species composition and abundance. Oil immersion will be utilized for identification and enumeration using the following reporting units:

| Algal Form | Reporting Unit units/ml) |
|---|---|
| Diatoms | Each frustule |
| Unicellular | Each cell |
| Colonial | 4 cells (colonial blue-greens like *Microcystis* are reported in 50 cell units) |
| Filamentous | 100 m lengths |

R291.19 Cont'd

Biovolume determinations will be made using the geometrical configuration that best suits the species and will be expressed as microliters per liter ( $\mu$l/l). Appropriate taxonomic keys will be used as identification aids. Carbon fixation rates and chlorophyll a concentrations will be determined and used as indices of phytoplankton primary productivity.

ZOOPLANKTON

Duplicate zooplankton samples will be collected six times per year at Locations 2 and 6 in the cooling lake (Figure 6.1-1; Table 291.19-2). The zooplankton community will be sampled with a conical plankton net. At each location, two bottom to surface hauls will be collected, combined, and preserved. Samples will be examined qualitatively to generate a checklist of zooplankton occurring in the cooling lake. Replicates will be collected at each location to determine mean zooplankton standing crop (mg/l).

PERIPHYTON

Periphyton collections in WCCL will not be initiated until the cooling lake reaches operating pool level (1087 MSL) or one year prior to station operation. Sample analysis, upon initiation of collections, will be similar to analytical methods utilized on Neosho River samples.

MACROINVERTEBRATES

Duplicate bottom samples will be collected six times per year from Locations 2 and 6 in the cooling lake (Figure 6.1-1; Table 291.19-2). Samples will be collected using a Ponar grab quantitative collecting device.

All quantitative samples will be sieved and the organisms that are retained will be fixed and stained. All organisms will be identified to species, if possible, or to the lowest positive taxonomic level. Identifications will be made using appropriate taxonomic keys. All benthic data will be reported as the number of organisms per square meter of substrate (no./$m^2$).

FISH

The fishery study will provide data useful to KG&E's management effort. The fish study has been designed to evaluate KG&E's stocking program by targeting stocked species of fish. The year and sampling effort utilized in the cooling lake follows recommendations made in The Kansas Fish and

R291.19 Cont'd

Game Commission manual of survey techniques for reservoir management. The sampling schedule for fishery studies during lake-fill appears in Table 291.19-3. Specifications for gear to be utilized is shown in Table 291.19-4.

Catch data will be expressed in units of effort. Additional parameters measured in the cooling lake will include conductivity, secchi disk readings, and temperature profiles. Physical data (depth, secchi disk and temperature) will be recorded at the beginning and end of each net set. Sample locations will be established and identified with land marks to ensure consistency over time.

A semi-balloon trawl will be used to sample young-of-year (YOY) fish during summer and fall months (Table 291.19-3). No larval fish sampling is scheduled for WCCL during the lake filling phase.

The planned operational monitoring program will be designed to assess the effects of station discharges on the environment. The operational studies will be continuations of the pre-operational lake filling phase studies with modifications based on study findings, lake use, and other factors. Changes to sampling frequency and additional studies as described in Section 6.2.1 of the ER(OLS) will be implemented.

The proposed schedule for operation monitoring is shown in Table 291.19-5. Larval fish sampling will be included in the operational phase monitoring of WCCL. Larval fish will be collected on a twice a month basis from April through July at Location 8. YOY and adult fish sampling will follow the methodology used in the last year of lake filling phase monitoring.

TABLE 291.19-1

WATER QUALITY PARAMETERS MEASURED IN SURFACE WATER SAMPLES

General Water Quality Parameters

Alkalinity, total
Calcium
Chloride
Color, true
Conductance, specific
Iron, soluble
Iron, total
Magnesium
Magnanese, total
Oxygen, dissolved
Oxygen, saturation
pH
Potassium
Residue, filtrable (total dissolved solids)
Residue, nonfiltrable (total suspended solids)
Sodium
Sulfate
Temperature
Turbidity

Aquatic Nutrients

Ammonia
Nitrate
Nitrite
Organic nitrogen, total
Orthophosphate, soluble
Phosphorus, total
Silica, soluble

Indicators of Industrial and Municipal Contamination

Bacteria, fecal coliform
Bacteria, fecal streptococci
Biochemical oxygen demand (5-day)
Chemical oxygen demand
Hexane soluble materials
Organic carbon, total

Trace Metals

Copper, total
Lead, total
Mercury, total
Selenium, total
Zinc, total

TABLE 291.19-2

SAMPLING SCHEDULE FOR THE AQUATIC PORTION OF THE 1981 LAKE FILLING PHASE OF THE CONSTRUCTION MONITORING PROGRAM FOR WOLF CREEK GENERATING STATION

| DISCIPLINE | Feb | Apr | Jun | Aug | Oct | Dec |
|---|---|---|---|---|---|---|
| Water Quality | | | | | | |
| Cooling Lake[a] | X | X | X | X | X | X |
| Aquatic Ecology | | | | | | |
| Cooling Lake | | | | | | |
| Phytoplankton | X | X | X | X | X | X |
| Zooplankton | X | X | X | X | X | X |
| Macroinvertebrates | | | | | | |
| Benthos | X | X | X | X | X | X |

[a] = Cooling Lake Locations 2 and 6

TABLE 291.19-3

FISH SAMPLING SCHEDULE FOR THE LAKE FILLING PHASE ENVIRONMENTAL MONITORING PROGRAM AT THE WOLF CREEK GENERATING STATION, 1981

| | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Cooling Lake | | | | | | | | | | | | |
| Electrofishing[a] | X | X | X | X | X | X | X | X | X | X | X | X |
| Trap netting[b] | | | X | X | | | | | | | | |
| Gill netting | | | | | | | | | | X | | |
| Seining | | | | | X | X | X | X | X | X | | |
| Trawling | | | | | | X | X | X | X | X | | |

[a] Winter sampling will depend on ice conditions.

[b] Trap netting will be in March or April depending on water temperature.

TABLE 291.19-4

SUMMARY OF GEAR TO BE UTILIZED FOR FISH SURVEYS IN THE COOLING LAKE FOR WOLF CREEK GENERATING STATION

| GEAR TYPE | DESCRIPTION[a] | UNIT OF EFFORT |
|---|---|---|
| D.C. electrofishing | Boat mounted boom shocker | Approximately 30 min per location |
| Trap net | Large frame fyke nets | 4 net nights |
| Gill net | Uniform mesh flag nets 100 ft x 8 ft with monofilament panels of 1, 1.5, 2.5, or 4 in. bar mesh | 4 net nights |
| Seine | 50 ft x 6 ft bag seine | 2 - 90° arc drags per location |
| Trawl | Semiballoon otter trawl | |

[a] From A Manual of Survey Techniques for Reservoir Management, Kansas Fish and Game Commission.

TABLE 291.19-5

SAMPLING SCHEDULE IN THE COOLING LAKE DURING THE OPERATIONAL MONITORING PROGRAM

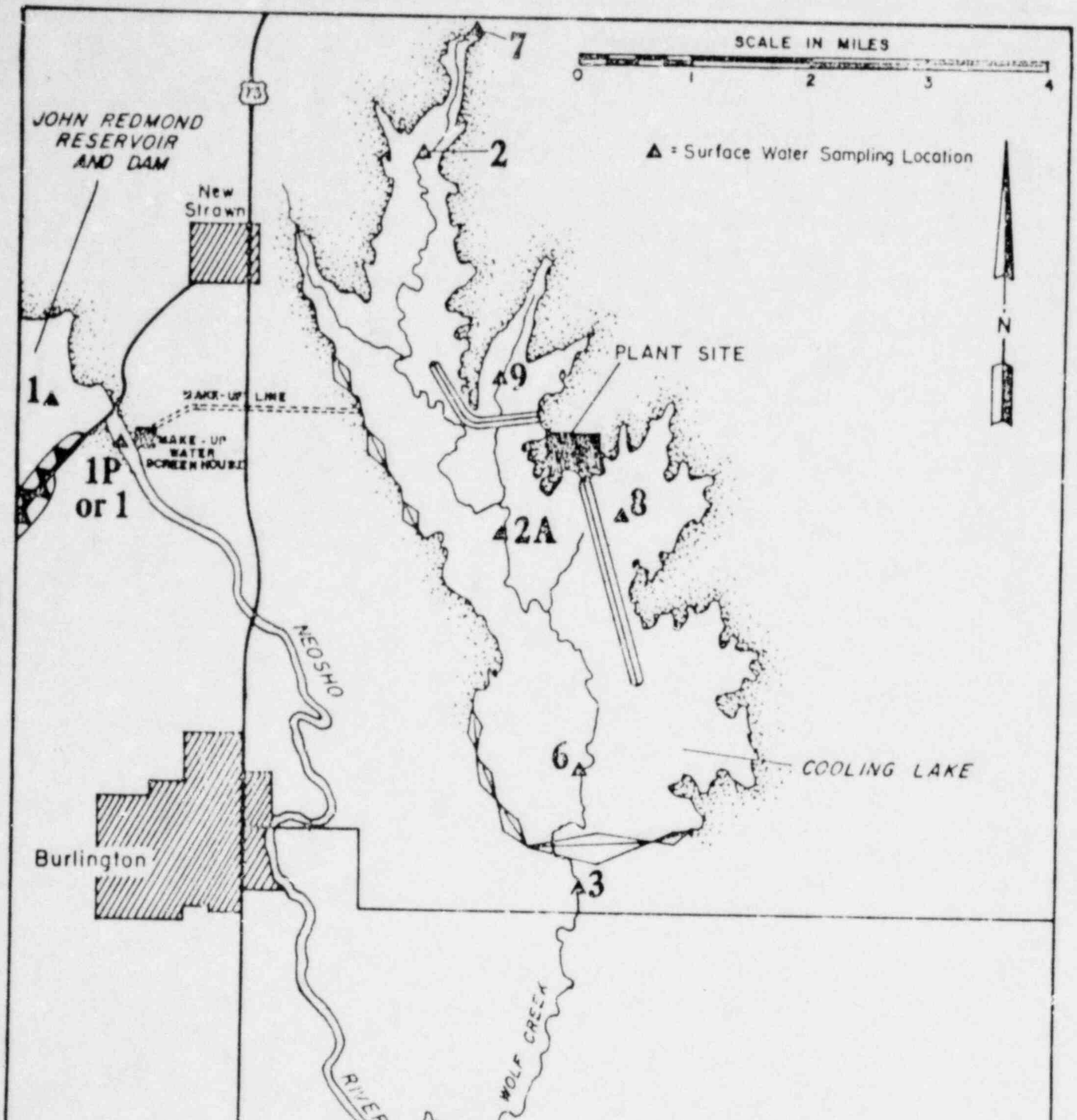
| Sample Type | Month | | | | | | | | Location | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Feb | Apr | May | Jun | Jul | Aug | Oct | Dec | 2 | 6 | 8 | 9 |
| Water Chemistry[a] | X | X | X | X | X | X | X | X | X | X | X | X |
| Phytoplankton | X | X | | X | | X | X | X | X | X | X | X |
| Zooplankton | X | X | | X | | X | X | X | X | X | X | X |
| Macroinvertebrates | X | X | | X | | X | X | X | X | X | X | X |
| Larval Fish[b] | | X | X | X | X | | | | | | X | |
| Adult Fish[c] | X | X | | X | | X | X | X | X | X | X | X |

[a] Water chemistry samples will be collected monthly for the first year of operation.

[b] Twice monthly April - July.

[c] Winter sampling will depend on ice conditions.

Figure 1




WOLF CREEK GENERATING STATION
UNIT NO. 1
ENVIRONMENTAL REPORT (OPERATING LICENSE STAGE)

FIGURE 6.1-1

SURFACE WATER SAMPLING LOCATIONS

Q291.20 (ER) (3.4) Provide better schematics showing the siting and configuration of the make-up water intake, the cooling water intake and the essential service water intake. The ER-OL provides figures showing locations, but details of configurations and adjacent shoreline are needed, [ER-OL p. 3.4-2, p. 3.4-3].

R291.20

a. Makeup Water Screen House (MU Intake)
   1. Siting of the MUSH is shown on S-1 and S-128.
   2. Configuration is shown on A-100 and A-101.
   3. Adjacent shoreline is shown on S-125, S-126 and S-127.

b. Circulating Water Screen House (Cooling Water Intake)
   1. Siting is shown on S-1 and S-11.
   2. Configuration is shown on A-115, A-116, A-117, S-490, S-491, S-492, S-493 and S-494.
   3. Adjacent shoreline is shown on S-62, S-183, S-185 and S-188.

c. Essential Service Water Pumphouse (ESW Intake)
   1. Siting is shown on S-1 and S-11.
   2. Configuration is shown on A-K901, A-K902 and C-KC305.
   3. Adjacent shoreline is shown on S-80 and S-184.

Q291.21 (ER) (3.4)

Clarify the following: The statement "The Wolf Creek Generating Station cooling system is designed to support two 1150-Mwe pressurized water reactors operating at 100 percent average annual load factor" (p. 3.4-1) is contradictory to the following statement, "Analyses indicate that the cooling lake will supply adequate water for the operation of one unit operating at 100 percent average annual load factor and two units operating at 88.5 percent average annual load factor" (p. 3.4-2).

R291.21

The statement on page 3.4-1 will be changed to read: "The Wolf Creek Generating Station, Unit No. 1 (WCGS) cooling system is designed to support two 1150-MWe pressurized water reactors (PWR) operating at a 100 percent average annual load factor for normal conditions."

The analyses referred to on page 3.4-2 (should be 3.3-2) indicated that during the once-in 50-year drought, that the cooling lake water level was lower and could support two 1150 MWe PWRs operating at an 88.5 percent average annual load factor.

Q291.22 (ER) Discuss the aquatic biotic monitoring program for area of makeup water intake in the Neosho River. Indicate the parameters to be monitored, the frequency and timing of sampling, the date(s) of program initiation, its duration and the location of the sampling stations.

R291.22 The aquatic monitoring program for the area of the Neosho River near the makeup water intake began in 1973. The results from that monitoring phase until the present can be found in the consultant's annual reports and in the ER(CPS), Sections 6.1.1.3.2 and 6.1.1.3.1.1, plus ER(OLS), Sections 2.2.2 and 2.4.3.1.1.1.

In 1981, the monitoring in this area will include the following parameters: water quality, phytoplankton, zooplankton, macroinvertebrates and fish. The schedule of sampling is enclosed and begins on January 1, 1981. The location of the sampling is the Neosho River directly below the stilling basin at John Redmond Reservoir. All fish impingement work is performed at the makeup water screen house (MUSH) which is located on the east side of the Neosho River about 150 yards below the John Redmond Reservoir dam.

The impingement study is performed exclusively by KG&E and was committed to by the utility in the FES, Section 6.1.3.2. Sample dates within the months are randomly selected. Collection work is performed twice per month from August to March and twice per week from April to July. This impingement monitoring is a one year program which was started in November, 1980.

SCHEDULE OF SAMPLING NEAR MAKEUP WATER INTAKE

| Discipline | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water Quality | | | | X | | X | | | | X | | X |
| Phytoplankton | | | | X | | X | | | | X | | X |
| Zooplankton | | | | X | | X | | | | X | | X |
| Macroinvertebrate | | | | X | | X | | | | X | | X |
| Fish | | | | | | | | | | | | |
| Electroshock | X | X | X | X | X | X | X | X | X | X | X | X |
| Seining | | | | X | X | X | X | X | | X | | X |
| Larval Fish | | | | ° | ° | ° | ° | | | | | |
| Impingement | ° | ° | ° | * | * | * | * | ° | ° | ° | ° | ° |

° - twice monthly
* - twice weekly
X - once monthly

Q291.23 (ER) Outline the aquatic biotic monitoring program for the site area during station operation (see requests by staff in FES-CP. Sections 6.1.3.2. p. 6-3, 6.2.3.2. p. 6-7).

R291.23 The planned operational monitoring program for the site area will include activities on Wolf Creek Cooling Lake (WCCL) as described in response 291.19 and the Neosho River. Biological sampling on the Neosho River during the operational monitoring program will be essentially the same as established in the last year of the Lake Filling Phase (Tables 291.23-1 and 291.23-2).

TABLE 291.23-1

PROPOSED SAMPLING SCHEDULE FOR THE AQUATIC BIOLOGICAL PORTION OF THE OPERATIONAL MONITORING PROGRAM FOR WOLF CREEK GENERATING STATION

| Discipline | Apr | Jun | Aug | Oct | Dec |
|---|---|---|---|---|---|
| Aquatic Ecology | | | | | |
| Neosho River | | | | | |
| Phytoplankton | X | X | | X | X |
| Periphyton[a] | | X | X | X | X |
| Zooplankton | X | X | | X | X |
| Macroinvetebrates | | | | | |
| Benthos | X | X | | X | X |
| Qualitative | X | X | | X | X |
| Drift[b] | X | X | | X | X |

[a]Neosho Ri er Locations 4 and 10
[b]Neosho River Location 1

TABLF 291.23-2

PROPOSED FISH SAMPLING SCHEDULE FOR THE LAKE FILLING PHASE ENVIRONMENTAL MONITORING PROGRAM AT THE WOLF CREEK GENERATING STATION, 1981

| | Feb | Apr | May | Jun | Jul | Aug | Oct | Dec |
|---|---|---|---|---|---|---|---|---|
| Neosho River | | | | | | | | |
| Electrofishing[a] | X | X | X | X | X | X | X | X |
| Seining[b] | | X | X | X | X | X | X | X |
| Larval fish[c] | | X | X | X | X | | | |

[a] Monthly at Location 1; Locations 4 and 10 in April, June, October and December.

[b] Locations 4, 10 and 11 in April, June, October and December; Location 1 during all indicated months.

[c] Day-night sampling twice monthly at Location 1.

Q291.24 (ER) Describe any stocking of fish in WCCL that has already taken place, including date introduced, species and number introduced. Also provide a description of future plans for stocking fish in the WCCL.

R291.24 Stocking activities on WCCL, both past and future, are designed to establish a desirable fishery in the lake. A fishery dominated by predator species will reduce negative impacts on plant operations due to impingement of forage and roughfish species. Stocking activities will additionally maintain options concerning future use of the lake.

The WCCL stocking program was initiated in 1978 and continued in 1979 with the renovation of selected ponds in the lake area followed by restocking with forage and gamefish. In 1980 that portion of Wolf Creek owned by KG&E and all ponds on KG&E property not previously renovated were treated to remove roughfish. Major stockings of forage and game species have followed renovation during preliminary filling of the cooling lake in 1980 and into 1981. All stocking activities to date are outlined in Table 291.24-1.

Table 291.24-2 outlines scheduled stocking of fish into the WCCL for 1981 and proposed stocking for the next several years. The number and species outlined in Table 291.24-2 after 1981 are based on a typically developing fishery. However, long-term stocking plans will be modified based on the success of various species and may result in increased or decreased rates for a given species.

TABLE 291.24-1

STOCKING RECORD OF WOLF CREEK COOLING LAKE

| SPECIES | DATE(S) | NUMBER | LOCATION |
|---|---|---|---|
| Flathead Minnow | 8/78 | 56,000 | Subimp. |
| Largemouth Bass | 8/78 | 3,500 | Subimp. |
| Flathead Minnow | 9/79 | 75,000 | Subimp. |
| | 11/79 | 52,000 | Subimp. |
| Bluegill | 9/79 | 5,000 | Subimp. |
| Smallmouth Bass | 11/79 | 40 | Subimp. |
| Largemouth Bass | 9/79 | 2,400 | Subimp. |
| Flathead Minnow | 5/80 | 90,000 | UHS |
| | 6/80 | 65,000 | UHS |
| | 8/80 | 270,000 | Subimp. |
| | 9/80 | 57,500 | Subimp. |
| Bluegill | 5/80 | 130 | Subimp. |
| | 6/80 | 3,150 | UHS |
| | 8/80 | 16,000 | Subimp. |
| | 9/80 | 12,700 | Subimp. |
| Red-ear Sunfish | 8/80 | 2,000 | Subimp. |
| Black Crappie | 10/80 | 1,000 | Subimp. |
| Smallmouth Bass | 8/80 | 500 | Subimp. |
| Largemouth Bass | 6/80 | 6,000 | UHS |
| | 10/80 | 1,000 | Subimp. |
| Striped Bass | 6/80 | 1,200 | UHS |
| Walleye | 6/80 | 7,000 | UHS |
| | 7/80 | 5,000 | UHS |
| Blue Catfish | 10/80 | 35,000 | WCCL |
| Channel Catfish | 5/80 | 100 | Subimp. |
| | 6/80 | 3,100 | UHS |
| | 8/80 | 25,000 | Subimp. |
| | 10/80 | 25,000 | WCCL |
| Striped X White Bass Hybrid | 5/81 | 50,000 | WCCL |

Subimp = Subimpoundment of WCCL
UHS = Ultimate Heat Sink Basin
WCCL = Wolf Creek Cooling Lake

TABLE 291.24-2

PLANNED STOCK PROGRAM FOR
WOLF CREEK COOLING LAKE

| SPECIES | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|
| Black Crappie | 25,000 | | | |
| Smallmouth Bass | 50,000 | 50,000 | 25,000 | |
| Spotted Bass | 25,000* | 25,000* | 25,000* | |
| Largemouth Bass | 100,000 | 50,000 | | |
| Striped Bass | 50,000 | 50,000 | | |
| Striped X White Bass Hybrid | 50,000** | 50,000 | | 50,000 |
| Walleye | 120,000 | 120,000 | 120,000 | 50,000 |
| Blue Catfish | 50,000 | 50,000 | 50,000 | 50,000 |
| Channel Catfish | 50,000 | 50,000 | 50,000 | |

* Actual Number Dependent on Supply
** Stocked 5/81

Q291.25 Provide the details and discuss the impacts of return of material collected from the plant intake screens to the Neosho River.

R291.25 The plant intake screens are located on the Wolf Creek Cooling Lake (WCCL). Any material impinged on these screens would be either removed from the collection pit and disposed of onsite or returned to WCCL. There is no possibility of material being impinged on the screens being returned to the Neosho River which is approximately five miles away.

However, the makeup water screen house (MUSH) intake will impinge material which could be returned to the Neosho River. This material is washed off the vertical travelling screens (VTS) into a collection pit which drains into the makeup channel. During low flow, the channel dead ends but still remains contiguous with the reservoir stilling basin. The channel becomes a flow-through system whenever John Redmond Reservoir releases large amounts of water.

Some fish fall back into the channel from the pit. However, because the makeup channel dead ends during the winter months, the fish will either be recycled on the VTS or eaten by the large groups of gulls which visit the area. Decay is slow because of the cold temperatures, thus allowing the gulls ample time to clean up the dead fish in a couple of days. The slow decay rate of the fish would also minimize any limnological effects which might occur due to the dead fish.

During the winter months, the large number of impinged fish are pumped from the collection pit into a dumpster and then disposed of onsite. From April to November, the impingement is less than one percent of the number of fish impinged during the winter. These fish will be allowed to drain back into the channel via the collection pit unless a significant number is present. Whereby, the fish will be collected in a 4½ foot deep bucket net and disposed of in an onsite landfill according to state and local regulations. A significant number of fish is that which impedes the flow of water through the VTS to such a degree as to endanger the operation of the pumps.

The effect of these fish being returned to the Neosho River would be minimal. The numbers involved are small, usually less than 100 per 24-hour period. High BOD concentrations would be

R291.25 Cont'd

spotty and would probably be the highest near the outfall of the collection pit drain pipe. In other areas of the channel, the BOD levels should be comparable to the Neosho River BOD levels because the pumps would be continually drawing "fresh" water into the channel. When the channel and the Neosho River merge during high flow, the effects of the returned material would be even less because the larger volume of water would dilute any effects from so few dead fish.

In conclusion, there will be no material returned to the Neosho River from the plant intake screens. Material from the MUSH screens could be returned to the Neosho River but the effects should be minimal.

## 310.0 SITING ANALYSIS BRANCH

Q310.1 (ER) Are there any substantial changes in the station external appearance or layout which have been made subsequent to the description in the OL-ER? If so, please describe.

R310.1 The following buildings/structures have been added to the immediate power block area:

1. An Auxiliary Warehouse located just east of the Shop Building;

2. Technical Support Center located between the Administration Building and Shop Building;

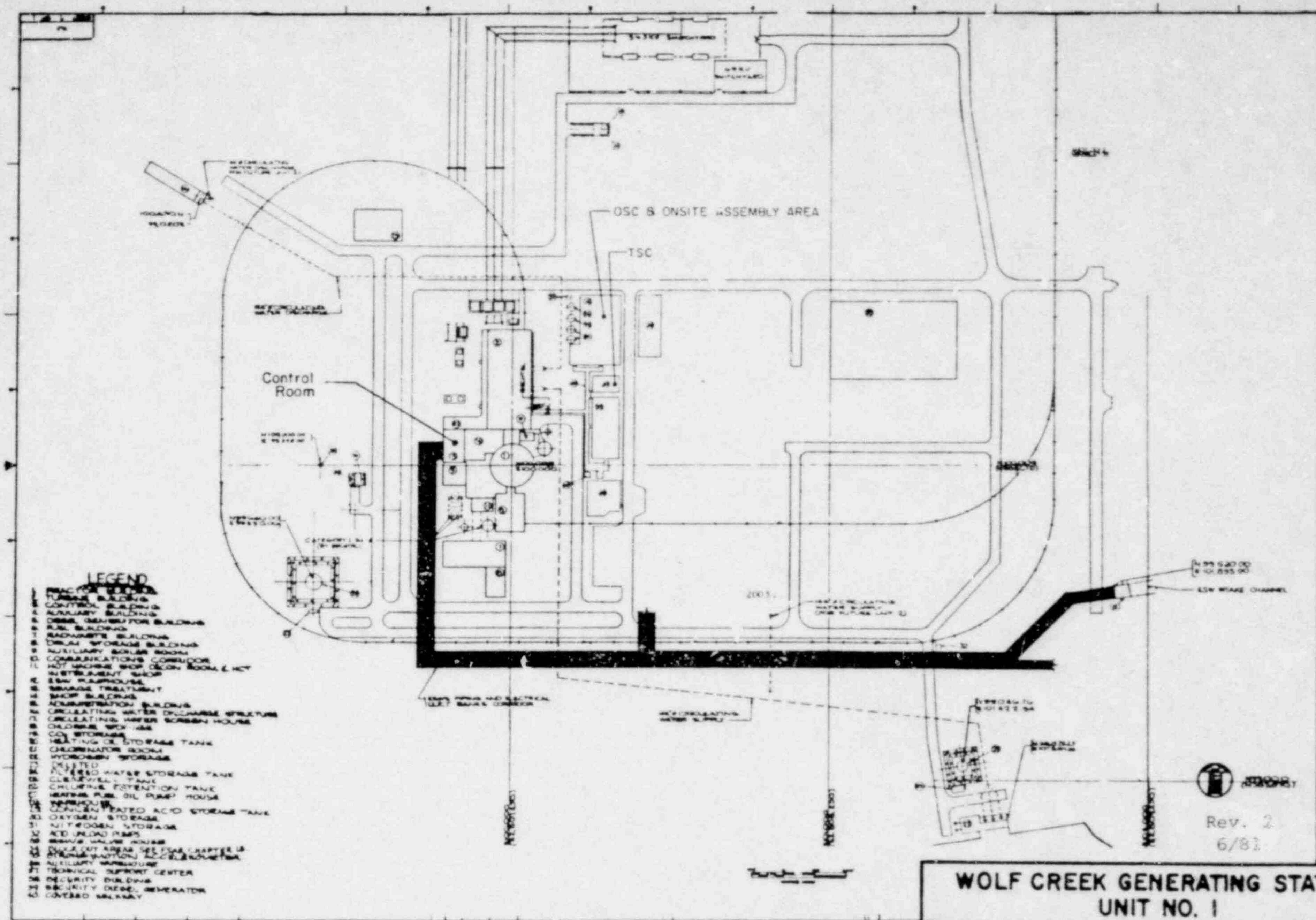
3. Security Building located south of the Administration Building;

4. Security Diesel Generator located immediately north of the northwest corner of the Security Building; and

5. A covered walkway connecting the Turbine Building, Administration Building, Technical Support Center, Shop Building, and Security Building.

These are low visibility structures and do not change the skyline appreciably.

The Emergency Operations Facility (EOF) - Simulator Complex has been located on the site but 2.8 miles northwest of the power block area (see revised Figure 2.1-4).




POOR ORIGINAL

**WOLF CREEK GENERATING STATION**
**UNIT NO. 1**
**ENVIRONMENTAL REPORT (OPERATING LICENSE STAGE)**

Figure 2.1-4

Plant Site Features

Q310.2 (ER) Are there any new roads or rail lines or relocations of roads or rail lines near the plant which have been proposed subsequent to the description in the OL-ER? If so, please describe.

R310.2 There are no new roads or rail lines and no relocations of existing roads or rail lines since the description in the ER(OLS).

Q310.3 (ER) (2.1.3)

Section 2.1.3.3.4 of the OL-ER states: "Currently, there are no plans for public use of the cooling lake or lands within the site boundary adjacent to the cooling lake not needed during operation of the station and related facilities." It also states that the visitors center location has not been selected.

Have the plans for public use of the cooling lake and adjacent lands been revised? If so, please describe. Also, has the visitors center site been selected? If so, please give its description and location.

R310 3

Section 2.8 of the ER(OLS) addresses public use of the cooling lake and adjacent lands. As stated therein, there are no plans for public use of the cooling lake. Lands adjacent to the cooling lake and inside the WCGS site boundary will be used to the extent practical as it was prior to its purchase for the WCGS site.

The Visitors Center is located about 2.8 miles northwest of the plant at the Emergency Operations Facility (EOF) complex (See Figure 2.1-6). The center occupies 760 square feet of display space in the EOF/Simulator/Visitors Center building.

Q310.4 (ER) (2.1.3) Section 2.1.3.2.11 mentions "an increase in the number of large rural homesites on nearby agricultural land." i.e., within five miles of the site.

Because of this increase, have the 1980 census results differed significantly from the 1980 population forecasts in Table 2.1-2, ER-OL? If so, please revise the population data for the five mile area around the site.

R310.4 Since census results are not generated based on distances from Wolf Creek, the applicants conducted a house survey in 1980 to determine the population distribution around the site. The actual 1980 population within 5 miles of Wolf Creek was 3,734 versus 3,640 projected in Table 2.1-2, a difference of less than 3 percent. The sectors whose populations differed the most from that projected were those which contain Burlington and New Strawn. This is primarily attributable to increased numbers of temporary construction personnel settling in these communities. Once Wolf Creek construction is complete the operations staff will only number 10 percent of the peak construction staff so that return to population figures projected for the future in Table 2.1-2 is anticipated. Table 2.1-2 will be updated to reflect the 1980 population information.

Q310.5 (ER) Provide an estimate of the average annual number of workers required for the operation of Wolf Creek Unit No. 1. State whether the workers are employees or contractors. Also provide an estimate of the average annual operating workers' payroll for the unit.

R310.5 It is estimated that 284 persons including security personnel will be required for the permanent operating staff of WCGS. All are expected to be KG&E employees. (This does not include additional or contract employment during refueling.)

The annual payroll for the first full year of operations is estimated to be $5.5 million.

Q310.6 (ER) Local purchases of goods and services for a nuclear power plant operation may frequently have a significant impact on the local economy. (For these purposes local may be defined as either the host county or the host county and one or more contiguous counties.)

Please provide information on local purchases of goods and services expected to be made by the plant during a typical year of operation. To the extent possible, identify specific types of dollar amounts of these purchases. If it appears that there will be no significant local purchases, explain why.

R310.6 Once WCGS is in operation local purchases of goods and services will no longer be at the level of those purchases during the construction period. Many of the supply and maintenance items and the specialized services required for operations and maintenance are not available in the local area or are not price competitive. Most purchases will be made in Wichita and Kansas City. Local purchases of goods such as small tools and office supplies are unlikely to exceed $25,000 per year.

Q310.7 (ER)

Construct a table containing dollar estimates of taxes attributable to Wolf Creek No. 1, for each of the first five full years of operation. Provide the dollar estimates by type of tax, and by taxing jurisdiction. What percent of the jurisdictions' total tax revenues are represented by the taxes attributable to the Wolf Creek No. 1 Plant?

R310.7

The most significant impact of taxes attributable to WCGS will be on local jurisdictions within Coffey County. As shown in Table 310.7-1, WCGS will be paying taxes to 20 individual county jurisdictions in amounts ranging in 1985 from $11 to $6,499,187 and contributing up to 99 percent of the revenues received by various jurisdictions. In addition, WCGS will be paying about $600,000 per year to the State of Kansas for its education and institutions building fund, based on property owned in Coffey County.

Taxes will also be paid to other nearby counties through which transmission line will pass. Estimated amounts for these taxes are shown on Table 310.7-2, together with estimated income and franchise taxes for 1987.

TABLE 310.7-1

WOLF CREEK GENERATING STATION
AD VALOREM TAX ESTIMATES
COFFEY COUNTY TAXING JURISDICTIONS
1985 - 1989

| TAXING JURISDICTION | 1985 WCGS TAX | 1985 % of TOTAL REVENUES | 1986 WCGS TAX | 1986 % of TOTAL REVENUES | 1987 WCGS TAX | 1987 % of TOTAL REVENUES | |
|---|---|---|---|---|---|---|---|
| State of Kansas | $ 593,089 | 3.61 | $ 600,166 | 3.59 | $ 606,155 | 3.57 | $ |
| Coffey County | 6,499,187 | 89.61 | 6,576,910 | 89.30 | 6,642,726 | 88.82 | |
| Townships | | | | | | | |
| Avon | 236 | 41.99 | 238 | 41.75 | 241 | 41.62 | |
| Hampden | 1,356 | 99.27 | 1,373 | 98.99 | 1,386 | 98.44 | |
| Pottawatomie | 500 | 43.03 | 500 | 42.37 | 500 | 41.74 | |
| Star | 194 | 48.87 | 197 | 48.76 | 199 | 48.54 | |
| Unified School Districts | | | | | | | |
| No. 243 | 32,778 | 5.43 | 33,079 | 5.39 | 33,379 | 5.36 | |
| No. 244 | 5,011,288 | 95.78 | 5,071,103 | 95.44 | 5,121,778 | 94.92 | |
| No. 245 | 32,139 | 5.22 | 32,987 | 5.28 | 33,332 | 5.25 | |
| Cemetary Districts | | | | | | | |
| Altamont | 126 | 48.84 | 127 | 48.47 | 129 | 48.50 | |
| Bowman-Adgate | 579 | 46.58 | 586 | 46.40 | 592 | 46.18 | |
| Pleasant Hill | 272 | 53.23 | 276 | 53.18 | 279 | 52.94 | |
| Stringtown | 2,980 | 99.33 | 3,014 | 98.95 | 3,045 | 98.42 | |
| Wharton | 32 | 10.88 | 34 | 11.41 | 34 | 11.22 | |
| Watersheds | | | | | | | |
| No. 24 | 11 | .04 | 11 | .04 | 11 | .03 | |
| No. 48 | 635 | 4.03 | 675 | 4.21 | 681 | 4.19 | |
| No. 90 | 62 | .10 | 63 | .10 | 63 | .10 | |
| No. 93 | 3,983 | 44.97 | 4,027 | 44.77 | 4,053 | 44.36 | |
| Fire Districts | | | | | | | |
| No. 5 | 581 | 4.96 | 588 | 4.95 | 594 | 4.92 | |
| No. 40 | 1,304 | 11.92 | 1,304 | 11.73 | 1,304 | 11.55 | |
| Southeast Kansas Regional Library | 197,668 | 54.16 | 200,042 | 53.97 | 202,119 | 53.69 | |
| Total | $12,379,000 | | $12,527,300 | | $12,652,600 | | $1 |

TABLE 310.7-1

F CREEK GENERATING STATION
D VALOREM TAX ESTIMATES
COUNTY TAXING JURISDICTIONS
1985 - 1989

| 6 | 1987 | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|
| % of TOTAL REVENUES | WCGS TAX | % of TOTAL REVENUES | WCGS TAX | % of TOTAL REVENUES | WCGS TAX | % of TOTAL REVENUES |
| 3.59 | $ 606,155 | 3.57 | $ 612,200 | 3.55 | $ 618,411 | 3.53 |
| 89.30 | 6,642,726 | 88.82 | 6,709,070 | 88.34 | 6,776,197 | 87.86 |
| 41.75 | 241 | 41.62 | 243 | 41.33 | 246 | 41.21 |
| 98.99 | 1,386 | 98.44 | 1,400 | 97.83 | 1,414 | 97.32 |
| 42.37 | 500 | 41.74 | 500 | 41.08 | 500 | 40.45 |
| 48.76 | 199 | 48.54 | 201 | 48.32 | 204 | 48.43 |
| 5.39 | 33,379 | 5.36 | 33,780 | 5.34 | 34,081 | 5.30 |
| 95.44 | 5,121,778 | 94.92 | 5,173,035 | 94.40 | 5,214,721 | 93.89 |
| 5.28 | 33,332 | 5.25 | 33,672 | 5.22 | 34,013 | 5.20 |
| 48.47 | 129 | 48.50 | 130 | 48.15 | 131 | 47.64 |
| 46.40 | 592 | 46.18 | 598 | 45.93 | 604 | 45.69 |
| 53.18 | 279 | 52.94 | 282 | 52.71 | 284 | 52.30 |
| 98.95 | 3,045 | 98.42 | 3,074 | 97.84 | 3,104 | 97.27 |
| 11.41 | 34 | 11.22 | 35 | 11.36 | 35 | 11.22 |
| .04 | 11 | .03 | 11 | .03 | 11 | .03 |
| 4.21 | 681 | 4.19 | 688 | 4.17 | 694 | 4.14 |
| .10 | 63 | .10 | 64 | .10 | 65 | .10 |
| 44.77 | 4,053 | 44.36 | 4,078 | 43.95 | 4,104 | 43.56 |
| 4.95 | 594 | 4.92 | 600 | 4.89 | 606 | 4.87 |
| 11.73 | 1,304 | 11.55 | 1,304 | 11.38 | 1,304 | 11.20 |
| 53.97 | 202,119 | 53.69 | 204,135 | 53.40 | 206,171 | 53.11 |
| | $12,652,600 | | $12,779,100 | | $12,906,900 | |

TABLE 310.7-2

ESTIMATED AD VALOREM TAXES 1985 - 1989
($000)

| Year | Coffey County | Anderson County | Butler County | Franklin County | Greenwood County | Johnson County | Lyon County | Miami County | Total All Counties |
|---|---|---|---|---|---|---|---|---|---|
| 1985 | 12,379 | 34 | 66 | 116 | 77 | 17 | 5 | 48 | 12,743 |
| 1986 | 12,527 | 34 | 70 | 118 | 81 | 17 | 12 | 49 | 12,909 |
| 1987 | 12,653 | 35 | 71 | 119 | 82 | 17 | 12 | 50 | 13,038 |
| 1988 | 12,779 | 35 | 72 | 120 | 83 | 18 | 13 | 50 | 13,169 |
| 1989 | 12,907 | 35 | 72 | 121 | 84 | 18 | 13 | 50 | 13,300 |

OTHER ESTIMATED TAXES 1987
($000)

| | |
|---|---|
| Federal Income | $92,945 |
| Kansas, Income & Franchise | 32,600 |
| Missouri, Income & Gross Receipts | 10,021 |

Q310.8 (ER) Please provide the distances of the proposed transmission corridors from the following properties listed in the National Register of Historic Places:

| | | |
|---|---|---|
| Samuel J. Tipton House | Harris Vicinity | Anderson County |
| Columbia Bridge | Peoria | Franklin County |
| I. O. Pickering House | Olathe | Johnson County |

Please give the same information for any other archeological and historical sites or properties listed or eligible for listing located within 2 km of the corridors.

R310.8 The distances of the proposed Wolf Creek-Craig transmission corridors from the following properties are: Samuel J. Tipton House, 9.8 km; Columbia Bridge, 2.1 km; and I. O. Pickering House, 16.9 km. The Wolf Creek-Craig transmission line has been shortened (approximately 14 miles) and is now the Wolf Creek-West Gardner transmission line terminating at the West Gardner Substation (See response to NRC question 290.1).

The National Register of Historic Places for Kansas dated February, 1981, obtained from the Kansas State Historical Society in Topeka, was examined to determine if any other archaeological and historical sites or properties were located within 2 km of the transmission corridors. None were found within 2 km of the corridors. The nearest site (greater than 4.3 km) was the C. N. James Cabin, 305 S. State Street, Augusta in Butler County.

311.0 SITING ANALYSIS BRANCH

Q311.1 As published in the Federal Register (Vol. 45, No. 116, June 13, 1980, Pages 40101-40104) the Nuclear Regulatory Commission (NRC) has revised its policy regarding accident considerations in National Environmental Policy Act (NEPA) reviews. Information regarding the site as well as events arising from causes external to the plant which are considered possible contributors to the risk associated with the plant are to be discussed. References to safety evaluations is acceptable provided the Environmental Report contains a complete overview with references to specific sections of the FSAR. Accordingly, please provide an analysis of all offsite activities and an assessment of potential hazards including: (1) transportation, (2) mining and mineral exploration and/or operations, (3) industrial activities, and (4) military activity.

R311.1 The requested analysis is presently provided in WCGS FSAR Addendum Section 2.2. The necessary references will be included in the next revision to ER(OLS).

Q311.2 (ER) (2.1.2.3) Section 2.1.2.3, Page 2.1-9, discusses peak monthly transient population at John Redmond Reservoir. Please provide an estimate of peak daily usage as well.

R311.2 The Corps of Engineers has recreational use statistics which indicate that during an average summer month daily use of the recreational area averages 1,400 persons. Peak usage of the John Redmond Reservoir occurred on July 5, 1979 when 10,820 persons entered the recreational area.

Q311.3 (ER) (2.1.3.2) Section 2.1.3.2.9, Page 2.1-18, and Figure 2.1-23 identifies several abandoned and one operating quarry within 5 miles. It is difficult to read Figure 2.1-23. Please clearly identify the location of these quarries. Please identify the maximum quantity and type of any explosives stored at the quarries. Please identify the frequency, quantity and transportaton route for each explosive type delivered to each quarry.

R311.3 Active and abandoned quarries within 5 miles of the plant site are identified in new Figure 2.1-23a. Abandoned quarries do not have explosives stored at the quarry. The only operating quarry is located 3 miles south-southeast of the plant site (See Figure 2.1-23a). The maximum quantity of explosives stored at this quarry is approximtely 15 tons of ammonium nitrate-fuel oil mixture. Irregular shipments of up to 15 tons of this explosive are delivered to the quarry via US75 and FAS10 (Figure 2.1-7). US75 is utilized to deliver explosives to other quarries located beyond five miles from WCGS. The maximum load the shipper's trucks can carry is 20 tons of explosives. Usually less than a maximum load is loaded on a truck for delivery with the explosives consisting of 75 percent ammonium nitrate-fuel oil mixture and 25 percent class A explosives.

Q311.4 (ER) (2.1) Figures 2.1-3, 5, 6 and 7, etc., show an abandoned A.T. & S.F. railroad line passing through the Wolf Creek Site. FSAR question 310.01 requested an explanation of the status of this line and discussion of any easements which may exist relative to this railroad line. For completeness, please include your response to FSAR question 310.01 in the ER.

R311.4 The information requested by FSAR question 310.01 was already contained in the FSAR Addendum Section 2.2.1.4 as follows:

The Santa Fe Railroad and right-of-way located 0.3 mile west of the plant site is abandoned. By Interstate Commerce Commission Order in Finance Docket No. 26591, dated February 4, 1972, captioned Atchinson, Topeka and Santa Fe Railroad Company Abandonment, B.H. Junction and Gridley, Franklin and Coffey Counties, it was ordered that the branch line of the railroad extending between milepost 0.0 at B.H. Junction, Kansas, and milepost 52 plus 1,518 feet at Gridley, Kansas, be abandoned. With this abandonment, title of the right-of-way property reverted to the fee simple title owners.

This paragraph will be included in the next revision to the ER(OLS).

320.0 UTILITY FINANCE BRANCH

Q320.1 (ER) (1.1) Please provide further information on KEPCo, including present status of purchase of 17% of WCGS and of applications for membership in SPP and MOKAN, and the latest annual report. Please provide information available for KEPCo which corresponds to that given for KG&E and KCPL in Tables 4-6, 16-18, 25-34 of the section 1.1.

R320.1 The purchase of a 17 percent interest of WCGS by KEPCo has been approved by the Kansas Corporation Commission, and the Kansas State Legislature has passed an authorization measure. This measure was signed by the Governor on April 17, 1981.

KEPCo will apply for membership in SPP and MOKAN as soon as the purchase is completed. This is expected by October, 1981.

It is not possible to provide more detailed information on KEPCo than is provided in the text and tables of the ER(OLS) revised. As shown in Table 1.1-3, KEPCo's only owned capacity will be the 195.5 MW of WCGS in 1984 and two low-head hydro projects with 29.35 MW in 1986.

Consolidated data are not available on system fuel costs, peak hour conditions, interchanges, etc., nor are comparisons maintained on system forecasts and actual peaks and energy for the 27 member cooperatives.

Q320.2 (ER) (1.3) In section 1.3.1 of the ER-OL, reserve margin deficiencies due to delay of WCGS operation are stated which for Sunflower Electric exceed expected sales to Sunflower by KEPCo. Please given details of KEPCo/Sunflower generation and purchases to support the margins stated.

R320.2 Section 1.3-1 of the ER(OLS) has been revised. The earlier statements are not applicable.

Q320.3 (ER) (1.1) On p. 1.1-27 of the ER-OL in the description of the KCPL econometric model C, $R^2$ and DW are not defined. Please do so.

R320.3 Definitions of terms not identified are as follows:

C = Constant

$R^2$ = Coefficient of determination

$\bar{R}^2$ = $R^2$ adjusted

DW = Durbin/Watson coefficient

Q320.4 (ER) (1.1) There appear to be typographical slips in the tables for Section 1.1 of the OL-ER. For example, in Table 1.1-12 all entries in the third column (GWH increase) from 1980 on are inconsistent with columns 2 and 4. Please provide any corrected tables for Section 1.1.

R320.4 Table 1.1-12 has been corrected and revised. All tables in Section 1.1 of the ER(OLS) have been updated with the exception of Table 1.1-7a.

Q320.5 (ER) (1.3) Please provide current revised numbers for any entries in Tables B.2-1 and 2 which have been significantly affected by changes in interest and escalation rates since completion of the ER-OL. Please provide any corresponding revisions of the text tables on p. 1.3-3.

R320.5 Tables 8.2-1 and 8.2-2 have been revised, as have the text tables on pages 1.3-3 and 1.3-4.

Q320.6 (ER) Please provide the most recent forecast (if any) updated by the current actual numbers of the electricity demand and the capacity for the applicants and the powerpools.

R320.6 The most recent forecasts of energy and demand, together with 1980 actual experience are given for KG&E and KCPL in Tables 1.1-12 and 1.1-13. KEPCo actual experience through 1979 and forecasts are provided in Table 1.1-14. Capacity data for the Applicants are presented in Tables 1.1-1, 1.1-2, 1.1-3, 1.1-4a and 1.1-5a. SPP and MOKAN energy, peak load and capacity data are presented in Tables 1.1-8, 1.1-9, 1.1-10 and 1.1-11.

Q320.7 (ER) Please provide, the estimate or evaluation of a reduction in the demand for electricity (use and capacity) as a result of various load management programs by the Applicant.

R320.7 The forecasts for energy and peak load in Tables 1.1-12, 1.1-13 and 1.1-14 take into account the effects of load management programs and reduced rates of growth in demand related to population, economic and social factors. It has not yet been possible to isolate the individual factors that contribute to a reduction in a growth rate.

Q320.8 (ER) Please provide the change (if any) in the reserve requirements of the applicant and the powerpool.

R320.8 There have been no changes to date in the reserve requirements for the Applicants and the power pools.

Q320.9 (ER) Please provide the fuel mix you would use in providing the replacement energy in case WCGS does not come on line. Also, provide the cost of producing electricity (mills/kwh) by each fuel type.

R320.9 The fuel mixes to be used in providing replacement energy in the event of a delay for WCGS are given in Table 1.1-30 and shown below:

FUEL MIX WITHOUT WCGS - IN PERCENT

| | 1 Year Delay | 2 Year Delay | 3 Year Delay |
|---|---|---|---|
| | | KG&E | |
| Coal | 61.7 | 57.4 | 60.4 |
| Oil | 0.3 | 5.4 | 4.9 |
| Gas | 38.0 | 37.2 | 34.7 |
| | | KCPL | |
| Coal | 97.3 | 97.0 | 93.2 |
| Oil | 2.6 | 2.9 | 6.8 |
| Gas | 0.1 | 0.1 | 0.1 |

Estimated fuel costs for replacement energy are:

FUEL COSTS IN MILLS PER KWH

| | 1 Year Delay | | 2 year Delay | | 3 Year Delay | |
|---|---|---|---|---|---|---|
| | KG&E | KCPL | KG&E | KCPL | KG&E | KCPL |
| Coal | 18.8 | 19.6 | 20.5 | 21.9 | 22.4 | 24.7 |
| Oil | 61.1 | 191.6 | 71.0 | 207.6 | 76.7 | 199.6* |
| Gas | 37.7 | 55.4 | 45.3 | 70.2 | 51.4 | 91.5 |

* Oil costs went down for third year of delay for KCPL because the oil units will change from low-load spinning reserve units to operation as base load units. The oil units operate at a more efficient heat rate when fully loaded.

These fuel costs may be compared with the following estimated nuclear fuel costs in mills per Kwh:

MILLS PER KWH AT CAPACITY FACTORS OF:

| | .60 | .50 | .75 | .65 |
|---|---|---|---|---|
| 1984 | 8.9 | 9.1 | | |
| 1987 | | | 8.1 | 8.3 |

Q320.10 (ER) Please provide the capacity charge, and the price of electricity paid to the powerpool to satisfy the future demand increase in case WCGS does not come on line. Please provide the portion of total incremental demand satisfied by in-house generation and the purchase from powerpool.

R320.10 It is assumed that this question refers to charges that are based on pool obligations. Therefore, the capacity deficiencies used are those shown in Tables 1.1-1 and 1.1-2 which contain data reported to the MOKAN pool. If WCGS were delayed, KG&E and KCPL would have to make capacity purchases from outside their systems to cover projected deficiencies in capacity responsibility. These capacity deficiencies are based on each utility's expected "capacity responsibility" which includes its system demand plus firm purchases and sales, etc.

On this basis the projected capacity deficiencies will be as follows, in the event of a delay:

| | Capacity Deficiencies in MW | |
|---|---|---|
| Delay in Years | KG&E | KCPL* |
| One | 37 | 178 |
| Two | 97 | 285 |

*KCPL's deficiencies are based on 20 percent reserve margin while KG&E's are 15 percent.

KG&E estimates the capacity charge would be $156.30/KW per year through 1984, calculated as follows:

> Capacity charge = $610 per KW x fixed charged rate of approximately .23 = $140.30 plus fixed operations and maintenance (O&M) costs of $16/KW per year = $156.30
>
> Through 1985 the capacity charge would be $140.30 plus fixed O&M costs of $17.60/KW per year = $157.90

KCPL estimates that the capacity charge in the time frame 1985-1987 would range between $125 and $250/KW per year.

If the capacity charges estimated by KG&E are applied to the capacity deficiencies above, the following total capacity charges are obtained.

R320.10 Cont'd

| | Capacity Charges | |
|---|---|---|
| Delay in Years | KG&E | KCPL |
| One | $ 5,783,100 | $27,821,400 |
| Two | $15,316,300 | $45,001,500 |

In addition to the capacity charges there would be energy costs. In the event of a delay for WCGS, KG&E would use all available coal capacity but then purchase as much outside coal capacity as possible before burning more expensive oil or gas in KG&E plants. It is assumed that the full capacity deficiency would be purchased about 60 percent of the time. On this basis the costs would be as follows:

For a one year delay:
37,000 x 8760 x .60 x 1.47¢ per KWH = $2,858,738

For a two year delay:
97,000 x 8760 x .60 x 1.62¢ per KWH = $8,259,278

If for the purpose of illustration KCPL's energy costs are computed on the same basis, they would be for one year:

178,000 x 8760 x .60 x 1.47¢/KWH = $13,752,850

For two years:

285,000 x 8760 x .60 x 1.62¢/KWH = $24,266,952

The total capacity charges and energy costs would then be:

| | | Total Cost in Thousands | | | |
|---|---|---|---|---|---|
| Delay | Cost Element | KG&E | | KCPL | |
| One year | Capacity charge | $ 5,783 | | $27,821 | |
| | Energy cost | 2,859 | | 13,753 | |
| | Total | | $ 8,642 | | $ 41,574 |
| Two Years | Capacity charge | $15,316 | | $45,002 | |
| | Energy cost | 8,259 | | 24,267 | |
| | Total | | 23,575 | | 69,269 |
| Two Years | Total Cumulative Costs | | $32,217 | | $110,843 |

Any delay of WCGS would cause KG&E to burn large quantities of gas and oil.

R320.10 Cont'd

It is assumed that "total incremental demand" refers to the increase in capacity responsibility without WCGS for the years 1984 over 1983 and 1985 over 1984. The table which follows gives the projected KG&E system capacity responsibility both with and without WCGS.

Projected KG&E System Capacity Responsibility 1983-1985

| | KG&E Total System Capacity Responsibility[a] | | KG&E System Capacity | Capacity Balance |
|---|---|---|---|---|
| With WCGS | | | | |
| 1983 | 2050 | | 2111 | +61 |
| 1984 | 2091 | | 2549 | +458 |
| 1985 | 2151 | | 2549 | +398 |
| Without WCGS | | | | |
| 1983 | 2050 | 98 Increase[b] | 2111 | +61 |
| 1984 | 2148 | 60 Increase[b] | 2111 | -37 |
| 1985 | 2208 | | 2111 | -97 |

[a] Includes KG&E system demand plus firm transactions.

[b] The 57 MW increase in capacity responsibility in 1984 and 1985 without WCGS is due to KG&E's power supply obligations to REC's which are different with and without WCGS.

If the "total incremental demand" is defined as the increase in capacity responsibility without WCGS for the years 1984 over 1983 and 1985 over 1984, then the following situation would exist:

In 1984 without WCGS, there would be a 98 MW increase in demand, 37 MW of which would have to be purchased outside KG&E. The remaining 61 MW would be satisfied by existing generation. In 1985 there would be an additional 60 MW increase in demand, all of which would have to be purchased outside KG&E. On a cumulative two year basis the increase would amount to 158 MW of which 97 MW would have to be purchased outside KG&E.

KCPL will have to make up any deficits through purchases outside the utility (based on a 20% reserve).

Q320.11 (ER) What fixed charge rate has been used to calculate the capital cost portion of the total cost of generating electricity by nuclear fuel? Please refer to Table B.2-2. Why is fixed charge into year 1986 higher than the year 1983 (269.10 vs. 21?.58 million dollars)? What inflation rates have been used to arrive at 1986 numbers in this table and other places?

R320.11 Fixed charge rates used to calculate the capital cost portion of the cost of generating electricity by nuclear fuel are as follows:

| | 1984 (Applied for 9 months) | 1987 |
|---|---|---|
| KG&E | 23.0% | 24.0% |
| KCPL | 27.23 | 21.63 |
| KEPCo | 13.82 | 12.71 |

The differences in the calculated amounts shown in Table 8.2-2 are due to the facts that the fixed charge is applied for 9 months in 1984 and that taxes and costs of money are different for the individual owners year by year.

Inflation rates vary by year but in general are those estimated by Data Resources, Inc. For 1980 and future years they are as follows:

INFLATION RATES BY YEARS

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|
| Materials | 9.5 | 9.9 | 10.0 | 9.0 | 8.6 | 9.8 | 9.6 |
| Labor | 10.0 | 10.9 | 10.6 | 10.5 | 10.5 | 11.4 | 10.4 |

The composite escalation rate over the life of the project is estimated to be 8.3 percent.

IMAGE EVALUATION
TEST TARGET (MT-3)

Q320.12 (ER) (1.1) Please refer to pages 1.1-3 and 1.3-3. Please provide the basis for calculating the fuel savings or consumptions (in terms of quantity and dollar both) resulting from bringing or not bringing WCGS on line. The unit of coal consumption on this table appears to be incorrect. The response to Question 3 may be extended to answer Question 6.

R320.12 Both KG&E and KCPL use computer runs to estimate future system consumption of fuels and to optimize station use so as to achieve lowest total cost. Unit fuel costs projected to exist in future years are applied to the quantities obtained to determine the costs for additional fossil fuels. In comparing costs with and without WCGS, a credit is taken for nuclear fuel not burned in the without WCGS case. The results of these computations are given on page 1.3-3 and shown below:

ADDITIONAL FUEL CONSUMPTION AND COSTS WITHOUT
WCGS AND WITH INDICATED DELAYS

| Fuel | Unit Measure | 1985 One Year Delay | 1986 Two Year Delay | 1986 Cumulative | 1987 Three Year Delay | 1987 Cumulative |
|---|---|---|---|---|---|---|
| | | **KG&E** | | | | |
| Coal | (000) Tons | - | - | - | - | - |
| Oil | (000) Bbls | 236 | 697 | 933 | 683 | 1,616 |
| Gas | MMCF | 31,639 | 29,352 | 61,171 | 29,929 | 91,100 |
| Net Additional Fuel Cost (000) | | $89,156 | $137,590 | $226,646 | $167,034 | $393,780 |
| | | **KCPL** | | | | |
| Coal | (000) Tons | 800 | 954 | 1,754 | 1,057 | 2,811 |
| Oil | (000) Bbls | 129 | 206 | 335 | 693 | 1,028 |
| Gas | MMCF | 50 | 15 | 65 | 0 | 65 |
| Net Additional Fuel Cost (000) | | $21,270 | $32,994 | $54,264 | $82,211 | $136,475 |
| | | **TOTAL** | | | | |
| Coal | (000) Tons | 800 | 954 | 1,754 | 1,057 | 2,811 |
| Oil | (000) Bbls | 365 | 903 | ,268 | 1,376 | 2,644 |
| Gas | MMCF | 31,689 | 29,367 | 61,236 | 29,929 | 91,165 |
| Net Additional Fuel Cost (000) | | $110,426 | $170,584 | $280,910 | $249,245 | $530,255 |

Q320.13 (ER) Please provide new estimates, if any, of decommissioning and dismantling costs.

R320.13 No new estimates have been made of decommissioning and dismantling costs.

450.0 ACCIDENT EVALUATION BRANCH

Q450.1 (ER) Will applicant initiate pre-operational fog monitoring program to provide baseline data? If so, provide details of the plan. If not, explain why such a study will not be undertaken.

R450.1 A pre-operational 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 of the WCGS FSAR Addendum Revision 1 2/81 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 startup. 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.

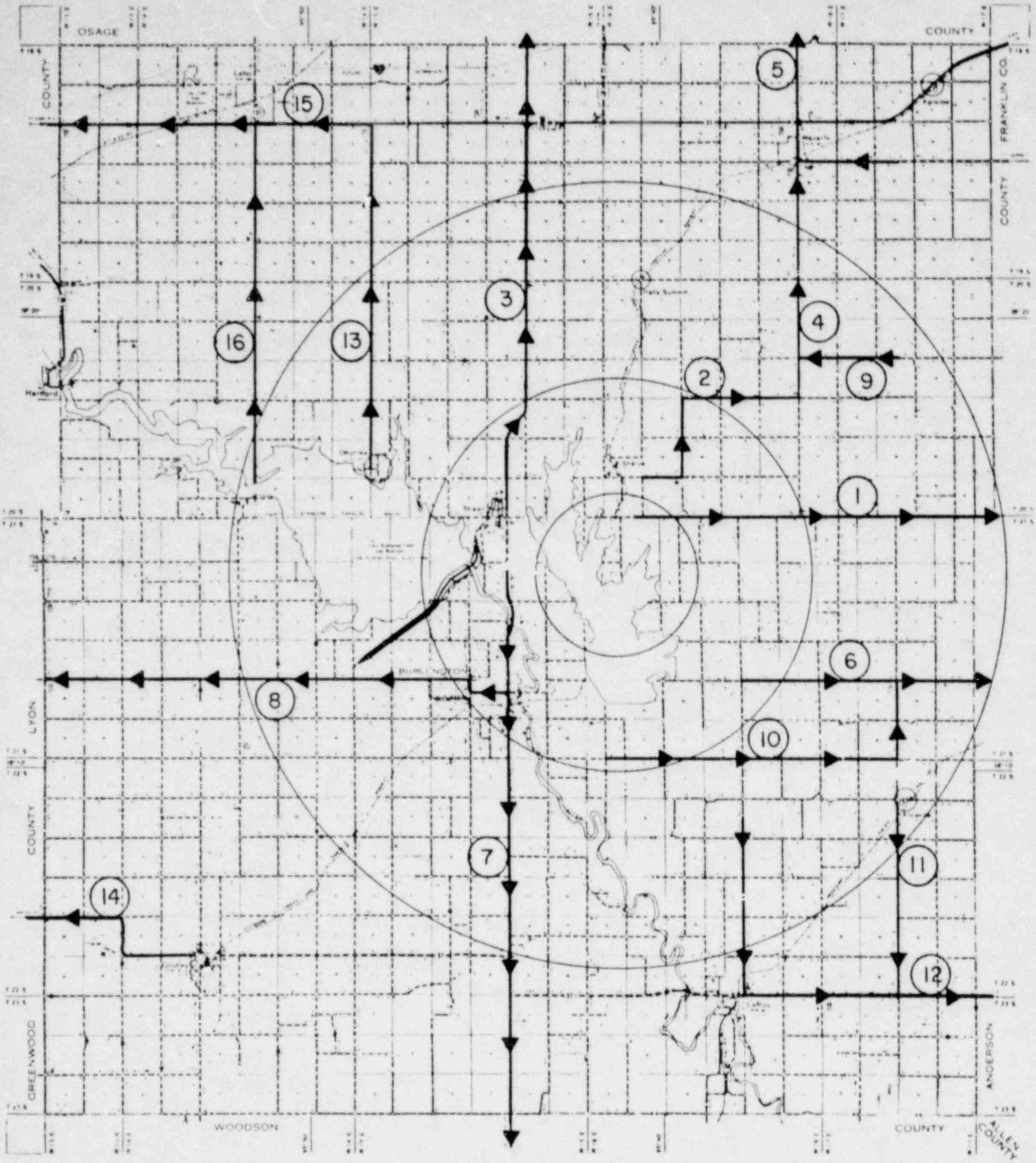
Q450.2 (ER) Please provide a transportation map detailing any controlled roads, uncontrolled roads, and railroads within two miles of the cooling lake. In addition, if available, provide data on the extent of traffic density on the controlled and uncontrolled roads.

R450.2 See Figure 450.2-1.

Coffey County has not developed traffic flow data for the roads near the cooling lake. The following data are annual average daily traffic estimates (AADT) made by the Kansas Highway Commission for Highway 75 north of Burlington between the city limit and New Strawn.

| Year | AADT |
|---|---|
| 1972 | 3000 |
| 1976 | 2880 |
| 1978 | 3800 |
| 1980 | 4685 |

Traffic counts were made by KG&E in 1979 to determine the impact of construction related traffic on local highways. These counts would not be relevant to the operational period for WCGS. It is estimated that during operations the average daily traffic on the controlled access road to the plant will be between 350 and 400 vehicles.




POOR ORIGINAL

FIGURE III.1

EVACUATION ROUTES

Q 430.2

REV. 2
4/81

Q450.2

TABLE III.1

Evacuation Routes (Sheet 1 of 2)

| Subzone | Route Identification per Figure III.1 |
|---|---|
| Center (0-2 mile) | (a) FAS 1935 east (1) to Anderson County<br>(b) FAS 153 east (2) to FAS 149 north (4) to Kansas 31 north (5) to Osage County |
| A1 | U.S. 75 north (3) to Osage County |
| B1 | FAS 153 east (2) to FAS 149 north (4) to Kansas 31 north (5) to Osage County |
| C1 | (a) FAS 149 north (4) to Kansas 31 north (5) to Osage County<br>(b) FAS 10 east (6) to Anderson County |
| D1 | (a) U.S. 75 south (7) to Woodson County<br>(b) FAS 10 west (8) to Lyon County<br>(c) FAS 1472 (10) east to Anderson County |
| E1 | (a) U.S. 75 north (3) to Osage County<br>(b) U.S. 75 south (7) to Woodson County |
| A2 | (a) U.S. 75 north (3) to Osage County<br>(b) Kansas 31 north (5) to Osage County |
| B2 | FAS 1134 west (9) to FAS 149 north (4) to Kansas 31 north (5) to Osage County |
| C2 | (a) FAS 1935 (1) to Anderson County<br>(b) FAS 10 east (6) to Anderson County |
| C3 | (a) FAS 10 east (6) to Anderson County<br>(b) FAS 1472 (10) to FAS 1135 north (11) to FAS 10 east (6) to Anderson County<br>(c) FAS 1135 south (11) to Kansas 57 east (12) to Anderson County |
| C4 | (a) Kansas 57 east (12) to Anderson County<br>(b) FAS 1135 south (11) to Kansas 57 east (12) to Anderson County |
| D2 | U.S. 75 south (7) to Woodson County |
| D3 | (a) FAS 10 west (8) to Lyon County<br>(b) U.S. 75 south (7) to Woodson County |
| E2 | FAS 10 west (8) to Lyon County |

Q450.2

TABLE III.1 (Sheet 2 of 2)

| Subzone | Route Identification per Figure III.1 |
|---|---|
| E3 | (a) FAS 793 north (13) to old U.S. 50 west (15) to Lyon County<br>(b) U.S. 75 north (3) to Osage County |
| E4 | (a) U.S. 75 north (3) to Osage County<br>(b) FAS 793 north (13) to old U.S. 50 west (15) to Lyon County |
| K1 | Kansas 57 east (12) to Anderson County |
| K2 | Kansas 57 east (12) to Anderson County |
| K3 | Kansas 57 west (14) to Greenwood County |
| K4 | Kansas 57 west (14) to Greenwood County |
| K5 | FAS 10 west ([illegible]) to Lyon County |
| K6 | FAS 152 north (16) to old U.S. 50 west (15) to Lyon County |
| K7 | (a) U.S. 75 north (5) to Osage County<br>(b) Old U.S. 50 west (15) to Lyon County |
| K8 | Kansas 31 north (5) to Osage County |

Note: Numbers in parentheses indicate road segment numbers as identified in Figure III.1.

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Q450.3 (ER) Please provide a copy of the latest version of the FOGALL Model User's Guide.

R450.3 One complete copy of the FOGALL certification/users manual is being provided. This manual contains proprietary program code listings which are not to become public record. This information is provided only to assist the NRC in its evaluation of WCGS ER(OLS) and WCGS FSAR Addendum.

Q450.4 (ER) Please provide documentation of the procedure used to validate the FOGALL Model.

R450.4 The procedure used to validate the FOGALL model is described in the certification/users manual provided in response to 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 mathmetical equation.

The model design is based upon accepted principles 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.

470.0 RADIOLOGICAL ASSESSMENT BRANCH

Q470.1 (ER) (2.1.3.2.4) Confirm that the land use in Table 2.1-18 has not changed since 1978.

R470.1 See new Table 2.1-18a which provides updated nearest receptor information determined in 1980. Dose calculations presented in Section 5.2 are based upon the 1980 receptor information.

TABLE 2.1-18a

DISTANCE TO NEAREST PLANT BOUNDARY, RESIDENCE, VEGETABLE GARDEN AND LIVESTOCK WITHIN 5 MILES

| Sector | Distance From Reactor (Miles): Nearest Plant Boundary | Nearest Residence | Nearest Vegetable Garden | Nearest Meat Animal | Nearest Dairy Cow | Nearest Dairy Goat | Milk Consumers |
|---|---|---|---|---|---|---|---|
| N | 1.1 | 1.4 | 1.4 | 1.1 | None | None | 2 adults |
| NNE | 1.1 | 2.6 | 2.7 | 0.8 | 4.7 | None | 3 adults/2 children |
| NE | 1.3 | 1.8 | 2.1 | 0.8 | None | None | |
| ENE | 1.5 | 2.0 | 2.2 | 0.8 | None | None | |
| E | 1.2 | 1.8 | 1.8 | 1.2 | 1.8 | None | 2 adults |
| ESE | 1.2 | 1.6 | 1.6 | 1.2 | 1.7 | None | 2 adults |
| SE | 1.2 | 1.4 | 1.4 | 1.2 | 1.4 | None | 2 adults/2 teens/2 children |
| SSE | 3.0 | 3.0 | 3.2 | 3.2 | 5.0 | None | 2 adults/1 infant |
| S | 3.3 | 3.5 | 3.5 | 3.3 | None | None | |
| SSW | 1.7 | 4.6 | 4.6 | 4.6 | None | None | |
| SW | 1.5 | 2.2 | 2.2 | 1.6 | None | None | |
| WSW | 1.5 | 2.7 | 2.7 | 1.5 | 4.7 | None | Various local families |
| W | 1.8 | 2.2 | 2.2 | 2.8 | None | None | |
| WNW | 2.1 | 2.9 | 2.9 | 2.1 | None | None | |
| NW | 2.6 | 1.3 | 1.4 | 2.2 | 3.5 | None | Various local families |
| NNW | 1.5 | 2.2 | 2.2 | 2.0 | None | None | |

Source: Field Investigation, Kansas Gas and Electric Company, 1980.

Q470.2 (ER) (2.1.3.3.4) Provide information concerning the location of the visitors center and an estimate of the number of visitors anticipated annually.

R470.2 The Visitor's Center is located in the EOF complex about 2.8 miles northwest of the power block (See Figure 2.1-6). The number of visitors anticipated annually at the Visitor's Center is 5,000 - 7,000 based on projections of visits to the Wolf Creek construction site.

Q470.3 (ER) (2.1.-15)

What is the fraction of daily intake of cows derived from pasture during the grazing season?

R470.3

Essentially 100 percent of the daily intake of cattle is derived from pasture during the grazing season. As the pasture becomes depleted late in each annual grazing season, farmer-stockmen may provide supplemental feed to their pastured livestock.

| | |
|---|---|
| Q470.4<br>(ER)<br>(2.1.3.4.1) | Provide information concerning the population served by the City of LeRoy's Municipal Water System. |
| R470.4 | The population of LeRoy determined during the 1980 census is 624 persons. |

Q470.5 (ER) (5.2) Provide a copy of the information referenced in Section 5.2 that was to have been updated in mid-1980.

R470.5 Updated gaseous and radiological dose information will be provided in June 1981.

# APPENDIX 5A

# DOSE CALCULATION MODELS AND ASSUMPTIONS

All dose calculations have been revised by means of the NRC computer codes GASPAR and LADTAP II. Computer programs ARRG, CRITR, GRONK, and FOOD developed at the Pacific Northwest Laboratory of Battelle Memorial Institute are no longer being used. The models and assumptions used in LADTAP II and GASPAR are identical or similar to those suggested in NRC Regulatory Guide 1.109. A list of assumptions and parameters used for the Wolf Creek site are presented in Table 5A-1 for liquid effluents and Table 5A-2 for gaseous effluents.

## 5A.1 INTERNAL DOSES TO AQUATIC ORGANISMS

Doses to aquatic and terrestrial organisms other than man were calculated using NUREG/CR-1276 LADTAP II - "A Computer Program for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents." The models used by this program are taken from Regulatory Guide 1.113, 1.109 and USAEC publication, WASH-1258.

## 5A.2 DOSE TO HUMANS

Doses to man from liquid effluents were calculated using NUREG/CR-1276 LADTAP II computer program. The models used by this program are taken from Regulatory Guide 1.113 and 1.109. Doses to man from gaseous effluents were calculated using NUREG-0597 GASPAR - "A Computer Program for the Evaluation of Radiological Impacts Due to the Release of Radioactive Material to the Atmosphere During Normal Operation of Light Water Reactors." The models used by this program are taken from Regulatory Guide 1.111 and 1.109.

## 5A.3 RECONCENTRATION FORMULA USED TO CALCULATE RECONCENTRATION FACTORS FOR LIQUID EFFLUENTS ACCUMULATING IN A REACTOR COOLING LAKE

Reconcentration models were based on Reg. Guide 1.113 and USEPA EPA-520 - "Radionuclide Accumulation in a Reactor Cooling Lake." Calculated reconcentration factors for the lake and at the circulating water discharge are presented in Table 5A-3. Reconcentration was determined as follows:

$$C = \frac{W}{V_T \ eff} (1 - e^{-\lambda eff\ t}) + Co\ e^{-\lambda\ eff\ t}$$ Lake Concentration

C = concentration of radionuclide in the lake at the end of the period

Co = concentration in the lake at the beginning of time period t

W = Ci/yr rate radioactivity is added to the lake

$V_T$ = lake volume $ft^3$

$$\lambda eff = \lambda + \frac{Q_b}{V_T}$$

$\lambda$ = the radionuclide decay constant $\frac{.693}{T½}$

T½ = radiological half life

$Q_b$ = lake blowdown rate cfs

t = time

$Q_p$ = plant pumping rate cfs

R = reconcentration of radionuclide in the lake at the end of the period

$R_o$ = reconcentration in the lake at the beginning of time period t

$$R = \frac{C\ Q_p}{W} \qquad C = \frac{W\ R}{Q_p}$$ therefore

$$R = \frac{Q_p}{V_T\ \lambda eff} (1 - e^{-\lambda eff\ t}) + R_o\ e^{-\lambda\ eff\ t}$$ Lake Reconcentration

Ccw = concentration at circulating water discharge point

$$Ccw = C + \frac{W}{Q_p} \quad \text{and} \quad C = \frac{RW}{Q_p}$$

therefore $(R + 1)\ \frac{W}{Q_p} = Ccw$ Circulating Water Discharge Concentration

R + 1 = reconcentration of radionuclide at the circulating water discharge

## 5A.4 REFERENCES

Attachment to Concluding Statement of Position of the Regulatory Staff. Public Rule-making Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Stations, USAEC, Docket No. RM-50-2, February 20, 1974.

Eckerman, K. F. and Lash, D. G., 1978 GASPAR version marked "revised 8/19/77": US Nuclear Regulatory Commission, Radiological Assessment Branch.

Eckerman, K. F., Congel, F. J., Roecklein, A. K. and Pasciak, W. J., 1980, NUREG-0597 Users Guide to GASPAR Code: U.S.N.R.C. Radiological Assessment Branch.

Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, USAEC Report WASH-1258, Washington, D.C., July 1973.

Fletcher, J. F., and Dotson, W. L. (compilers). HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, USAEC Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, 1971.

Lyon, R. J., Shearin, R. L., 1976, EPA-520 Radionuclide Accumulation in a Reactor Cooling Lake: USEPA, Office of Radiation Programs.

Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Office of Standards Development.

Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Office of Standards Development.

Regulatory Guide 1.113, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Office of Standards Development.

Simpson, D. B., McGill, B. L., 1980, NUREG/CR-1276 User's Manual for LADTAP II Computer Program: U.S.N.R.C. and Oak Ridge National Laboratory.

Warminski, N. C., 1979, Horticulture Agent for the Sedgwick County Extension Office of the Kansas State University Cooperative Extension Service, Wichita, Kansas, telephone conversation (25, 26 January), written communication (29 January).

TABLE 5A-1 (Sheet 1 of 4)

The following assumptions and parameters were used in LADTAP II for estimating doses at the Wolf Creek Generating Station site from liquid effluents:

| PARAMETER | INDIVIDUAL | POPULATION | REFERENCE |
|---|---|---|---|
| Cooling Lake volume, | | | |
| Normal | 4.847E+009 $ft^3$ | 4.847E+009 $ft^3$ | WCGS-ER(OLS) page 3.4-3 |
| Pre-drought | 4.649E+009 $ft^3$ | 4.649E+009 $ft^3$ | |
| Low-drought | 4.451E+009 $ft^3$ | 4.451E+009 $ft^3$ | |
| Seepage | 3.5 $ft^3$/sec | 3.5 $ft^3$/sec | WCGS-ER(OLS) page 3.3-3 |
| Blowdown Discharge | | | Sargent & Lundy Report SL-3204 Revised March 26, 1976, on Cooling Lake Operation pgs. 10, 11, 13, 14 & 15 |
| Normal-post drought | 40.0 $ft^3$/sec | 40.0 $ft^3$/sec | |
| Pre-drought | 3.5 $ft^3$/sec | 3.5 $ft^3$/sec | |
| Drought | 0.0 $ft^3$/sec | 0.0 $ft^3$/sec | |
| Ave. Neosho River flow rate | 1335 $ft^3$/sec | 1335 $ft^3$/sec | WCGS-ER(OLS) 5.1.2.2 page 5.1-3 |
| Dilution at Le Roy | 31.69 | 31.69 | |
| Population at Le Roy | -- | 624 | 1980 Census from Coffey County Clerk Telephone Call Record 4/17/81 |
| Population - 50 mile | -- | 1980 168,130<br>2000 184,470 | WCGS-ER(OLS) Table 2.1-4 |
| Circulating water discharge flow rate | 1204 cfs | 1204 cfs | WCGS-ER(OLS) Section 3.3 page 3.3-1 Circulating Water and Service Water |

TABLE 5A-1 (Sheet 2 of 4)

| PARAMETER | INDIVIDUAL | POPULATION | REFERENCE |
|---|---|---|---|
| Shore width factor, Cooling Lake | .3 | .3 | Reg. Guide 1.109 p. 15 Table A-2 |
| Shore width factor, Neosho River | .2 | .2 | Reg. Guide 1.109 p. 15 Table A-2 |
| Drinking Water | | | Reg. Guide 1.109 pgs. 39 & 40, Tables E-4, E-5 |
| Adult | 730 l/yr | 370 l/yr | |
| Teen | 510 l/yr | 370 l/yr | |
| Child | 510 l/yr | 370 l/yr | |
| Infant | 330 l/yr | 370 l/yr | |
| Fish Consumption | | | Reg. Guide 1.109 Pgs. 39 & 40, Tables E-4 & E-5 |
| Adult | 21 Kg/yr | 6.9 Kg/yr | |
| Teen | 16 Kg/yr | 5.2 Kg/yr | |
| Child | 6.9 Kg/yr | 2.2 Kg/yr | |
| Infant | 0.0 Kg/yr | 0.0 Kg/yr | |
| Invertebrate Consumption | | | Reg. Guide 1.109 Pgs. 39 & 40, Tables E-4 & E-5 |
| Adult | 5 Kg/yr | 1.0 Kg/yr | |
| Teen | 3.8 Kg/yr | .75 Kg/yr | |
| Child | 1.7 Kg/yr | .33 Kg/yr | |
| Infant | 0.0 Kg/yr | 0.0 Kg/yr | |
| Shoreline Exposure | | | Reg. Guide 1.109 Pgs. 39 & 40, Tables E-4 & E-5 |
| Adult | 12 hr/yr | 8.3 hr/yr | |
| Teen | 67 hr/yr | 47 hr/yr | |
| Child | 14 hr/yr | 9.5 hr/yr | |
| Swimming | hrs per person | | HERMES Pgs. 144 & 145, Tables III-31 & 32 |
| Adult | 7.8 hr/yr | 3.42 hr/yr | |
| Teen | 45.0 hr/yr | 19.2 hr/yr | |
| Child | 28.2 hr/yr | 12.0 hr/yr | |

TABLE 5A-1 (Sheet 3 of 4)

| PARAMETER | INDIVIDUAL | POPULATION | REFERENCE |
|---|---|---|---|
| Boating | hrs per person | | HERMES Pgs. 144 & 145, Tables III-31 & 32 |
| Adult | 52.2 hr/yr | 29 hr/yr | |
| Teen | 52.2 hr/yr | 29 hr/yr | |
| Child | 29.0 hr/yr | 16.53 hr/yr | |
| Hold up time | hrs | hrs | Inherent to program |
| Water | 12 | 24 | Reg. Guide 1.109 P. 69 |
| Fish | 24 | 168 | Pgs. 12 & 69 |
| Invertebrate | 24 | 168 | Pgs. 12 & 69 |
| Shoreline exposure | 0 | 0 | P. 69 |
| Swimming | 0 | 0 | P. 69 |
| Boating | 0 | 0 | P. 69 |

POPULATION

| Fraction of Population | | Inherent to program |
|---|---|---|
| Adult | 71% | |
| Teen | 11% | |
| Child | 18% | |

| Le Roy Population - 1980 | | 50 Mile Population - 1980 | | Reference |
|---|---|---|---|---|
| Adult | 443 | Adult | 119,372 | Reference calculated from Le Roy - 1980 Census from Coffey County Clerk. 50 Mile - WCGS-ER(OLS) Table 2.1-4 |
| Teen | 69 | Teen | 18,494 | |
| Child | 112 | Child | 30,263 | |
| Total | 624 | Total | 168,130 | |

Sport Fish Harvest - Hazleton Lake Use Feasibility Study WCGS-ER(OLS) Appendix 2A
Page 2A-8 Lake Capability 54,000 fishing trips annually 2 lbs per trip from lake.
Page 2A-4 18.4% of Kansas population are fishermen.

| | | |
|---|---|---|
| Sport Fish Harvest 675 Kg/yr | Fish Harvest 48,990 Kg/yr | Site Specific |
| Sport Invertebrate Harvest 97.9 Kg/yr | Invertebrate Harvest 26,350 Kg/yr | Site Specific |

TABLE 5A-1 (Sheet 4 of 4)

| POPULATION | | REFERENCE |
|---|---|---|
| Le Roy Population - 1980 | 50 Mile Population - 1980 | |
| Shoreline Recreation<br>7,984 hrs/yr | Shoreline Recreation<br>2,147,000 hrs/yr | Site Specific |
| Swimming<br>4,184 hrs/yr | Swimming<br>1,126,500 hrs/yr | Site Specific |
| Boating<br>16,700 hrs/yr | Boating<br>4,498,000 hrs/yr | Site Specific |
| Nearest Downstream Water Intake Location - Le Roy | | |
| Individual Intake<br>.2678 gal/day | Population Intake<br>167 gal/day | Reg. Guide 1.109<br>Site Specific |
| Annual Liquid Release Source Terms | | WCGS-ER(OLS)<br>Table 3.5-2 |

TABLE 5A-2

The following assumptions and parameters were used in GASPAR for estimating doses at the Wolf Creek Generating Station site from gaseous effluents:

| PARAMETER | VALUE ASSIGNED | REFERENCE |
|---|---|---|
| Distance from facility to the NE corner of the US (Maine) in miles | 1546 miles | Map measurement |
| Fraction of year leafy vegetables are grown | .75 | K-State Extension Service |
| Fraction of crop from garden | Default value .76 | Reg. Guide 1.109-7 |
| Fraction of year cows are on pasture | .5 | K-State Extension Service |
| Fraction of daily intake of cows derived from pasture while on pasture | Default value 1.00 | Reg. Guide 1.109-28 |
| Fraction of year goats are on pasture | .5 | K-State Extension Service |
| Fraction of daily intake of goat from pasture while on pasture | Default value 1.00 | Reg. Guide 1.109 |
| Fraction of year beef cattle are on pasture | .5 | K-State Extension Service |
| Fraction of daily intake of beef cattle derived from pasture while on pasture | Default value 1.00 | Reg. Guide 1.109 |
| Absolute humidity over growing season | 63.1% | Table 2.3-3 WCGS-ER(OLS) |
| Average temperature over growing season | 64.4°F | Table 2.3-1 WCGS-ER(OLS) |
| Total annual release time of intermittent purge operation | 1925 hrs/yr | Bechtel letter to SNUPPS BLSE-6610 Oct. 31, 1978 |
| Annual gaseous release source terms | Table 3.5-3 | WCGS-ER(OLS) |
| Average meteorological relative concentrations (X/Qs) | Table 5.2-1 WCGS-ER(OLS) | Dames & Moore X/Q Report 7699-062-07 |

# TABLE 5A-3

## 40 YR. RECONCENTRATION FACTORS

| NUCLIDE | RECONCENTRATION IN LAKE | RECONCENTRATION AT CWD |
|---|---|---|
| H-3 | 6.13E+001 | 6.23E+001 |
| Cr-51 | 9.35E-001 | 1.94E+000 |
| Mn-54 | 9.90E+000 | 1.09E+001 |
| Fe-55 | 2.75E+001 | 2.85E+001 |
| Fe-59 | 1.51E+000 | 2.51E+000 |
| Co-58 | 2.38E+000 | 3.38E+000 |
| Co-60 | 4.37E+001 | 4.47E+001 |
| Br-83 | 3.37E-003 | 1.00E+000 |
| Mo-99 | 1.00E-001 | 1.10E+000 |
| Tc-99M | 8.42E-003 | 1.01E+000 |
| Te-129M | 1.14E+000 | 2.14E+000 |
| I-131 | 2.72E-001 | 1.27E+000 |
| Te-132 | 1.09E-001 | 1.11E+000 |
| I-132 | 3.23E-003 | 1.00E+000 |
| I-133 | 2.95E-002 | 1.03E+000 |
| Cs-134 | 2.27E+001 | 2.37E+001 |
| I-135 | 9.40E-003 | 1.01E+000 |
| Cs-136 | 4.37E-001 | 1.44E+000 |
| Cs-137 | 7.30E+001 | 7.40E+001 |
| Zr-95 | 2.18E+000 | 3.18E+000 |
| Nb-95 | 1.18E+000 | 2.18E+000 |
| Rb-86 | 6.29E-001 | 1.63E+000 |
| Ru-103 | 1.34E+000 | 2.34E+000 |
| Ru-106 | 1.20E+001 | 1.30E+001 |
| Ag-110M | 8.31E+000 | 9.31E+000 |
| Ce-144 | 9.30E+000 | 1.03E+001 |
| Br-84 | 7.45E-004 | 1.00E+000 |
| Sr-89 | 1.75E+000 | 2.75E+000 |
| Te-127M | 3.64E+000 | 4.64E+000 |
| Te-127 | 1.32E-002 | 1.01E+000 |
| Te-129 | 1.61E-003 | 1.00E+000 |
| I-130 | 1.75E-002 | 1.02E+000 |
| Te-131M | 4.22E-002 | 1.04E+000 |
| Br-85 | 7.01E-005 | 1.00E+000 |
| Rb-88 | 4.18E-004 | 1.00E+000 |
| Sr-91 | 1.35E-002 | 1.01E+000 |
| Y-91M | 1.17E-003 | 1.00E+000 |
| Te-131 | 5.87E-004 | 1.00E+000 |
| I-134 | 1.24E-003 | 1.00E+000 |

(1) 40 yrs of reconcentration based on:

| | Years | Blowdown + | Seepage | Lake Level |
|---|---|---|---|---|
| Normal-post drought | 31.59 | 40 cfs | 3.5 cfs | 4.847E+009 $ft^3$ |
| Pre-drought | 3.58 | 3.5 cfs | 3.5 cfs | 4.650E+009 $ft^3$ |
| Drought | 4.83 | 0 cfs | 3.5 cfs | 4.451E+009 $ft^3$ |

(2) Drought occurs at the end of the 40 yr period.

TABLE 3.5-2

ANNUAL EFFLUENT RELEASES (1)
LIQUID

| Nuclide | Half-life (Days) | Boron Recycle (Curies) | Misc. Wastes (Curies) | Secondary (Curies) | Turb. Bldg. (Curies) | Total LWS (Curies) | Adjusted Total(2) (Ci/yr) | Detergent Wastes (Ci/yr) | Total (Ci/yr) |
|---|---|---|---|---|---|---|---|---|---|
| Corrosion & activation products | | | | | | | | | |
| CR-51 | 2.78+001 | .00001 | .00000 | .00000 | .00000 | .00001 | .00007 | .00000 | .00007 |
| MN-54 | 3.03+002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00001 | .00010 | .00011 |
| FE-55 | 9.50+002 | .00001 | .00000 | .00000 | .00000 | .00001 | .00006 | .00000 | .00006 |
| FE-59 | 4.50+001 | .00000 | .00000 | .00000 | .00000 | .00001 | .00004 | .00000 | .00004 |
| CO-58 | 7.13+001 | .00007 | .00002 | .00000 | .00000 | .00009 | .00059 | .00040 | .00099 |
| CO-60 | 1.92+003 | .00001 | .00000 | .00000 | .00000 | .00001 | .00007 | .00087 | .00094 |
| ZR-95 | 6.50+001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00014 | .00014 |
| NB-95 | 3.50+001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00020 | .00020 |
| NP-239 | 2.35+000 | .00001 | .00000 | .00000 | .00000 | .00001 | .00004 | .00000 | .00004 |
| Fission products | | | | | | | | | |
| BR-83 | 1.00-001 | .00000 | .00006 | .00000 | .00000 | .00006 | .00038 | .00000 | .00038 |
| BR-84 | 2.21-002 | .00000 | .00003 | .00000 | .00000 | .00003 | .00020 | .00000 | .00020 |
| BR-85 | 2.08-003 | .00000 | .00000 | .00000 | .00000 | .00000 | .00002 | .00000 | .00002 |
| RB-86 | 1.87+001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00003 | .00000 | .00003 |
| RB-88 | 1.24-002 | .01050 | .00024 | .00000 | .00000 | .01074 | .06768 | .00000 | .06800 |
| SR-89 | 5.20+001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00001 | .00000 | .00001 |
| SR-91 | 4.03-001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00002 | .00000 | .00002 |
| Y-91M | 3.47-002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00001 | .00000 | .00001 |
| MO-99 | 2.79+000 | .00037 | .00010 | .00000 | .00002 | .00049 | .00307 | .00000 | .00310 |
| TC-99M | 2.50-001 | .00021 | .00006 | .00000 | .00002 | .00028 | .00179 | .00000 | .00180 |
| RU-103 | 3.96+001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00001 | .00002 |
| RU-106 | 3.67+002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00024 | .00024 |
| AG-110M | 2.53+002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00004 | .00004 |
| TE-127M | 1.09+002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00001 | .00000 | .00001 |
| TE-127 | 3.92-001 | .00000 | .00000 | .00000 | .00000 | .00000 | .00003 | .00000 | .00003 |
| TE-129M | 3.40+001 | .00001 | .00000 | .00000 | .00000 | .00001 | .00005 | .00000 | .00005 |
| TE-129 | 4.79-002 | .00001 | .00000 | .00000 | .00000 | .00001 | .00006 | .00000 | .00006 |
| I-130 | 5.17-001 | .00000 | .00002 | .00000 | .00000 | .00003 | .00018 | .00000 | .00018 |
| TE-131M | 1.25+000 | .00001 | .00000 | .00000 | .00000 | .00001 | .00009 | .00000 | .00009 |
| TE-131 | 1.74-002 | .00000 | .00000 | .00000 | .00000 | .00001 | .00004 | .00000 | .00004 |
| I-131 | 8.05+000 | .00012 | .00321 | .00000 | .00040 | .00373 | .02349 | .00006 | .02400 |
| TE-132 | 3.25+000 | .00012 | .00003 | .00000 | .00000 | .00016 | .00098 | .00000 | .00098 |
| I-132 | 9.58-002 | .00004 | .00119 | .00000 | .00003 | .00126 | .00795 | .00000 | .00790 |
| I-133 | 8.75-001 | .00017 | .00452 | .00000 | .00045 | .00514 | .03238 | .00000 | .03200 |
| I-134 | 3.67-002 | .00002 | .00056 | .00000 | .00000 | .00058 | .00366 | .00000 | .00370 |
| CS-134 | 7.49+002 | .00131 | .00003 | .00000 | .00001 | .00135 | .00850 | .00130 | .00980 |
| I-135 | 2.79-001 | .00008 | .00226 | .00000 | .00013 | .00248 | .01562 | .00000 | .01600 |
| CS-136 | 1.30+001 | .00068 | .00002 | .00000 | .00000 | .00070 | .00442 | .00000 | .00440 |
| CS-137 | 1.10+004 | .00095 | .00002 | .00000 | .00000 | .00097 | .00612 | .00240 | .00850 |
| BA-137M | 1.77-003 | .00007 | .00002 | .00000 | .00000 | .00009 | .00059 | .00000 | .00059 |
| CE-144 | 2.84+002 | .00000 | .00000 | .00000 | .00000 | .00000 | .00000 | .00052 | .00052 |
| All Others | | .00000 | .00000 | .00000 | .00000 | .00001 | .00003 | .00000 | .00003 |
| Total (Except Tritium) | | .01481 | .01242 | .00000 | .00107 | .02830 | .17830 | .00629 | .19000 |

Tritium Release 410 curies per year

(1) Releases are based on assumptions given in Appendix 3A.

(2) Adjustment is 0.15 Ci/yr based on Regulatory Guide 1.112.

## 5.2 RADIOLOGICAL IMPACT FROM ROUTINE OPERATION

Normal operation of the Wolf Creek Generating Station (WCGS) will result in the release of only very low level liquid and gaseous radioactive discharges. In order to evaluate any potential impact from these releases, the dose contribution of the radioactive materials in the environment was predicted on the basis of terrestrial and aquatic pathways discussed in this section and in Sections 5.2 and 5.3 of the Environmental Report-Construction Permit Stage (ER(CPS)). In summary, negligible radiological impact is expected on man and the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released from the WCGS.

A detailed discussion of important dose pathways and resultant exposure rates was presented in Sections 5.2 and 5.3 of the ER(CPS) and is updated below. An update of this section was necessitated to reevaluate the potential impact from liquid and gaseous radioactive effluent discharges using the NRC computer codes GASPAR and LADTAP II. This update is based on a full three years of meteorological data collected at WCGS and a revised set of liquid source terms which are being incorporated into Section 3.5 at this time. The NRC computer codes used in this revision are based on the methods and models outlined in Regulatory Guides 1.109, 1.111 and 1.113.

### 5.2.1 EXPOSURE PATHWAYS

#### 5.2.1.1 Exposure Pathways for Radiation Exposure of Biota Other Than Man

Dose rate estimates to biota as herein presented should be considered extremely conservative since they are predicated on the following assumptions:

1. Liquid discharges are diluted only by the circulating cooling water. No credit was taken for further reduction of radionuclide concentrations in the cooling lake;

2. Buildup of the radionuclides in the cooling lake over the period of the life of the plant;

3. Aquatic organisms are continuously submerged at the point of discharge to the cooling lake;

4. Predatory species obtain their entire diet from primary organisms in equilibrium with water at effluent concentrations.

Liquid and gaseous releases will result in radiation doses to aquatic and terrestrial biota through pathways summarized in Figure 5.2-1. Many of the pathways of exposure for biota are similar to those for man. These pathways include ingestion of water and aquatic foods, submersion in air, immersion in water and exposure to sediments and shorelines. Other pathways such as inhalation and direct radiation from air deposition of radionuclides on soils are not considered significant for inclusion in the total dose to such organisms. Pathways of exposure from liquid effluents are generally the most significant contributors to radiation dose to organisms other than man. Because aquatic organisms can actively concentrate some radionuclides, these food chain components are potentially the most important contributors to radiation dose to terrestrial animals. The impact through the food chain pathway is expected to reach a maximum in predatory species such as muskrats, raccoons and herons which could conceivably obtain their total diet from aquatic organisms in equilibrium with water at effluent concentrations. The dose rate estimates for biota other than man are discussed in Section 5.2.3.

5.2.1.2 Exposure Pathways to Man

Radioactive effluents from the WCGS will become distributed throughout the terrestrial ecosystem by dispersion of gaseous releases, deposition of radioactive particulates and dilution of liquid radioactive discharges. Liquid and gaseous releases will result in radiation doses to man through pathways summarized in Figure 5.2-2.

Gaseous exposure pathways to man include:

1. Submersion in the cloud of gaseous effluents;

2. Inhalation of gaseous effluents;

3. Direct radiation exposure from deposition of radionuclide deposition on vegetation, soil and exposed surfaces; and

4. Ingestion of contaminated food chain components.

The annual individual dose from noble gases was evaluated in each of the 16 directional sectors around the plant at the Exclusion-Restricted Area Boundary (.75 miles), to evaluate cloud submersion and air dose from beta and gamma radiations. Also the calculated population dose rates from submersion in gaseous effluents were evaluated within a 50 mile radius of the plant. Radioactive iodine and particulate gaseous pathway doses were evaluated for a hypothetical worst case and for the controlling existing resident in the prevailing X/Q sector which is north. The hypothetical worst case assumes a resident lives in the north sector at the Exclusion-Restricted Area Boundary (.75 miles) with members of each age group present and all pathways present. The controlling existing resident lives 1.4 miles north of the plant and was evaluated as the maximum existing case. The dose rate estimates for man are presented in Section 5.2.4.

Liquid exposure pathways to man include:

1. Internal exposure from ingestion of water or contaminated food chain components;

2. External exposure from contaminated water or shoreline sediment.

Dose rate estimates to maximum individuals from liquid effluent concentrations were evaluated at the circulating water discharge point.

Water is not available for public consumption at the plant site and no population or individual exposure is expected from this pathway. Although recreational uses of the cooling lake are not planned it is conservatively assumed that individual exposures from swimming, boating, fishing or ingestion of fish could result.

Discharge water concentrations, bioaccumulation factors, and ingestion rates were used to estimate internal dose rates. Although such activities may not be allowed on the lake, external dose rates were estimated for individuals boating or swimming in the vicinity of the discharge. The exposure rate from contaminated shoreline sediments was also calculated.

Evaluation of each pathway is based on maximizing conditions. No credit was taken for dilution of the effluents in the cooling lake; buildup of the radionuclides in the lake over the life of the plant is assumed; all interactions are assumed to occur with radionuclide concentrations as they will occur at the point of discharge. Aquatic food chain elements are assumed to be in equilibrium with discharge concentrations prior to consumption. Since any swimming, boating, or fishing activities, if allowed, would be expected to be conducted in places in the cooling lake other than at the discharge point, evaluation of this pathway provides an upper estimate of the potential dose.

Dose rate estimates to maximum individuals and the population of the town of Le Roy were also evaluated for exposure from liquid effluent concentrations.

Important aquatic pathways for consideration are summarized in Figure 5.2-2.

## 5.2.2 RADIOACTIVITY IN THE ENVIRONMENT

Estimated gaseous and liquid effluents from the WCGS are presented in Section 3.5.

On-site meteorological data collected over three full years was used to predict gaseous effluent distribution in the environment. Both the PUFF and straight-line Gaussian dispersion models, described in Regulatory Guide 1.111, were used for determination of ground level and mixed mode annual average diffusion estimates. Resultant CHI/Q values are summarized for each sector in Table 5.2-1. For estimation of effluent dispersion a combination of both a mixed mode and ground-level release was assumed. The meteorological data indicates that maximum concentrations would be expected to occur in the north sector. Gaseous dose calculations were done using GASPAR computer code. Dose calculation models used in GASPAR are outlined in Regulatory Guides 1.109 and 1.111. Assumptions used were either site specific or default values taken from the Regulatory Guides. These assumptions are presented in Appendix 5A.

Liquid dose calculations were done using LADTAP II computer code. Dose calculation models used in LADTAP II are outlined in Regulatory Guides 1.109 and 1.113 for doses to man and USAEC Report WASH-1258 for doses to biota other than man. Site specific values were used when available. Default values used were either recommended in Regulatory Guide 1.109 or taken from HERMES USAEC Report HEDL-TME-71-168. The assumptions used in LADTAP II are presented in Appendix 5A.

Liquid radioactive releases will be diluted by cooling water with a flow rate of 1114 cfs and service water with a flow rate of 90 cfs for a total discharge of 1204 cfs. This is the only dilution assumed for dose calculations to the maximum individual interacting with the cooling lake environment. Buildup or reconcentration of the radionuclides in the cooling lake and at the circulating water discharge is taken into consideration over a 40 year plant life expectancy. The last five of these years are considered to be during a drought. The model used for calculating buildup of the radionuclides in the lake is presented in Appendix 5A. The models were taken from Regulatory Guide 1.113 and USEPA EPA-520 Radionuclide Accumulation in a Reactor Cooling Lake. The town of Le Roy, Kansas, is the nearest downstream water user intake from WCGS. Dose rates to an individual residing in Le Roy and to the population at Le Roy have been evaluated. These dose rates take into consideration a 40 year buildup of radionuclides in the lake and then a further dilution in the Neosho River. No credit is taken for the radionuclides decay during transition from the lake to

Le Roy. Estimated radionuclide concentrations in the effluent water at the discharge to the cooling lake and at Le Roy are listed in Table 5.2-2. Bioaccumulation factors used to predict uptake of radionuclides by fish and invertebrates are listed in Table 5.2-3.

### 5.2.3 DOSE RATE ESTIMATES FOR BIOTA OTHER THAN MAN

The pathways for radiation exposure of biota other than man were discussed in Section 5.2.1.1. For calculation of these dose rates it was assumed that aquatic organisms and terrestrial species live at the circulating water discharge point. Buildup of radionuclides was considered over the 40 year plant life. All food consumed has been grown or has lived in the liquid effluent at discharge concentrations. Internal and external dose rates to biota are summarized in Table 5.2-4. The primary aquatic organism, fish, receive an estimated maximum internal exposure of 13.6 mrad/yr and a maximum external exposure of 9.41 mrad/yr. The muskrat is a terrestrial animal which could receive an estimated maximum internal exposure of 51.6 mrad/yr and a maximum external exposure of 6.42 mrad/yr.

According to information presented in USAEC report WASH-1258 doses to biota at WCGS are well within expected annual doses when assuming the organisms live at the discharge point in effluent concentrations.

While these doses may be experienced by a few organisms which live at the discharge point of the station, the doses received by an entire population of aquatic or terrestrial organisms would be significantly less.

### 5.2.4 DOSE RATE ESTIMATES FOR MAN

#### 5.2.4.1 Liquid Pathways

Radionuclide concentrations in the discharge water were calculated based on a total discharge of 1204 cfs. Release rates and resultant radionuclide concentrations are listed in Table 5.2-2. Dose rate estimates to maximum individuals from liquid effluent concentrations were evaluated at the circulating water discharge point. No credit was taken for dilution of the effluents in the cooling lake; buildup of the radionuclides in the lake over a 40 year life expectancy are assumed to occur with radionuclide concentrations as they will occur at the discharge point. Pathways to man are discussed in Section 5.2.1.2. Assumptions used in dose calculations are given in Appendix 5A.

Dose rate estimates were calculated for maximum individuals and to the population residing at Le Roy. No credit was taken for the radionuclides decay during transition between discharge from the lake and Le Roy.

Dose rates to maximum individuals from liquid effluents are listed in Tables 5.2-5 and 5.2-6. Population doses at Le Roy are listed in Table 5.2-7.

The maximum organ and total body doses to individuals residing in Le Roy were calculated to be 1.96E-001 mrem/yr to the liver of a child and 1.49E-001 mrem/yr to the total body of an adult, Table 5.2-5. The most significant internal doses will be from eating fish (1.29E-001 mrem/yr to the liver of a teenager and 8.92E-002 mrem/yr to the total body of an adult). The most significant external dose rate will be to the skin of a teenager from exposure to radionuclide deposits in shoreline sediments 5.19E-004 mrem/yr.

Estimated dose from liquid effluents to the population of Le Roy are presented in Table 5.2-7.

The maximum organ and total body doses to individuals at the circulating water discharge point were calculated to be 4.27 mrem/yr to the liver of a teenager and 2.95 mrem/yr to the total body of an adult, Table 5.2-6. The most significant internal doses will be from eating fish (4.19 mrem/yr to the liver of a teenager and 2.90 mrem/yr to the total body of an adult). The most significant external dose rate will be to the skin of a teenager from exposure to radionuclide deposits in shoreline sediments 2.52E-002 mrem/yr.

5.2.4.2 Gaseous Pathways

The doses from gaseous effluents were calculated assuming intermittent purge operation. Intermittent purge mode release rates were taken from Table 3.5-3. The values of the dispersion and deposition coefficients, X/Q (non-decayed), X/Q (depleted and non-decayed) and D/Q used in the calculations are listed in Table 5.2-1.

The north sector was determined to be the prevailing X/Q sector for calculating annual dose from noble gases as well as from particulates and iodines. Exposure pathways to man are discussed in Section 5.2.1.2. Assumptions used in these dose calculations are given in Appendix 5A.

The annual doses due to normal gaseous effluents from WCGS are listed in Tables 5.2-9a, b and 5.2-10. Doses attributable to radioactive iodines and particulates at the controlling sector Exclusion-Restricted Area Boundary are contained within Table 5.2-9a (Hypothetical Worst Case). Doses from iodines and particulates at the controlling residence are contained within Table 5.2-9b (Controlling Existing Resident). Table 5.2-10 contains doses from noble gases at the Exclusion-Restricted Area Boundary.

Results of noble gas calculations at the Exclusion-Restricted Area Boundary (.75 miles) show the cloud submersion dose to the total body to be 2.2E-002 mrem/yr and 7.24E-002 mrem/yr to the skin in the north sector. The air dose resulted in exposure rates of 3.55E-002 mrad/yr gamma and 1.00E-001 mrad/yr from beta.

Doses attributable to radioactive particulates and iodines were evaluated at the north sector Exclusion-Restricted Area Boundary. A hypothetical worst case assumed members of each age group were present and all pathways were present at the boundary. Members of each age group were assumed to ingest goat milk rather than cow milk to consider the worst case milk ingestion pathway. The maximum organ and total body dose was 6.51 mrem/yr to the thyroid of an infant and 4.66E-001 mrem/yr to the total body of a child. Doses attributable to the actual controlling existing resident (1.4 miles north sector) for the maximum organ and total body dose were 3.07 mrem/yr to an infants thyroid and 1.94E-001 to the total body of an adult.

Calculated population dose rates from submersion in gaseous effluents were predicted based on the population in the year 2000. The results of these calculations are presented in Table 5.2-8.

#### 5.2.4.3 Direct Radiation From Facility

This subject was discussed in Section 5.3.4 of the ER(CPS). Although the source strengths involved have changed slightly, the conclusion reached-that negligible annual population exposure would be received in direct radiation from WCGS-has not changed.

#### 5.2.4.4 Annual Population Doses

Population dose rates at radial distances are summarized in Table 5.2-8. From these calculations, the average person within 50 miles of the site would receive an annual dose of $2.9 \times 10^{-4}$ mrem. The actual doses would be much lower due to shielding effects of housing.

### 5.2.5 SUMMARY OF ANNUAL RADIATION DOSES

The design of the WCGS will assure that gaseous and liquid effluent concentrations are within the guidelines stated in 10 CFR 20. During reactor operation, actual radionuclide concentrations in the environment will be determined by continuous environmental monitoring.

A series of previously discussed tables from Sections 5.2.3 and 5.2.4 estimate individual, population and biota annual doses from liqui nd gaseous effluents. A brief summary of calculated total body and thyroid dose rates from liquid and gaseous effluents is presented in Table 5.2-11 for maximum individual exposures and population exposures.

The exposure pathways considered for calculation of doses to man and biota are outlined in Sections 5.2.1.1 and 5.2.1.2.

A conformance summary with 10 CFR 50, Appendix I, is outlined in Table 5.2-12.

5.2.6 REFERENCES

Attachment to Concluding Statement of Position of the Regulatory Staff. Public Rule-making Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Stations, USAEC, Docket No. RM-50-2, February 20, 1974.

Eckerman, K. F. and Lash, D. G., 1978 GASPAR version marked "revised 8/19/77": US Nuclear Regulatory Commission, Radiological Assessment Branch.

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Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, USAEC Report WASH-1258, Washington, D.C., July 1973.

Fletcher, J. F., and Dotson, W. L. (compilers), HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, USAEC Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, 1971.

Lyon, R. J., Shearin, R. L., 1976, EPA-520 Radionuclide Accumulation in a Reactor Cooling Lake: USEPA, Office of Radiation Programs.

Regulatory Guide 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I, Office of Standards Development.

Regulatory Guide 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, Office of Standards Development.

Regulatory Guide 1.113, Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I, Office of Standards Development.

Simpson, D. B., McGill, B. L., 1980, NUREG/CR-1276 User's Manual for LADTAP II Computer Program: U.S.N.R.C. and Oak Ridge National Laboratory.

Warminski, N. C., 1979, Horticulture Agent for the Sedgwick County Extension Office of the Kansas State University Cooperative Extension Service, Wichita, Kansas, telephone conversation (25, 26 January), written communication (29 January).

TABLE 5.2-1 Sheet 1 of 3
AVERAGE METEOROLOGICAL RELATIVE CONCENTRATION ANALYSIS

Data Period 3 years:
(6/1/73 - 5/31/75,
3/5/79 - 3/4/80)

Dames and Moore 7699-062-07
7/12/80 (Ground)
7/19/80 (Mixed Mode)

| Sector | Nearest Plant Boundary | MIXED MODE X/Q Rel. | MIXED MODE X/Q Depl. | MIXED MODE X/Q Depos. | GROUND X/Q Rel. | GROUND X/Q Depl. | GROUND X/Q Depos. |
|---|---|---|---|---|---|---|---|
| NNE | 1.1 | 2.8E-07 | 2.5E-07 | 4.1E-09 | 5.9E-07 | 5.1E-07 | 5.1E-09 |
| NE | 1.3 | 9.3E-08 | 8.2E-08 | 1.1E-09 | 2.4E-07 | [illegible].0E-07 | 1.5E-09 |
| ENE | 1.5 | 5.4E-08 | 4.8E-08 | 4.3E-10 | 1.7E-07 | 1.5E-07 | 7.3E-10 |
| E | 1.2 | 8.0E-08 | 7.1E-08 | 7.5E-10 | 2.8E-07 | 2.4E-07 | 1.4E-09 |
| ESE | 1.2 | 1.2E-07 | 1.1E-07 | 1.1E-09 | 3.3E-07 | 2.9E-07 | 1.7E-09 |
| SE | 1.2 | 1.5E-07 | 1.3E-07 | 1.6E-09 | 3.8E-07 | 3.3E-07 | 2.3E-09 |
| SSE | 3.0 | 4.8E-08 | 4.0E-08 | 4.7E-10 | 1.0E-07 | 7.9E-08 | 6.3E-10 |
| S | 3.3 | 4.6E-08 | 3.8E-08 | 3.9E-10 | 8.5E-08 | 6.6E-08 | 4.9E-10 |
| SSW | 1.7 | 1.0E-07 | 8.9E-08 | 1.0E-09 | 2.5E-07 | 2.1E-07 | 1.5E-09 |
| SW | 1.5 | 8.1E-08 | 7.2E-08 | 6.3E-10 | 2.5E-07 | 2.1E-07 | 1.2E-09 |
| WSW | 1.5 | 8.3E-08 | 7.3E-08 | 6.5E-10 | 2.6E-07 | 2.2E-07 | 1.2E-09 |
| W | 1.8 | 9.0E-08 | 7.8E-08 | 5.9E-10 | 2.3E-07 | 1.9E-07 | 1.0E-09 |
| WNW | 2.1 | 7.5E-08 | 6.4E-08 | 4.9E-10 | 1.8E-07 | 1.5E-07 | 8.5E-10 |
| NW | 2.6 | 8.5E-08 | 7.0E-08 | 4.1E-10 | 2.0E-07 | 1.[illegible]E-07 | 7.0E-10 |
| NNW | 1.5 | 2.5E-07 | 2.1E-07 | 1.6E-09 | 6.3E-07 | 5.3E-07 | 3.0E-09 |
| N | 1.1 | 5.6E-07 | 4.9E-07 | 6.4E-09 | 1.0E-06 | 8.8E-07 | 8.0E-09 |

| Sector | Nearest Residence | MIXED MODE X/Q Rel. | MIXED MODE X/Q Depl. | MIXED MODE X/Q Depos. | GROUND X/Q Rel. | GROUND X/Q Depl. | GROUND X/Q Depos. |
|---|---|---|---|---|---|---|---|
| NNE | 3.1* | 7.3E-08 | 6.6E-08 | 7.7E-10 | 1.4E-07 | 1.1E-07 | 9.3E-10 |
| NE | 1.8 | 5.8E-08 | 5.0E-08 | 6.1E-10 | 1.5E-07 | 1.2E-07 | 8.6E-10 |
| ENE | 2.0 | 3.7E-08 | 3.2E-08 | 2.7E-10 | 1.1E-07 | 9.0E-08 | 4.3E-10 |
| E | 1.8 | 4.7E-08 | 4.1E-08 | 3.9E-10 | 1.6E-07 | 1.3E-07 | 7.1E-10 |
| ESE | 1.7* | 9.4E-08 | 8.1E-08 | 7.7E-10 | 2.4E-07 | 2.0E-07 | 1.2E-09 |
| SE | 1.4 | 1.1E-07 | 9.8E-08 | 1.2E-09 | 3.1E-07 | 2.6E-07 | 1.8E-09 |
| SSE | 3.0 | 4.8E-08 | 4.0E-08 | 4.7E-10 | 1.0E-07 | 7.9E-08 | 6.3E-10 |
| S | 3.5 | 4.3E-08 | 3.5E-08 | 3.5E-10 | 7.8E-08 | 6.1E-08 | 4.4E-10 |
| SSW | 2.5* | 6.2E-08 | 5.3E-08 | 5.3E-10 | 1.5E-07 | 1.2E-07 | 7.6E-10 |
| SW | 2.1 | 5.0E-08 | 4.4E-08 | 3.5E-10 | 1.5E-07 | 1.2E-07 | 6.5E-10 |
| WSW | 2.7* | 5.3E-08 | 5.5E-08 | 3.4E-10 | 1.6E-07 | 1.3E-07 | 7.3E-10 |
| W | 2.2 | 7.3E-08 | 6.2E-08 | 4.5E-10 | 1.7E-07 | 1.4E-07 | 7.1E-10 |
| WNW | 2.9 | 5.2E-08 | 4.4E-08 | 3.0E-10 | 1.2E-07 | 9.2E-08 | 4.8E-10 |
| NW | 1.3* | 2.9E-07 | 3.3E-07 | 1.9E-09 | 8.3E-07 | 7.3E-07 | 3.7E-09 |
| NNW | 2.2* | 1.7E-07 | 1.9E-07 | 1.0E-09 | 4.3E-07 | 3.6E-07 | 1.9E-09 |
| N | 1.4 | 4.1E-07 | 3.5E-07 | 4.4E-09 | 7.3E-07 | 6.2E-07 | 5.5E-09 |

| Sector | Nearest Veg. Garden | MIXED MODE X/Q Rel. | MIXED MODE X/Q Depl. | MIXED MODE X/Q Depos. | GROUND X/Q Rel. | GROUND X/Q Depl. | GROUND X/Q Depos. |
|---|---|---|---|---|---|---|---|
| NNE | 3.6* | 6.3E-08 | 5.2E-08 | 5.7E-10 | 1.2E-07 | 9.2E-08 | 7.6E-10 |
| NE | 2.1* | 5.1E-08 | 4.4E-08 | 5.1E-10 | 1.3E-07 | 1.0E-07 | 7.3E-10 |
| ENE | 2.2* | 3.8E-08 | 3.3E-08 | 2.7E-10 | 1.1E-07 | 9.2E-08 | 4.4E-10 |
| E | 1.8 | 4.7E-08 | 4.1E-[illegible] | 3.9E-10 | 1.6E-07 | 1.3E-07 | 7.1E-10 |
| ESE | 1.7* | 9.4E-08 | 8.1E-08 | 7.7E-10 | 2.4E-07 | 2.0E-07 | 1.2E-09 |
| SE | 1.4 | 1.1E-07 | 9.8E-08 | 1.2E-09 | 3.1E-07 | 2.6E-07 | 1.8E-09 |
| SSE | 3.2* | 4.8E-08 | 4.0E-08 | 4.7E-10 | 1.0E-07 | 8.0E-08 | 6.4E-10 |
| S | 3.5 | 4.3E-08 | 3.5E-08 | 3.5E-10 | 7.8E-08 | 6.1E-08 | 4.4E-10 |
| SSW | 4.6* | 2.5E-08 | 2.0E-08 | 1.7E-10 | 6.2E-08 | 4.6E-08 | 2.6E-10 |
| SW | 3.0* | 3.3E-08 | 2.8E-08 | 1.9E-10 | 8.9E-08 | 7.0E-08 | 3.5E-10 |
| WSW | 2.7* | 5.3E-08 | 5.5E-08 | 3.4E-10 | 1.4E-07 | 1.1E-07 | 5.8E-10 |
| W | 2.2 | 7.3E-08 | 6.2E-08 | 4.5E-10 | 1.7E-07 | 1.4E-07 | 7.1E-10 |
| WNW | 2.9 | 5.2E-08 | 4.4E-08 | 3.0E-10 | 1.2E-07 | 9.2E-08 | 4.8E-10 |
| NW | 1.4* | 2.9E-07 | 3.3E-07 | 1.9E-09 | 8.3E-07 | 7.3E-07 | 3.7E-09 |
| NNW | 2.2 | 1.5E-07 | 1.3E-07 | 8.4E-10 | 3.8E-07 | 3.1E-07 | 1.6E-09 |
| N | 1.4 | 4.1E-07 | 3.5E-07 | 4.4E-09 | 7.3E-07 | 6.2E-07 | 5.5E-09 |

* The closest conservative distance X/QS were used for these distances.

POOR ORIGINAL

TABLE 5.2-1 Sheet 2 of 3
AVERAGE METEOROLOGICAL RELATIVE CONCENTRATION ANALYSIS

Data Period 3 years:
(6/1/73 - 5/31/75,
3/5/79 - 3/4/80)

Dames and Moore 7699-062-07
7/12/80 (Ground;
7/19/80 (Mixed Mode)

| Sector | Exclusion-Restricted Area Boundary | MIXED MODE X/Q Rel. | MIXED MODE X/Q Depl. | MIXED MODE X/Q Depos. | GROUND X/Q Rel. | GROUND X/Q Depl. | GROUND X/Q Depos. |
|---|---|---|---|---|---|---|---|
| NNE | .75 | 4.7E-07 | 4.2E-07 | 7.5E-09 | 1.0E-06 | 8.9E-07 | 9.1E-09 |
| NE | .75 | 1.9E-07 | 1.7E-07 | 2.8E-09 | 5.2E-07 | 4.7E-07 | 3.6E-09 |
| ENE | .75 | 9.2E-08 | 8.3E-08 | 8.6E-10 | 4.5E-07 | 4.0E-07 | 2.1E-09 |
| E | .75 | 1.6E-07 | 1.5E-07 | 1.6E-09 | 5.8E-07 | 5.2E-07 | 3.0E-09 |
| ESE | .75 | 2.2E-07 | 2.0E-07 | 2.[illegible]E-09 | 7.1E-07 | 6.4E-07 | 3.8E-09 |
| SE | .75 | 2.5E-07 | 2.3E-07 | 3.0E-09 | 7.5E-07 | 6.6E-07 | 4.7E-09 |
| SSE | .75 | 2.9E-07 | 2.6E-07 | 4.2E-09 | 7.6E-07 | 6.8E-07 | 6.3E-09 |
| S | .75 | 3.4E-07 | 3.0E-07 | 4.4E-09 | 7.5E-07 | 6.7E-07 | 5.8E-09 |
| SSW | .75 | 2.9E-07 | 2.6E-07 | 3.4E-09 | 8.4E-07 | 7.5E-07 | 5.4E-09 |
| SW | .75 | 2.2E-07 | 2.0E-07 | 2.0E-09 | 7.0E-07 | 6.2E-07 | 3.7E-09 |
| WSW | .75 | 2.0E-07 | 1.8E-07 | 1.8E-09 | 8.0E-07 | 7.1E-07 | 4.2E-09 |
| W | .75 | 3.0E-07 | 2.7E-07 | 2.4E-09 | 1.0E-06 | 9.0E-07 | 5.2E-09 |
| WNW | .75 | 2.5E-07 | 2.2E-07 | 2.1E-09 | 7.6E-07 | 6.8E-07 | 4.2E-09 |
| NW | .75 | 4.2E-07 | 3.8E-07 | 2.8E-09 | 1.3E-06 | 1.2E-06 | 5.9E-09 |
| NNW | .75 | 6.2E-07 | 5.5E-07 | 4.4E-09 | 1.8E-06 | 1.6E-06 | 9.7E-09 |
| N | .75 | 9.2E-07 | 8.2E-07 | 1.1E-08 | 1.9E-06 | 1.7E-06 | 1.6E-08 |
| | L.P. Zone | | | | | | |
| NNE | 2.5 | 1.0E-07 | 8.6E-08 | 1.1E-09 | 1.8E-07 | 1.5E-07 | 1.3E-09 |
| NE | 2.5 | 3.6E-08 | 3.1E-08 | 3.2E-10 | 8.5E-08 | 6.8E-08 | 4.6E-10 |
| ENE | 2.5 | 2.8E-08 | 2.4E-08 | 1.8E-10 | 7.8E-08 | 6.2E-08 | 2.8E-10 |
| E | 2.5 | 3.3E-08 | 2.8E-08 | 2.3E-10 | 9.6E-08 | 7.7E-08 | 4.0E-10 |
| ESE | 2.5 | 4.8E-08 | 4.0E-08 | 3.3E-10 | 1.3E-07 | 1.0E-07 | 5.3E-10 |
| SE | 2.5 | 6.0E-08 | 5.0E-08 | 5.2E-10 | 1.3E-07 | 1.0E-07 | 6.3E-10 |
| SSE | 2.5 | 6.1E-08 | 5.1E-08 | 6.4E-10 | 1.4E-07 | 1.1E-07 | 9.3E-10 |
| S | 2.5 | 6.4E-08 | 5.4E-08 | 6.1E-10 | 1.3E-07 | 1.0E-07 | 7.9E-10 |
| SSW | 2.5 | 6.1E-08 | 5.2E-08 | 5.2E-10 | 1.5E-07 | 1.2E-07 | 7.9E-[illegible] |
| SW | 2.5 | 3.9E-08 | 3.4E-08 | 2.5E-10 | 1.2E-07 | 9.4E-08 | 4.9E-10 |
| WSW | 2.5 | 5.2E-08 | 4.4E-08 | 3.4E-10 | 1.4E-07 | 1.1E-07 | 5.7E-10 |
| W | 2.5 | 6.4E-08 | 5.4E-08 | 3.7E-10 | 1.4E-07 | 1.1E-07 | 5.5E-10 |
| WNW | 2.5 | 6.0E-08 | 5.0E-08 | 3.7E-10 | 1.5E-07 | 1.2E-07 | 6.4E-10 |
| NW | 2.5 | 9.0E-08 | 7.5E-08 | 4.4E-10 | 2.1E-07 | 1.7E-07 | 7.5E-10 |
| NNW | 2.5 | 1.3E-07 | 1.1E-07 | 6.8E-10 | 3.2E-07 | 2.6E-07 | 1.3E-09 |
| N | 2.5 | 1.9E-07 | 1.6E-07 | 1.6E-09 | 3.2E-07 | 2.6E-07 | 2.1E-09 |
| | Nearest Meat Animal | | | | | | |
| NNE | .8 | 4.3E-07 | 3.9E-07 | 6.8E-09 | 9.1E-07 | 8.1E-07 | 8.2E-09 |
| NE | .8 | 1.7E-07 | 1.5E-07 | 2.4E-09 | 4.8E-07 | 4.3E-07 | 3.3E-09 |
| ENE | .8 | 9.5E-08 | 8.5E-08 | 8.8E-10 | 4.1E-07 | 3.6E-07 | 1.9E-09 |
| E | 1.2 | 8.0E-08 | 7.1E-08 | [illegible].5E-10 | [illegible].8E-07 | 2.4E-07 | 1.4E-09 |
| ESE | 1.2 | 1.2E-07 | 1.1E-07 | 1.1E-09 | 3.3E-07 | 2.9E-07 | 1.7E-09 |
| SE | 1.2 | 1.5E-07 | 1.3E-07 | 1.6E-09 | 3.8E-07 | 3.3E-07 | 2.3E-09 |
| SSE | 3.2 | 4.5E-08 | 3.7E-08 | 4.2E-10 | 9.3E-08 | 7.2E-08 | 5.7E-10 |
| S | 3.3 | 4.6E-08 | 3.8E-08 | 3.9E-10 | 8.5E-08 | 6.6E-08 | [illegible].9E-10 |
| SSW | 3.3 | 3.8E-08 | 3.2E-08 | 2.9E-10 | [illegible].1E-07 | 8.2E-08 | 5.0E-10 |
| SW | 1.6 | 7.4E-08 | 6.6E-08 | 5.6E-10 | 2.2E-07 | 1.8E-07 | 1.0E-09 |
| WSW | 1.5 | 8.3E-08 | 7.3E-08 | 6.5E-10 | 2.6E-07 | 2.2E-07 | 1.2E-09 |
| W | 1.7 | 9.5E-08 | 8.2E-08 | 6.4E-10 | 2.6E-07 | 2.2E-07 | 1.2E-09 |
| WNW | 3.0* | 5.1E-08 | 5.2E-08 | 2.9E-10 | 1.1E-07 | 8.9E-08 | 4.6E-10 |
| NW | 2.3* | 1.2E-07 | 1.3E-07 | 6.5E-10 | 3.0E-07 | 2.5E-07 | 1.1E-09 |
| NNW | 2.0 | 1.7E-07 | 1.4E-07 | 9.9E-10 | 4.3E-07 | 3.5E-07 | 1.9E-09 |
| N | 1.1 | 5.6E-07 | 4.9E-07 | 6.4E-09 | 1.0E-06 | 8.8E-07 | 8.0E-09 |

* The closest conservative distance X/QS were used for these distances.



POOR ORIGINAL

TABLE 5.2-1 Sheet 3 of 3

AVERAGE METEOROLOGICAL RELATIVE CONCENTRATION ANALYSIS

Data Period 3 years:
(6/1/73 - 5/31/75,
3/5/79 - 3/4/80)

Dames and Moore 7699-062-07
7/12/80 (Ground)
7/19/80 (Mixed Mode)

| | | MIXED MODE | | | GROUND | | |
|---|---|---|---|---|---|---|---|
| Sector | Nearest Dairy Goat | X/Q Rel. | X/Q Depl. | X/Q Depos. | X/Q Rel. | X/Q Depl. | X/Q Depos. |
| NNE | 5.0 | 3.6E-08 | 2.9E-08 | 2.8E-10 | 6.7E-08 | 5.0E-08 | 3.8E-10 |
| NE | 5.0 | 1.6E-08 | 1.3E-08 | 9.6E-11 | 2.8E-08 | 2.0E-08 | 1.2E-10 |
| ENE | 5.0 | 9.0E-09 | 7.5E-09 | 4.0E-11 | 2.1E-08 | 1.5E-08 | 5.8E-11 |
| E | 5.0 | 1.4E-08 | 1.1E-08 | 7.0E-11 | 2.8E-08 | 2.0E-08 | 8.8E-11 |
| ESE | 5.0 | 1.8E-08 | 1.4E-08 | 9.0E-11 | 4.6E-08 | 3.4E-08 | 1.5E-10 |
| SE | 5.0 | 2.2E-08 | 1.7E-08 | 1.4E-10 | 4.0E-08 | 2.9E-08 | 1.5E-10 |
| SSE | 5.0 | 2.2E-08 | 1.8E-08 | 1.8E-10 | 4.5E-08 | 3.4E-08 | 2.4E-10 |
| S | 5.0 | 2.9E-08 | 2.3E-08 | 2.1E-10 | 4.8E-08 | 3.5E-08 | 2.4E-10 |
| SSW | 5.0* | 2.1E-08 | 1.7E-08 | 1.3E-10 | 5.1E-08 | 3.8E-08 | 2.1E-10 |
| SW | 5.0* | 1.8E-08 | 1.5E-08 | 8.2E-11 | 4.3E-08 | 3.2E-08 | 1.4E-10 |
| WSW | 5.0 | 2.2E-08 | 1.8E-08 | 1.0E-10 | 5.2E-08 | 3.8E-08 | 1.7E-10 |
| W | 5.0 | 2.4E-08 | 1.9E-08 | 1.0E-10 | 5.7E-08 | 4.2E-08 | 1.8E-10 |
| WNW | 5.0 | 2.3E-08 | 1.8E-08 | 1.0E-10 | 5.5E-08 | 4.0E-08 | 1.8E-10 |
| NW | 5.0 | 3.4E-08 | 2.7E-08 | 1.2E-10 | 8.1E-08 | 6.0E-08 | 2.2E-10 |
| NNW | 5.0 | 6.1E-08 | 4.7E-08 | 2.4E-10 | 1.3E-07 | 9.4E-08 | 4.0E-10 |
| N | 5.0 | 7.4E-08 | 5.8E-08 | 4.9E-10 | 1.1E-07 | 8.2E-08 | 5.7E-10 |
| N | 1.1 | 5.6E-07 | 4.9E-07 | 6.4E-09 | 1.0E-06 | 8.8E-07 | 8.0E-09 |
| | Nearest Dairy Cow | | | | | | |
| NNE | 4.7 | 3.9E-08 | 3.2E-08 | 3.2E-10 | 7.3E-08 | 5.5E-08 | 4.2E-10 |
| NE | 3.0* | 2.8E-08 | 2.4E-08 | 2.3E-10 | 5.8E-08 | 4.6E-08 | 3.0E-10 |
| ENE | 5.0/None | 9.0E-09 | 7.5E-09 | 4.0E-11 | 2.1E-08 | 1.5E-08 | 5.8E-11 |
| E | 1.8 | 4.7E-08 | 4.1E-08 | 3.9E-10 | 1.6E-07 | 1.3E-07 | 7.1E-10 |
| ESE | 1.[illegible] | 1.5E-07 | 1.4E-07 | 1.4E-09 | 4.5E-07 | 4.0E-07 | 2.3E-09 |
| SE | 1.2* | 1.8E-07 | 1.6E-07 | 2.0E-09 | 5.0E-07 | 4.3E-07 | 3.1E-09 |
| SSE | 4.0* | 3.3E-08 | 2.6E-08 | 2.8E-10 | 6.5E-08 | 5.0E-08 | 3.7E-10 |
| S | 5.0/None | 2.9E-08 | 2.3E-08 | 2.1E-10 | 4.8E-08 | 3.5E-08 | 2.4E-10 |
| SSW | 5.0/None | 2.1E-08 | 1.7E-08 | 1.4E-10 | 5.1E-08 | 3.8E-08 | 2.1E-10 |
| SW | 5.0*/None | 1.8E-08 | 1.5E-08 | 8.2E-11 | 4.3E-08 | 3.2E-08 | 1.4E-10 |
| WSW | 4.7 | 2.4E-08 | 2.0E-08 | 1.2E-10 | 5.7E-08 | 4.3E-08 | 1.9E-10 |
| W | 5.0/None | 2.4E-08 | 1.9E-08 | 1.0E-10 | 5.7E-08 | 4.3E-08 | 1.8E-10 |
| WNW | 5.0/None | 2.3E-08 | 1.8E-08 | 1.0E-10 | 5.5E-08 | 4.0E-08 | 1.8E-10 |
| NW | 3.5* | 5.9E-08 | 6.0E-08 | 2.4E-10 | 1.3E-07 | 1.0E-07 | 4.2E-10 |
| NNW | 2.0* | 1.7E-07 | 1.9E 07 | 1.0E-09 | 4.3E-07 | 3.6E-07 | 1.9E-09 |
| N | 5.0*/None | 7.7E-08 | 6.1E-08 | 4.7E-10 | 1.1E-07 | 8.3E-08 | 5.8E-10 |
| N | 1.1 | 5.6E-07 | 4.9E-07 | 6.4E-09 | 1.0E-06 | 8.8E-07 | 8.0E-09 |

* The closest conservative distance X/QS were used for these distances.

POOR ORIGINAL

TABLE 5.2-2

CALCULATED LIQUID EFFLUENT
DISCHARGE CONCENTRATIONS
FROM ROUTINE OPERATION

| Isotope | Release Ci/yr | pCi/l | | |
|---|---|---|---|---|
| | | Circulating Water[b] | Cooling Lake[c] | LeRoy[d] |
| H-3 | 4.10E+002 | 2.38E+004 | 2.34E+004 | 7.38E+002 |
| Cr-51 | 7.00E-005 | 1.26E-004 | 6.09E-005 | 1.92E-006 |
| Mn-54 | 1.10E-004 | 1.12E-003 | 1.01E-003 | 3.19E-005 |
| Fe-55 | 6.00E-005 | 1.59E-003 | 1.53E-003 | 4.82E-005 |
| Fe-59 | 4.00E-005 | 9.34E-005 | 5.62E-005 | 1.7[illegible]E-006 |
| Co-58 | 9.90E-004 | 3.11E-003 | 2.19E-003 | 6.[illegible]1E-005 |
| Co-60 | 9.40E-004 | 3.91E-002 | 3.82E-002 | 1.[illegible]1E-003 |
| Br-83 | 3.80E-004 | 3.53E-004 | 1.19E-006 | [illegible]6E-008 |
| Mo-99 | 3.10E-003 | 3.17E-003 | 2.88E-004 | 9.09E-006 |
| Tc-99M[a] | 1.80E-003 | 1.69E-003 | 1.41E-005 | 4.45E-007 |
| TE-129M | 5.09E-005 | 9.95E-005 | 5.30E-005 | 1.67E-006 |
| I-131 | 2.40E-002 | 2.84E-002 | 6.07E-003 | 1.92E-004 |
| Te-132 | 9.80E-004 | 1.01E-003 | 9.94E-005 | 3.14E-006 |
| I-132 | 7.90E-003 | 7.35E-003 | 2.37E-005 | 7.48E-007 |
| I-133 | 3.20E-002 | 3.07E-002 | 8.78E-004 | 2.77E-005 |
| Cs-134 | 9.80E-003 | 2.16E-001 | 2.07E-001 | 6.53E-003 |
| I-135 | 1.60E-002 | 1.50E-002 | 1.40E-004 | 4.42E-006 |
| Cs-136 | 4.40E-003 | 5.89E-003 | 1.79E-003 | 5.65E-005 |
| Cs-137 | 8.50E-003 | 5.85E-001 | 5.77E-001 | 1.82E-002 |
| Zr-95 | 1.40E-004 | 4.14E-004 | 2.84E-004 | 8.98E-006 |
| Nb-95 | 2.00E-004 | 4.06E-004 | 2.20E-004 | 6.94E-006 |
| Rb-86 | 3.00E-005 | 4.55E-005 | 1.76E-005 | 5.55E-007 |
| Ru-103 | 2.00E-005 | 4.35E-005 | 2.49E-005 | 7.86E-007 |
| Ru-106 | 2.40E-004 | 2.90E-003 | 2.68E-003 | 8.46E-005 |
| Ag 110M | 4.00E-005 | 3.46E-004 | 3.09E-004 | 9.75E-006 |
| Ce-144 | 5.20E-004 | 4.98E-003 | 4.50E-003 | 1.42E-004 |
| Br-84 | 2.00E-004 | 1.86E-004 | 1.39E-007 | 4.39E-009 |
| Sr-89 | 1.00E-005 | 2.56E-005 | 1.63E-005 | 5.14E-007 |
| Te-127M | 1.00E-005 | 4.32E-005 | 3.39E-005 | 1.07E-006 |
| Te-127 | 3.00E-005 | 2.82E-005 | 3.68E-007 | 1.16E-008 |
| Te-129 | 6.00E-005 | 5.58E-005 | 8.99E-008 | 2.84E-009 |
| I-130 | 1.80E-004 | 1.71E-004 | 2.93E-006 | 9.25E-008 |
| Te-131M | 9.00E-005 | 8.71E-005 | 3.53E-006 | 1.11E-007 |
| Br-85 | 2.00E-005 | 1.86E-005 | 1.30E-009 | 4.10E-011 |
| Rb-88 | 6.80E-002 | 6.33E-002 | 2.64E-005 | 8.33E-007 |
| Sr-91 | 2.00E-005 | 1.88E-005 | 2.51E-007 | 7.92E-009 |
| Y-91M | 1.00E-005 | 9.30E-006 | 1.09E-008 | 3.44E-010 |
| Te-131 | 4.00E-005 | 3.72E-005 | 2.18E-009 | 6.88E-010 |
| I-134 | 3.70E-003 | 3.44E-003 | 4.27E-006 | 1.35E-007 |
| All Others | 3.00E-005 | - | - | - |

[a] M = metastable
[b] Based solely on dilution by the circulating water discharge and buildup of radionuclides over 40 year plant life.
[c] Based on dilution by the circulating water discharge and build-up of radionuclides in the cooling lake over 40 year plant life.
[d] Concentration of radionuclides at the LeRoy water works intake. Based on dilution by circulating water discharge and build-up of radionuclides in the cooling lake over 40 year plant life and additional dilution in the Neosho River.

## TABLE 5.2-3

### BIOACCUMULATION FACTORS*
(pCi/kg per pCi/liter)

| | FRESHWATER | | SALTWATER | |
|---|---|---|---|---|
| ELEMENT | FISH | INVERTEBRATE | FISH | INVERTEBRATE |
| H | 9.0E-01 | 9.0E-01 | 9.0E-01 | 9.3E-01 |
| C | 4.6E 03 | 9.1E 03 | 1.8E 03 | 1.4E 03 |
| NA | 1.0E 02 | 2.0E 02 | 6.7E-02 | 1.9E-01 |
| P | 1.0E 05 | 2.0E 04 | 2.9E 04 | 3.0E 04 |
| CR | 2.0E 02 | 2.0E 03 | 4.0E 02 | 2.0E 03 |
| MN | 4.0E 02 | 9.0E 04 | 5.5E 02 | 4.0E 02 |
| FE | 1.0E 02 | 3.2E 03 | 3.0E 03 | 2.0E 04 |
| CO | 5.0E 01 | 2.0E 02 | 1.0E 02 | 1.0E 03 |
| NI | 1.0E 02 | 1.0E 02 | 1.0E 02 | 2.5E 02 |
| CU | 5.0E 01 | 4.0E 02 | 6.7E 02 | 1.7E 03 |
| ZN | 2.0E 03 | 1.0E 04 | 2.0E 03 | 5.0E 04 |
| BR | 4.2E 02 | 3.3E 02 | 1.5E-02 | 3.1E 00 |
| RB | 2.0E 03 | 1.0E 03 | 8.3E 00 | 1.7E 01 |
| SR | 3.0E 01 | 1.0E 02 | 2.0E 00 | 2.0E 01 |
| Y | 2.5E 01 | 1.0E 03 | 2.5E 01 | 1.0E 03 |
| ZR | 3.3E 00 | 6.7E 00 | 2.0E 02 | 8.0E 01 |
| NB | 3.0E 04 | 1.0E 02 | 3.0E 04 | 1.0E 02 |
| MO | 1.0E 01 | 1.0E 01 | 1.0E 01 | 1.0E 01 |
| TC | 1.5E 01 | 5.0E 00 | 1.0E 01 | 5.0E 01 |
| RU | 1.0E 01 | 3.0E 02 | 3.0E 00 | 1.0E 03 |
| RH | 1.0E 01 | 3.0E 02 | 1.0E 01 | 2.0E 03 |
| TE | 4.0E 02 | 6.1E 03 | 1.0E 01 | 1.0E 02 |
| I | 1.5E 01 | 5.0E 00 | 1.0E 01 | 5.0E 01 |
| CS | 2.0E 03 | 1.0E 03 | 4.0E 01 | 2.5E 01 |
| BA | 4.0E 00 | 2.0E 02 | 1.0E 01 | 1.0E 02 |
| LA | 2.5E 01 | 1.0E 03 | 2.5E 01 | 1.0E 03 |
| CE | 1.0E 00 | 1.0E 03 | 1.0E 01 | 6.0E 02 |
| PR | 2.5E 01 | 1.0E 03 | 2.5E 01 | 1.0E 03 |
| ND | 2.5E 01 | 1.0E 03 | 2.5E 01 | 1.0E 03 |
| W | 1.2E 03 | 1.0E 01 | 3.0E 01 | 3.0E 01 |
| NP | 1.0E 01 | 4.0E 02 | 1.0E 01 | 1.0E 01 |

*Regulatory Guide 1.109

TABLE 5.2-4

MAXIMUM INTERNAL AND EXTERNAL DOSE RATES
TO BIOTA OTHER THAN MAN AT THE
CIRCULATING WATER DISCHARGE POINT

| Biotic Type | Dose Rate (mrad/yr) | | |
|---|---|---|---|
| Primary Organisms | Internal | External | Total |
| Fish | 1.36E+001 | 9.41E+000 | 2.30E+001 |
| Invertebrate | 5.12E+000 | 1.88E+001 | 2.39E+001 |
| Algae | 5.72E+000 | 1.37E-002 | 5.73E+000 |
| Secondary Organisms | | | |
| Muskrat | 5.16E+001 | 6.42E+000 | 5.80E+001 |
| Raccoon | 2.80E+000 | 4.84E+000 | 7.64E+000 |
| Heron | 2.84E+002 | 6.41E+000 | 2.90E+002 |
| Duck | 4.64E+001 | 9.55E+000 | 5.60E+001 |

Assumes aquatic and terrestrial organisms and species live at the circulating water discharge point. Build-up of radionuclides is considered over the 40 year plant life. All food consumed is considered to be in equilibrium with water at effluent concentrations.

POOR ORIGINAL



TABLE 5.2-5

ESTIMATED DOSE RATES TO MAXIMUM INDIVIDUALS FROM LIQUID EFFLUENTS
RESIDING IN THE TOWN OF LEROY

ADULT

MREM PER YEAR

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 7.80-002 | 1.25-001 | 8.92-002 | 1.57-003 | 4.29-002 | 1.52-002 | 3.94-003 |
| Invertebrate | | 9.47-004 | 1.90-003 | 1.42-003 | 3.63-004 | 9.36-004 | 5.13-004 | 9.29-004 |
| Drinking | | 1.36-003 | 5.87-002 | 5.80-002 | 5.68-002 | 5.72-002 | 5.67-002 | 5.66-002 |
| Shoreline | 9.30-005 | 7.97-005 | 7.97-005 | 7.97-005 | 7.97-005 | 7.97-005 | 7.97-005 | 7.97-005 |
| Swimming | .00 | 3.38-007 | 3.38-007 | 3.38-007 | 3.38-007 | 3.38-007 | 3.38-007 | 3.38-007 |
| Boating | .00 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 |
| Total | 9.30-005 | 8.03-002 | 1.86-001 | 1.49-001 | 5.88-002 | 1.01-001 | 7.25-002 | 6.16-002 |

TEENAGER

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 8.27-002 | 1.29-001 | 5.05-002 | 1.23-003 | 4.37-002 | 1.76-002 | 2.98-003 |
| Invertebrate | | 1.00-003 | 1.86-003 | 8.76-004 | 2.82-004 | 8.72-004 | 4.64-004 | 6.87-004 |
| Drinking | | 1.32-003 | 4.19-002 | 4.06-002 | 4.01-002 | 4.05-002 | 4.01-002 | 3.99-002 |
| Shoreline | 5.19-004 | 4.45-004 | 4.45-004 | 4.45-004 | 4.45-004 | 4.45-004 | 4.45-004 | 4.45-004 |
| Swimming | .00 | 1.95-006 | 1.95-006 | 1.95-006 | 1.95-006 | 1.95-006 | 1.95-006 | 1.95-006 |
| Boating | .00 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 | 1.13-006 |
| Total | 5.19-004 | 8.55-002 | 1.73-001 | 9.24-002 | 4.20-002 | 8.56-002 | 5.86-002 | 4.40-002 |

CHILD

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 1.03-001 | 1.14-001 | 1.99-002 | 1.03-003 | 3.73-002 | 1.40-002 | 1.65-003 |
| Invertebrate | | 1.30-003 | 1.69-003 | 4.88-004 | 2.46-004 | 7.65-004 | 3.91-004 | 3.84-004 |
| Drinking | | 3.82-003 | 8.05-002 | 7.70-002 | 7.69-002 | 7.77-002 | 7.68-002 | 7.64-002 |
| Shoreline | 1.09-004 | 9.29-005 | 9.29-005 | 9.29-005 | 9.29-005 | 9.29-005 | 9.29-005 | 9.29-005 |
| Swimming | .00 | 1.21-006 | 1.21-006 | 1.21-006 | 1.21-006 | 1.21-006 | 1.21-006 | 1.21-006 |
| Boating | .00 | 6.28-007 | 6.28-007 | 6.28-007 | 6.28-007 | 6.28-007 | 6.28-007 | 6.28-007 |
| Total | 1.09-004 | 1.08-001 | 1.96-001 | 9.75-002 | 7.82-002 | 1.16-001 | 9.13-002 | 7.85-002 |

INFANT[1]

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| Drinking | | 3.95-003 | 8.01-002 | 7.53-002 | 7.58-002 | 7.63-002 | 7.55-002 | 7.50-002 |
| Shoreline | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| Total | .00 | 3.95-003 | 8.01-002 | 7.53-002 | 7.58-002 | 7.63-002 | 7.55-002 | 7.50-002 |

(1) Assumes drinking water is the only liquid pathway an infant would receive exposure from.

POOR ORIGINAL



TABLE 5.2-6

ESTIMATED DOSE RATES TO MAXIMUM INDIVIDUALS FROM LIQUID EFFLUENT CONCENTRATIONS AT THE CIRCULATING WATER DISCHARGE POINT

MREM PER YEAR

ADULT

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 2.52+000 | 4.07+000 | 2.90+000 | 6.47-002 | 1.39+000 | 4.94-001 | 1.31-001 |
| Invertebrate | | 3.19-002 | 6.25-002 | 4.66-002 | 1.36-002 | 3.75-002 | 1.66-002 | 6.27-002 |
| Drinking[1] | | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| Shoreline | 4.51-003 | 3.86-003 | 3.86-003 | 3.86-003 | 3.86-003 | 3.86-003 | 3.86-003 | 3.86-003 |
| Swimming | .00 | 1.22-005 | 1.22-005 | 1.22-005 | 1.22-005 | 1.22-005 | 1.22-005 | 1.22-005 |
| Boating | .00 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 |
| Total | 4.51-003 | 2.56+000 | 4.14+000 | 2.95+000 | 8.22-002 | 1.43+000 | 5.14-001 | 1.98-001 |

TEENAGER

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 2.67+000 | 4.19+000 | 1.64+000 | 5.28-002 | 1.42+000 | 5.70-001 | 9.88-002 |
| Invertebrate | | 3.38-002 | 6.13-002 | 2.91-002 | 1.09-002 | 3.57-002 | 1.50-002 | 4.53-002 |
| Drinking | | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| Shoreline | 2.52-002 | 2.16-002 | 2.16-002 | 2.16-002 | 2.16-002 | 2.16-002 | 2.16-002 | 2.16-002 |
| Swimming | .00 | 7.06-005 | 7.06-005 | 7.06-005 | 7.06-005 | 7.06-005 | 7.06-005 | 7.06-005 |
| Boating | .00 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 | 4.08-005 |
| Total | 2.52-002 | 2.73+000 | 4.27+000 | 1.69+000 | 8.53-002 | 1.48+000 | 6.07-001 | 1.66-001 |

CHILD

| PATHWAY | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
|---|---|---|---|---|---|---|---|---|
| Fish | | 3.34+000 | 3.70+000 | 6.47-001 | 4.73-002 | 1.21+000 | 4.53-001 | 5.40-002 |
| Invertebrate | | 4.37-002 | 5.55-002 | 1.66-002 | 1.01-002 | 3.14-002 | 1.26-002 | 1.96-002 |
| Drinking | | .00 | .00 | .00 | .00 | .00 | .00 | .00 |
| Shoreline | 5.26-003 | 4.51-003 | 4.51-003 | 4.51-003 | 4.51-003 | 4.51-003 | 4.51-003 | 4.51-003 |
| Swimming | .00 | 4.39-005 | 4.39-005 | 4.39-005 | 4.39-005 | 4.39-005 | 4.39-005 | 4.39-005 |
| Boating | .00 | 2.27-005 | 2.27-005 | 2.27-005 | 2.27-005 | 2.27-005 | 2.27-005 | 2.27-005 |
| Total | 5.26-003 | 3.38+000 | 3.76+000 | 6.68-001 | 6.19-002 | 1.25+000 | 4.71-001 | 7.82-002 |

[1] Assumes the lake is not a source of drinking water.
[2] Assumes an infant would not be exposed to the existing pathways.

TABLE 5.2-7

ESTIMATED DOSE FROM LIQUID EFFLUENTS
TO POPULATION OF LEROY

| | POPULATION DOSE (person-rem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SKIN | BONE | LIVER | TOTAL BODY | THYROID | KIDNEY | LUNG | GI-LLI |
| INGESTION | | | | | | | | |
| Fish | | 3.06E-003 | 4.56E-003 | 2.68E-003 | 5.15E-005 | 1.55E-003 | 5.62E-004 | 1.26E-004 |
| Invertebrate | | 2.27E-005 | 4.16E-005 | 2.67E-005 | 7.36E-006 | 1.97E-005 | 1.09E-005 | 1.65E-005 |
| Drinking Water | | 5.69E-004 | 1.92E-002 | 1.88E-002 | 1.85E-002 | 1.87E-002 | 1.85E-002 | 1.85E-002 |
| EXTERNAL EXPOSURE | | | | | | | | |
| Shoreline | 6.19E-005 | 5.30E-005 | 5.30E-005 | 5.30E-005 | 5.30E-005 | 5.30E-005 | 5.35E-005 | 5.35E-005 |
| Swimming | | 1.81E-007 | 1.81E-007 | 1.81E-007 | 1.81E-007 | 1.81E-007 | 1.81E-007 | 1.81E-007 |
| Boating | | 3.62E-007 | 3.62E-007 | 3.62E-007 | 3.62E-007 | 3.62E-007 | 3.62E-007 | 3.62E-007 |
| Totals | 6.19E-005 | 3.71E-003 | 2.39E-002 | 2.16E-002 | 1.86E-002 | 2.03E-002 | 1.91E-002 | 1.87E-002 |

TABLE 5.2-8

CALCULATED POPULATION DOSE RATES
FROM SUBMERSION IN GASEOUS EFFLUENTS

| Cumulative Radius (miles) | Cumulative 2000 Population[a] | Cumulative Dose (person-rem/yr) | Average Annual Dose (mrem/yr) |
|---|---|---|---|
| 1 | 20 | 0.0024 | 0.12 |
| 2 | 100 | 0.0055 | 0.055 |
| 3 | 260 | 0.0076 | 0.029 |
| 4 | 2,750 | 0.021 | 0.008 |
| 5 | 4,870 | 0.026 | 0.0054 |
| 10 | 6,180 | 0.026 | 0.0043 |
| 20 | 12,100 | 0.026 | 0.0021 |
| 30 | 72,020 | 0.041 | 0.00058 |
| 40 | 114,630 | 0.046 | 0.0004 |
| 50 | 184,470 | 0.054 | 0.00029 |

[a]Demographic data are presented in Section 2.1.2. Since population in the vicinity of the site will be reduced, the calculated doses are conservative.

TABLE 5.2-9a
CALCULATED RADIOACTIVE IODINE AND PARTICULATE GASEOUS
PATHWAY DOSES (Hypothetical Worst Case)

| Location | Age Group | Pathway | Critical Organ Dose Contributions (mRem/yr) | | | |
|---|---|---|---|---|---|---|
| | Adult | | Skin | Thyroid | Bone | Total Body |
| Controlling | | Ground Contamination | 1.26 E-02* | 1.08 E-02 | 1.08 E-02 | 1.08 E-02 |
| Sector Exclusion- | | Air Inhalation | 3.69 E-02 | 6.13 E-02* | 9.63 E-05 | 3.69 E-02 |
| Restricted Area | | Vegetable Ingestion | 8.92 E-02 | 3.97 E-01* | 1.78 E-01 | 9.35 E-02 |
| Boundary .75 miles | | Cow Milk Ingestion | --------- | --------- | --------- | --------- |
| North Sector | | Goat Milk Ingestion | 5.35 E-02 | 8.68 E-01* | 7.98 E-02 | 6.13 E-02 |
| | | Meat Inspection | 2.15 E-02 | 4.60 E-02 | 6.69 E-02* | 2.18 E-02 |
| | | Total Dose (mRem/yr) | 2.14 E-01 | 1.38 E+00 | 3.36 E-01 | 2.24 E-01 |
| | Teen | | Skin | Thyroid | Bone | Total Body |
| | | Ground Contamination | 1.26 E-02* | 1.08 E-02 | 1.08 E-02 | 1.08 E-02 |
| | | Air Inhalation | 3.71 E-02 | 6.75 E-02* | 1.29 E-04 | 3.71 E-02 |
| | | Vegetable Ingestion | 1.20 E-01 | 3.78 E-01* | 2.92 E-01 | 1.24 E-01 |
| | | Cow Milk Ingestion | --------- | --------- | --------- | --------- |
| | | Goat Milk Ingestion | [illegible] 76 E-02 | 1.37 E+00* | 1.47 E-01 | 8.60 E-02 |
| | | Meat Ingestion | [illegible].61 E-02 | 3.38 E-02 | 5.65 E-02* | 1.63 E-02 |
| | | Total Dose (mRem/yr) | 2.63 E-01 | 1.86 E+00 | 5.06 E-01 | 2.74 E-01 |
| | Child | | Skin | Thyroid | Bone | Total Body |
| | | Ground Contamination | 1.26 E-02* | 1.08 E-02 | 1.08 E-02 | 1.08 E-02 |
| | | Air Inhalation | 3.28 E-02 | 6.73 E-02* | 1.65 E-04 | 3.29 E-02 |
| | | Vegetable Ingestion | 2.37 E-01 | 6.30 E-01 | 7.05 E-01* | 2.40 E-01 |
| | | Cow Milk Ingestion | --------- | --------- | --------- | --------- |
| | | Goat Milk Ingestion | 1.46 E-01 | 2.69 E+00* | 3.60 E-01 | 1.55 E-01 |
| | | Meat Ingestion | 2.70 E-02 | 5.38 E-02 | 1.06 E-01* | 2.71 E-02 |
| | | Total Dose (mRem/yr) | 4.55 E-01 | 3.45 E+00 | 1.18 E+00 | 4.66 E-01 |
| | Infant | | Skin | Thyroid | Bone | Total Body |
| | | Ground Contamination | 1.26 E-02* | 1.08 E-02 | 1.08 E-02 | 1.08 E-02 |
| | | Air Inhalation | 1.89 E-02 | 5.05 E-02* | 1.16 E-04 | 1.89 E-02 |
| | | Vegetable Ingestion | --------- | --------- | --------- | --------- |
| | | Cow Milk Ingestion | --------- | --------- | --------- | --------- |
| | | Goat Milk Ingestion | 2.60 E-01 | 6.45 E+00* | 6.98 E-01 | 2.72 E-01 |
| | | Meat Ingestion | --------- | --------- | --------- | --------- |
| | | Total Dose (mRem/yr) | 2.92 E-01 | 6.51 E+00 | 7.09 E-01 | 3.02 E-01 |
| | | Appendix I Limit (mRem/yr) | 15.00 E+00 | 15.00 E+00 | 15.00 E+00 | 15.00 E+00 |

Note: (1) Assumes members of each age group are present and all pathways are present at the Controlling Exclusion-Restricted Area Boundary.

(2) Assumes members of each age group ingest goat milk rather than cow milk to consider the worst case milk ingestion pathway.

(3) Assumes no vegetable or meat ingestion by infants.

* Identifies the critical organ dose for each given pathway.

POOR ORIGINAL



TABLE 5.2-9b
CALCULATED RADIOACTIVE IODINE AND PARTICULATE GASEOUS
PATHWAY DOSES (Controlling Existing Resident)

| Location | Age Group | Pathway | Critical Organ Dose Contributions (mRem/yr) | | | |
|---|---|---|---|---|---|---|
| | Adult | | Skin | Thyroid | Bone | Total Body |
| 1.4 miles N | | Ground Contamination | 4.78 E-03* | 4.08 E-03 | 4.08 E-03 | 4.08 E-03 |
| 1.4 miles N | | Air Inhalation | 1.64 E-02 | 2.67 E-02* | 3.96 E-05 | 1.64 E-02 |
| 1.4 miles N | | Vegetable Ingestion | 3.77 E-02 | 1.58 E-01* | 6.91 E-02 | 3.94 E-02 |
| 1.1 miles N | | Cow Milk Ingestion | 1.94 E-02 | 4.05 E-01* | 4.04 E-02 | 2.12 E-02 |
| 1.1 miles N | | Meat Inspection | 1.20 E-02 | 2.60 E-02 | 3.55 E-02* | 1.22 E-02 |
| | | Total Dose (mRem/yr) | 9.03 E-02 | 6.20 E-01 | 1.49 E-01 | 9.33 E-02 |
| | Teen | | Skin | Thyroid | Bone | Total Body |
| 1.4 miles N | | Ground Contamination | 4.78 E-03* | 4.08 E-03 | 4.08 E-03 | 4.08 E-03 |
| 1.4 miles N | | Air Inhalation | 1.65 E-02 | 2.94 E-02* | 5.30 E-05 | 1.66 E-02 |
| 1.4 miles N | | Vegetable Ingestion | 5.04 E-02 | 1.51 E-01* | 1.13 E-01 | 5.19 E-02 |
| 1.1 miles N | | Cow Milk Ingestion | 2.94 E-02 | 6.39 E-01* | 7.45 E-02 | 3.17 E-02 |
| 1.1 miles N | | Meat Ingestion | 8.93 E-03 | 1.90 E-02 | 3.00 E-02* | 9.03 E-03 |
| | | Total Dose (mRem/yr) | 1.10 E-01 | 8.42 E-01 | 2.22 E-01 | 1.13 E-01 |
| | Child | | Skin | Thyroid | Bone | Total Body |
| 1.4 miles N | | Ground Contamination | 4.78 E-03* | 4.08 E-03 | 4.08 E-03 | 4.08 E-03 |
| 1.4 miles N | | Air Inhalation | 1.46 E-02 | 2.92 E-02* | 6.80 E-05 | 1.46 E-02 |
| 1.4 miles N | | Vegetable Ingestion | 9.76 E-02 | 2.51 E-01 | 2.74 E-01* | 9.91 E-02 |
| 1.1 miles N | | Cow Milk Ingestion | 5.89 E-02 | 1.27 E+00* | 1.83 E-01 | 6.18 E-02 |
| 1.1 miles N | | Meat Ingestion | 1.48 E-02 | 3.00 E-02 | 5.64 E-02* | 1.49 E-02 |
| | | Total Dose (mRem/yr) | 1.91 E-01 | 1.58 E+00 | 5.18 E-01 | 1.94 E-01 |
| | Infant | | Skin | Thyroid | Bone | Total Body |
| 1.4 miles N | | Ground Contamination | 4.78 E-03* | 4.08 E-03 | 4.08 E-03 | 4.08 E-03 |
| 1.4 miles N | | Air Inhalation | 8.41 E-03 | 2.17 E-02* | 4.81 E-05 | 8.42 E-03 |
| 1.4 miles N | | Vegetable Ingestion | --------- | --------- | --------- | --------- |
| 1.1 miles N | | Cow Milk Ingestion | 1.10 E-01 | 3.04 E+00* | 3.57 E-01 | 1.14 E-01 |
| 1.1 miles N | | Meat Ingestion | --------- | --------- | --------- | --------- |
| | | Total Dose (mRem/yr) | 1.23 E-01 | 3.07 E+00 | 3.61 E-01 | 1.27 E-01 |
| | | Appendix I Limit (mRem/yr) | 15.00 E+00 | 15.00 E+00 | 15.00 E+00 | 15.00 E+00 |

Note: (1) All pathways actually exist for this resident except the cow milk ingestion pathway which is assumed.

(2) Assumes members of each age group are present and that there is no vegetable or meat ingestion by infants.

* Identifies the critical organ dose for each given pathway.

TABLE 5.2-10
ANNUAL DOSE FROM NOBLE GASES

| Sector | Exclusion-Restricted Area Boundary (miles) | Cloud Submersion Total Body (mrem/yr) | Cloud Submersion Skin (mrem/yr) | Air Dose Gamma (mrad/yr) | Air Dose Beta (mrad/yr) |
|---|---|---|---|---|---|
| NNE | .75 | 1.12 E-02 | 3.74 E-02 | 1.83 E-02 | 5.17 E-02 |
| NE | .75 | 4.71 E-03 | 1.67 E-02 | 7.62 E-03 | 2.30 E-02 |
| ENE | .75 | 2.57 E-03 | 1.08 E-02 | 4.13 E-03 | 1.48 E-02 |
| E | .75 | 4.17 E-03 | 1.60 E-02 | 6.73 E-03 | 2.20 E-02 |
| ESE | .75 | 5.61 E-03 | 2.08 E-02 | 9.07 E-03 | 2.87 E-02 |
| SE | .75 | 6.30 E-03 | 2.28 E-02 | 1.02 E-02 | 3.16 E-02 |
| SSE | .75 | 7.14 E-03 | 2.51 E-02 | 1.16 E-02 | 3.45 E-02 |
| S | .75 | 8.17 E-03 | 2.74 E-02 | 1.32 E-02 | 3.79 E-02 |
| SSW | .75 | 7.26 E-03 | 2.62 E-02 | 1.17 E-02 | 3.60 E-02 |
| SW | .75 | 5.60 E-03 | 2.07 E-02 | 9.04 E-03 | 2.85 E-02 |
| WSW | .75 | 5.32 E-03 | 2.10 E-02 | 8.59 E-03 | 2.89 E-02 |
| W | .75 | 7.70 E-03 | 2.89 E-02 | 1.25 E-02 | 3.97 E-02 |
| WNW | .75 | 6.31 E-03 | 2.30 E-02 | 1.02 E-02 | 3.17 E-02 |
| NW | .75 | 1.06 E-02 | 3.90 E-02 | 1.72 E-02 | 5.37 E-02 |
| NNW | .75 | 1.55 E-02 | 5.59 E-02 | 2.52 E-02 | 7.71 E-02 |
| N | .75 | 2.20 E-02 | 7.24 E-02 | 3.55 E-02 | 1.00 E-01 |
| Appendix I Limit | | 5.00 E+0 | 15.00 E+0 | 10.00 E+0 | 20.00 E+0 |

TABLE 5.2-11

SUMMARY OF CALCULATED TOTAL-BODY AND THYROID
DOSE RATES FROM LIQUID AND GASEOUS EFFLUENTS

| Pathway | Dose Rate: Total Body | Dose Rate: Thyroid |
|---|---|---|
| Maximum Individual Exposures: | | |
| Liquid effluents[a] | | |
| Ingestion | | |
| fish | 2.90E+000 mrem/yr | 5.28E-002 mrem/yr |
| invertebrate | 4.66E-002 mrem/yr | 1.09E-002 mrem/yr |
| drinking water | 0.0 mrem/yr | 0.0 mrem/yr |
| External exposure | | |
| shoreline | 3.86E-003 mrem/yr | 2.16E-002 mrem/yr |
| swimming | 1.22E-005 mrem/yr | 7.06E-005 mrem/yr |
| boating | 4.08E-005 mrem/yr | 4.08E-005 mrem/yr |
| Subtotal | 2.95E+000 mrem/yr | 8.53E-002 mrem/yr |
| Gaseous effluents[b] | | |
| noble gas submersion | 2.20E-002 mrem/yr | -- |
| particulate and iodine gases | 1.27E-001 mrem/yr | 3.07E+000 mrem/yr |
| Subtotal | 1.49E-001 mrem/yr | 3.07E+000 mrem/yr |
| Population Exposures: | | |
| Liquid effluents[c] | | |
| Ingestion | | |
| fish | 2.68E-003 person-rem/yr | 5.15E-005 person-rem/yr |
| invertebrate | 2.67E-005 person-rem/yr | 7.36E-006 person-rem/yr |
| drinking water | 1.88E-002 person-rem/yr | 1.85E-002 person-rem/yr |
| External exposure | | |
| shoreline | 5.30E-005 person-rem/yr | 5.30E-005 person-rem/yr |
| swimming | 1.81E-007 person-rem/yr | 1.81E-007 person-rem/yr |
| boating | 3.62E-007 person-rem/yr | 3.62E-007 person-rem/yr |
| Subtotal | 2.16E-002 person-rem/yr | 1.86E-002 person-rem/yr |
| Gaseous effluents[d] | | |
| submersion | 5.4E-002 person-rem/yr | -- |
| direct radiation | 1.0E-003 person-rem/yr | -- |
| Subtotal | 5.5E-002 person-rem/yr | -- |

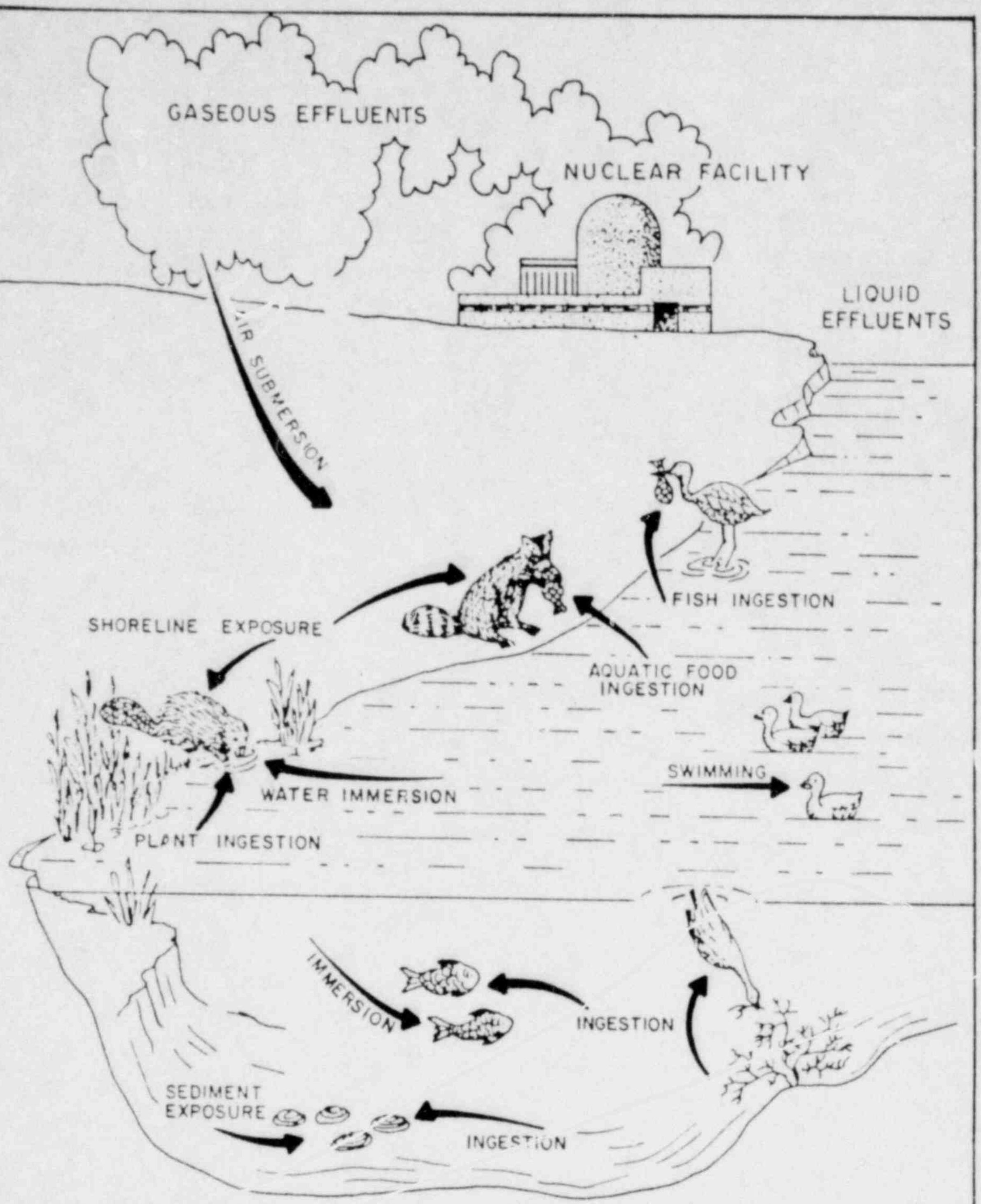
[a] Doses were calculated at the circulating water discharge for maximum individual exposures. Total body doses were for an adult and thryoid doses were to a teen.
[b] Doses were calculated at a point 1.4 miles from the vent in the maximally exposed sector for an infant.
[c] To the population in the town of Le Roy.
[d] To the population within a 50 mile radius.

TABLE 5.2-12

APPENDIX I CONFORMANCE SUMMARY TABLE FOR LIQUID AND GASEOUS EFFLUENTS

| Type of Dose | Design Objective[a] | Calculated Dose[b] | Point of Dose Evaluation |
|---|---|---|---|
| Liquid Effluents | | | |
| Dose to total body from all pathways | 5 mrem/yr per site | 2.95 mrem/yr[b] | Point of Discharge Cooling Lake |
| Dose to any organ from all pathways | 5 mrem/yr per site | 4.27 mrem/yr[c] | Same as above |
| Gaseous Effluents | | | |
| Dose to total body of an individual | 5 mrem/yr per site | 0.0220 mrem/yr | .75 mi N of stack vent[d] |
| Dose to skin of an individual | 15 mrem/yr per site | 0.0724 mrem/yr | .75 mi N of stack vent |
| Radioiodine and Particulates | | | |
| Dose to any organ from all pathways | 15 mrem/yr per site | 3.07 mrem/yr[e] | Residence, 1.4 mi. N of stack vent. Milk cow 1.1 mi. N of stack. |
| I-131 releases | 1 Ci/yr per unit | 0.0577 Ci/yr | gaseous |
| | | 0.0240 Ci/yr | liquid |
| | Total | 0.0817 Ci/yr | |

[a] Design objective as specified in the Commission's Appendix I Conformance Option, 40 FR, 40816, September 4, 1975, RM-50-2.
[b] Maximum dose to an individual from all liquid pathways.
[c] Maximum dose to a teen liver from all liquid pathways.
[d] Maximally exposed sector.
[e] Dose to an infant thyroid.




WOLF CREEK GENERATING STATION
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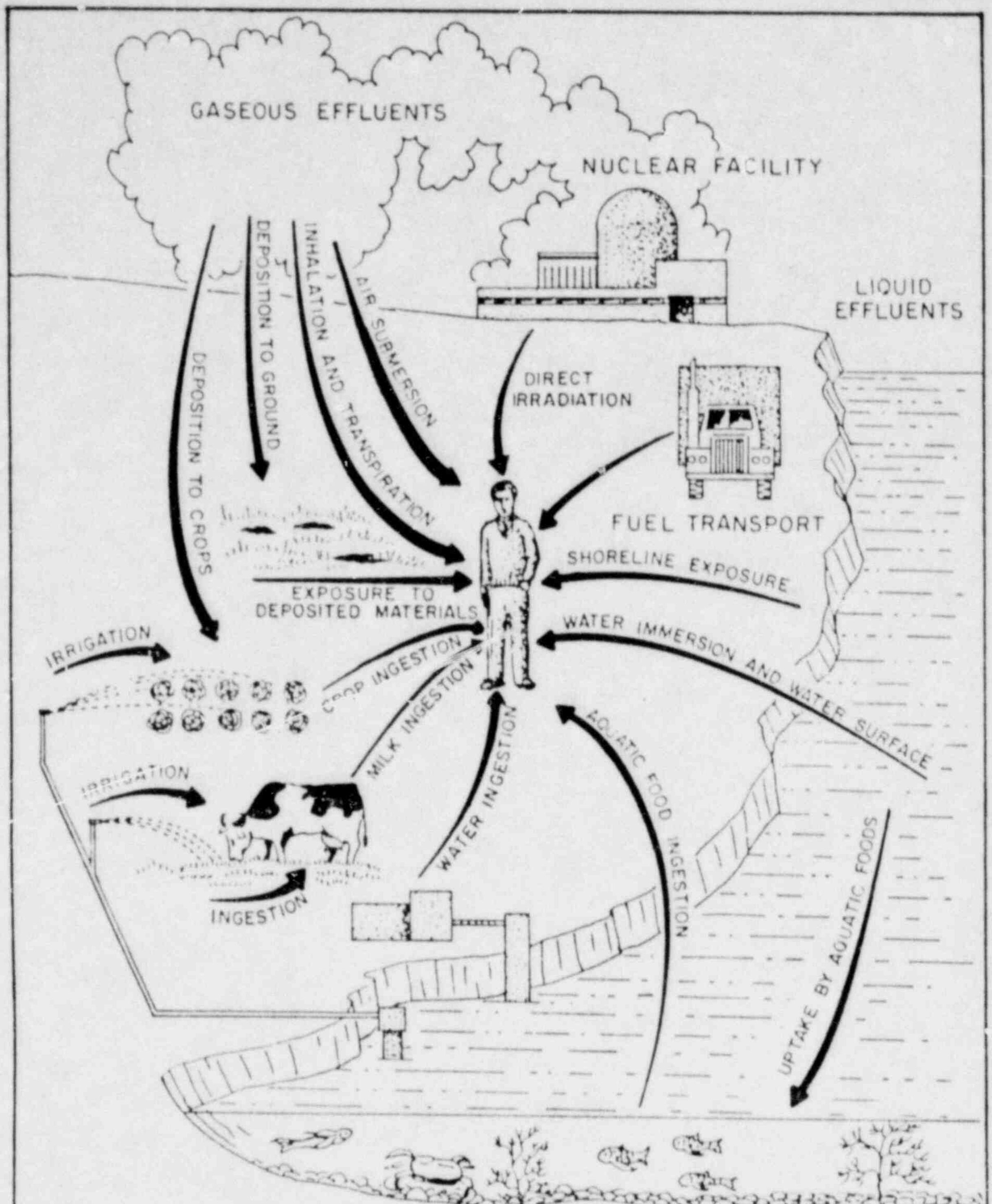
FIGURE 5.2-1

EXPOSURE PATHWAYS TO ORGANISMS OTHER THAN HUMANS

REFERENCE:
U.S. Atomic Energy Commission, 1973




REFERENCE:
U.S. Atomic Energy Commission, 1973

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FIGURE 5.2-2

EXPOSURE PATHWAYS FOR HUMANS

| | |
|---|---|
| Q470.6 (ER) (Appendix 5A) | Appendix 5A of the ER states that a summary of dose models and a list of assumptions used for Wolf Creek were presented in Appendix 5.2A of the ER-Construction Permit Stage, however in reviewing this information, the addition of the computer code FOOD in the ER-OL became apparent. Therefore, please provide an updated summary of the dose models and assumptions used. |
| R470.6 | Appendix 5A has been revised. Computer Code FOOD and other dose models have been replaced with more current computer codes (GASPAR, LADTAP II) and information in Appendix 5A is for these current codes. |