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 7

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

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
DETERMINED 0 3 2 7	8 4		8 4	—	0 0 5	—	0 0	0 4	2 6	8 4		0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (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)		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
0 0 0		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	X 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
Frank Novachek, Technical Services Engineering Supervisor	AREA CODE 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	NO							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
X YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		0 7	2 6	8 4

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

Inservice inspection of the anchor end assemblies of the Prestressed Concrete Reactor Vessel prestressing tendons revealed some individual wire failures in some tendons due to corrosion attack. Although not definitive at this time, it is believed that moisture within the assembly, the dry system used, and inadequate corrosion protection at the anchor washer end contributed to the corrosion attack. Investigation into the mechanism for moisture introduction is continuing, although probable mechanisms have been hypothesized. An increased number of anchor assemblies were examined, and additional assemblies continue to be examined. In addition, an increased surveillance frequency is planned.

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

8405080064 840426
PDR ADOCK 05000267
S PDR

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, which would detect any significant loss of prestress in the PCRV, are installed on select tendons as noted above.

The tendons maintain the concrete of the PCRV in a 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 evidence of corrosion attack beyond this point was observed on complete wire samples (two failed, one intact) removed from one tendon.

Tendon operability was confirmed on all accessible vertical tendons with raised buttonheads, as well as accessible adjacent vertical tendons, by lift-off testing (which measured the load applied by individual tendons and verified that it was above a minimum value based on the original design end-of-life applied tendon load).

ANALYSIS OF EVENT:

Corrosion of select wires 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 to the bundle interior wires near the anchor washer, or it was removed at some stage during the fabrication/installation process 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 tended 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 the prestressing system. Consequently, this does not represent an unanalyzed condition that compromises plant safety.

CAUSE DESCRIPTION:

Moisture was introduced into the tendon anchor assembly covers by a mechanism not completely understood at this writing. 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 where moisture was occasionally observed on the interior of the tendon wire bundle in the vicinity of the buttonhead washer.

CORRECTIVE ACTION:

The top head anchor assemblies of 89 of the 90 vertical tendons have been inspected.

Lift-off tests have been conducted on all accessible vertical tendons (74 of 90) to verify that all tendons meet design condition.

Those vertical tendons that were given lift off tests were inspected at the upper end and regreased.

One vertical tendon (VM-17) was detensioned. One good wire and one bad wire were pulled for metallurgical examination and engineering evaluation. This tendon has since be retensioned.

One tendon in each of the remaining groups (circumferential, top cross-head, and bottom cross-head) will be detensioned. A good wire and a bad wire (if available) will be pulled from each tendon for metallurgical and engineering evaluation.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	8 4	— 0 0 5	— 0 0	0 4 OF 0 7

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

The 27 load cells are being monitored monthly to establish a data base for identifying possible trends of tendon degradation.

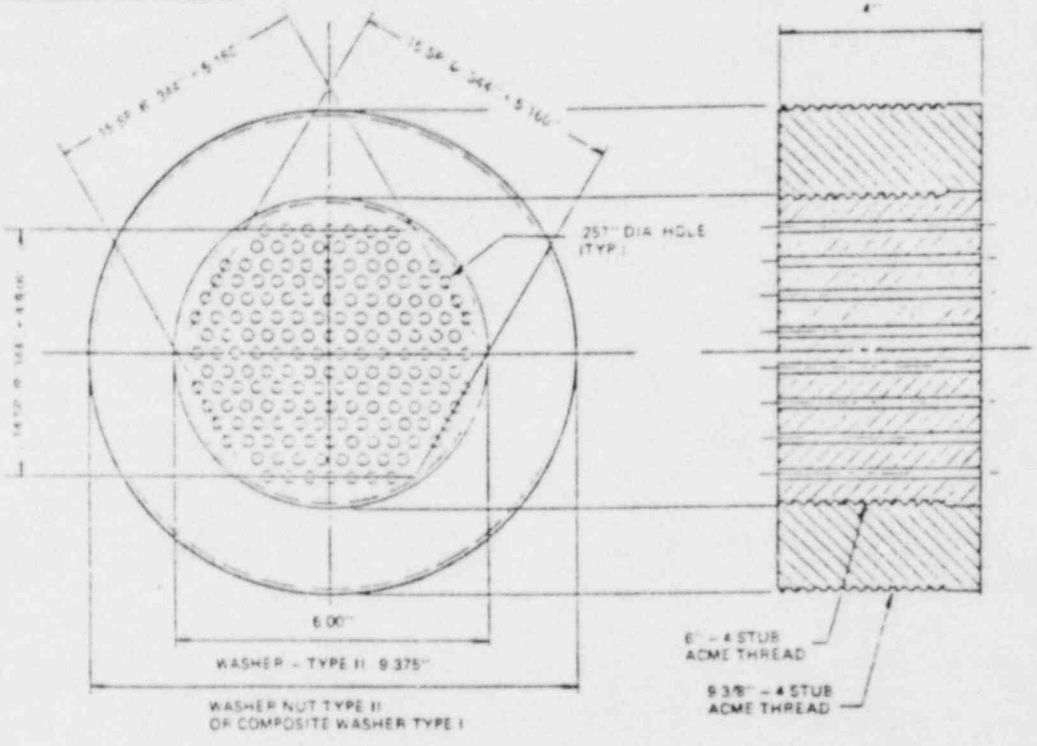
An overall tendon surveillance program is being developed to inspect a sample of the tendon terminations on a semi-annual basis.

Detailed engineering evaluations are in progress wherein the corrosion is being analyzed, wire properties are being determined, pull tests are being conducted, and ductility tests are being conducted, along with other tests to provide a basis for an overall analysis of the problem.

A supplement report will follow.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	8 4	— 0 1 0 5	— 0 1 0	0 5 OF 0 7

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



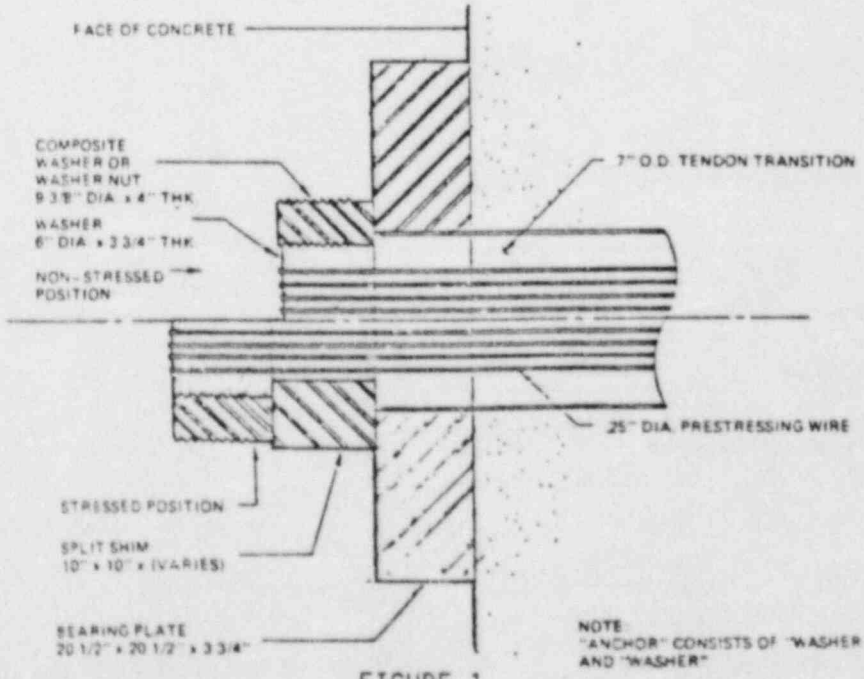


FIGURE 1

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	8 4	— 0 1 0 5	— 0 1 0	0 1 6 OF 0 1 7

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

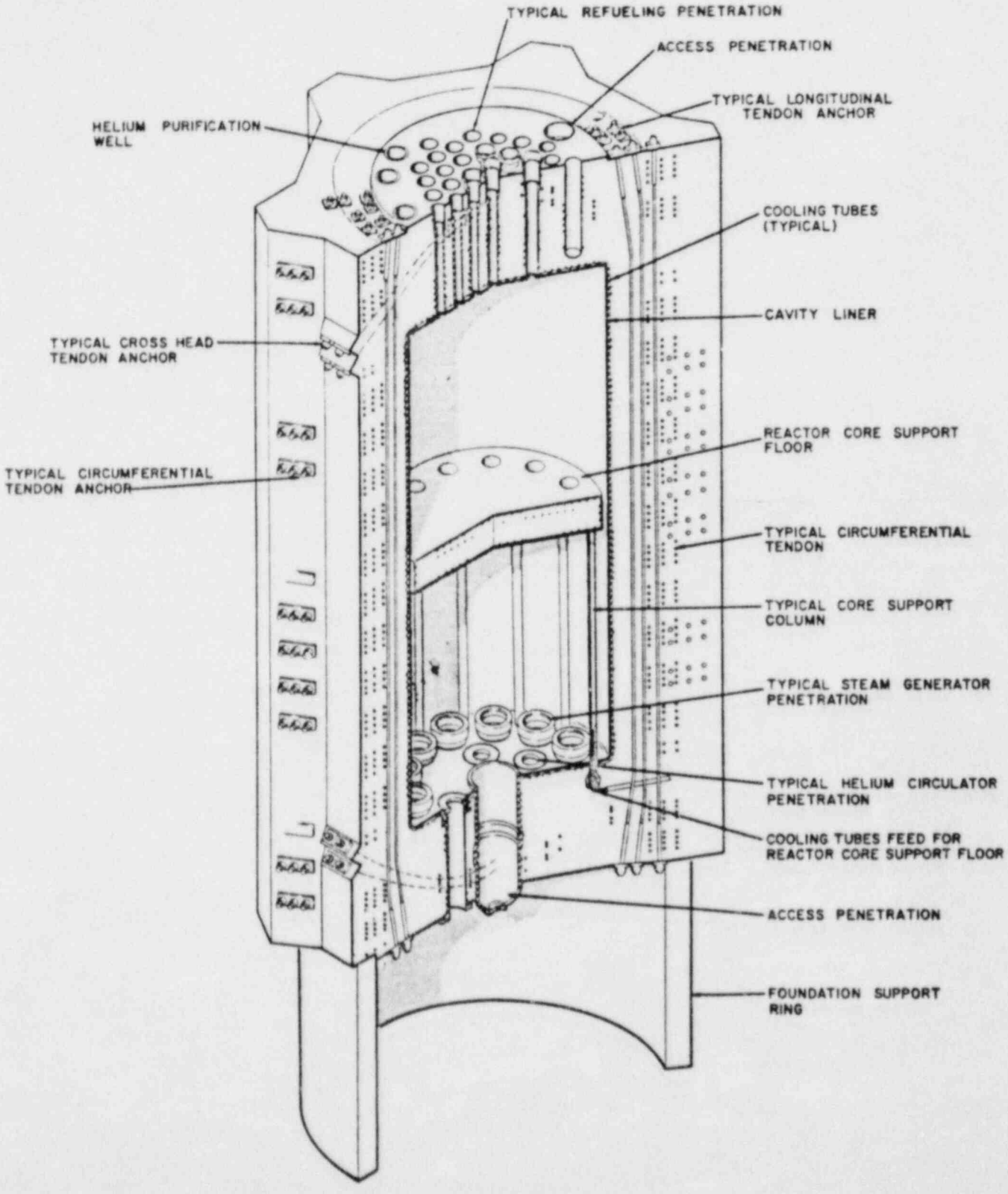


FIGURE 2

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	8 4	— 0 0 5	— 0 0	0 7 OF 0 7

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

Jim Eggebroten
Reactor Engineer

Frank J. Novachek
Technical Services Engineering Supervisor

L. M. McBride
Station Manager

Don Warembourg
Manager, Nuclear Production