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Subject: Arkansas Nuclear One - Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6
Emergency Cooling Pond Design

Gentlemen:

In a letter dated October 25, 1995, the Nuclear Regulatory Commission requested that Arkansas Nuclear One provide a summary of the design basis of the Emergency Cooling Pond and address certain related issues. The response to that request is attached.

Very truly yours,

Dwight C. Mims

Dwight C. Mims
Director, Nuclear Safety

DCM/tfs

Attachment

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EMERGENCY COOLING POND LICENSING BASIS SUMMARY

ULTIMATE HEAT SINK COMPLEX DESCRIPTION

In accordance with Regulatory Guide 1.27, Rev. 1, "ULTIMATE HEAT SINK FOR NUCLEAR POWER PLANTS," section C.3, Arkansas Nuclear One (ANO) Units 1 and 2 share an Ultimate Heat Sink (UHS) complex consisting of two sources of water, the Dardanelle Reservoir and the Emergency Cooling Pond (ECP). The Dardanelle Reservoir is part of the "Multiple-Purpose Improvement Plan for the Arkansas River" and includes the Arkansas River and the former Illinois Bayou. The area of the Dardanelle Reservoir is 36,000 acres. Its normal pool elevation (336-338 feet) is controlled downstream by the Dardanelle Lock and Dam No. 10 on the Arkansas River for navigation purposes. Appendix 2F of the ANO-1 Preliminary Safety Analysis Report (PSAR) documents that Dardanelle Lock and Dam is capable of withstanding an earthquake of Safe Shutdown Earthquake magnitude (0.2g) without losing its functional integrity.

EMERGENCY COOLING POND PHYSICAL DESCRIPTION

The ECP is a seismic category one, 14-acre, kidney-shaped pond located northwest of the plant. The bottom of the pond is at elevation 341 feet with normal water level between five and six feet. Maximum ECP level of six feet is maintained by a spillway that discharges back to the Dardanelle Reservoir. Plant discharge (ECP inlet) flows into a structure that is surrounded by a 100 foot long weir that peaks at 346 feet. The purpose of the weir is to promote a uniform flow distribution in the ECP and direct the hot discharge to the surface. This maximizes the surface temperature which maximizes heat rejection. The plant intake piping is at the lowest point of the ECP with the pipe centerline at 339.5 feet. The kidney shape of the ECP and the location of supply and return lines at opposite extremes serve to prevent a hydraulic short circuit.

EMERGENCY COOLING POND DESIGN REQUIREMENTS

The ECP serves as a backup to the Dardanelle Reservoir as a source of service water. It must serve this function while satisfying two criteria: 1) the peak service water return temperature must not exceed the maximum temperature tolerable by safety-related equipment, and 2) sufficient inventory must be available to ensure ECP availability for a thirty day period following the ECP Design Basis Accident (DBA) as defined in Regulatory Guide 1.27, Rev. 1. The peak service water return temperature is addressed by an evaluation that calculates the worst-case temperature of the ECP return water (ECP exit) using meteorology data that minimizes the heat rejection capability. The inventory analysis utilizes an evaporative loss estimate based upon meteorology data that maximizes the heat rejection and evaporative loss.

The ECP analysis of record, which is performed consistent with Regulatory Guide 1.27, Rev. 1, section C.1, results in a calculated worst-case transient peak ECP temperature of

120.8°F (or 121°F) and a calculated worst-case inventory adequate to ensure ECP availability for the thirty day period following the event. Changes to the Safety Analysis Report (SAR) to incorporate the results of this analysis have been issued for ANO-1 and are scheduled to be issued with the next revision to the ANO-2 SAR. The ANO-2 SAR currently shows the 129.5°F result of the previous analysis of record.

Performance of certain safeguards equipment is dependent upon the temperature of the cooling water provided by the UHS. This temperature becomes one of the input assumptions for analyses involving the performance of such equipment. Using the approach described in the following discussion, these analyses determine the criteria to be applied in assuring that Loss of Coolant Accident (LOCA) mitigating equipment in the reactor building(ANO-1)/containment(ANO-2) is environmentally qualified to withstand the post-LOCA conditions when the ECP is aligned as the source for cooling water. For ANO-1, the UHS cooling water temperature originally assumed was 85°F (see Figure 6-5 of the ANO-1 Final Safety Analysis Report [FSAR]) based on expected maximum temperature of the water being drawn from the Dardanelle Reservoir. Subsequent operating experience indicated that, on rare occasions, the water drawn from the Dardanelle Reservoir could slightly exceed 90°F. As a result, the analyses were revised to assume 95°F. Regulatory Guide 1.27, Rev. 1, points out in section B (specifically the final paragraph on page 2) that provision must be made to accommodate a single failure that could lead to loss of one of the sources of water in the UHS complex. Included within such single failures, per section C.2.d of Regulatory Guide 1.27, Rev. 1, is a single failure of man-made structural features, e.g., Dardanelle Lock and Dam. Therefore, for analyses involving scenarios where the single failure is the loss of Dardanelle Reservoir, the UHS temperature assumption must conform to the ECP temperatures predicted by the ECP analysis. In addition, the final paragraph of section B of Regulatory Guide 1.27, Rev. 1, states that if UHS capability is lost and "cannot be restored . . . within a reasonable period of time, all units served by the sink be shut down and remain shut down until this capability is restored." Since Dardanelle Reservoir is the operational heat sink during normal operation, its loss would require the units to be shut down anyway. Therefore, the loss of Dardanelle Reservoir must be treated as an initiating event as well as a single failure for other initiating events when it can be identified as the limiting single failure for a specific event. Equipment required to accomplish a safe shutdown of the unit following a loss of Dardanelle Reservoir as an initiating event (vis-à-vis a single failure) must be able to perform its required function given service water temperatures at least equal to the ECP temperature profile over time predicted by the ECP analysis. For both ANO-1 and ANO-2, all equipment required to accomplish a safe shutdown of the unit following a loss of Dardanelle Reservoir as an initiating event has been shown to meet this performance requirement.

SINGLE FAILURE CONSIDERATIONS

With the loss of Dardanelle Reservoir as an initiating event, no additional single failure need be applied. The NRC treatment of failure of the UHS in SECY 77-439 section 3.E (in conjunction with the section 3.E reference to section 3.D) states, "...the staff applies a

limited passive failure as an initiating event for the [ultimate heat sink] system. For this event, no additional single failure is applied to the [Ultimate Heat Sink] System." This is consistent with the later treatment in NUREG-0305 of the failure of a DC power supply as an example of a very low probability initiating event with extensive available recovery time. In this report, the NRC evaluated a scenario that involved the loss of a train of vital DC power as an initiating event followed by a single failure in the other train that would lead to an inability to cool the reactor core. In summary, the NRC concluded that the additional single failure in the other train did not need to be considered because the initiating event was of low probability and considerable time existed for recovery action. Since the failure of the Dardanelle Reservoir is both of low probability and quite slow (at least two hours before a shift to the ECP is required, as stated in section 9.2.1.3 of the SAR), this conclusion can be extrapolated to the ANO UHS as well.

Both SECY 77-439 and NUREG-0305 support the position taken in Regulatory Guide 1.27 Rev. 1, that a failure of one water source (train) of a UHS complex need not be assumed to occur coincident with an additional single failure that might degrade the availability of the other water source. Regulatory Guide 1.27, Rev. 1, section C.2 lists the phenomena, events, and failures that the UHS complex must be capable of withstanding without loss of the sink safety functions. Only item (c) in that list involves combinations of phenomena, events, or failures, and that item is explicitly limited to "[r]easonably probable combinations." In addition, section B of the regulatory guide provides a discussion in the second and third paragraphs on page two making it clear that this approach is intended. The discussion in these paragraphs concludes with the following three sentences that refer to a UHS complex, such as ANO's, "[w]here the sink includes more than one source of water."

> The complex (but not necessarily its individual features) must be capable of withstanding each of the most severe natural phenomena expected, other site-related events, reasonable combinations of natural phenomena and/or site-related events, and a single failure of man-made structural features without loss of capability of the sink to accomplish its safety functions. The most severe phenomena may be considered to occur independently and not simultaneously. In addition, the single failure of man-made structural features need not be considered to occur simultaneously with severe natural phenomena or site-related events.

For accident analyses in general, however, and for the reactor building/containment DBA analysis in particular, a single failure must be assumed in addition to the initiating event as specified in 10CFR50, Appendix A, GDC 38. Because of the large number of single failures that can be postulated, it is both practical and effective to identify the single failure whose consequences bound those of the others and analyze that one instead of analyzing many different scenarios. Therefore, the single failure that should be assumed for the reactor building/containment DBA should be the one that is the worst case, i.e., that results in the most severe consequences.

SINGLE FAILURE CONSIDERATIONS FOR UNIT 1

For equipment in the ANO-1 reactor building, the UHS design requirements described above mean that the environmental qualification temperature should be high enough to bound the temperatures predicted to occur following a reactor building Design Basis Accident (DBA) event given the single failure that results in the worst reactor building conditions. That single failure has been identified as the failure of a train of vital electrical power that disables a train of reactor building cooling, a train of emergency core cooling system injection, and a train of decay heat cooling. The limiting single failure is specifically not failure of Dardanelle Lock and Dam. The failure of the Dardanelle Lock and Dam would not result in consequences as severe as the failure of a single train of vital electrical power. All LOCA-mitigating equipment in the reactor building has been qualified to meet the limiting reactor building conditions; i.e., those predicted to occur following a LOCA with a loss of a train of vital electrical power using cooling water assumptions that bound Dardanelle Reservoir temperatures. This also ensures that the equipment is environmentally qualified to withstand the post-LOCA conditions predicted to occur when the ECP is used for cooling and no other single failure is assumed. This is consistent with the approach described in the ANO letter to Mr. Jose A. Calvo dated April 14, 1989, (1CAN048906).

The regulatory approach to the UHS complex described above is reflected in ANO-1 SAR Table 9-15. The relevant portions of this table are reproduced in Table 1 (page 7 below) along with additional information pertinent to this discussion.

Other aspects of the Unit 1 UHS design also reflect this approach to single failure considerations. The UHS has one discharge line back to the Dardanelle Reservoir from the service water system with one valve to isolate this path. If failure of the Dardanelle Dam and failure of that one valve to isolate system discharge flow are both assumed, all ECP inventory will eventually be transferred via service water system operation to an emptying Dardanelle Reservoir. A similar double failure can be postulated on the discharge path to the ECP (a single valve failing to open) which would prevent alignment of the discharge to the ECP. However, per the requirements of Regulatory Guide 1.27, Rev. 1, as described above, these additional failures need not be postulated. This design was explicitly approved by the Atomic Energy Commission during their review of the ANO-1 FSAR that led to the issuance of the ANO-1 Operating License. As a result, the ANO UHS licensing and design bases are not compatible with the loss of Dardanelle Reservoir and an additional failure.

SINGLE FAILURE CONSIDERATIONS FOR UNIT 2

ANO-2 employs a considerably more conservative approach than that of ANO-1 by effectively assuming two single failures. Although Table 6.4-1 of the ANO-2 PSAR indicates that 85°F was assumed as the cooling water inlet temperature for the containment cooling unit performance post-LOCA and section 9.7.2.3 of the ANO-2 PSAR indicated that the post-DBA ECP temperature was predicted to be 120°F, the

additional Dardanelle Lock and Dam failure was later added to the ANO-2 containment analysis. The Unit 2 containment analysis is performed assuming a failure of the Dardanelle Reservoir simultaneously with a design basis containment event (LOCA or Main Steam Line Break). In addition to the failure of the Dardanelle Reservoir, an additional single failure has been assumed to disable one train of the containment spray system. The Combustion Engineering analysis techniques lead to this being the worst case for peak containment pressure because of the mass contribution of both trains of low pressure safety injection, one of which would not be operating if the single failure was a train of electrical power.

The temperature of 120°F used for determining Unit 2 long-term containment temperature was originally used to approximate the ECP temperature profile when the peak was 129.5°F. This was necessary since the code used to model containment response could not incorporate a variable service water temperature. Since the peak ECP temperature was only above 120°F for a short period of time, this was considered acceptable. This same rationale applies to the use of this value with a peak ECP temperature of 121°F. Consistent with the requirements of 10CFR50.49(k), (i.e., using the NRC Division of Operating Reactors [DOR] guidelines referenced there) the equipment in the Unit 2 containment has been environmentally qualified to "the containment temperature and pressure conditions as a function of time . . . based on the analyses in the FSAR." The analysis thus specified in the DOR guidelines is the containment peak pressure analysis described above, i.e., a DBA consisting of a LOCA with a single failure disabling one train of the containment spray system and an additional failure of the Dardanelle Dam necessitating the use of the worst-case ECP temperature profile. The failure of the Dardanelle Dam is explicitly listed as a single failure in the Unit 2 service water system single failure analysis in SAR Table 9.2-5.

Calculations performed to evaluate the peak containment pressure and temperature for Unit 2 utilize a heat sink temperature of 105°F in lieu of the 120°F used for the long-term containment analysis described previously. This is due to the peak containment pressure and temperature occurring long before the ECP temperature becomes elevated. The temperature of 105°F conservatively bounds the potential initial conditions which could occur because of the ECP temperature limit of 100°F contained in the unit Technical Specifications.

GENERAL

Regulatory Guide 1.27 requires that the UHS be capable of heat removal for a period of thirty days after the initiating event. This is ensured by estimating the worst-case evaporative loss from the ECP, assessing the various inventory demands on the ECP, and comparing that value to the inventory available in the ECP. The ECP inventory analysis includes the effect of evaporative losses, safe shutdown unit condensate requirements, spent fuel pool makeup requirements, sluice gate leakage, system boundary valve leakage, two hours of fire pump usage, the impact on ECP inventory due to transferring service water system discharge and suction from the Dardanelle Reservoir to the ECP, and

seepage. Margins are maintained such that the level thirty days after the start of the event is maintained above the acceptable minimum. The minimum ECP depth for proper hydraulic performance (cooling capability) is computed to be eighteen inches. Operator action is credited, as allowed by Regulatory Guide 1.27, Rev. 1, section C.1.b, in the inventory analysis during the transfer of the service water system to the ECP. Specifically, pump returns are transferred to the ECP shortly after initiation of a loss of Dardanelle Reservoir event, and pump suctions are transferred later in the event depending on pump bay level. In the time frame between the transfer of the returns and suctions to the ECP, water is pumped from the Dardanelle Reservoir into the ECP resulting in an increasing level. This additional water is credited, along with that maintained by Technical Specifications, to ensure a 64.5 inch ECP depth that corresponds to a thirty day supply of cooling water.

The peak ECP temperature analysis is affected in a minor way by the assumed initial ECP level. This analysis uses an initial level of five feet that is consistent with the initial level required by Technical Specifications. The operator action credited in the inventory analysis was included after the calculations were performed which determined the peak ECP temperature and the maximum evaporative loss. Only after these calculations were performed and the inventory issue was fully evaluated was it determined that there would be a need to credit operator action in the inventory analysis. Although the higher level would result in a lower peak temperature, this operator action was not credited in the peak temperature analysis.

CONCLUSIONS

The ANO-2 SAR update to reflect the most recent ECP analyses is in preparation but not yet issued. The ANO-1 SAR sections discussing the most recent ECP analyses are updated and correct. Even though ANO-2 has been shown to be able to maintain safe conditions under double failure conditions, the actual regulatory requirements for both units are that loss of Dardanelle Reservoir must be treated as an initiating event and, when determined to be the most limiting single failure, must be treated as a single failure. Loss of Dardanelle Reservoir need not be treated either as a failure or as an initiating event in conjunction with another independent failure. Equipment in the reactor building/containment is environmentally qualified to withstand the post-LOCA conditions when the ECP is used for cooling. The UHS for ANO is consistent with Regulatory Guide 1.27, Rev. 1, requirements. The design basis temperatures of Dardanelle Reservoir and the ECP have changed since the units were licensed, but the basic UHS requirements have not. There is sufficient capacity in the ECP to respond to postulated accident requirements.

TABLE 1

Mode of Operation	Water Source	Single Failure Assumed for Reactor Building/Containment Analysis
	Unit 1	
Normal	Dardanelle	None required
Shutdown w/loss of Lake	Emergency Cooling Pond	None required
DBA	Dardanelle	Loss of Diesel
	Unit 2	
Normal	Dardanelle	None required
Shutdown w/ loss of Lake	Emergency Cooling Pond	None required
DBA	Emergency Cooling Pond	Loss of one train of Containment Spray