REVISED REPORT - PREVIOUS REPORT DATE 7/17/80

NRC FORM 366 (7-77)

U. S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

EXHIBIT A

CONTROL BLOCK: (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1	LICENSEE CODE: A R A N O 1 (2) LICENSE NUMBER: 0 0 - 0 0 0 0 0 - 0 0 (3) LICENSE TYPE: 4 1 1 1 1 (4) CAT (5)
CON'T 0 1	REPORT SOURCE: L (6) DOCKET NUMBER: 0 5 0 0 0 3 1 3 (7) EVENT DATE: 0 5 1 0 8 0 (8) REPORT DATE: 0 4 1 3 8 1 (9)

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 During steady state power operation, the operations staff observed a step

0 3 increase in RCS leak rate, as indicated by an increased rate of change in

0 4 Makeup tank level. Reactor Coolant Pump (RCP) "C" seal instrumentation

0 5 confirmed that a problem existed with the seal or associated piping. The

0 6 unit was brought to cold shutdown condition in an orderly manner per

0 7 T.S. 3.1.6.1 with actions governed by the Small Break procedure. Similar

0 8 to LER 50-313/76-022. Reportable per T.S. 6.12.3.1.C.

	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
0 9	C B (11)	E (12)	B (13)	P U M P X X (14)	B (15)	Z (16)

(17) LER/RO REPORT NUMBER	EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
	8 0	—	0 1 5	/	0 1	X	—	2

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
A (18)	Z (19)	A (20)	A (21)	0 7 1 5	Y (23)	Y (24)	N (25)	B 5 8 0 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0 Following cooldown of the unit, the RCP "C" seal cartridge was replaced.

1 1 The failed cartridge was disassembled and inspected. The root cause of

1 2 the failure could not be determined because the seals were so badly

1 3 damaged as a result of operating the pump for a short time after the

1 4 seals had failed. Seal reliability will be studied on a continuing basis.

	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
1 5	E (28)	0 8 6 (29)	NA	A (31)	Operator Observation

	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
1 6	G (33)	M (34)	2844.7 Curies @ Xe-133	Containment Vent to Atmosphere (Controlled)

PERSONNEL EXPOSURES

	NUMBER	TYPE	DESCRIPTION (39)
1 7	1 0 0 (37)	E (38)	25 Man-Rem

PERSONNEL INJURIES

	NUMBER	DESCRIPTION (41)
1 8	0 0 0 (40)	NA

LOSS OF OR DAMAGE TO FACILITY (43)

	TYPE	DESCRIPTION
1 9	B (42)	Damage to RCP "C" seal

PUBLICITY

	ISSUED	DESCRIPTION (45)	NRC USE ONLY
2 0	Y (44)	News Release, 5/12/80	

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1. Reportable Occurrence Report No. 50-313/80-015/01X-2

2. Report Date: April 13, 1981 3. Occurrence Date: 5/10/80

4. Facility: Arkansas Nuclear One - Unit One
Russellville, Arkansas

5. Identification of Occurrence:

Abnormal degradation discovered in Reactor Coolant System pressure boundary, due to a total reactor coolant leakage rate exceeding 10 GPM, defined by T.S. 3.1.6.1. Reportable per T.S. 6.12.3.1.C.

6. Conditions Prior to Occurrence:

Steady-State Power	X	Reactor Power	2208 MWth
Hot Standby		Net Output	672 MWe
Cold Shutdown		Percent of Full Power	86 %
Refueling Shutdown		Load Changes During Routine Power Operation	
Routine Startup Operation			
Routine Shutdown Operation			

Other (specify)

Operations personnel conducting RCS leak rate calculation at time of occurrence.

7. Description of Occurrence:

At 0145 on May 10, 1980, while at approximately 86% full power, the "C" Reactor Coolant Pump seal on ANO-Unit 1 failed resulting in excessive RCS leakage to the Containment sump. Operations personnel were taking leak rate data when a step decrease in makeup tank level occurred. This was the first indication that an RCS inventory loss had occurred. Reactor Coolant Pump "C" seal instrumentation confirmed that a problem existed with the seal or associated piping. Based on this information, it was decided to initiate a power reduction in preparation for shutdown as required by Technical Specification 3.1.6.1. The system dispatcher was notified of the problem and associated power reduction. At 0220, RCS letdown was secured to reduce RCS inventory loss. Due to the observed symptoms, Operations personnel actions were governed by the small break procedure (O.P. 1202.06, Sect. II). Extra Operations staff were called in at approximately 0225 because it was decided to go to Cold

Shutdown operation. The decision to go to Cold Shutdown operation was made during the power reduction. The resident NRC Inspector was notified at approximately 0227. NRC headquarters in Maryland was also notified of a controlled shutdown at approximately 0227. The Main Turbine Generator was off line at 0247 (approximately 62 minutes after power reduction was initiated). The power reduction initially started at a rate of approximately 5% per minute decrease with an estimated RCS leak rate of 10 to 20 gpm. During the power reduction, the RCS leak rate was observed to be increasing and the load reduction rate was increased to approximately 20 to 30% per minute. The "C" RCP was tripped one minute after the turbine was taken off line with the Reactor still critical. RCS leak rate took a step increase following the "C" RCP being shut off. The "C" RCP lift pumps were started and stopped four times in succession in an attempt to reduce the leak rate. After the fourth lift pump start, a decrease in RCS leak rate was observed. The Reactor was manually tripped from approximately 10% full power three minutes after the Main Generator was off line. In order to maintain pressurizer level and RCS pressure following the Reactor trip, "B" and "C" 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" Reactor Coolant Pump seal return was isolated at 0254 to prevent RCS inventory loss through the seal return line. The Reactor Coolant Pump seal flow was increased to quench the steam/water that was leaking by the failed seal. At this time, it was noted that the Reactor Building pressure had increased from 14.7 psia to 15.2 psia. The increase of building pressure and the associated increase in building radiation levels confirmed that the RCS leakage was inside the containment. At 0256 the Reactor Building Emergency Coolers were put in service to reduce the containment building pressure increase. "A" Reactor Coolant pump was secured at 0301. "C" High Pressure Injection pump was stopped and the High Pressure Injection valves were closed at 0305. This action terminated High Pressure Injection and normal RCS Makeup was established with "A" and "C" Makeup pumps taking suction from the Borated Water Storage Tank (BWST). Due to the relatively high Reactor Coolant System cooldown rate (~75^{o}F/Hr), the operators did not reach the remote controls to bypass the SLBIC System actuation prior to reaching the 600 psi setpoint on the "B" Loop. When SLBIC actuated, the steam driven Emergency Feedwater pump (P-7A) started automatically. The "A" Loop did not reach the SLBIC actuation setpoint at this time. Steam header pressure was controlled by cracking open the Main Steam Isolation valve on the "B" Loop and then closing again. After raising header pressure above 600 psi, the SLBIC function was bypassed; however, the header pressure was increased to approximately 650 psi which reset SLBIC and removed the bypass. Consequently, "A" Loop had SLBIC actuation when steam header pressure was decreased to the 600 psi setpoint. The steam header pressure was again increased and SLBIC reset. This time the SLBIC function was successively bypassed and the header pressure was dropped below the 600 psi setpoint without SLBIC actuation. At approximately 0320, the Emergency Feedwater pump (P-7A) was stopped and the Auxiliary Feedwater pump (P-75) was lined up to feed the steam generators. CV-1220 (HPI Valve to RCS Loop A) was throttled as a makeup path in addition to the normal makeup through CV-1234 and CV-1235. This was performed as flow control was needed until about 1600 psi primary pressure. As RCS pressure was decreased, a containment building entry was made to isolate the Core Flood Tank discharge valves. The entry was required to prevent the Core Flood Tanks from discharging to the RCS as the system pressure is decreased to below the Core Flood Tank pressure of 600 psi. Following the Core Flood Tank isolation, the total decrease in Core Flood Tank levels

were 18 inches on tank "A" and 12 inches on tank "B". The decrease occurred during the time Operations took to isolate the tanks. The RCS cooldown was essentially complete at 0900 on May 10, 1980, with the Decay Heat system in service and all four Reactor Coolant pumps off. Throughout the incident, RCS conditions were maintained such that >100^{o}F margin to saturation was maintained. As a result of the RCP seal failure and subsequent cooldown, it is estimated that approximately 60,000 gallons was collected in the Reactor Building basement. Stack activities and Reactor Auxiliary Building areas remained at background levels. No unusual offsite radiological releases have resulted from the incident. Normal Reactor Building purge operations were performed prior to maintenance activities. There were no personnel injuries or high radiation exposures.

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8. Designation of Apparent Cause of Occurrence:

Design	______	Procedure	______
Manufacture	______	Unusual Service Condition Including Environmental	______
Installation/ Construction	______	Component Failure (See Failure Data)	X
Operator	______		

Other (specify)

Reactor Coolant Pump "C" seal failure. Description of damage: The Upper (3rd) Seal Stage damage was very severe. There was nothing left of the 3rd stage stationary carbon ring. The Titanium Carbide rotating face ring was broken into small pieces of about 1 cubic inch or less. The rotating face lock-ring was distorted and somewhat flattened outward. The upper portion of the shaft sleeve was heavily dented, galled, fretted and grooved. There was also heavy galling and denting in the 3rd seal flange, the stationary face back-up ring, which was still in place, and the rotating face body. The spring assembly was "locked" on the sleeve and took considerable time and effort to remove for further disassembly of the seal. It was also difficult to remove the upper seal flange.

All of the damage to the Lower (1st) Seal Stage assembly, aside from the overheated U-cup, was in the form of stationary carbon ring failure. The carbide (rotating face ring) was intact with only light heat checking. Damage to the carbon appeared to be a general breakup from the ID of the ring with some parts of the ring missing entirely. On one of the larger pieces, part of the face nose remained, suggesting that the wear condition was not severe going into the failure. Some of the broken portions had the slight brown discoloration associated with steam flow through the seal, suggesting that the breaks were not caused by the pounding and generally rough handling that was required to disassemble the seal cartridge.

The Middle (2nd) Seal Stage carbon was in a more severe condition than the Lower Stage. The failure mode appeared to be the same as for the Lower Seal Stage, but the total material remaining would only constitute perhaps 1/3 of the original ring. The 2nd stage carbide did not appear to be broken, however, it was physically locked in a distorted lock-ring and it had sheared the lock-ring drive pins. There was a heavy groove in the shaft sleeve perhaps corresponding to the location of the 2nd stage carbide, which conceivably may have cut the groove. The groove is approximately 1/4 inches high and about 3/16 inches deep. The source of the groove or the cause for distorting the lock-ring and shearing the engagement pins could not be determined.

9. Analysis of Occurrence:

After a thorough examination of the failed seal, it is apparent that the upper stage stationary carbon ring was the initial failure. This ring could have failed in two different modes, each yielding the same ultimate result - the loss of seal stage axial integrity.

The first postulated mode of failure is high wear. The upper carbon could have worn through the "nose" (a raised sealing surface of less total than the body of the carbon) and down into the body. This would increase the total closing force on the seal faces and would not necessarily increase seal leakage or affect the other critical seal parameters until the carbon (which continues to wear at a higher rate) broke apart. This breakup eventually may have caused the grinding up of the carbon into a dust which disappeared with the leaking water. The upper stage springs expanded in an attempt to close the seal faces, but in the absence of the carbon (1" thick) the rotating face moved upward .250". A void was left below the stationary face backup ring and the rotating face of up to .75". While this was taking place, axial shaft vibration vibrated the locking ring from its position upward (the locking ring prevents relative motion between the rotating motion between the rotating face body and the rotating face), allowing the rotating face (titanium carbide) to jam between the shaft sleeve and the upper seal flange causing severe galling of the shaft sleeve and eventually fracturing the rotating face into small pieces which were retained in the upper seal cavity.

The destruction of the upper seal stage would undoubtedly produce shaft excursions great enough to break the carbon rings on the lower two stages and the groove on the middle stage was the beginning of the same scenario that destroyed the upper stage.

The second scenario differs only in the cause of the initial breakup of the upper carbon. This may have been caused by excessive axial movement or improper setting of the seal cartridge, which forced the carbon rings to fail in compression. The upper carbon happened to be the first to break up because one stage is more limiting to excessive axial movement than another as a function of seal component dimensional tolerances within each stage. Once the carbon broke up, the scenario follows the previous one postulated.

As a result of this investigation, it is concluded that the actual cause of failure of the upper stage carbon ring cannot be determined and that the other damage was a direct result of the total failure of this ring.

Operational indications of pump seal performance will be monitored closely for determination of seal condition during plant operation.

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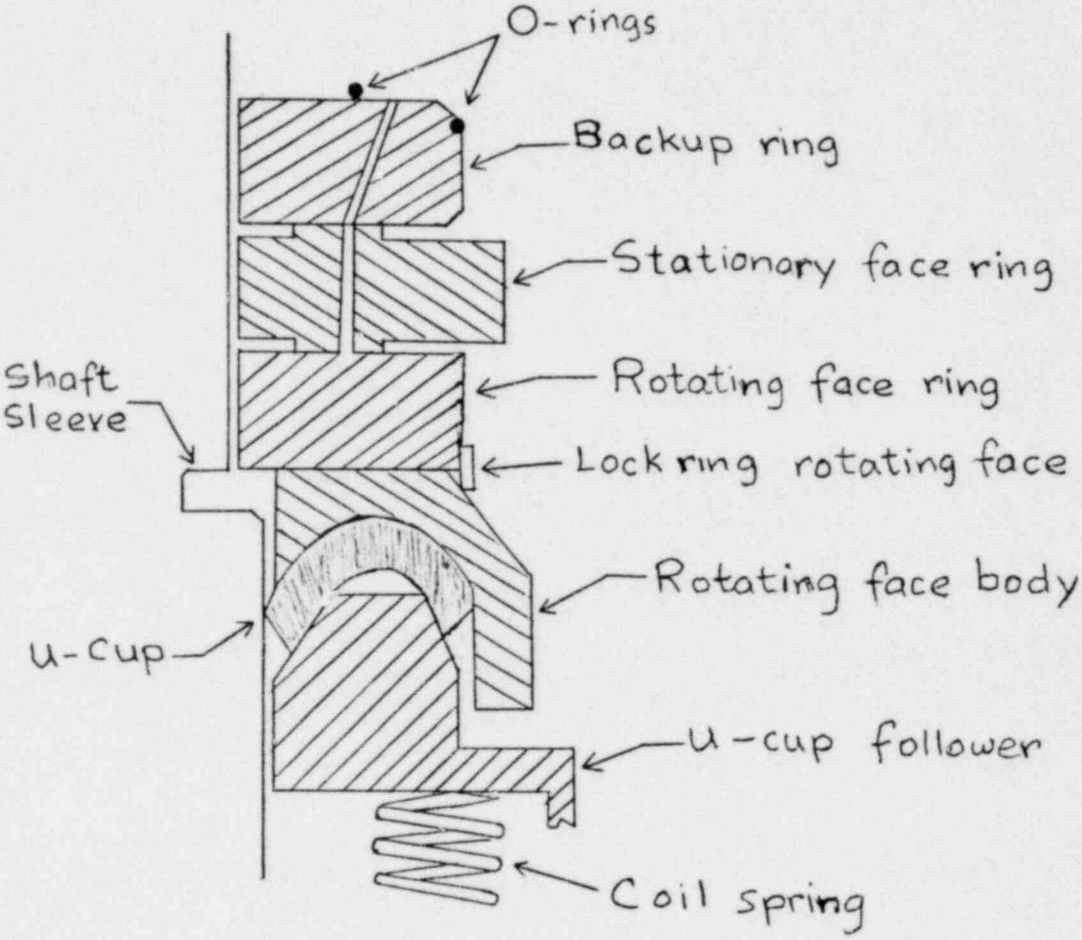

Figure 1

Byron Jackson Pump
Seal Arrangement

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10. Corrective Action:

Following the cooldown of the unit, the RCP "C" seal cartridge was replaced. Due to seal staging pressure variances and/or preventive maintenance, the remaining three Reactor Coolant Pump seal cartridges were replaced.

All Reactor Coolant System (RCS) leakage was reprocessed for reuse in the RCS, thus requiring no liquid releases as a result of the seal failure.

11. Failure Data:

There has been one other report of a seal failure, LER 50-313/76-022, with a leakage rate of approximately 25 GPM.