AmerenUE
Callaway Plant

PO Box 620
Fulton, MO 65251

March 12, 2008

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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Washington, DC 20555-0001

Ladies and Gentlemen: ULNRC-05484

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION REGARDING PROPOSED REVISION TO TECHNICAL SPECIFICATION 3.8.3, "DIESEL FUEL OIL, LUBE OIL, AND STARTING AIR"

Reference 1: AmerenUE Letter ULNRC-05379, "Proposed Revision to Technical Specification 3.8.3, 'Diesel Fuel Oil, Lube Oil, and Starting Air'," dated August 20, 2007

By letter dated August 20, 2007 (Reference 1) and pursuant to 10 CFR 50.90 AmerenUE (Union Electric Company) submitted a license amendment request (LAR) to incorporate proposed changes to Technical Specification (TS) 3.8.3, "Diesel Fuel Oil, Lube Oil, and Starting Air," which specifies requirements for the diesel fuel oil storage tanks associated with the standby emergency diesel generators (EDGs) at Callaway Plant. Specifically, AmerenUE proposed an increase in the minimum fuel oil volume required to be maintained in the EDG storage tanks during applicable operating conditions. Supporting information was provided in accordance with 10 CFR 50.90.

From its ongoing review of this proposed revision to TS 3.8.3, the NRC staff has transmitted a request for additional information (RAI) containing several individual questions/requests for which responses from AmerenUE are needed in order to support completion of the NRC's review. Accordingly, this letter provides AmerenUE's response to the NRC's RAI in Attachment 1. Within the attachment, each of the individual questions/requests contained in the associated RAI is stated and immediately followed with AmerenUE's response. Text from the NRC's RAI is shown in italics.

Responding to the NRC's RAI requires no changes to be made to the proposed changes for TS 3.8.3. Further, the response to the NRC's RAI does not change the evaluations provided in the license amendment request, including the determination of no significant hazards consideration.

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NRR

AmerenUE appreciates the NRC staff's continued review of the proposed revision to TS 3.8.3. For any questions regarding the attached information, please contact Scott A. Maglio at 573-676-8719 or Tom Elwood at (573) 676-6479.

I declare under penalty of perjury that the foregoing and attached are true and correct.

Sincerely,

Executed on: March 12, 2008

Mark A. McLachlan
Manager Engineering Services

KRG/nls

Attachments: 1) Responses to NRC RAI Questions Regarding License Amendment Request OL-1271

cc: Mr. Elmo E. Collins, Jr.
Regional Administrator
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-4005

Senior Resident Inspector
Callaway Resident Office
U.S. Nuclear Regulatory Commission
8201 NRC Road
Steedman, MO 65077

Mr. Jack N. Donohew
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop O-8B1
Washington, DC 20555-2738

Mr. Mohan C. Thadani (2 copies)
Licensing Project Manager, Callaway Plant
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop O-8G14
Washington, DC 20555-2738

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Attachment 1 to
ULNRC-05484

RESPONSES TO NRC RAI QUESTIONS
REGARDING LICENSE AMENDMENT REQUEST OL-1271

RESPONSES TO NRC RAI QUESTIONS
REGARDING LICENSE AMENDMENT REQUEST OL-1271

In its letter dated August 20, 2007, Union Electric Company (the licensee) submitted a request to incorporate proposed changes to Technical Specification (TS) 3.8.3, "Diesel Fuel Oil, Lube Oil, and Starting Air," which specifies requirements for the diesel fuel oil storage tanks associated with the standby emergency diesel generators (EDGs) at the facility. As noted in the letter, the proposed changes are to Condition A of TS 3.8.3 and associated Surveillance Requirement (SR) 3.8.3.1 in order to incorporate new values for the minimum fuel oil volume required to be contained in the EDG fuel oil storage tanks. The minimum required fuel oil volume is being revised (increased) to provide conservative margin against potential vortex effects that could otherwise occur during fuel oil transfer pump operation. AmerenUE's request is currently under review by the NRC staff.

To continue the review of AmerenUE's LAR OL-1271, the NRC staff requests the following additional information.

1. *As stated in the application dated August 20, 2007 (ULNRC-05379), for each emergency diesel generator (EDG), fuel oil is transferred from the storage tank to the EDG's day tank by a can-type transfer pump that is submerged in the fuel storage tank. The operating experience report identified a design control issue wherein vortex prevention was not taken into account in the calculation for determining the usable volume in the diesel fuel oil storage tank. The revised calculation identified an additional unusable fuel oil volume of approximately 0.6% to preclude vortex problems. Describe the hydraulic calculation of the vortex problems and explain how the 0.6% unusable fuel oil volume was determined.*

   Response

   The equations in ASME JPGC2001/PWR-19010 were used to determine the required fuel oil transfer pump submergence. The ASME JPGC2001/PWR-19010 paper was commissioned by D.C. Cook Nuclear Plant due to discovery of a scenario where their suction line from the Refueling Water Storage Tank (RWST) could become uncovered.

   The goal of the ASME investigations was to determine the amount of air ingestion that would be expected due to vortexing (when the suction is still submerged) and when the suction is partially uncovered under several different flow conditions. Since the available data at the time of the study were not applicable to these situations, hydraulic testing was conducted using a 1:4 geometric scale model of the RWST and associated pump suction piping. Several water levels and flow rates were tested with the water level both above and below the top of the suction pipe.

During the ASME testing, it was observed that at model flow rates greater than 120 gpm, air entrainment occurred with the water level above the top of the horizontal suction pipe due to the formation of free vortices in the tank. At this flow rate, the Reynolds number and the Weber number exceeded 3×10^4 and 120, respectively. Founded on previously developed generalized techniques for evaluating scale effects on vortex formation, the study concluded that the viscous and surface tension forces were negligible.[1] Based on this, the study concluded that the governing dimensionless parameter is the Froude number.

This conclusion becomes very important when the formulations developed in this paper are applied to Callaway's EDG fuel oil transfer pumps. Clearly, disparities in physical properties exist between the fluid studied in the ASME model (fresh water) and in the fluid pumped by the EDG fuel oil transfer pumps (#2 diesel). The primary differences are in the densities, viscosities, and surface tension. Recalling the conclusion that the viscous and surface tension forces were negligible (i.e., the Reynolds and Weber numbers are not the governing dimensionless parameters), it is reasonable to assume that the results of the study may be utilized for applications using diesel fuel oil as the pumped fluid.

Because geometry is an important consideration when utilizing scale models to analyze fluid flow characteristics, another difference between the ASME JPCG2001/PWR-19010 model and Callaway's fuel oil transfer pump installation needed to be reconciled. The ASME model consisted of a suction line connected to the side of a tank. Callaway's fuel oil transfer pumps' suction is horizontal; however, it is located in an open portion of its tank.

A flush penetration (inside) side suction configuration like that of the ASME model tends to be beneficial in the breakup of free vortices. The vertical portion of the tank wall above the suction line acts like a vortex breaker. When a vortex collides with the side of the tank, it gets disrupted and may break up prior to being pulled into the suction line.

Callaway's fuel oil transfer pumps take suction through a weld neck flange connected directly to the pump inlet. (There are no connections to the flange.) The hub surrounding the inlet of the flange will act in a manner similar to the tank wall described previously.

Another consideration for applying the ASME model to some tank configurations (such as at Callaway) is that for small suction inlet diameters and relatively high flowrates (at runout conditions), the Froude number is higher than the Froude number range studied in ASME JPCG2001/PWR-19010 ($0 \leq Fr \leq 1.40$). For example, Brunswick Nuclear Power Plant applied the results of ASME JPCG2001/PWR-19010

[1] For Reynolds numbers greater than 3×10^4, viscous forces are negligible, and for Weber numbers greater than 120, surface tension forces are negligible. [ASME JPCG2001/PWR-19010]

to a vortex issue associated with their Condensate Storage Tank. For the Condensate Storage Tank vortexing evaluations performed at Brunswick, it was determined that the Froude number range was outside the range specified in the ASME paper. Brunswick's solution was to perform their own scale model testing. The purpose of the testing was not to establish new equations, but instead to validate the existing equations published in the ASME paper for the original range of Froude numbers and to determine their behavior for an expanded range of Froude numbers (Fr > 1.40). Brunswick's testing concluded that the required submergence predicted by the ASME formulations was conservative (i.e., the ASME equations required the suction inlet to be deeper). This conclusion was found to be true for the entire tested range of Froude numbers.

The Brunswick results supported use of the ASME JPGC2001/PWR-19010 methodology in the calculations performed for Callaway's EDG fuel oil storage tanks. Accordingly, Callaway's calculation used pump suction inlet diameter and runout flowrate to calculate the fluid velocity and subsequently the Froude number. The Froude number was then input into the equations developed in ASME JPGC2001/PWR-19010 to determine the required submergence, a dimensionless parameter used to ensure the depth of the suction pipe entrance is sufficient to preclude free vortex formation and ingestion. Using the calculated submergence and the pipe inner diameter, the required fluid depth was determined which, after subtracting the pipe inner diameter, yielded the liquid height required to maintain the new unusable fuel oil volume. This value was then rounded up to 2 inches to incorporate additional conservatism.

Because the Callaway EDG Fuel Oil Storage Tanks are installed at a slight angle, a model was developed wherein incremental cross-sectional volume slices were added to get the total fluid volume of the tanks. (Cross-sectional volumes were determined using fluid level, tank radius, and slice thickness.) In the model the fluid level was increased in $1/10^{th}$ inch increments until the computed transfer pump submergence was at least two inches. The volume at this fluid level represents the new unusable volume of approximately 500 gallons. The increase of the required 7-day fuel oil volume from 80,400 gallons to 80,900 gallons corresponds to an increase of approximately 0.6%.

References:

ASME JPGC2001/PWR-19010
Calculation JE-13 Rev. 0

2. *The formation of surface and subsurface vortices can cause numerous hydraulic problems. If the disturbance continues, the fluid flow will carry the submerged part of the vortex down toward the suction and ultimately into the pump. However, the vortex disturbance may also carry the submerged sludge, water and bio-film from bottom of the tank toward the pump suction. Discuss how fuel oil contamination caused by vortex disturbance is prevented.*

   Response

   The required minimum fuel oil storage volumes contain an unusable volume that provides sufficient submergence of the transfer pump suction nozzle to preclude the formation of surface and subsurface vortices. Therefore, fuel oil contamination due to vortex disturbance is not credible.

   Furthermore, several system features are present to protect the EDGs from contaminated fuel oil:

   - The oil fill connection to the underground storage tank is located above grade and includes a strainer.
   - Duplex basket strainers and duplex oil filters are installed in series on the fuel oil lines from the day tank to the engine.
   - The storage tanks have integral sumps. Each tank is sloped to the sump. Sample lines extend from the sumps to the vaults for periodic bottom sampling and water draw-off.

   References:
   Calculation JE-13 Rev. 0
   FSAR SP Sections 9.5.4.2.1 & 9.5.4.2.2

3. *As stated in the application, the original calculation for the fuel oil storage tank has accounted for net positive suction head with respect to the fuel oil transfer pumps. Address whether the fuel oil storage tank useable fuel volume calculation has considered transfer pump minimum submergence including fuel oil at bottom of the tank that is not draw-able.*

   Response

   The required minimum fuel oil storage volumes contain an unusable volume that accounts for the location of the pump suction nozzle location (9-1/2" above tank bottom), includes an allowance for vortex prevention, and ensures the fluid height necessary to provide the required net positive suction head is available.

   Reference:
   Calculation JE-13 Rev. 0

4. *The application did not address whether outdoor temperature changes were taken into account in the original calculations. For cold weather operation, both pour point and viscosity may affect the capability of the fuel oil transfer from the storage tank to the EDG. Provide information on pour point, cloud point, and viscosity characteristics for the fuel oil transfer calculation during extreme cold ambient temperature conditions.*

Response

FSAR SP Table 9.5.4-3 describes Callaway's compliance with Regulatory Guide 1.137, Fuel-Oil Systems for Standby Diesel Generators. As noted therein, Callaway complies with Section 7.3 of ANSI N195-1976 which states that adequate heating shall be provided for the fuel oil system. Further, assurance is provided that fuel oil can be supplied and ignited at all times under the most severe environmental conditions expected at the facility. This is accomplished by maintenance of the onsite fuel oil above the "Cloud Point" temperature per Callaway Chemistry departmental procedure, CSP-ZZ-07350, Diesel Fuel Oil Testing Program. In addition, prior to addition to the supply tanks, new fuel oil is tested for viscosity (in lieu of cloud point), as stated in FSAR SP Table 9.5.4-3, and per CSP-ZZ-07350, Diesel Fuel Oil Testing Program.

In addition, as described in FSAR SP Section 9.5.4.3, maintenance of the fuel oil temperature is achieved for portions of the system that are above ground by enclosing the equipment in heated buildings and by burial below the frostline for underground portions of the system.

Regardless of the above, however, and as noted in the response to Question 1, the ASME study concluded that the viscous and surface tension forces are negligible in the determination of required submergence for precluding vortex formation. Viscosity was therefore not an input to Callaway's calculation. See the response to Question 1 for a discussion of the ASME study and Callaway's EDG fuel oil storage tank and day tank volume requirements calculation.

Reference:
FSAR SP Table 9.5.4-3 and Section 9.5.4.3
ANSI N195-1976
CSP-ZZ-07350, Diesel Fuel Oil Testing Program
ASME JPGC2001/PWR-19010
Calculation JE-13 Rev. 0