ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

December 10, 1984

ØCAN128401

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Units 1 & 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6
NUREG-0737 Items II.K.2.16 and
II.K.3.25, Reactor Coolant Pump
Seal Integrity Following
Loss of Offsite Power

Gentlemen:

This information is provided in response to your letter dated August 29, 1984 (ØCNAØ88428) pertaining to NUREG-0737 Items II.K.2.16 and II.K.3.25, Reactor Coolant Pump Seal Integrity Following Loss of Offsite Power.

By previous correspondence (1CANØ58Ø14, 1CANØ18202, 2CANØ18306) AP&L has attempted to address the NRC's concerns regarding auto reinitiation of RCP seal cooling following a loss of offsite power event for both ANO-1 and 2. Throughout that correspondence, we maintained that auto reinitiation of seal cooling to the ANO RCP seals is not a safety concern, and that more than sufficient time is available to manually reestablish RCP seal cooling prior to any significant seal damage. Further, we contended that the Byron Jackson (BJ) seals used on the ANO RCPs are not subject to gross failure and leakage due to the lack of seal cooling because of their unique design.

The NRC Safety Evaluation Report (SER) provided in your above referenced letter, indicated that AP&L had not considered the industry's experience in this area and that we had not provided sufficient detail for NRC to concur with our position. In an effort to more clearly substantiate our position and to resolve your concerns, the attachment provided is a consolidation of previously provided information enhanced and expanded in the concerned areas noted in the SER.

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We believe the response, contained in the attachment, more than adequately resolves the areas of concern in the SER and conclusively substantiates our position with regard to our current BJ RCP seal design.

The majority of seal failures which have occurred throughout the industry can be attributed to inadequate seal design and improper maintenance practices. To enhance seal reliability AP&L, along with other BJ seal users, are participating in a program to develop a new more reliable RCP seal. This new seal will be tested for loss of seal cooling prior to use on the ANO RCPs. We have a high degree of confidence that the new seals will be even less sensitive to seal cooling than the current design.

Although we do not believe auto reinitiation of RCP seal cooling is a safety concern for our facility, we have preliminarily evaluated the modifications necessary to effect such. The necessary modifications are substantial both in design and resources, possibly requiring new pumping systems and/or additional diesel generator capacity. Such modifications are subject to being superseded by the resolution of Station Blackout USI-A44, RCP Seals GI-23, and CCW Failures GI-65.

Recognizing that it is the desire of both AP&L and NRC to integrate requirements and modifications to achieve maximum safety improvement with efficient use of resources, it seems prudent to rely on the inherent capability of the ANO BJ seals, at least until such time as these generic issues are consolidated and resolved. This will allow effective use of AP&L resources on more immediate safety issues as well as effecting a thorough and integrated resolution to the generic issues at the appropriate time.

Very truly yours,

J. Ted Enos

J. Ted Enos
Manager, Licensing

JTE:DEJ:sh
Attachment

STATE OF ARKANSAS)
) SS
COUNTY OF PULASKI)

I, J. Ted Enos, being duly sworn, subscribe to and say that I am the Manager, Licensing for Arkansas Power & Light Company; that I have full authority to execute this oath; that I have read the document numbered ØCAN1284Ø1 and know the contents thereof; and that to the best of my knowledge, information and belief the statements in it are true.

J. Ted Enos
J. Ted Enos

SUBSCRIBED AND SWORN TO before me, a Notary Public in and for the County and State above named, this 10th day of December, 1984.

Sharon Kaye Hendrix
Notary Public

My Commission Expires:
9-19-89

ATTACHMENT

AP&L believes one of the most important factors to consider in our response, is the fact that both ANO-1 and 2 utilize Byron Jackson (BJ) Reactor Coolant Pump (RCP) seals. The BJ seal is a balanced hydrodynamic seal, which is considerably different in design and operation from the Westinghouse hydrostatic seal and has several design enhancements not incorporated in the Bingham-Williamette seals.

ANO-1 utilizes a modified three stage seal design which is currently used . most Babcock and Wilcox (B&W) units. During normal pump operation, both seal injection water and intermediate cooling water are utilized for seal cooling. Seal injection water is provided by makeup pumps which are powered from a safety grade bus. This bus receives its power from either offsite or an ssociated diesel generator. The power supply for the intermediate cooling water pump is offsite power.

Seal injection flow provides about 8 gpm of water to each pump seal. About 6.5 gpm of the seal injection water flows down into the reactor coolant system. The remainder of the 8 gpm injection flow (about 1.5 gpm) fills the area below the lower seal. From this point it flows through pressure breakdown orifices into the lower seal cavity, then into the upper seal cavity, and finally into the seal return line. This controlled bleedoff flow provides seal cooling and pressure staging to equalize the pressure drop across each stage of the seal.

When the reactor coolant pump is running there is a recirculation flow of approximately 70 gpm generated by the recirculation impeller. Water from the RCP bowl is circulated through the pump integral heat exchangers where it transfers its heat to the intermediate cooling water (ICW) system. The ICW system then transfers its heat to the service water system. These systems provides cooling for the RCP seals in case of loss of seal injection flow.

ANO-2 uses a BJ four stage seal cartridge design. The seal cartridge consists of four hydrodynamic mechanical seals; three full pressure seals mounted in tandem and a fourth low pressure vapor seal designed to withstand system operating pressure when the pumps are not operating. Controlled bleedoff flow is used to cool the seals and to equalize the pressure drop across the three lower stages.

The seal cartridge assembly is cooled by circulating the controlled bleedoff flow through a coiled tube heat exchanger integral with the pump case cover. The seal coolant recirculation is accomplished by the recirculating impeller located directly below the seal cartridge like that used on the ANO-1 pumps.

Component cooling water (CCW) is used on the secondary side of the coiled tube heat exchanger to carry heat away from the seals. The CCW system is a closed loop system which transfers its heat to the service water system in the CCW system heat exchanger. The CCW pumps are normally supplied from offsite power sources. However, on an extended loss of offsite power, following the sequencing of vital loads onto the diesels, a CCW system pump can be loaded on an emergency diesel generator fed bus.

Following a loss of offsite power on ANO-1 the RCPs trip, and until the operators take appropriate action to restore cooling services there is a loss of both seal injection and ICW. On ANO-2 following a loss of offsite power the RCPs trip and there is a loss of CCW until the operators take steps to reestablish it.

There are several general areas for consideration with respect to a loss of cooling to the pump seals and subsequent restoration. During the time that cooling services are lost, the primary interests are the peak temperatures reached within the seal assembly and the time-temperature history of the transient. These factors are affected by controlled bleedoff flow, the condition of the seal at the time of entry into the transient, and the status of the pump (running or idle). These factors will determine the extent of damage and the performance of the seal.

The second issue is that of restoration of cooling services to the pump. Damage to the seal as a result of thermal shock must be evaluated to assess the probable affects upon both seal leakage integrity and seal life.

First, we will discuss the seal cartridge heatup rate versus time during the loss of cooling and the damage caused by the overheating. Actual plant data pertaining to a loss of cooling services to an idle RCP is limited. This implies that such occurrences are relatively rare. Seal cartridge heatup rate can be heavily affected by the condition of the seal upon entering the transient and the status of the controlled bleedoff. RCS water, supplied at cold leg temperature (of approximately 550°F), will be flowing through the seal cartridge to supply total seal outflow (the sum of controlled bleedoff flow and leakage to atmospheric pressure escaping from the third seal or the fourth stage vapor seal in the case of ANO-2). In addition to the heating load of the outflow water, there will be the natural flow of heat upward through the pump internals from the RCS. If there is substantial outflow, cooling will actually be supplied for a limited period of time by the relatively cold mass of pump components (thermal barrier, seal cover, seal components, etc.).

Although the thermal barrier is substantial with respect to restricting the upward migration of heat through the pump's components, the heat supplied due to substantial outflow will quickly overwhelm its positive benefit. Therefore, the heatup rate of the seal cartridge is largely a function of the outflow rates of seal leakage and controlled bleedoff flow. The total seal outflow (leakage + control bleedoff) for a single stage failure will vary from Ø gpm to about 2.5 gpm. In a properly functioning seal, leakage will be essentially Ø gpm while controlled bleedoff flow will be about 1.0

gpm for an unmodified seal cartridge (like those used on ANO-2) and 1.5 gpm for a fully modified seal cartridge (like those used on ANO-1). Although not normally operated in this condition, both ANO-1 and 2 are allowed to operate with a single stage seal failure. The maximum anticipated total outflow in this condition can conservatively be estimated at 2.5 gpm. Therefore, conservatively without the controlled bleedoff line being isolated, our worst case normal operating situation, in which seal cartridge heatup rates will be at the maximum anticipated level, will occur with outflow of approximately 2.5 gpm. The following analysis is performed using this worst case outflow.

For the Byron Jackson seals in the idle pump condition, no damage is expected to occur due to extended exposure (several hours) at temperatures below 200°F. In addition, thermal shock due to rapid restoration of cooling services is not expected to be severe enough to cause carbide fracture or other damage to seal parts when the temperature is below 200°F .

At seal cartridge temperatures above 200°F, some damage may occur in the upper most seal stage, whose leakage is vented to atmospheric pressure, due to the two-phase flow condition across the sealing face surface. Steam flow erosion of the carbon seal may develop. The extent of erosion will be dependent upon the leakage rate through the affected stage. During both the San Onofre and St. Lucie tests, seal leakage in the form of two-phase mixture across the upper most seal was recorded. In the case of San Onofre the maximum leakage recorded was 0.51 gpm, for St. Lucie the maximum leakage was 0.27 gpm. An examination of the seal following the San Onofre test showed only that the vapor seal rotating face had cracked due to thermal distortions but was still sealing. Also noted were some changes in clearances in some areas of the seal cartridge. None of these conditions would have been severe enough to cause a pump to be shutdown nor would they cause excessive leakage in an idle pump condition. For the St. Lucie test, similar observations were made.

At about 300°F, the elastomers within the seal cartridge will begin to deteriorate in a significant manner over a period of hours. The higher the temperature is above 300°F, the more rapid will be the deterioration. Deterioration of the secondary seal U-cup will be the primary concern as it appears to be the most vulnerable component. Elevated temperatures will weaken the U-cup, resulting in extrusion of U-cup material between the seal sleeve and rotating face body due to the differential pressure forces existing at this sealing surface interface. In addition, exposure to elevated temperatures will cause a hardening of the material. The combined effects of hardening and extrusion will result in a shortening of useful seal life and a possible immediate degradation in sealing performance.

An important data point with respect to the seal performance is the result of the St. Lucie test performed by BJ. This data suggests that if normal staging is maintained on a seal in good condition, the seal leakage integrity will not be compromised and damage will be minimal even for a prolonged loss of cooling (in this case, 39 hours without cooling). Given the peak lower seal temperature reaching 516°F, the damage to the U-cups and the seals themselves during this test was minimal. Similar results would be expected with respect to U-cup performance during such an event for nearly all U-cups, regardless of their age, owing to the large cross-section of material available for extrusion. Based on the test results, it seems to be a reasonable conclusion that the U-cup should not be expected to fail in a manner that compromises leakage integrity for many hours in the idle pump condition without cooling at normal seal stage pressure drops. The exception would be the relatively rare cases where a U-cup has been badly shredded or otherwise mutilated such that it is essentially non-functional prior to transient entry. A U-cup in this condition would be noted as a single stage failure by the operators. Because of procedural restrictions, we would not normally operate with more than a single U-cup failure per seal. Even in this condition, a minimum of two stages in the case of ANO-1 and three in the case of ANO-2, would be available for sealing.

Heat damage to other elastomers within the BJ seal cartridge is judged to be a lower magnitude of concern.

The problem with determining the outcome of an extended high temperature condition in a seal cartridge rests with the condition of the seal upon transient entry. Both ANO-1 and 2, as previously mentioned, are allowed to operate with one seal stage completely failed and some amount of leakage through the remaining stages. In this condition, at least one sealing stage will be carrying a minimum of one-half of RCS pressure rather than one-third, as was the case in the St. Lucie test. If the controlled bleedoff line is closed, a single seal stage may be subjected full system pressure. AP&L has not been able to locate any data to provide a clear basis for elevated temperature U-cup extrusion rates at these higher differential pressures. However, it is not believed that the increased pressure would significantly affect the results. It is worthwhile to note that following a loss of offsite power, control bleedoff is not isolated for either ANO-1 or 2, and therefore, seal staging should not change from its normal operating condition.

The observed condition reported by Byron Jackson for the U-cups in the San Onofre and St. Lucie tests appears to be quite valuable in that the test conditions were quite severe while the reported damage was minimal (only slight extrusion and hardening). Considering these results, it is the professional opinion of knowledgeable individuals with B&W that a seal cartridge operating with a maximum outflow of 2.5 gpm upon entering the loss of cooling transient will not exceed 10 gpm total outflow in less than one hour. B&W believes that this is conservative for the BJ seals and that leakage is not likely to exceed 10 gpm for at least 2 hours, the time frame that the NRC had requested AP&L to address in NUREG 0737. For conservatism AP&L has taken the position that seal cooling should be procedurally restored within one hour following a loss of offsite power.

As a final note in considering the effects of elevated temperatures, there are no parts in the seal cartridge that will be subject to fracture as a result of differential expansion at elevated temperatures. Fractures that have been observed in Titanium carbide rotating face rings are believed to be primarily the result of excessive loading and possible impact loads during operation or thermal shock that may be imposed while operating or in the idle pump condition. Similarly, fractures observed in carbon stationary face rings are believed to be primarily the result of overload or impacting during operation. Fractures of other parts in the seal cartridge assembly are rare.

The effect of thermal shock when cooling is restored to an idle RCS pump is limited. The worst case scenario would occur when a seal stage is subjected to a differential pressure equal to full system pressure and is heated to RCS cold leg temperature (554°F). If it is assumed that while in this condition cold water is introduced rapidly at 40°F (minimum Technical Specification allowable temperature), fracture of the rotating face ring is likely. It is believed that under this condition, several fractures may occur. However, operating experience has shown that leakage integrity is not significantly affected by fractures in the Titanium carbide rings. Many instances have occurred where carbide rings were broken into several pieces and continued to operate with only slight increases in seal leakage through the affected stage (usually 0.2 to 0.4 gpm).

The Byron Jackson seals can operate in a satisfactory manner with broken Titanium carbide rotating face rings because a stainless steel lock ring is incorporated in the design such that the rotating face ring is effectively captured. The lock ring acting in conjunction with the differential pressure acting upon the ring has been demonstrated to hold the pieces together sufficiently to limit leakage. It is believed, however, that the discontinuities at the fracture locations may form slightly raised cutting edges that will accelerate the wear rate of the carbon stationary face sealing nose. Thus, carbide fractures are likely to significantly shorten seal operating life but are unlikely to significantly affect seal leakage.

Based on the above discussion, acceptable results can conservatively be obtained by providing procedures which will reasonably assure seal cooling is reestablished within one hour following a loss of offsite power event. Procedures for this purpose currently exist for both ANO-1 and 2.

Reestablishment of seal cooling following a loss of offsite power event is addressed in the ANO-1 Emergency Operating Procedure (Procedure 1202.01). The third objective addressed for the degraded power condition is to "restart a makeup pump and establish RCP seal injection and pressurizer level control." The specific steps for this action, as identified in the procedure, are as follows:

> The makeup pump will not automatically restart, unless it has an ES signal. To start a makeup pump and establish seal injection and pressurizer level control:
>
> A) Place the pressurizer level control in HAND and close.
>
> B) Place the seal injection control valve in HAND and close.

C) Start the operating or standby makeup pump (Start oil pump first).

D) Open the seal injection isolation valve (CV-1206). While CV-1206 is opening, slowly open the seal injection control valve CV-1207 and adjust for 32 GPM then place in AUTO. (CV-1206 will auto close if total flow is less than 22 gpm.)

Based on simulator training experience this step is usually accomplished within the first 15 minutes following the loss of offsite power event.

ANO-1 operator training stresses the importance of reestablishing seal cooling and discusses the techniques for accomplishing this step. AP&L is, therefore, confident that seal cooling will be reestablished within one hour and that the seals will not degrade substantially during this time.

The reestablishment of seal cooling following a loss of offsite power event is currently discussed in ANO-2 Emergency Operating Procedure "Degraded Power." This procedure will be superseded, however, following the March 1985 refueling outage with the new ANO-2 EOP. Therefore, for the purposes of this discussion we will refer to the actions called for in the draft EOP. The ninth major step of the draft EOP under the Degraded Power Section is to "restore RCS support systems as required." Although there appear to be a number of steps preceding the reestablishment of seal cooling in the ANO-2 EOP, as compared to the ANO-1 EOP, part of this can be attributed to the more detailed writing style of the ANO-2 procedure. Although the ANO-2 EOP has yet to be used, it is anticipated that seal cooling will be established by the operators within one hour following the loss of offsite power event. The detailed steps for reestablishing seal cooling, as they currently exist in the draft EOP, are as follows.

9. Restore RCS support systems, as required.

   A) Loop II CCW

9. <u>IF</u> buses 2A1, 2A2, 2H1 and 2H2 are re-energized from a startup transformer, restore the following systems as required.

   A) Replace Loop II CCW system in service as follows:

      1) Restart Condensate Transfer Pump (2P9A or 2P9B) for CCW Expansion Tank makeup.

      2) Verify a CCW pump is running to provide flow through Loop II CCW.

      3) Verify SW is aligned for CCW heat exchanger cooling.

      4) Monitor Loop II CCW expansion tank level.

B) Instrument Air — B) Restart one Instrument Air Compressor and place Instrument Air System in service.

C) CCW to RCPs — C) Restore CCW flow to RCPs as follows:

1) Close CCW containment return header isolation valve (2CCW-150) located in upper north piping penetration room).

CAUTION
RCP SEALS SHOULD BE COOLED SLOWLY TO PREVENT DAMAGE TO THE SEALS.

2) Open CCW containment supply valve, 2CV-5236-1, on 2C17.

3) Slowly open 2CCW-150 to establish a small amount of CCW flow to the RCP seals.

4) Monitor RCP controlled bleedoff and lower seal temperature to establish a slow cooldown rate.

5) When the RCP seal temperatures have stabilized, fully open 2CCW-150.

As was the case for ANO-1, the ANO-2 operators have also been trained on the importance of reestablishing seal cooling and on the techniques to do so.

It should be noted that if only one emergency diesel generator is available following a loss of offsite power, the CCW pump will not be started until the other diesel is available or offsite power is restored. This action is required to avoid an under voltage condition which could adversely affect safety related systems. This same restriction would be in effect if the CCW pump was auto loaded.

In the NRC's August 29, 1984 SER, the following was stated:

"The licensees did not describe the information required by the operators to determine that cooling water to the RCP seals was lost; to determine the need for, and effectiveness of, restoring cooling water to the RCP seal coolers; the details of how the current sources of information provide what the operators need to know; and how the information is presented (e.g., annunciated, displayed on the control panels or back panel, provided on a computer printout, etc.).

Further, the licensees did not address the control requirements, including the information necessary to perform and verify the proper control actions for restoring cooling water to the RCP seals. They did not address how the current controls and sources of information provide the operator with control requirements and associated information requirements. No information was submitted outlining the instructions to the operators as documented in the abnormal operating procedures and or the emergency operating procedures. The instructions for obtaining information contained in the operating procedures and those left to operator training and experience were not discussed."

Based on their training the operators would be aware, following a loss of offsite power, that RCP seal cooling would be lost. The procedures as discussed above also identify this fact. In addition, the operators will be made aware of the circumstance through the following alarms and indications.

In the ANO-1 control room, operators are provided with alarms to indicate low seal injection flow, high control bleedoff temperature, high control bleedoff flow, low intermediate cooling water flow, and high or low seal cavity pressures. The ANO-1 operators have control room indications of seal injection flow to each pump, total seal injection flow, control bleedoff flow, control bleedoff temperature and seal cavity pressures for each pump. The operators would use these indications along with pump and valve controls to reestablish seal cooling

In ANO-2 the control room operators are provided with alarms to indicate RCP control bleedoff flow low and high, RCP control bleedoff flow temperature high, and RCP cooling water discharge flow low. The operators have control room indication of CCW flow for each loop, control bleedoff flow, control bleedoff temperature, lower seal cavity temperature, and seal cavity pressures for each pump. The operators would use these indications along with pump and valve controls to reestablish seal cooling.

Appropriate operator actions to be taken to reestablish RCP seal cooling following a loss of offsite power event were discussed in the above described Emergency Operating Procedure. Discussions of these procedural actions are covered in operator training courses.

Further, the SER stated:

"The licensees did not address the general sequences of events that could include a loss of offsite power (and resultant loss of cooling water for the RCP seals) for which reliance on operators is proposed. Nor were there any discussions of the priority of the specific actions required to restore cooling water to the RCP seals relative to all the other actions needed to deal with the occurrence."

The ANO-1 and 2 EOPs were written with the understanding of the importance of reestablishing RCP seal cooling. The time frame in which reestablishing of cooling is necessary, was also considered in the development of the procedures. As was previously stated, we believe that cooling will be reestablished within one hour for both ANO-1 and 2 and that reinitiation of seal cooling within this time frame will lead to acceptable results.

The SER also questioned whether the FSAR LOCA analysis would bound a four pump seal failure. Preliminary discussions with the NSSS vendors indicate that the analyses do bound multi-loop failures of the maximum anticipated magnitude as previously discussed ($\leq$10 gpm). In fact normal make-up is more than sufficient to maintain RCS inventory with a 40 gpm leak. Emergency Core Cooling would not be necessary to mitigate such an event.

The SER also stated:

> "The licensees' justification for relying upon operator action to maintain seal integrity following loss of offsite power (LOOP) did not address operating reactor experiences involving seal failures. These events do not support the licensees' conclusions. Examples of such events are contained in the enclosure sighted."

To address this concern AP&L conducted an investigation of the ten examples cited (examples 9 and 10 of the SER pertain to the same event). To aid us in this effort B&W was contracted to provide input on failures they were familiar with. The following is a discussion of our findings:

Examples 1 and 3 pertain to failures of BJ RCP seals at Davis-Besse. B&W representatives were involved in the investigation of both of these failures. Davis-Besse has never experienced a high outleakage failure of greater than 3 to 4 gpm. Therefore, with respect to a loss of seal integrity with which the NRC is concerned, we would argue that these are not examples of seal failures.

During the disassembly of the Davis-Besse seal package associated with example 1, it was noted that the first stage seal faces were severely damaged, the second stage faces were cracked, and the third stage faces were not damaged. The seal failure was attributed to a loss of offsite power event, which occurred eight days earlier, where the seals were thermally shocked due to the delayed automatic reinitiation of seal cooling. The leakage associated with this event never exceeded 3 to 4 gpm. As was discussed earlier, this situation could have been anticipated. While thermal shock may ultimately degrade a seal, it does not immediately cause gross leakage.

The second Davis-Besse event cited occurred during normal pump operation with seal cooling available. As previously mentioned the leak rate associated with this event never exceeded 4 gpm. As this event occurred during normal seal operation, we fail to see the relationship between it and the performance of a seal following a loss of offsite power event where seal cooling is manually reinitiated.

Example 2 cited by the NRC is the failure of a Westinghouse seal at H. B. Robinson Unit 2. B&W investigated this failure. In this case, the #1 seal (hydrostatic seal stage) had failed and the pump was idle. A decision was made to start the pump. Up to that time, it was the position of Westinghouse that the #2 seal was capable of operating for up to 24 hours with the #1 seal failed. Operation of the pump was continued after it was observed that the #3 seal leakage was in the form of steam. It was B&W's conclusion that the high outleakage failure would not have occurred if the pump had not been started or if it had been shutdown when it became obvious that a significant failure was in progress. Instead, operation continued until the seal failure was complete. As in the previous example seal cooling was available throughout the event. As was previously mentioned there is also a significant difference between the Westinghouse and BJ seal design. Because of these factors we fail see to the relevance of this example.

Example 4 listed by the NRC was the May 1980 failure of a BJ seal at ANO-1. B&W representatives reviewed the operating data surrounding the failure and inspected the seal. The conclusion was that the failure was precipitated by a massive breakup of the third (top) seal stage. Damage to the carbon rings in the lower two sealing stages is believed to have been caused by severe shaft excursions produced by the breakup of the third stage. This failure was totally unrelated to seal cooling, as cooling was available throughout the incident.

Example 5 cited an RCP seal failure at Salem 1. Salem 1 utilizes both Westinghouse RCPs and seals. During a normal plant heat-up with seal cooling in effect, an unexpected gross seal failure occurred which resulted in a total leakage of approximately 15,000 gallons. The failure has been attributed to improper back flushing during seal fill and vent operation. Again, AP&L sees no correlation between this event and the concern expressed in NUREG 0737 pertaining to seal cooling following a loss of offsite power.

Examples 6 and 8 pertain to seal failures which occured at ANO-1. Example 6 pertains to a seal failure which occurred on December 3, 1977. During startup of the plant following an outage the "C" RCP outer seal differential pressure dropped to zero. Visual inspection of the seal showed an approximate 5 to 6 gpm leakage. The apparent cause of the failure was a natural end of life due to plant startups and shutdowns. Example 8 pertains to a seal failure which occurred on August 16, 1976. While at steady-state power operation the "D" RCP seal failed creating an RCS leakage of approximately 25 gpm. The reactor was immediately shutdown and brought to the cold shutdown condition. The cause of this failure was suspected to be improper venting of the seals during installation. The failures identified by examples 6 and 8 both occurred during normal pump operation with seal cooling services available.

Example 7 describes an RCP seal failure which occurred at Indian Point 2, a Westinghouse PWR which utilizes the vendors pumps and seals. During startup, while at two percent power, the reactor tripped. Following the trip one of the RCP seals suddenly failed resulting in an approximate 75 gpm leak rate. This failure occurred during normal pump operation with both seal injection and seal cooling in operation. The failure was thought to have been caused by dirt incursion into the seal.

The NRC failures noted as numbers 9 and 10 both pertain to the 1974 failure of a Bingham seal at Oconee unit 2 during hot functional testing. In this case, seal injection was secured to an idle RCP to perform repairs to a leaking seal injection flow control needle valve. The seal became overheated due to the ineffectiveness of the pump's CCW heat exchanger in the idle pump condition. Unlike the BJ pump seals, there was a differential expansion problem in the two stage seal that was installed at that time. The Bingham seals do not have a lock-ring to hold the carbide together in the event of a fracture. Therefore, if the pump is operated during or following a breakup of the Tungsten carbide rotating face ring, a high outleakage failure can be expected to develop. As previously explained the lock-ring incorporated in the BJ seal design prevents this type of incident from occurring.

Example 11 deals with a reactor recirculation pump seal failure which occurred at LaSalle 1. The failure apparently was the result of thermal stresses created by first overheating the seal and then rapidly cooling it. This failure resulted in leakage in excess of 20 gpm. The seals in use at the time of incident were manufactured by Bingham-Williamette. This failure was similar to the Oconee failure described in example 9 in that leakage was attributed to a broken carbide ring. The failure of the carbide ring was most likely due to thermal shock resulting from rapidly increasing cooling water flow to the seals. Since the Bingham seals do not have a lock-ring to hold the carbide together the fracture and subsequent separation of the carbide ring leads to gross seal leakage.

With the exception of the first example, AP&L fails to see the relevance of the events the NRC has cited. The seal failures occurred during normal pump operation with adequate seal cooling being supplied or in the case of examples 9 and 10 the failures were due to a combination of improper operation and a design weakness of the Bingham seal. In our opinion, these examples have nothing in common with a loss of offsite power event, where the RCPs are idle and cooling services to the BJ seal are interrupted.

AP&L has also reviewed available vendor data to determine if there have been other recorded seal failures resulting from a loss of seal cooling to a BJ RCP seal.

From a manual produced for the B&W Technical Conference on Byron Jackson RC Pump Seal Performance, held March 10-11, 1981 in Atlanta, Georgia, it was noted in a summary table of seal replacements for ANO-1, Davis-Besse and Crystal River that only the previously mentioned Davis-Besse event (Example 1) required seal replacement due to a loss of seal cooling. This report failed to identify loss of seal cooling events which did not lead to seal replacement. AP&L was unable to obtain any documentation which identified these events.

On April 14, 1983, Combustion Engineering (CE) made a presentation to the NRC staff on the subject of CE RCP seal design and performance. One of the slides used during the presentation identified loss of seal cooling events at CE operating plants. Identified in this slide were six loss of seal cooling events affecting two plants (identified as plants E and F). Plant E replaced its RCP seals following loss of seal cooling events in 1974 and 1975. This same plant in 1981 had its RCPs remain in hot standby for one hour after loss of seal cooling. The RCPs were restarted following this event with no seal problems identified. Plant F also experienced two loss of seal cooling events after which its seals were replaced. Plant F in 1980 was involved in a natural circulation cooldown because seal cooling could not be restored. It was noted that no loss of seal function occurred during any of these events.

The review of industry data, including the examples cited by the NRC, does not, in our opinion, support the need for automatic reinitiation of seal cooling following a loss of offsite power. In fact we believe it supports the contrary, that is, an idle BJ RCP seal will provide adequate leak protection for many hours following a loss of seal cooling event.

Finally, the SER stated:

> "A staff review of the Interim Reliability Program (IREP) Analysis of ANO-1 (NUREG/CR-2787) has concluded that a dominant sequence which contributes to both core melt frequency and risk is a small loss of coolant accident initiated by reactor coolant pump seal ruptures. This also was not addressed by the licensees."

AP&L did not reference NUREG/CR-2787 because the assumptions used which resulted in RCP seal ruptures being a dominant sequence contributing to core melt frequency were unfounded. The IREP report assumed from AP&L's May 23, 1980, letter for Mr. R. W. Reid (1-050-14) that RCS leakage from an uncooled seal increases from time zero linearly up to 70 gpm, with leakage increasing at a rate of 2/3 gal/min. This assumption was based on AP&L's statement "It is estimated that under the worst condition, leakage from a static pump may reach 5 gpm in thirty minutes and 10 gpm in sixty minutes". AP&L certainly did not intend to imply by this statement that a linear increase in leakage would be expected. The results of the St. Lucie test would tend to indicate that for up to 39 hours seal leakage would only slightly increase.

The IREP report also assumed no makeup capability and no operator action to restore seal cooling. Following a loss of offsite power event at ANO makeup capability will be restored and seal cooling will be procedurally reestablished.

In summary, based on the facts available to us at this time, AP&L does not believe automatic reinitiation of seal cooling following a loss of offsite power event is necessary for the safe operation of the units. AP&L does not believe the lack of seal cooling, during the time it will take to procedurally reestablish it following a loss of offsite power event, will substantially degrade the ANO-1 or 2 RCP seals. Nor do we believe that inappropriate operator actions in reestablishing seal cooling will lead to a gross seal leakage.