UNION ELECTRIC COMPANY
1901 GRATIOT STREET
ST. LOUIS, MISSOURI

July 6, 1981

JOHN K. BRYAN
VICE PRESIDENT

MAILING ADDRESS:
P. O. BOX 149
ST. LOUIS, MISSOURI 63166

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

ULNRC-460

Dear Mr. Denton:

DOCKET NUMBERS 50-483 and 50-486
CALLAWAY PLANT, UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

Reference: NRC letter dated June 10, 1981 from R. L. Tedesco

The referenced letter requested additional information concerning the Callaway Plant FSAR. Transmitted herewith are responses to questions in the referenced letter. This information will be formally incorporated into the Callaway Plant FSAR in the next revision. This information is hereby incorporated into the Callaway Application.

Very truly yours,

John K. Bryan

John K. Bryan

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STATE OF MISSOURI)
)   S S
CITY OF ST. LOUIS)

John K. Bryan, of lawful age, being first duly sworn upon oath says that he is Vice President-Nuclear and an officer of Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By John K Bryan
John K. Bryan
Vice President
Nuclear

SUBSCRIBED and sworn to before me this 6th day of July, 1981

Margaret S Heida

MARGARET S. HEIDA
NOTARY PUBLIC — STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXPIRES JANUARY 2, 1982

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ITEM 240.1C: Figure 2.1-3 does not show the location of the inlet nor pipeline (as indicated in the second paragraph of section 2.4.1.1). Revise that figure or provide another figure to show the location as discussed in the text.

RESPONSE: The correct reference is Figure 2.1-2, which shows the inlet and pipeline. This correction was included in Revision 3 to the FSAR Addendum, dated May 1981.

ITEM 240.2C: Figure 2.1-4 does not show the location of the UHS retention pond (as indicated in the fourth paragraph of section 2.4.1.1). Revise that figure or provide another figure showing the retention pond as discussed in the text.

RESPONSE: The correct reference is Figure 2.1-3, which shows the location of the UHS retention pond. This correction was included in Revision 3 to the FSAR ddendum, dated May 1981.

ITEM 240.3C: The U.S. Army Corps of Engineers hypothetical flood studies for the Missouri River (1979) cited in section 2.4.3 does not appear in the list of references. Provide the complete title and other pertinent information. If the reference is to a written communication from the Corps of Engineers, please provide a copy of the communication.

RESPONSE: The reference to data provided by the U.S. Army Corps of Engineers (1979) concerning hypothetical flood studies for the Missouri River cited in Section 2.4.3 of the FSAR Addendum is one of several personal communications received from the Corps of Engineers in 1979 listed in the references for Section 2.4. A copy of the written communication in question is attached.

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

LMSED-HE

2 July 1979

Mr. Gary Lake
Dames and Moore Consulting Engineers
605 Parfet Street
Denver, Colorado 80215

Dear Mr. Lake:

Reference is made to your telephone conversation on 20 June 1979 with Mr. Gary Dyhouse, Chief, Hydrologic Engineering Section, this office, concerning hypothetical flood information on the Lower Missouri and Mississippi Rivers for use in Callaway Nuclear Power Plant Siting at Mile 115, Missouri River. This letter is intended to supplement that conversation.

This office is not aware of any specific, detailed studies which have been made to identify either a standard project or probable maximum flood on the Lower Missouri or Middle Mississippi Rivers. The Kansas City District is responsible for the Missouri River and should also be contacted on this subject. Various hypothetical floods were analyzed during the 1950's to define and/or compare design discharges for levee grade establishment along the Middle and Lower Mississippi River. The hypothetical flood giving the greatest discharge on the Middle Mississippi River (mouth of the Missouri to mouth of the Ohio River) was designated as Hypothetical Flood 52-A. This flood is the result of a combination of actual large storm events and was developed by Corps of Engineers' studies. Hypothetical Flood 52-A was developed from the combination of the 7-11 May 1943 storm transposed over the Missouri and Upper Mississippi Basins, but with the rainfall decreased 20 percent, followed three days later by the actual 15-20 May 1943 storm over all drainage areas above the latitude of Red River landing, and two days later by the actual 28-30 June 1928 storm over all areas above Cairo, Illinois.

The design floods eventually adopted for the Middle Mississippi River levee system were a 50-year and 200-year event for agricultural and urban areas, respectively, unmodified by reservoirs. Hypothetical Flood 52-A was thus used primarily as a comparison with the levee design event.

The comparison was made by using the Mississippi River Basin physical model (MBM) at Clinton, Mississippi. The flood hydrograph from Hypothetical Flood 52A was introduced at St. Louis and downstream peak water surface elevations would be obtained from model measurements. The effects of various combinations of reservoirs on Mississippi River discharges were to be estimated as well. These tests, incorporating many actual and hypothetical floods to be analyzed for the Mississippi Basin, were initiated in 1959 and conducted through 1969. After initial testing was underway, it was decided to incorporate portions of the Missouri and Mississippi Rivers upstream of St. Louis. In particular, water surface elevations for hypothetical events on the Missouri River from Sioux City, Iowa, to the mouth were now required. Upon introducing the 52-A hydrographs at the upstream end of the model and at tributary outflow points to the Missouri River and routing flows using the MBM, it was found that a significantly reduced hydrograph resulted at St. Louis as compared to the results using simplified techniques.

The original test data input, from which the Hypothetical Flood 52-A hydrograph was obtained at St. Louis, was developed through the techniques available at that time - rather simplified hydrologic routing methods computed and routed by hand to the St. Louis Gage. It was felt that this difference in hydrographs at St. Louis was due to the inadequacy of the hydrologic routing techniques performed during the 1950's to develop the hypothetical flood hydrograph at St. Louis. To differentiate between these two conditions, the hypothetical flood 52-A (simplified hydrologic routings) was redesignated as M 52-A (routing with MBM).

At meetings the with Lower Mississippi Valley Division, Missouri River Division, and St. Louis District personnel, it was determined that Hypothetical Flood M 52-A was the more accurate estimate of the discharges that could be expected from an actual occurrence of this rare flood event. Consequently, the adopted discharges from the hypothetical flood would be those derived from M 52-A. There is no frequency associated with this hypothetical flood; however, it is felt that it is a reasonable representation of discharges which might be experienced from storms of standard project proportions over the Missouri and Upper Mississippi River Basins. Discharge values for Hypothetical Floods 52-A and M 52-A, along with the flood of record information, are given in the accompanying table. The results for different combinations of possible reservoir conditions are also shown.

LMSED-HE 2 July 1979

Mr. Gary Lake

I trust the above information will be suitable for your needs. Any further questions should be directed to Mr. Gary Dyhouse at (314) 263-5849.

Sincerely,

JACK R. NIEMI
Chief, Engineering Division

1 Incl
As stated

HYPOTHETICAL FLOODS

LOCATION	FLOOD	E	EN	END
Mississippi River at St. Louis, MO	52-A	1,900,000	1,670,000	1,585,000
Mississippi River at St. Louis, MO	M 52-A	1,380,000	1,180,000	1,080,000
Missouri River at Hermann, MO	M 52-A	980,000	790,000	700,000

Group E (Existing) - Reservoirs that were existing and under construction in 1959, at the start of model testing.

Group N (Near future) - Reservoirs scheduled for construction and expected to be operable by 1970, based on study and construction schedules available in the late 1950's.

Group D (Distant future) - Reservoirs that are expected to become operable after 1970 that will complete the ultimate system of reservoirs. Reservoirs in Group D were estimated in the late 1950's, based on upcoming planning studies.

Group EN is considered to best represent the current condition of the Mississippi River. The actual reservoirs in operation today include a few from the D group. Some reservoirs in the N group have not been constructed.

FLOODS OF RECORD

LOCATION	YEAR	DISCHARGE (C.F.S.)
Mississippi River at St. Louis, MO	1844	1,300,000
Mississippi River at Alton, IL	1973	535,000
Missouri River at Hermann, MO	1844	892,000

The 1844 values were estimated in the early 1900's based on measurements from the 1903 flood at Chester and Thebes, Illinois. The values at St. Louis and at Hermann are considered to be rough estimates at best and may be conservative. The highest discharge measured by modern gaging techniques at these two points occurred in 1973 at St. Louis (852,000 c.f.s.) and in 1951 at Hermann (618,000 c.f.s.).

ITEM 240.4C: a) Your analysis of forces on the UHS retention pond safety related structures is based upon thermal expansion of an ice layer with a thickness that has a recurrence interval of 100 years (1 percent chance per year). This is not an adequate design basis for safety related structures with respect to natural phenomena as required by General Design Criterion 2 of 10 CFR 50 Appendix A and does not meet Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants." Also, no basis for the assumed temperature rate of rise at 5 F per hour is provided.

Provide an analysis to determine the upper limit of ice thrust forces that could be exerted on safety related structures in the UHS retention pond. Provide all historical data (and their source) used in your analysis. Provide details of any frequency analyses performed and describe any joint probability considerations between ice layer thickness and rate of temperature rise. If the mechanical and/or heat transfer properties of the ice layer are used to limit the thrust forces, provide the basis for all coefficients assumed.

b) If all safety related structures in the UHS retention pond cannot be shown to withstand the upper limit of ice thrust forces determined in response to a) above, discuss procedures to be included in the plant technical specifications to limit the thrust forces, protect the structures, or shut the plant down during times of ice buildup.

RESPONSE: a) Use of the 100 year ice thickness is considered to be an adequately conservative design condition. The forces associated with the 100 year ice condition have been used as normal live loads (see Section 3.8.4.3.1) and have been combined separately with extreme environmental loads (see Table 3.8-2) such as PMP, SSE, etc., to demonstrate that the design is conservative. To design for conditions more severe than the 100 year ice condition in combination with extreme environmental events would not significantly add to the conservatisms already included in the design and is therefore not justified. The 100 year ice condition is adequately conservative such that the design is in compliance with the requirements of General Design Criterion 2 and the recommendations of Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants."

The assumed temperature rate of rise of 5 F per hour for ice thrust is based on the recommendations of Cold Regions Research and Engineering Laboratory (Ref. 1). The reference states that in most cold regions the mean rise of air temperature rarely exceeds 5 F per hour for extended periods of time. Some extremes in temperature rises are reported in the literature but because of their very short durations they are not representative of the temperature fluctuations inside the ice sheet itself which has a great thermal inertia.

b) All safety related structures in the UHS retention pond are designed to withstand the ice thrust force as described above.

REFERENCE: 1. Michael, B., "Ice Pressure on Engineering Structures." Cold Regions Science and Engineering Monograph III-Bl b, June, 1970.

ITEM 240.5C: Provide the basis for the wind speeds used in the computation of drag forces on the ice surface in the ultimate heat sink retention pond. Justify that the severity meets the intent of General Design Criterion 2 and Position 2 of Regulatory Guide 1.27. Provide the drag coefficient used and the thrust forces calculated. Discuss the impact forces that would result if the pond was only partially covered by ice and ice sheets were driven by wind into the ESWS pumphouse. Provide the basis for all assumptions used in your analysis.

RESPONSE: The drag force due to wind acting on the ice surface in the Ultimate Heat Sink Retention pond is determined considering the different winter wind speeds at the site. Based on climatological data collected at Columbia, Missouri during the years 1931 through 1960 and 1970 through 1973, the fastest wind speeds for the months of December, January, and February are 58, 56, and 45 mph, respectively (based on 1 minute maximum duration) (FSAR Table 2.3-7). The mean monthly wind speeds for these months are 10.7, 10.7, and 11.9 mph, respectively.

The drag coefficient is evaluated considering turbulent flow over ice (smooth surface) and using the figures given in Schlicting (Ref. 1) and Vennard (Ref. 2). The average drag coefficient is 0.002. The drag force computations assume that the entire pond surface is covered with ice and the the entire thrust force is transmitted to the pumphouse, with a frontal contact width of 31.5 ft. The wind drag forces on the retention pond outlet structure are based on a contact with 7 ft. of concrete at the normal operating water level of 836 ft.

The actual wind drag forces exerted on the pumphouse and outlet structure due to a 40 mph wind acting on a two foot thick layer of ice are 24 and 99 lbs/ft, respectively. The Callaway FSAR Site Addendum describes the method by which the wind induced ice force is combined with other forces to determine the structure section strength required to resist design loads. This information is in Section 3.8.4.3.1 and Table 3.8-2. Because the magnitude of the wind induced ice force is very small compared to the other forces, more severe wind conditions were not evaluated.

The effect of impact forces on the pumphouse and outlet structure due to wind driven ice or ice sheets has never been considered as a design basis. However, the pumphouse and outlet structures have been designed for natural phenomena that produced more severe effects than wind driven ice, i.e., SSE, tornado, missiles, etc. The design of these structures is conservative with respect to the SSE and tornado missiles and therefore is expected to withstand the effects of the wind driven ice.

REFERENCES:

1. Schlicting, H., "Boundary Layer Theory," McGraw Hill Book Company, 1968.

2. Vennard, J.K., "Elementary Fluid Mechanics," John Wiley and Sons, Inc., 1961.

ITEM 240.6C: Provide additional details regarding the determination of the probable maximum wind for determination of wave action on the UHS retention pond. Describe the origin of the data used in the analysis and show the maximum likelihood frequency estimate and 95% confidence interval. Discuss the effect of recent regional windspeed data (collected since Thom's report) on the frequency estimate.

RESPONSE: The probable maximum wind was determined based on the method of Thom (1968). Thom used meteorological data collected over a 21-year period from 150 monitoring stations to provide isotachs of the 0.50, 0.10, 0.04, 0.02, and 0.01 quantiles for the annual extreme fastest wind speed for the United States. Thom then provided an empirical method to use these data to determine the fastest wind speed for other quantiles at any U.S. location. This method was used to determine the fastest wind speed likely to occur at the 0.001 quantile; the 1000-year mean recurrence interval.

The data provided by Thom do not allow the calculation of the 95 percent confidence interval for estimates of wind speed at this quantile.

Since Thom's isotach's and statistics are based on a specific 21-year data base, more recent data cannot be taken into account, except as a comparison of actual extreme speeds with those predicted by Thom.

As an example, the fastest mile wind speed recorded by the National Weather Service station at Columbia, Missouri from August 1889 through 1979 (a 90-year period) was 63 miles per hour. This compares with values determined from Thom's method of 72 miles per hour (50-year recurrence interval) and 85 miles per hour (100-year recurrence interval).

REFERENCES:

Thom, H.C.S., 1968, New distribution of extreme winds in the United Stated, in Journal of structural division. Proceedings of the American Society of Civil Engineers, vol. 94, no. st. 7 (July).

U.S. Department of Commerce, 1979, Local climatological data, annual summaries for 1979. National Oceanic and Atmospheric Administration, Asheville, North Carolina.

ITEM 240.7C: a) Provide details of your transient analyses of temperature and water supply for the UHS cooling tower system during the critical 30-day period as discussed in Position 1 of Regulatory Guide 1.27.

b) Discuss a pre-operational testing program and the analysis of the resulting data to be used to verify the conservation of estimates made in response to part a) above.

RESPONSE: a) The following details of the UHS transient analysis supplement the information provided or referenced in Table 9.2-5:

1. Power block heat rejection rates and emergency make-up water requirements are provided in Standard Plant Section 9.2.5, including Tables 9.2-17 and 9.2-18 and Figures 9.2-6 through 9.2-11.

2. Meteorological data are discussed in Table 9.2-5.

3. Cooling tower performance data are provided in Table 9.2-4.

4. Transient analysis conservatism and design allowances for water inventory are discussed in Section 9.2.5.2.2. These design allowances are based on the original retention pond transient analysis. Since that time, it has been determined that the UHS cooling tower is designed to maintain 95 F cold water temperature with 81 F entering wet bulb temperature rather than 81 F ambient wet bulb temperature as committed to in the PSAR. The manufacturer estimates that under worst case conditions tower recirculation (increase in inlet air temperature) will not exceed 4 F, and cold water temperature with 81 F ambient (85 F entering) wet bulb temperature will not exceed 97.4 F. This represents a cold water elevation of 2.4 F. However, the following conservatisms in the original analysis support the overall design bases for the UHS.

   a. The minimum heat transfer analysis produced a maximum pond outlet temperature of 89.5 F. Indicating a 5.5 F margin between ESW design temperature of 95 F.

b. The original tower analysis assumes a constant 95 F pond outlet temperature throughout the 30 day period for establishing cooling tower inlet temperatures. This represents a margin of 6 F to 19 F throughout the 30 day period. The range of 6 F to 19 F is based on calculated pond outlet temperature from the original analysis.

c. Cooling tower evaporation loss and discharge water temperatures were calculated considering both units in LOCA.

d. The original analysis indicated a 25 percent margin in UHS retention pond volume.

e. Wind speeds during the minimum heat transfer periods average less than 5 MPH (never exceeding 7.5MPH). This indicates elevation of entering temperature due to recirculation effects will be less than the manufacturer's estimate of 4 F with 10 MPH cross wind.

A final analysis incorporating updated cooling tower performance and power block heat loads will be performed. Based on the above reasons, it is expected that this analysis will indicate a significant margin on UHS volume. The methodology for the final analysis will be available in September 1981.

b) The UHS cooling tower system performance test data will be utilized to verify the conservatism of the information used as the basis for the final transient analysis. Details for the test are under preparation and will be included in the test abstracts for the system (Chapter 14.0 of the Power Block FSAR). The abstracts will be available in September 1981.

ITEM 240.8C: Discuss provisions to replace make-up water in the UHS retention pond in the event that the Missouri River intake and pumping system should remain inoperable after 30 days.

RESPONSE: Section 9.2.5.3 has been revised to describe provisions for trucking in make-up water should the Missouri River intake and pumping system remain inoperable after 30 days.

Regulatory Guide 1.27 of the single failure of man-made structural features does not apply. The UHS pond is designed to withstand the most severe natural phenomena expected. See Section 2.4.3 for coincident wind wave activity and Section 2.4.5 for surge and seiche sources. Slope stability is discussed in Section 2.5.5. The UHS pond is so located that its function is not to be affected by postulated accidents incurred by traffic on the plant railroad or vehicle access road or other site-related events.

The nearest nonseismic Category I structure to the seismic Category I ultimate heat sink cooling towers is the fire pumphouse and portable water plant located approximately 90 feet northeast of the unit one tower, as shown in Figure 1.2-1. A postulated structural failure of this nonseismic Category I building would not impose a hazard to the cooling towers since the tower enclosures are designed as tornado-resistant structures.

Conformance with Regulatory Guide 1.27 is tabulated in Table 9.2-5. A single failure analysis for the UHS is contained in Table 9.2-6.

SAFETY EVALUATION THREE - The UHS retention pond normal capacity is 55.35 acre-feet. Less than 44 acre-feet are needed for 30 days of makeup water for the two units conservatively assumed to be experiencing a LOCA Under maximum evaporation conditions for this period. The total pond water volume remaining after 30 days is 11.8 acre-feet. The usable portion of this volume is 10.7 acre-feet, which is above the ESWS pumphouse forebay sill. This margin is 25 percent of the total water volume requirement. Adequate submergence is provided for the ESW pumps when the retention pond is at the minimum water level.

In the event normal plant facilities are not in operation within 30 days (plus the number of days for depleting the 25 percent margin in the UHS pond) after an emergency shutdown, approximately 22 acre-feet of water are available from the water treatment plant clarifiers. This water can be pumped into the UHS retention pond by portable pumps for UHS heat dissipation purposes. In the event the clarifiers have been damaged, water will be trucked from offsite. An adequate number of 40,000 to 45,000 pound capacity bulk liquid carriers are available in the metropolitan area. These trucks would be mobilized to obtain water from Fulton (10 miles), Jefferson City (25 miles), or Columbia (32 miles). In the extremely unlikely event water would not be available from any of the above cities, portable pumps will be obtained and water can be pumped from the Missouri River (6 miles) to fill the trucks.

9.2.5.4 Testing and Inspections

The UHS is designed to include the capability for testing through the full operational sequence that brings the system into operation for reactor shutdown and for loss-of-coolant accidents, including

ITEM 240.9C: State whether any pemanent underdrain or ground water dewatering systems are installed, being constructed or planned at the plant site. If so, provide the information called for in Branch Technical Position HMB/GSB-1, "Safety-Related Permanent Dewatering Systems."

RESPONSE: As discussed in Section 2.4.13.5 and Section 3.4, the normal water table at the plant site is 10 to 30 feet below grade and all the safety-related structures are designed for full hydrostatic loading to El, 840 ft. MSL (Standard Plant Elevation 1999.5 ft.) which is the plant grade. No permanent underdrain or gound water dewatering systems are installed or planned at the site.