NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	1 OF 0 9

TITLE (4) Corrosion of PCRV Tendon Wires (Voluntary LER)

EVENT DATE (5) MONTH	DAY	YEAR	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	REPORT DATE (7) MONTH	DAY	YEAR	OTHER FACILITIES INVOLVED (8) FACILITY NAMES	DOCKET NUMBER(S)
DETERMINED 0 3	2 7	8 4	8 4	0 0 5	0 2	1 0	3 0	8 4	N/A	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

[ ] 20.402(b)	[ ] 20.405(c)	[ ] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 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)	[XX] OTHER (Specify in Abstract below and in Text, NRC Form 366A)
[ ] 20.405(a)(1)(iii)	[ ] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	
[ ] 20.405(a)(1)(iv)	[ ] 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	
Jim Eggebroten, Technical Services Engineering Supervisor	3 0 3	7 8 5 - 2 2 2 4

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 B	R P V	W 0 9 4	N					

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
[X] YES (If yes, complete EXPECTED SUBMISSION DATE)	[ ] NO		0 1	2 5	8 5

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

This report supplements the initial LER in which an inservice inspection of the anchor end assemblies of the Prestressed Concrete Reactor Vessel (PCRV) prestressing tendons revealed some individual wire failures in some tendons due to corrosion attack.

| Since then, detailed evaluations and inspections have been performed to assess the severity of tendon wire corrosion. Preliminary results from corrosion analyses have indicated that moisture is a common element and present efforts are concentrating on corrosion prevention, protection, and monitoring methods.

Since the extent of corrosion has been evaluated and determined not to compromise | plant safety, this report is being submitted in the interests of operational information.

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EVENT DESCRIPTION:

The Prestressed Concrete Reactor Vessel (PCRV) utilizes a system consisting of 448 prestressing tendons in two basic configurations consisting of 152 or 169 1/4 inch diameter wires. Each wire terminates at a buttonhead supported by an anchor (buttonhead) washer which seats through a split shim onto a bearing plate on the PCRV surface (see Figure 1). The tendons may be delineated into four different types according to the following table (also see Figure 2).

448 Tendons Total	27 Load Cells
310 Circumferential	17 Load Cells
90 Vertical	6 Load Cells
24 Top Cross Head	2 Load Cells
24 Bottom Cross Head	2 Load Cells

| Note that load cells, designed to detect any significant loss of prestress in the PCRV tendons, are installed on select tendons as noted above.

The tendons maintain the concrete of the PCRV in a continuous state of compression under nominal design loads. Prestress is applied by the individual wires of the various tendons by established strain values determined by the split shim thickness.

While the plant was shutdown for refueling, performance of In-Service Inspection by Maintenance Quality Control personnel indicated that some Prestressed Concrete Reactor Vessel tendons had experienced individual wire failure as evidenced by raised buttonheads on the anchor (buttonhead) washer. Removal of these wire ends indicated failure due to corrosion within approximately 36 inches of the end, just below the anchor washer. No significant corrosion attack beyond this point has been observed on the complete wire samples removed from the tendons to date.

The additional lift-off testing has continued to verify tendon operability on tendons with raised buttonheads, as well as tendons with no apparent failures. Lift-off measures the load applied by individual tendons and verifies that it is above a minimum value based on the original design end-of-life applied tendon load.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

ANALYSIS OF EVENT:

| Corrosion of select wires near the anchor washer ends within the prestressing tendons occurred as a result of moisture and oxygen in the vicinity of the anchor assembly. In addition, the corrosion inhibiting agent was apparently either never applied adequately to some wires or removed at some stage during the fabrication, installation, or operation phase so that conditions favorable to local corrosion attack were present at this location. Corrosion failures were not observed at tendon anchor assemblies (bottom of vertical tendons and top cross-head tendons) where any gravity flow of the corrosion inhibiting grease would tend to protect the wire ends. Most failures were observed near the top anchor assembly of vertical tendons and near the anchor assembly on bottom-head tendons.

Failures of individual wires within tendons would result in a fractional loss of the overall prestress applied by that tendon. Failure of individual wires would not, however, result in increased loads on adjacent wires (hence increased probability of failure of such wires) due to the constant strain method of anchoring (i.e., the relaxation of the concrete from complete removal of applied stress is orders of magnitude lower than the strain change of the wires so that concrete dimensional changes are essentially nil).

Longitudinal (vertical) tendon load levels established by shims at prestressing allowed for losses over the PCRV life due to effects such as concrete shrinkage and wire relaxation. Nominal load for a 169 wire longitudinal tendon at prestressing was 1395 KIPS; the end of life value due to maximum predicted prestress losses is 1116 KIPS. Lift off testing established that all tested tendon loads were well above the design end-of-life load levels, hence fully capable of meeting all design loads determined for the PCRV. Further, the load | cells will detect any significant degradation in a representative sample of the prestressing system. Consequently, this event does not represent an unanalyzed condition that compromises plant safety.

CAUSE DESCRIPTION:

| The results from corrosion analyses indicate that moisture is a common element in the corrosion attack. In some instances, (circumferential and bottom-head tendons) direct flow may have been responsible; in others, original construction practice (vertical tendons) may have allowed condensation to occur prior to establishing uniform elevated vessel temperature, since the vessel was constructed prior to reactor building completion. In addition, split shim assemblies frequently had air gaps allowing communication with the cover air space. Finally, | corrosion-resistant grease coverage apparently was inadequate or removed, where moisture was occasionally observed on the interior of the tendon wire bundle in the vicinity of the buttonhead washer.

CORRECTIVE ACTION:

The examinations to date include the following:

Visual Inspection of Anchor Assemblies

			Tendons With 1 or More Wire Failures
Verticals	89 of 90*	Tophead	
	1 of 90*	Bottomhead	11
Bottom Crossheads	44 of 48*		7
Top Crossheads	4 of 48*		0
Circumferentials	33 of 620*		2

Lift-Off Testing To Verify Design Conditions

NOTE: For verticals, a lift off of one end is adequate for the entire tendon due to low friction. All others must have each end considered individually.

Veriticals	74 of 90*
B-Crossheads	29 of 48
T-Crossheads	2 of 48*
Circumferentials	24 of 620

Detensioning For Wire Removal and Further Inspection

VM-17, Vertical*

BILU4, Bottom Crosshead*

BILU3, Bottom Crosshead

CO2.5, Circumferential*

TORL2, Top Crosshead*

*These examinations were previously reported.

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Atmosphere Sampling

The atmospheres of a representative number of each type of accessible tendon have been tested and found to contain sufficient moisture to allow corrosion. Based on this conclusion, continued atmosphere sampling is not anticipated as existing moisture levels have been established.

Metallurgical Analyses

Sample wire sections have been taken from full length wires removed from the detensioned tendons. These samples have been mechanically tested per Reg. Guide 1.35.

The fifty failed wire samples which were sent to GA Technologies have been analyzed and a final report is being prepared.

Other failed samples have been analyzed by Public Service Company and a final report is being prepared.

Preliminary results from metallurgical analyses indicate that microbiological corrosion may be the primary contributor to the corrosion problem. Additional evaluations related to bacterial control, and short term, as well as long term protection have been initiated.

Tendon Surveillance Program:

The scope of the tendon surveillance program is currently being increased to monitor the adequacy of the new corrosion protection methods to be provided for the PCRV prestressing components, and assure that the required prestressing forces are sustained throughout the operational life of the plant. A meeting has been requested with the NRC to discuss the basis for this program.

Actions which are currently being pursued:

1. Continuing to monitor the 27 load cells monthly to establish a data base for identifying possible trends of tendon degradation.

2. Continuing to develop and seek NRC concurrence of the tendon surveillance program.

3. Continuing to evaluate corrosion prevention methods related to the mitigation of moisture and microbiological bacteria.

Long Term Program:

The final metallurgical and corrosion evaluations and reports by Public Service Company and GA Technologies are being prepared. Once these reports are completed, a final engineering report by Public Service Company will be prepared which will present all of the findings to date, and layout the specifics of the long term tendon program.

A supplemental report will follow.

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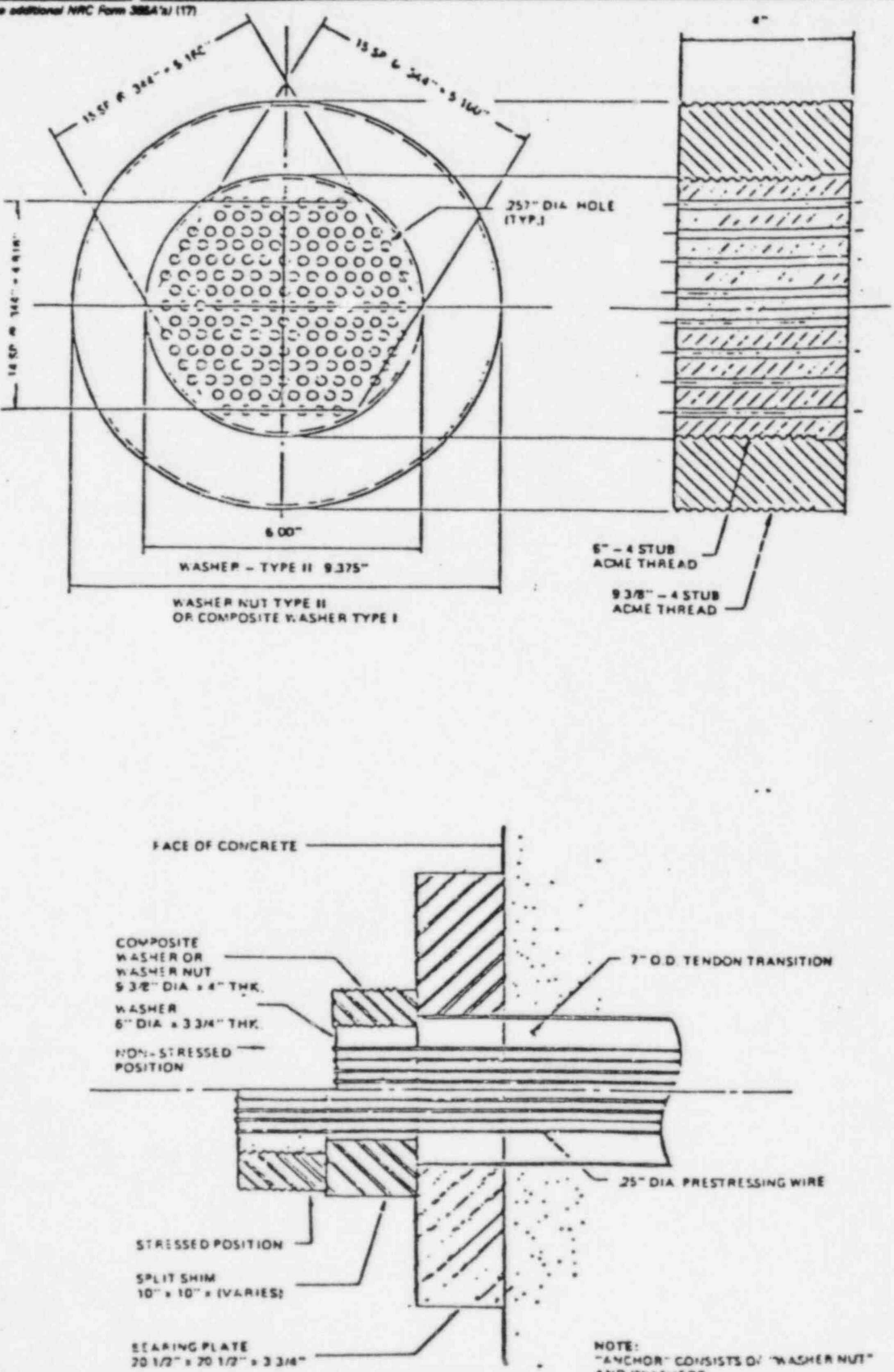

FIGURE 1

NRC Form 366A (9-83)

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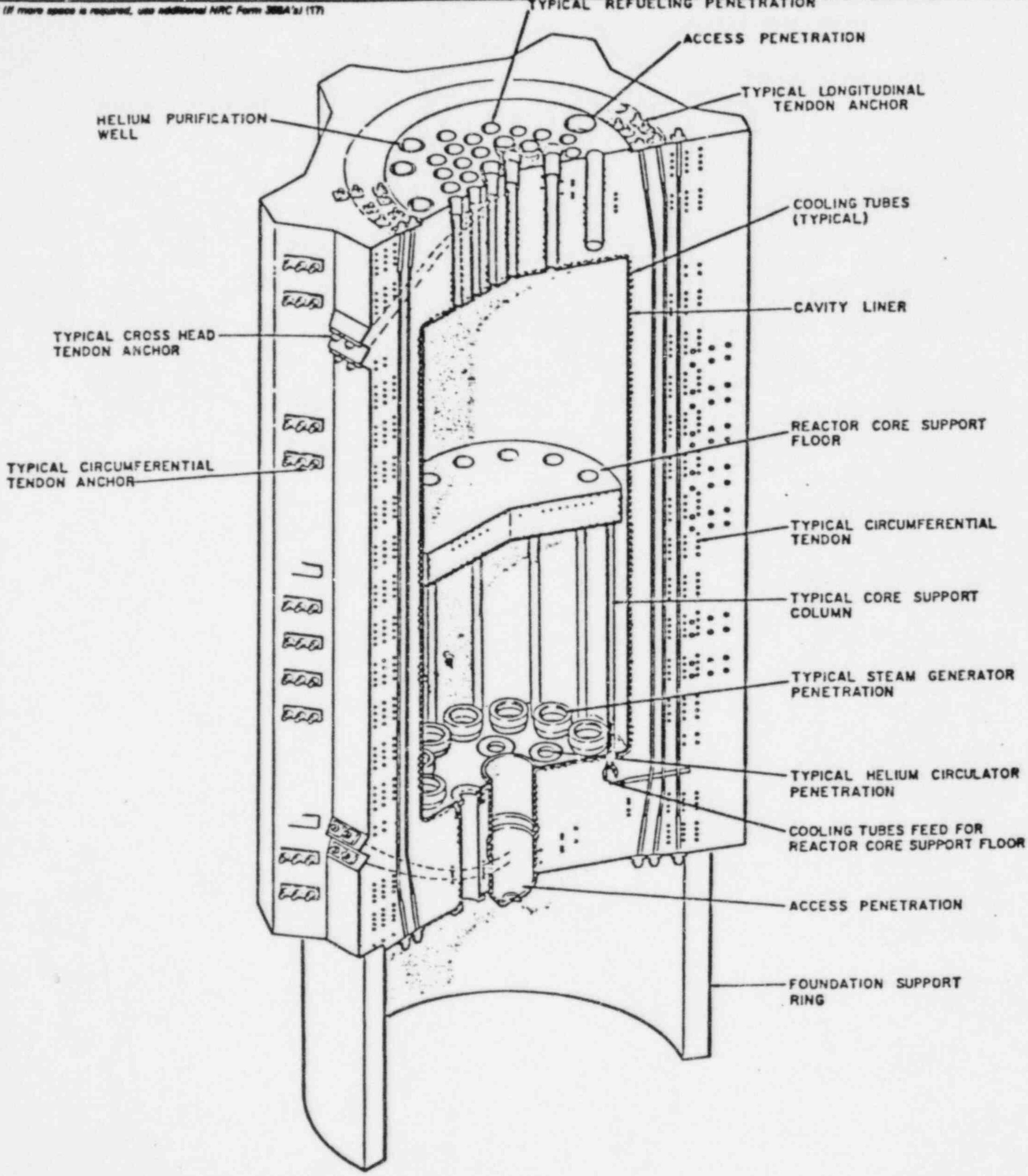

FIGURE 2

NRC FORM 366A

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