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

February 17, 1982

2CAN028206

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Emergency Feedwater System
Evaluation
(File: 2-4415)

Gentlemen:

Your letter dated January 15, 1982, (2CNA018201) requested further information on four items concerning the Emergency Feedwater (EFW) system. We are providing a schedule for response on one item and the requested response on the remaining three items below.

The first item in the enclosure to your above referenced letter requested a Technical Specification (TS) submittal on surveillance of the motor-driven EFW pump. We are currently processing the requested change to our Technical Specification which will include some modifications to the steam driven EFW pump surveillance requirements as well. We currently plan to have the above TS changes finalized for submittal by April 21, 1982.

The next item numbered C.1. requested that AP&L supplement our July 1, 1982, letter (2CAN078101) with the response time for switching the EFW pump suction from the condensate storage tank (CST) to service water, and the adequacy of this to prevent pump damage from possible loss of suction. In response, the ANO-2 CST suction to the EFW pumps has two (2) valves that take 42.3 seconds (to 2P7A) and 49.4 seconds (to 2P7B) to close after a low suction pressure alarm sounds. The service water supply has two (2) valves that take 23.5 seconds (to 2P7A) and 31.5 seconds (to 2P7B) to open after a low suction pressure alarm sounds. Therefore, the slow closing of the CST suction line in relation to the more rapid opening of the service water supply will preclude loss of suction due to the overlapping operation. Also, the CST will contain enough inventory to supply water for a minimum of 42 minutes after the low suction pressure alarm sounds. The above valve stroke times are

A001
S.1

verified by our Inservice Testing program at least every three (3) months. Due to the flow characteristics of the gate valves used in the above applications a partial opening (~20 to 25%) will provide almost 100% flow through the valves so the service water supply is available much earlier than the above stroke time numbers would tend to indicate.

The third request numbered D.1. requested a copy of the report indicating resolution of the problem of recurrence of overspeed trips during startups of the turbine driven EFW pump. This report is included as Attachment "A".

The final request numbered D.3. stated "The staff had previously understood that the EFW steam turbine admission valves are locked open with power removed during normal power operations. The licensee is requested to confirm the present status of these valves and to identify the procedures and/or controls governing the status of these valves." The above understanding is incorrect and we apologize for the misunderstanding. Basically, the EFW steam turbine admission valves are neither locked open nor do they have power removed. Plant procedure 1015.01 "Conduct of Operation" requires that the valve position indicator be checked once per shift to verify the valve is open. Procedures 2203.12 "Annuciator Corrective Action" and 2106.06 "Emergency Feedwater System Operation" define what operator actions are necessary upon annuciater indication of valve closure or upon EFW system operation requiring valve operation. Therefore, AP&L uses administrative control to ensure the EFW steam admission valves remain open and operating procedures define what operator actions are to be taken if valve operation is required or occurs inappropriately.

Very truly yours,

John R. Marshall

John R. Marshall
Manager, Licensing

JRM:LDY:sc
LDY
Attachment

ATTACHMENT A

EFW Overspeed Trip Report

I. Equipment Description

The Emergency Feedwater Pump and Driver are Q components. The subject steam turbine (2K-3) is a single stage, solid wheel, non-condensing, horizontal, split case unit manufactured by the Terry Steam Turbine Company of Windsor, Connecticut. It is rated at 525 H.P. at 3575 R.P.M. It is designed to operate on steam from 1100 psia to 60 psia and to trip at 4470 R.P.M. It is capable of variable speed operation and is equipped with a Woodward Electro-Hydraulic EG Type governor, a mechanical overspeed trip mechanism, and an integral trip-throttle valve. The governor system consists of a Ramp Generator/Signal Converter, an EG-M Control Box, an EG-R Acutator, and a Remote Servo. The Ramp Generator/Signal converter produces a ramping demand signal which is fed to the EG-M Control Box. The EG-M compares demand signal with speed signal and produces an error signal which is fed to the EG-R Actuator. The EG-R receives this electric error signal and converts it to a hydraulic signal which is capable of causing an extension or retraction of the Remote Servo. The EG-R contains an internal gear pump which is driven by the turbine. This gear pump takes suction from the EG-R Auxiliary Sump and produces an output pressure of 325 psig. The EG-R Auxiliary Sump is fed from the turbine driven Tuthill Pump, which also supplies bearing lubrication oil. The Remote Servo acts through mechanical linkage to open or close the plug-venturi type steam governor valve. The governor valve is spring loaded open, so that all turbine starts begin with the governor valve in the full open position. The governor system is designed to produce a full open hydraulic signal upon loss of electric input signal to the EG-R. Although this would most probably produce an overspeed trip, it would allow the Trip and Throttle Valve to be manually throttled in the event a loss of signal to the EG-R. This Emergency Feedwater Pump unit (2P-7A and 2K-3) is required to be operable with the plant in modes 1, 2, or 3 by Technical Specification 3.7.1.2. It is required to respond to an emergency actuation signal within 21.4 seconds per T.S. table 3.3-5.

II. History of Problem

Since the Technical Specifications list as one of the "Limiting Conditions for Operatoin" that both Emergency Feedwater Pumps be operable, any event which produces or demonstrates an inoperable status must be reported to the Nuclear Regulatory Commission by means of a Licensee Event Report, or LER. The first LER was written on the Emergency Feedwater Pump Turbine Driver (2K-3) on 12-28-78 and the most recent LER was written 11-3-80. A total of 19 LER's were written on 2K-3 during this period; 14 of those LER's were the result of turbine overspeed trips. All of these overspeed trips occurred almost immediately following the start signal. Several of

the trips were observed and pertinent parameters recorded and several more were merely observed. In every case, the trip occurred during the initial speed transient. The Governor Valve position was visually observed and also measured and recorded, and was observed either to have never moved during the transient or to have begun to move only at about the same time as the turbine speed reached the overspeed trip set-point. Unsuccessful attempts to start the turbine could usually be followed by successful attempts. The likelihood of producing an overspeed trip with a rapid start was seen to be time related. The longer the time span between successive starts, the greater the likelihood of an overspeed trip. The problems of overspeed trips on Terry Turbines with Woodward Governor Systems was found to be somewhat widespread. Although there are a variety of turbine models with a variety of governor models in service, the problem was seldom found to be present during steady state operation but rather, almost always, during the initial speed transient encountered in a rapid start. The Institute of Nuclear Power Operations, following an industry wide review of LER's, judged the Auxiliary (Emergency) Feedwater System troublesome enough to warrant two day workshops for representatives of both the PWR and BWR industries. The stated intent of these workshops was to improve availability and reliability of the Auxiliary Feedwater System.

III. History of Corrective Actions

In June of 1979, condensate in the steam line feeding the turbine was considered to be a likely cause for the overspeed trips. Steam traps were installed at low points in the line, but the problem persisted. In February of 1980, Art Foster of Woodward Governor was on site. He indicated that the behavior of our turbine sounded identical to that of various other Terry Turbines he had worked with. Mr. Foster said that Terry Turbine had solved this problem for many people with their Design Improvement #6 (DI#6) which consisted of adding the auxiliary oil sump for the EG-R. An examination of 2K-3 revealed that DI#6 had already been applied. Mr. Foster then recommended we replace the existing EG-R with a large capacity sump. This idea was vetoed by Terry Turbine in a telephone conversation. In April of 1980, AP&L replaced the Remote Servo with a new one from stock. However, the new Servo leaked oil through casting porosities in the body and so was replaced with the old servo, which had had a new oil seal installed. In May of 1980, George Planck of Terry Turbine and Allen Zweig of Woodward Governor arrived on site for what was to be a concerted effort to solve the overspeed trip problem. Mr. Planck checked and replaced lube oil piping, oil and filter were changed, seal water and drain piping were checked. The bearing supply from the EG-R sump was found to be connected to the port for Counter Clockwise rotation (our turbine rotates clockwise) and so was moved to the proper port. Governor Valve linkage was checked and adjusted. The Governor Valve was disassembled and the diametral clearance between plug and venturi throat was increased from .004" to .006". Mr. Zweig examined the Woodward Governor system and found severe corrosion inside the EG-M control box on one of the circuit card pins. The EG-M and the Ramp

Generator/Signal Converter were both replaced with parts which Mr. Zweig had hand carried from the Woodward factory. The EG-R Actuator was replaced with one from our stock after Mr. Zweig changed the gear pump configuration in the new EG-R to make it compatible with our clockwise rotation turbine. The Remote Servo was also replaced at this time.

The turbine was then started once ever four hours. After six successful starts, it tripped on overspeed. Mr Planck and Mr. Zweig had no further recommendations and departed the site. Two days later, AP&L reduced the idle speed setting from 1100 R.P.M. to 800 R.P.M. and delayed the initiation of the ramp signal by six seconds. Also, Governor valve travel was reduced from 7/8" to 5/8". A testing program was begun, initially starting the turbine after one hour, and then doubling the elapsed time between starts for each successive test. The turbine started successfully until the elapsed time between starts reached 48 hours, at which time it tripped on overspeed.

In June of 1980, Mr. Herb Sirois and Mr. Bill Sweeney, both of Terry Turbine arrived on site. They attempted to recalibrate the electronic portion of the Governor and found it impossible. They found that two of the potentiometers showed extreme sensitivity to the slightest vibration. The EG-M Control Box and the Ramp Generator/Signal Converter were replaced with new parts provided by Terry Turbine. A six-channel brush recorder was installed to monitor; A) Governor Valve Position, B) EG-M to EG-R signal, C) Ramp Generator/Signal Converter output signal, D) Limit Switch position. Mr. Sirois and Mr. Sweeney departed the site and AP&L began a new testing program. When the elapsed time between starts reached 48 hours, the turbine tripped on overspeed. Brush recordings showed that EG-M output to EG-R was normal, but there was a time lag between the EG-R receiving a "decrease steam" signal and the Governor Valve being repositioned by the Remote Servo to affect the reduction in steam flow. The greater the elapsed time between starts, the greater was this time lag. Terry Turbine concluded that the EG-R must be at fault. Upon their recommendation, the EG-R was replaced with a new one and new test program was begun. When the elapsed time between starts reached 72 hours, the turbine tripped on overspeed. The test program was restarted and this time the turbine didn't trip until the elapsed time between starts reached 96 hours. Attempts to restart the turbine produced five more overspeed trips before the turbine was started successfully. A third test program was begun at Terry Turbines recommendation. The turbine tripped after 72 hours elapsed time was reached, and then restarted successfully. In September of 1980, AP&L contracted with MPR Associates, Incorporated, of Washington, D.C., to investigate the overspeed trip problem on 2K-3 and make recommendations. Site visits were made by Mr. R. T. Fink and Mr. Will Grant. A meeting took place September 4, 1980, in Little Rock, which was attended by AP&L, Terry, and MPR. At that time Terry Turbine recommended: a) Replace EG-R to Servo Hydraulic Lines, b) Replace EG-R Sump, c) Add Pressure Instrumentation, d) Add sight glass to EG-R Sump, and e) Reroute Bearing Supply from EG-R Sump back to port for CCW

rotation. Possible design modifications which were discussed were: a) Motor-Driven EG-R Actuator, b) Addition of Auxiliary Lube Oil Pump, c) Bypass around Motor Operated Steam Inlet Valve, and d) Replace MOV with throttle valve. Mr. Fink, of MPR Associates, submitted a report to AP&L dated September 24, 1980. In that report, he concluded that "We consider that design modification is required to increase the margin to overspreed trip on startup of the emergency feedwater pump."

He went on to outline four possible design changes.

1) Reduce the number or size of the steam jets in the turbine.
2) Install a motor drive for the hydraulic actuator to make the governor operational sooner in the startup sequence.
3) Install in parallel with the motor-operated isolation valve a steam bypass valve to be opened first, which will limit the initial steam flow.
4) Replace the motor operated valve with a different design valve which will allow throttling of the initial steam flow.

In October of 1980, AP&L originated, approved and installed Design Change Package 80-D-2174. This DCP accomplished the following:

1) Removed and replaced the EG-R sump.
2) Replaced existing .065" wall thickness tubing from EG-R to Remote Servo with .035" wall tubing.
3) Install pressure transducers in the three lines from the EG-R to the Remote Servo and in the supply line to the EG-R sump, to allow monitoring of pressure during a startup.
4) Install a sight glass on the EG-R sump to allow monitoring of oil level in the sump during the between startups.
5) Reroute bearing supply line to the port provided for a CCW rotation turbine. (Ours is CW rotation).

The four transducers were coupled to a six-channel recorder to make permanent records of pressure during a startup. A new testing program was begun. Elapsed time between starts was initially one day. Two tests were run at each elapsed time and then the time was increased. The test program called for an increasing elapsed time between starts until two tests with a one month interval between starts had been completed, at which time the test program would be complete. Recordings were made of all test starts. The slow response of the Governor Valve (Servo) position was no longer noted. The amount of overshoot, which is the highest R.P.M. reached by the turbine during the initial speed transient, was no longer seen to increase as elapsed time increased. At this time, one test start has been successfully completed with an elapsed time of 28 days. The overshoot on this start was 2400 R.P.M. which is considered to be indicatible of a very responsive governor. A total of 22 consecutive starts have been successfully completed with no overspeed trips.