POOR ORIGINAL

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 18 1980

MEMORANDUM FOR: H. R. Denton, Director, NRR
W. J. Dircks, Director, NMSS
T. Murley, Acting Director, RES
V. Stello, Director, IE
R. B. Minogue, Director, SD
H. K. Shapar, Executive Legal Director
J. J. Fouchard, Director, PA
C. Michelson, Director, AEOD

FROM: Norman M. Haller, Director, MPA

SUBJECT: PROPOSED ABNORMAL OCCURRENCE - REACTOR COOLANT PUMP SEAL FAILURE

Enclosed is a draft Commission Paper with a proposed Federal Register Notice in regard to the failure of a reactor coolant pump seal at Arkansas Nuclear One - Unit 1.

The event is under consideration as an abnormal occurrence since it appears to satisfy one of the examples stated in the abnormal occurrence policy statement; major degradation of the primary coolant boundary.

During preparation of the Second Quarter Abnormal Occurrence Report to Congress, AEOD proposed this event as an abnormal occurrence. NRR and IE both previously suggested it be reported as an Appendix C event due to the publicity regarding the gaseous release from containment.

Your review, comments and written (or telephone) concurrence are requested by close of business August 22, 1980. We are processing the event separately and will include it in the Second Quarter Report to Congress if Commission approval is received in time.

If required, MPA will arrange for an informal briefing of the Commission. Suggested participants are IE, NRR, AEOD, and MPA. It is suggested that AEOD take the lead at the briefing.

If you have questions or wish to discuss details, please contact P. Bobe or J. Crooks of my office at 49-27735.

Norman M. Haller, Director, MPA

Enclosure:
Commission Paper

Contact:
P. Bobe/J. Crooks, MPA
49-27735

8009240

134

cc: w/enclosure
W. J. Dircks, EDO
T. A. Rehm, EDO
D. G. Eisenhut, NRR (2)
D. Thompson, IE (2)
R. L. Fonner, ELD
G. C. Gower, IE (5)
L. B. Higginbotham, IE
G. G. Beveridge, NMSS
H. H. Scott, RES
R. E. Alexander, SD
M. A. Taylor, RES
W. T. Russell, NRR
J. Roe, NRR (2)
R. L. O'Connell, NMSS
R. H. Gramann, NMSS
F. Ingram, PA
R. A. Hartfield, MPA
J. L. Crooks, MPA
P. E. Bobe, MPA (3)

NUCLEAR REGULATORY COMMISSION

ABNORMAL OCCURRENCE

REACTOR COOLANT PUMP SEAL FAILURE

Section 208 of the Energy Reorganization Act of 1974, as amended, requires the NRC to disseminate information on abnormal occurrences (i.e., unscheduled incidents or events which the Commission determines are significant from the standpoint of public health and safety). The following incident was determined to be an abnormal occurrence using the criteria published in the Federal Register on February 24, 1977 (42 FR 10950). Appendix A (Example II.A.2) criteria of the Policy Statement notes that major degradation of the primary coolant pressure boundary can be considered an abnormal occurrence. The following description of the event also contains the remedial action taken.

Date and Place - On May 10, 1980, Arkansas Power and Light Company reported that a reactor coolant pump seal had failed at Arkansas Nuclear One - Unit 1,* a pressurized water reactor (PWR), located in Pope County, Arkansas.

Nature and Probable Consequences - The nature of the failure of a reactor coolant pump seal, described below, is a degradation of the primary coolant pressure boundary. This boundary is one of three barriers designed to contain radioactive materials generated by the nuclear reactor - the other two are the fuel cladding and the primary containment boundary. The primary coolant system circulates pressurized cooling water between the nuclear reactor core and steam generators for heat transfer via reactor coolant pumps. Each reactor coolant pump has a Shaft/Seal/System which is to maintain essentially zero reactor coolant leakage. Should seal leakage occur, however, it requires a reactor shutdown when the leak

*A similar incident occurred at the H. B. Robinson plant in May 1975.

rate exceeds 10 gallons per minute. Emergency coolant water makeup is available should small or intermediate sized loss of coolant accidents occur following pipe breaks, valve failures or coolant pump seal failures. Safety systems exist to mitigate the consequences of these and similar malfunctions, but it is desirable to keep the frequency of incidents to as low a level as practical.

The likely consequences of an incident that similarly degrades the primary coolant pressure boundary are (1) loss of primary coolant into containment, and (2) a controlled shutdown of the reactor to a cold shutdown condition. Containment pressure and gaseous radioactivity levels may increase in proportion to conditions existing in the plant prior to and during the incident. If additional failures occur simultaneously due to significant equipment problems or personnel errors, the consequences can increase in severity.

The following sequence of events occurred at Arkansas Nuclear One - Unit 1:

At 0145 on May 10, 1980, while the plant was at approximately 86% full power, Operations personnel were taking Reactor Coolant System (RCS) leak rate data when a step decrease in makeup tank level occurred, indicating an unusual RCS inventory loss. The "C" Reactor Coolant Pump (RCP) seal instrumentation confirmed that a problem existed with the seal or associated piping. Based on this information, power was reduced in preparation for shutdown as required by the license. Due to the observed indications, operations personnel actions were governed by the small break procedure. After 35 minutes, RCS letdown was secured to reduce RCS inventory loss. Extra Operations staff were called in when it was decided to go to Cold Shutdown operation. The NRC Resident Inspector and NRC Headquarters

Maryland were notified of the controlled shutdown. After 62 minutes, the Main Turbine Generator was tripped by the operators. The power reduction initially started at a rate of approximately 5% per minute decrease when the estimated RCS leak rate was 10 to 20 gpm; when the RCS leak rate increased, the load reduction rate was increased to approximately 20 to 30% per minute. The "C" RCP was stopped one minute after the turbine was taken off line with the Reactor still critical. The RCS leak rate than took a step increase to an estimated maximum leak rate of 350 gpm. The "C" RCP lift pumps were started and stopped four times in succession and, after the fourth try, caused a decrease in RCS leak rate. The Reactor was shut down by the operators from approximately 10% full power 3 minutes after the Main Generator shutdown.

In order to maintain pressurizer level and RCS pressure during the subsequent transient, the two additional High Pressure Injection pumps were started, and all High Pressure Injection valves (CV-1219, CV-1220, CV-1227, and CV-1228) were manually opened. The "C" RCP seal return was then isolated to prevent RCS inventory loss through the seal return line, and seal flow was increased to quench the steam/water that was leaking by the failed seal. At this time, operators noted that the Reactor Building pressure had increased from 14.7 psia to 15.2 psia and that radiation levels had increased, confirming that RCS leakage was inside the containment. The operators then put the Reactor Building Emergency Coolers in service to reduce the containment building pressure increase. Shortly thereafter, the operators secured the "A" Reactor Coolant pump and terminated High Pressure Injection. Normal RCS Makeup was established with "A" and "B" Makeup Pumps taking suction from the Borated Water Storage Tank (BWST). The

RCS was then cooled down with a relatively high Reactor Coolant System cooldown rate, and depressurized to minimize pressure on the RCP seals and thus leakage through the seals.

Two and one-half hours after being initially notified, the NRC requested additional information regarding Reactor Coolant System conditions (pressure and temperature), Reactor Building pressure and temperature, and the mode of cooldown. To expedite the RCS depressurization, one person from the Operations staff and one Health Physics technician entered the containment building to energize the Core Flood Tank discharge valves controls, which are required to be locked out in certain operational modes. The two persons were in the Reactor Building for about five minutes. The Health Physics technician received 53 mrem and the operator received 44 mrem exposures, while in general radiation fields of between 400 and 1000 mR per hour.

The State Health Department and the Office of Emergency Services were notified at 0850. The RCS cooldown was essentially complete at 0900 with the Decay Heat Removal Systems in service and all four Reactor Coolant pumps off. The margin to saturation in the RCS hot leg was always maintained greater than 100°F. The total amount of water transferred to the RCS from the DWST was estimated to be 64,000 gallons as of 0900: approximately 25,000 gallons was required for make-up as a result of RCS shrinkage, and about 39,000 gallons collected in the Reactor Building basement during cooldown. Subsequently, 11,000 more gallons were drained from the hot legs to the containment building. Radioactivity levels at the stack and Reactor Auxiliary Building areas were at background levels. There were no personnel injuries or high radiation exposures.

Following NRC approval, the reactor containment building was vented on May 13, 1980. The release was monitored by the EPA, the State of Arkansas, and the licensee. Venting was completed on May 15 and monitoring results detected traces of Xenon-133 that were a small fraction of the regulatory limits. The RCS leakage was reprocessed for use in the RCS.

Cause or Causes

A failure investigation was initiated, which included:

(1) Examination of the failed seal, the three remaining seals, and one spare seal. The findings of this examination were as follows:

(a) The RCP 'C' Seal 3rd stage damage was very severe. The stationary carbon ring was destroyed, the titanium carbide rotating face ring was broken, and the rotating face lock ring was distorted. There was additional related damage. The damage to the 3rd stage seal was too extensive to identify with certainty the initiating cause or failure mode. The failure to the lower two seal stages most probably resulted from damage sustained during shaft excursions produced by the breakup of the upper (3rd) seal stage.

(b) The three remaining seals indicated that high temperature conditions had been experienced.

(2) Review of the seal failure history at Arkansas Nuclear One and other utilities of similar design.

(3) Review of the possible failure mechanisms:

(a) Some types of transients, such as operating with the controlled bleed-off valve shut, can initiate a damaging wear pattern leading to a latent failure.

(b) Inaccurate setting of the seal; specifically axial seal location, could produce abnormal wear, resulting in an increase in total closing force, sealing area, and total horsepower of the seal stage - all leading to failure.

(4) Recommendations to prevent recurrence.

Actions Taken to Prevent Recurrence

Licensee - The licensee replaced the seals on the four Reactor Coolant Pumps at ANO Unit 1. The licensee is working closely with Byron Jackson, the pump manufacturer, and Babcock and Wilcox, the Nuclear Steam System Supplier, on the failure analysis investigations. The problem was reviewed with the plant operators and maintenance personnel. The licensee also relocated the electrical breakers for the Core Flood Tank Discharge Valves outside of the Reactor Containment Building, for ease of access.

NRC - The NRC investigated the various aspects of the incident. The NRC met with the licensee and reviewed the planned corrective actions and the results of the licensee's preliminary analyses. The NRC is continuing with these review efforts. In conjunction, the NRC has been following the various types of seal failures that have occurred on Reactor Coolant Pumps and the industry efforts

related to pump seal development to improve reliability and availability, including efforts to reduce failure modes and frequency.

In addition, the NRC licensing staff is reviewing concerns on large amounts of water collecting in the containment during operational transients and accidents, since useful equipment may become submerged and fail to operate.