LICENSEE EVENT REPORT (LER)

Form Rev 2.0

Facility Name (1)	Docket Number (2)	Page (3)
Dresden Nuclear Power Station, Unit 2	0 5 0 0 0 2 3 7	1 of 1 1

Title (4)

Inoperative CRD Hydraulic Control Unit Charging Header Ball Check Valves Due to Procedural Deficiency

Event Date (5)			LER Number (6)				Report Date (7)			Other Facilities Involved (8)	
Month	Day	Year	Year	///	Sequential Number	Revision Number	Month	Day	Year	Facility Names	Docket Number(s)
										N/A	0 5 0 0 0
0 1	3 0	8 9	8 9	---	0 0 6	--- 0 0	0 3	0 1	8 9	N/A	0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (Check one or more of the following) (11)			
N		___ 20.402(b)	___ 20.405(c)	___ 50.73(a)(2)(iv)	___ 73.71(b)
POWER LEVEL (10)	0 0 0	___ 20.405(a)(1)(i)	___ 50.36(c)(1)	___ 50.73(a)(2)(v)	___ 73.71(c)
		___ 20.405(a)(1)(ii)	___ 50.36(c)(2)	___ 50.73(a)(2)(vii)	___ Other (Specify in Abstract below and in Text)
		___ 20.405(a)(1)(iii)	___ 50.73(a)(2)(i)	___ 50.73(a)(2)(viii)(A)	
		___ 20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	___ 50.73(a)(2)(viii)(B)	
		___ 20.405(a)(1)(v)	___ 50.73(a)(2)(iii)	___ 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

Name	TELEPHONE NUMBER AREA CODE
Daniel G. Daly, Technical Staff Engineer Ext. 2347	8 1 5 9 4 2 - 2 9 2 0

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
X	A A	V	G 0 8 0	Y					

SUPPLEMENTAL REPORT EXPECTED (14)		Expected Submission Date (15)	Month	Day	Year
___ Yes (If yes, complete EXPECTED SUBMISSION DATE)	___ X NO				

ABSTRACT (Limit to 1400 spaces, i.e, approximately fifteen single-space typewritten lines) (16)

During a scheduled Unit 2 refueling outage, as part of an In-Service Testing (IST) upgrade program, the Control Rod Drive (CRD) System charging water header ball check valves were leak tested on November 11, 1988. At that time, seven valves failed to meet the check valve leakage acceptance criteria. Subsequently, the valves were flushed with water to improve their performance and retested. Three valves for hydraulic control units (HCUs) E-11, J-10 and N-13 still failed the acceptance criteria. The charging water header ball check valve for HCU N-13 was disassembled at which time it was discovered that the check valve ball was scratched. It was subsequently reassembled with a new ball. The charging water header ball check valves for HCU E-11 and J-10 were also disassembled at which time it was discovered that their check valve balls were missing. Due to a concern that the degraded ball check valves could have resulted in a failure to insert or a slower scram insertion time for the affected CRDs at low reactor pressures, a 10CFR50.72 notification was made at that time. Safety significance was mitigated by the fact that scram insertion times would have been unaffected under normal operating conditions. The cause of the missing check valve balls was determined to be a result of a procedural deficiency since the maintenance procedure did not have a step verifying that the ball was in place during reassembly. Corrective actions include revising the maintenance procedure to include a verification step regarding the ball being in place prior to valve reassembly. This was the first occurrence of missing check valve balls for a CRD charging water header ball check valve at Dresden Station.

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PLANT AND SYSTEM IDENTIFICATION:

General Electric - Boiling Water Reactor - 2527 MWt rated core thermal power.

Nuclear Tracking System (NTS) tracking code numbers are identified in the text as (XXX-XXX-XX-XXXXX).

EVENT IDENTIFICATION:

Control Rod Drive (CRD) [AA] Hydraulic Control Unit (HCU) Charging Water Header Check Valve Ball Missing on Hydraulic Control Units (HCUs) E-11 and J-10 Due to a Procedural Deficiency.

A. CONDITIONS PRIOR TO EVENT:

Unit: 2 Event Date: January 30, 1989 Event Time: 1500 hours

Reactor Mode: N Mode Name: Shutdown Power Level: 0%

Reactor Coolant System (RCS) Pressure: 0 psig

B. DESCRIPTION OF EVENT:

On November 11, 1988, at 0820 hours with Unit 2 in the Shutdown mode the operating CRD pump was manually tripped in accordance with Dresden Operating Surveillance (DOS) 300-3, Cold Shutdown CRD Accumulator Charging Water Check Valve Leak Test. Seven accumulator low pressure alarms annunciated within five minutes after the CRD pump trip, procedurally rendering the charging water header ball check valve inoperable for the following HCUs:

HCU	Time of Alarm	Accumulator Pressure (psig)
*E-11	Just after CRD pump trip	500
*J-10	Just after CRD pump trip	550
J-15	Just after CRD pump trip	580
N-13	Alarm < 1 min.	920
G-7	2 min. < alarm < 3 min.	980
K-3	2 min. < alarm < 3 min.	970
P-8	4 min. < alarm < 5 min.	1000

*Missing charging water header check valve ball.

Annunciation of the accumulator low pressure alarm (1000 psig setpoint) within five minutes is a possible indication of excessive leakage of the charging water header ball check valve, 2-2305-115. See Figure 1.

Approximately 210 minutes after the CRD pump trip, all of the accumulator pressures were inspected locally and three HCUs had significantly lower accumulator pressures (< 700 psig) indicative of slow leakage of water from the CRD accumulators. Consequently the charging water header ball check valves for these three HCUs were also considered "marginal".

CRD	Accumulator Pressure (psig)
C-8	680
F-4	610
G-12	580

On December 26 and 27, 1988, ten HCU charging water header ball check valves, consisting of the seven DOS 300-3 failures plus the three "marginals", were flushed with clean demineralized water in accordance with Special Procedure (SP) 88-12-186, CRD Charging Water Check Valve (115) Flush/Leak Test. This procedure involved individually flushing and testing the charging water header ball check valve for leakage in addition to also testing the scram inlet valve (2-0305-126) for leakage. The procedure was terminated after flushing because at the time the control rod drives were not vented nor coupled to their respective control rods. Since the next step in the procedure was to charge the CRD accumulators it was decided to wait until the CRDs were vented and coupled to their respective control rod blades in order to prevent possible drive damage in the event of an unplanned reactor scram.

On January 6 and 7, 1989, the ten HCUs' charging water header ball check valves and scram inlet valves were tested for leakage in accordance with SP 88-12-186. The testing of the charging water header ball check valve involved isolating the test HCUs, with the accumulator charged, by closing the 2-0305-101, 102, 103, 104, and 113 valves. The charging water header is then depressurized. Individual testing of the charging water header ball check valve for each test HCU is then performed by opening the charging water isolation valve (2-0305-113) and observing the local HCU pressure indicator. The accumulator had to maintain greater than 1000 psig for at least a five minute duration to be considered a successful test. The scram inlet valve test involved closing the charging water isolation valve (2-0305-113) on an unisolated test HCU with the charging water header pressurized and verifying that the local HCU pressure indicator stayed above 1000 psig for at least a five minute duration.

Three HCUs, C-8, G-7 and J-15, passed both leak tests. CRDs F-4, K-3, N-13 and P-8 were evaluated as having leaking 2-0305-115 and 2-0305-113 valves since these accumulators depressurized prior to opening their respective charging water header isolation valve. It was later determined that water leaking past the charging water header isolation valve does not create a sufficient differential pressure across the charging water header ball check valve to adequately seat the ball. Thus, with water leaking past the charging water header isolation valve, the charging water header ball check valve does not prevent the backflow of water. HCU P-8 failed the scram inlet valve leak test with a time of 30 seconds. Its valve stem was eventually lengthened prior to retesting. The remaining three CRD HCUs tested failed the five minute leakage acceptance criteria for the charging water header ball check valve:

CRD	Time (sec)
E-11	3
J-10	10
G-12	240

Because of the leaking charging water header isolation valves and the difficulty of disassembling the charging water header ball check valve, it was decided to flush the ball check valves and reperform the leak test. SP 88-12-186 was started on January 18, 1989. The seven remaining HCUs, E-11, F-4, G-12, J-10, K-3, P-8 and N-13, charging water header ball check valves were flushed with clean demineralized water on January 19, 1989. On January 20, 1989, each charging water header ball check valve for these seven HCUs was leak tested and three of the HCUs failed to meet the acceptance criteria. The three failures are listed below along with the time it took to reach 1000 psig.

CRD	Time (sec)
E-11	6
J-10	7
N-13	199

Six of the seven scram inlet valves passed leakage tests. HCU K-3 took 34 seconds to reach 1000 psig, therefore failing to meet the acceptance criteria.

On January 30, 1989, at 1500 hours with Unit 2 in the Shutdown mode at 0% thermal power, HCUs E-11, J-10 and N-13 had their charging water header ball check valves disassembled. At that time, it was discovered that HCU E-11 and J-10 had no ball in the charging water header ball check valve. HCU N-13 had some scratches on the check valve ball. The three valves were cleaned and a new ball was placed in each of the charging water header ball check valves.

On February 3, 1989, HCUs E-11, J-10 and N-13 passed the charging water header ball check valve leak test per SP 88-12-186. Also, HCU K-3 passed the scram valve inlet leak test on February 10, 1989, after having its valve stem extended. Consequently, all valves passed leak tests prior to the Unit 2 startup following the refueling outage.

C. APPARENT CAUSE OF EVENT:

The discovery of the missing HCU charging water header check valve ball from two HCUs prompted a four hour NRC notification as required by 10CFR50.72(b)(2)(i). This Licensee Event Report is being submitted in accordance with 10CFR50.73(a)(2)(ii)(A).

A new check valve ball was obtained from the Storeroom, and was provided to the Station Chemistry Department for examination. The check valve ball is made of Haynes Stellite Grade 3 alloy. The Commonwealth Edison System Material Analysis Department (SMAD) metallurgy group provided the following breakdown for this particular alloy:

Carbon	2.4%	
Chromium	30.0%	
Tungsten	13.0%	
Cobalt	54.6%	(all are % by weight)

The ball weighed 50.38 grams, meaning that each ball contained approximately 27.5 grams of cobalt. The Commonwealth Edison Corporate Chemistry and Radwaste Group calculated the impact on plant radiochemistry in the event such a ball were to enter the reactor. Assuming complete activation of the cobalt to cobalt-60 (Co-60), the event would yield 31,000 curies (Ci) of Co-60. This relates to a concentration of $\simeq$ 118 μCi/gm Co-60 in the reactor coolant. The normal concentration of Co-60 in reactor coolant, which has remained relatively stable for the past two fuel cycles, ranges from 1×10^{-4} μCi/gm to 1×10^{-3} μCi/gm.

If the ball dissolved evenly over the period of 500 days (approximately one fuel cycle), the Co-60 concentration would increase by $\simeq$ .25 μCi/gm each day (discounting cleanup removal). This is an increase of a factor of 2500. In addition, a sample containing one liter of water at these concentrations would range from four REM for the slow dissolution, to 200 REM for instantaneous injection. These dose rates have never been observed on a reactor coolant sample.

The charging water header ball check valve body is made of 304 stainless steel. If the check valve ball, being made of Haynes Stellite Grade 3 alloy ($\simeq$ 51 to 58 Rc) which is an alloy harder than 304 stainless steel ($\simeq$ 20 Rc) were to fail (break into pieces), it would score/deform the check valve body prior to its failure. The interiors of the charging water header ball check valves were inspected and no score marks/defects were noted.

Because the reactor coolant dose rates have been relatively low and the charging water header ball check valve seat and body were not scored/deformed, it has been concluded the check valve balls did not disintegrate or break apart.

Initial CRD System pre-operational testing did not include testing of the HCU charging water header ball check valves. However, the HCUs were factory built and tested by General Electric prior to shipment. See Figure 2. General Electric has a Quality Control (QC) hold point which specifies a water leakage of < 5 cc/min at 1750 pounds pressure for the charging water header ball check valve. It is therefore unlikely that the HCUs were received without a ball in its charging water ball check valve.

The most plausible reason the check valve balls were missing is because of maintenance performed on the HCUs. The only time the charging water header ball check valve is disassembled is when there is maintenance performed on the ball check valve or when the seat of the scram inlet valve is replaced. HCU E-11 had the charging water header ball check valve disassembled during maintenance on the scram inlet valve on August 27, 1986. Ball check valve internals were inspected for cleanliness during this maintenance. However, the ball must not have been replaced prior to valve reassembly. Documentation identifying when HCU J-10 charging water header ball check valve may have been disassembled has not been located.

The root cause of the missing charging water header check valve ball for HCUs E-11 and J-10 is a result of inadequate procedural controls. Dresden Maintenance Procedure (DMP) 300-18, Control Rod Drive Inlet and Outlet Scram Valve Maintenance, did not address placement or verification of the ball in the charging water header ball check valve.

The cause for scratches on the charging water header check valve ball for HCU N-13 is unknown. The valve internals, other than the ball, showed no apparent defects. The ball check valve passed a leak test after it was cleaned and had a new ball installed.

Two HCUs, K-3 and P-8, had leaking scram inlet valves that may have contributed to their failure of DOS 300-3. However, after flushing the charging water header ball check valves for HCUs G-7, J-15, K-3 and P-8, each passed a leak test. This indicated that a hard foreign substance had preventing proper seating of the ball in the check valve.

D. SAFETY SIGNIFICANCE:

During normal operation the CRD System maintains each CRD scram accumulator charged to approximately 1400 psig to provide an independent source of stored energy to scram the drive should the CRD System pressure be lost. If CRD System pressure is lost, the charging water header ball check valve serves to keep the scram accumulators charged. See Figure 3. When the reactor is at elevated pressures (above 800 psig), the control rods will be able to scram within specifications on reactor pressure alone without assistance from the scram accumulators. When the reactor is at lower pressure, control rod scram performance on reactor pressure alone deteriorates to the point where the control rod may fail to insert without assistance from the scram accumulator. Therefore, during reactor startup, the two HCUs without charging water header check valve balls could have failed to scram if both CRD pumps had become unavailable. At operating reactor pressures (920-1005 psig), loss of a CRD pump and CRD System pressure is not an automatic scram; however, a manual scram is required if greater than eight accumulator trouble lights actuate, or if two accumulator trouble lights occur adjacent to each other.

Commonwealth Edison's Nuclear Fuel Services (NFS) Department performed a series of criticality calculations simulating the situation where the seven HCUs, that failed DOS 300-3 were incapable of being inserted following a scram signal during the previous cycle.

Table 1 provides the results of calculations for core eigenvalue as a function of cycle exposure for the situation where the seven control rods are inoperable and fully withdrawn. Keff is the value of the core's eigenvalue, Kcrit is the eigenvalue generally established as that value where the core is considered critical as modeled by the three-dimensional simulator being used. The third column measures the subcriticality of the core as a function of exposure. From these results it can be concluded that there was adequate margin to criticality at all times. Additionally, the core becomes increasingly subcritical as cycle exposure is accumulated even with the seven control rods inoperable in the fully withdrawn position.

Commonwealth Edison Production Services Department (PSD) also performed a probability risk analysis for assessing the annual probability of inadequate shutdown margin due to CRD charging water header ball check valve failures, taking into account the three HCU accumulators that rapidly discharged when the CRD pump was manually tripped per DOS 300-3. For the purposes of this analysis, a manual scram is assumed if the standby CRD pump cannot be started immediately. The shutdown margin is a concern only if an additional rod face adjacent or diagonally adjacent to one of the three failed rods fails to insert. This analysis takes into account the probabilities of: a trip of the running CRD pump while the reactor is critical and < 800 psig; the failure to recover a CRD pump; an additional rod fails to insert that is face adjacent or diagonally adjacent to one of the failed rods; the additional stuck rod is a high worth rod; and the xenon level is not adequate to achieve shutdown margin. The probability of a CRD System pipe break was considered, but it was negligible compared to the pump trip frequency. The probability of inadequate shutdown margin due to the three immediate CRD charging water header ball check valve failures during DOS 300-3 was calculated at 2.5×10^{-8}.

Due to the widely distributed locations throughout the core of the seven HCUs that had failed DOS 300-3 and the low probability of inadequate shutdown margin due to the three CRD charging water check valve failures (immediate failures of DOS 300-3, including the two check valves without a check valve ball) ocurring, the safety significance of this event is considered minimal.

E. CORRECTIVE ACTIONS:

DMP 300-18 has been revised to include a sign-off step verifying the charging water header check valve ball is in place prior to aligning the valve body and cap for reassembly. The same sign-off step was added for the scram discharge check valve (2-0305-114) which is disassembled when the seat of the scram outlet valve (2-0305-127) is replaced.

A maintenance procedure will be written (237-200-89-02401) for inspecting/rebuilding the charging water header ball check valve. This procedure will include a sign-off step verifying that the check valve ball is in place prior to aligning the valve body and cap for reassembly.

HCUs E-11, J-10 and N-13 had their charging water header ball check valves disassembled, cleaned and had a new check valve ball installed in each valve. The remaining charging water header ball check valves that failed DOS 300-3 were flushed with clean demineralized water and successfully passed a leak test. The scram inlet valve for HCUs K-3 and P-8 had their valve stems extended and satisfactorily passed a leak test. Additionally, the accumulator charging water header isolation valves for HCUs F-4, K-3, N-13 and P-8 previously identified as leaking were overhauled and inspected.

Finally three procedures; Dresden Operating Abnormal (DOA) 300-1, Control Rod Drive System Failure, Dresden Operating Annunciator (DOA) 902(3), B-2 Control Rod Drive Pump Trip, and DOA 902(3)-5 F-2, Charging Water Low Pressure, were revised to manually scram the reactor should any accumulator trouble light illuminate on the full core display when the mode switch is in startup and CRD System pressure is lost and cannot be restored immediately.

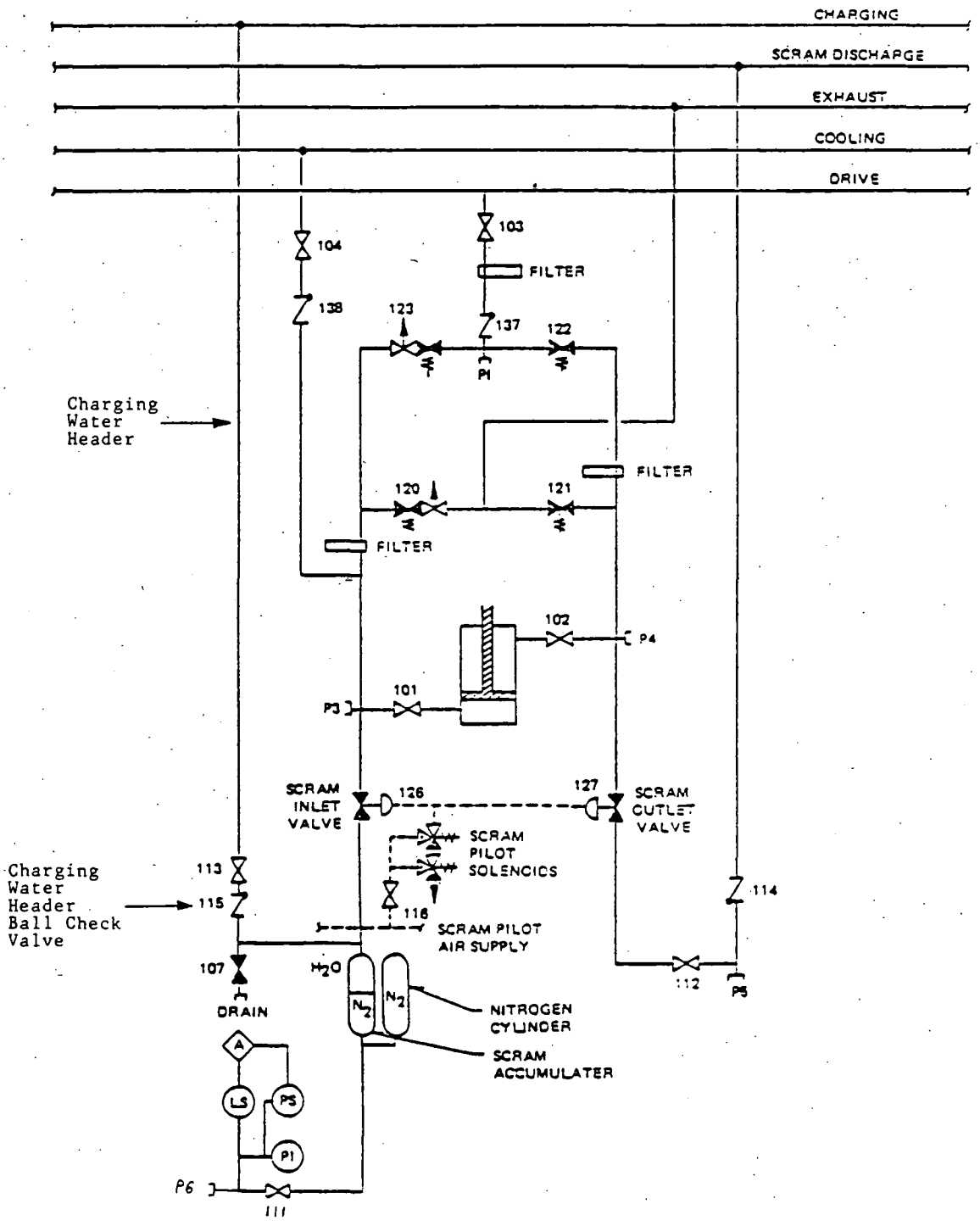
F. PREVIOUS EVENTS:

There have been no previous events where the HCU charging water header ball check valve was found to be missing its ball.

G. COMPONENT FAILURE DATA:

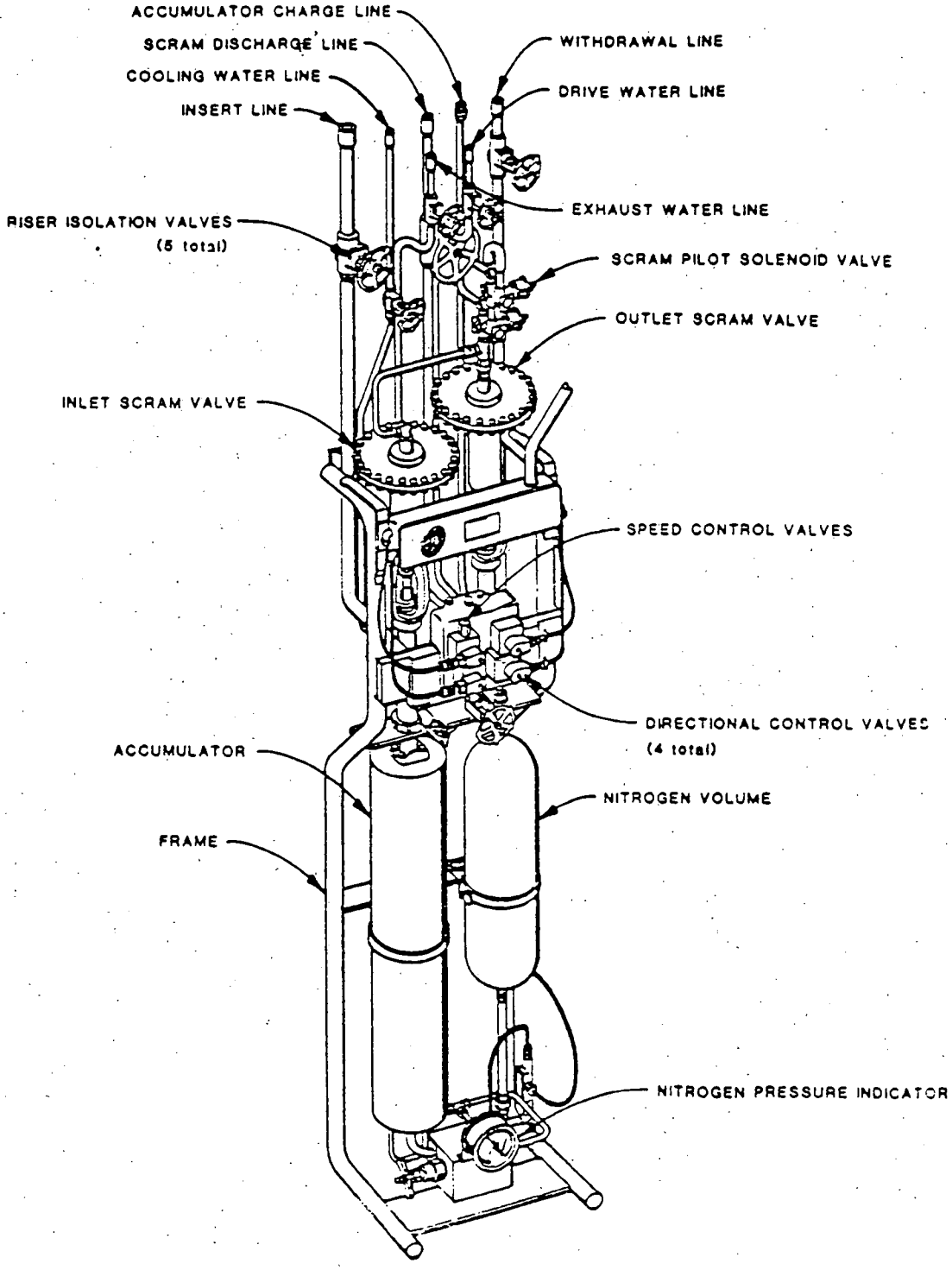
Manufacturer	Nomenclature	Model Number	Mfg. Part Number
General Electric	Ball Check Valve	0305-115	N/A

An industry-wide NPRDS data search was performed for leaking HCU charging water header ball check valves and a total of 45 were found. Most had scratched or worn valve seats. The valve seats for these ball check valves were lapped/reworked with some having the ball replaced. There were two instances where a foreign substance was obstructing proper seating of the ball. There were no reported instances of a missing charging water check valve ball.



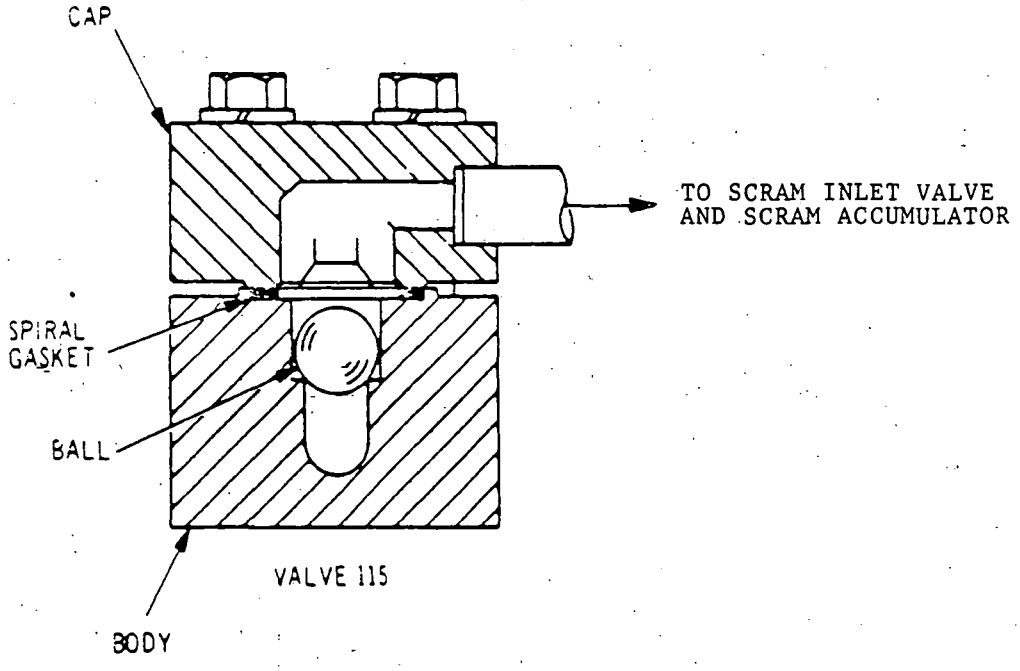
CRD HYDRAULIC PIPING ARRANGEMENT

Figure 1



CRD HYDRAULIC CONTROL UNIT COMPONENTS

Figure 2



CRD CHARGING WATER HEADER BALL CHECK VALVE

Figure 3

Cycle Exposure (MWD/MTU)	Keff	Kcrit	Margin to Criticality (%Δk)
0	0.9848	0.9996	1.48
1000	0.9795	0.9974	1.79
2000	0.9767	0.9952	1.85
3000	0.9734	0.9928	1.94
4000	0.9714	0.9922	2.58
5000	0.9707	0.9914	2.07
6100	0.9708	0.9914	2.06
7525 (LFPC)	0.9676	0.9914	2.38

MWD/MTU - Megawatt Days/Metric Ton Uranium

LFPC - Loss of Full Power Capability

Core Eigenvalues As a Function of Cycle Exposure

for Seven Inoperable Rods Fully Withdrawn

TABLE 1

Commonwealth Edison
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Morris, Illinois 60450
Telephone 815/942-2920

March 1, 1989

EDE LTR #89-174

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Licensee Event Report #89-006-0, Docket #050237 is being submitted as required by Technical Specification 6.6, NUREG 1022 and 10 CFR 50.73(a)(2)(ii)(A).

E.D. Eenigenburg
Station Manager
Dresden Nuclear Power Station

EDE/ade

Enclosure

cc: A. Bert Davis, Regional Administrator, Region III
File/NRC
File/Numerical

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