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 8

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)
DETERMINED 0 3	2 7	8 4	8 4	0 0 5	0 1	0 7	2 7	8 4	N/A	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iii)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(iv)	73.71(c)
		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		1 0	2 6	8 4

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. Although final analysis is pending, it is believed that moisture within the assembly, the type of lubrication system used, and inadequate corrosion protection at the anchor washer end contributed to the corrosion attack. Final investigations into the mechanisms for moisture introduction are continuing, although probable mechanisms have been hypothesized and are under investigation. Discovery of the unexpected failures has resulted in an expanded examination, testing, and analysis program.

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.

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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, 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 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 evidence of 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.

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 some 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 event 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 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 420		2

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

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	5 of 48
T-Crossheads	2 of 48
Circumferentials	2 of 620

Detensioning For Wire Removal and Further Inspection

VM-17, Vertical*

BILU4, Bottom Crosshead

CO2.5, Circumferential

TORL2, Top Crosshead

*These examinations were previously reported in LER 84-005, dated 4-26-84.

Gas Sampling

Atmosphere analysis on 10 tendons

H_2S sampling on 48 tendons (microbiological corrosion indications were negative for atmosphere sampling).

Metallurgical Analysis

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

Fifty failed wire samples have been sent to GA Technologies for analysis and a preliminary report has been prepared.

Approximately twenty-five failed samples have been analyzed by Public Service Company and a preliminary Lab Report has been drafted.

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| Overall Tendon Surveillance Program:

| An overall tendon surveillance program is currently being written to provide the capability to monitor the PCRV tendons for signs of any further degradation. The basis for this program is to use a systems approach whereby each specific type of tendon anchor assembly is examined using sampling techniques to detect degradation and to provide assurance that the PCRV is capable of meeting its design conditions for safe operation. Regulatory Guide 1.35 is being used as a reference for the specifics of the 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. Additional lift-off tests may be performed on accessible circumferential and crosshead tendons to expand the data base on this type of tendons load capacity.

| 3. Remove additional accessible anchor caps for visual inspection and moisture removal/investigation.

| 4. Continue to develop and finalize the overall tendon surveillance program.

| 5. Detension a bottom crosshead tendon for a detailed corrosion examination.

| 6. Procure additional gas samples on accessible tendons to identify atmospheres associated with corrosion and/or to monitor any moisture present.

| Long Term Program:

| The metallurgical and corrosion examinations by Public Service Company and GA Technologies will be finalized following the conclusion of several near term action items. 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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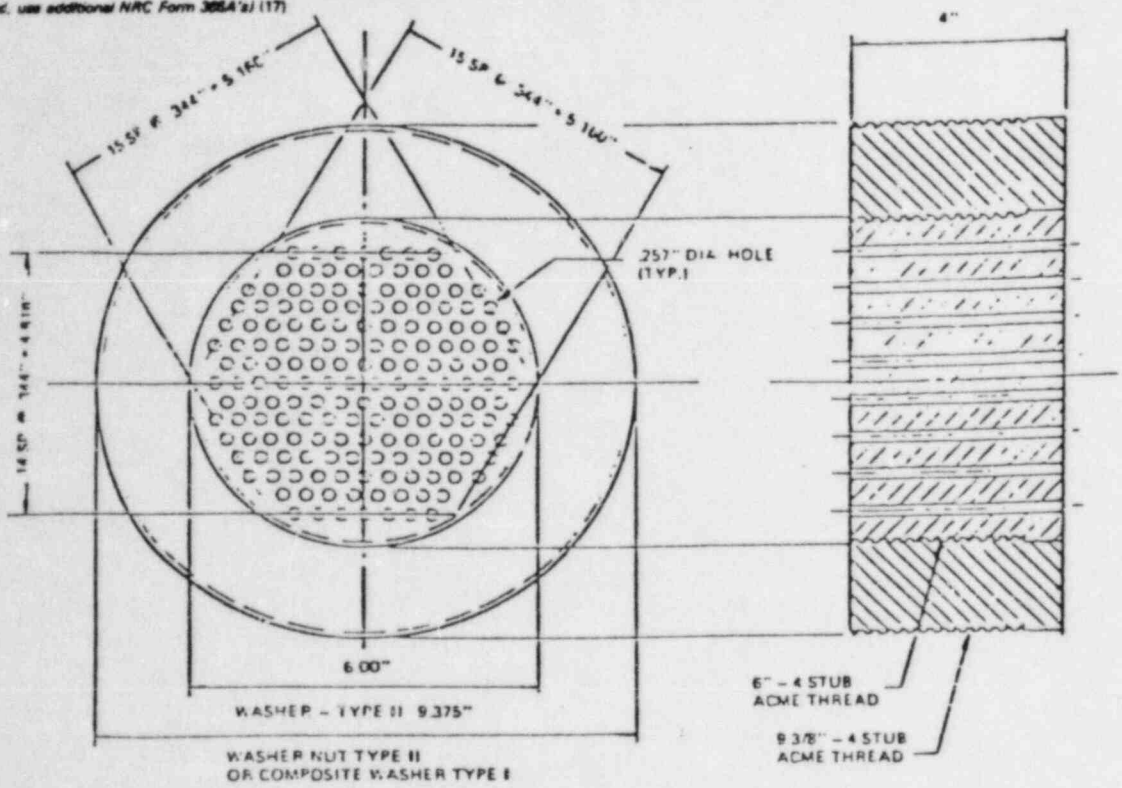

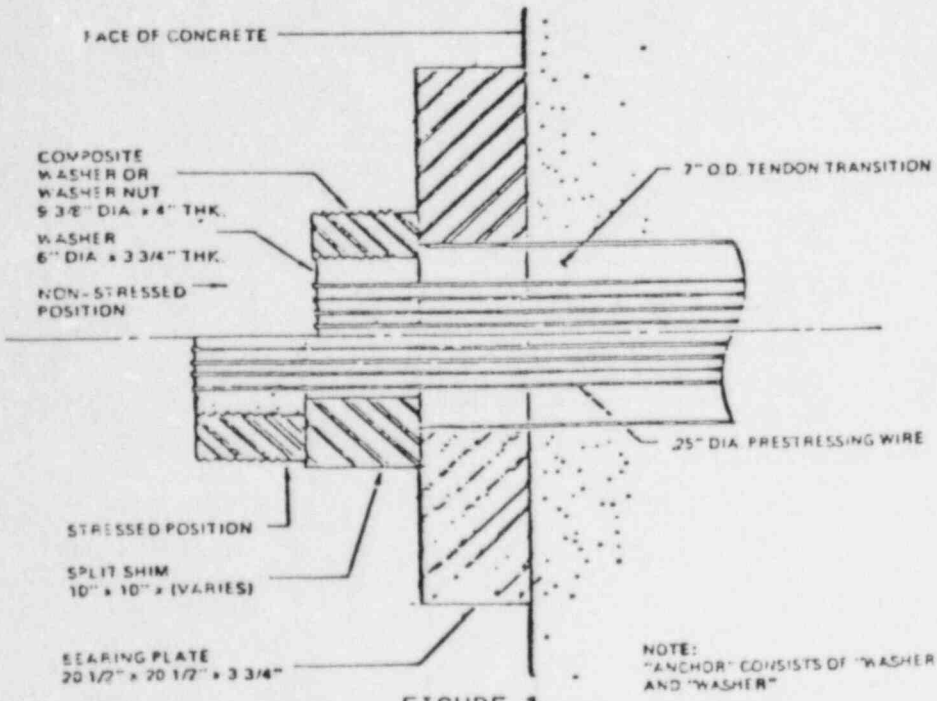

FIGURE 1

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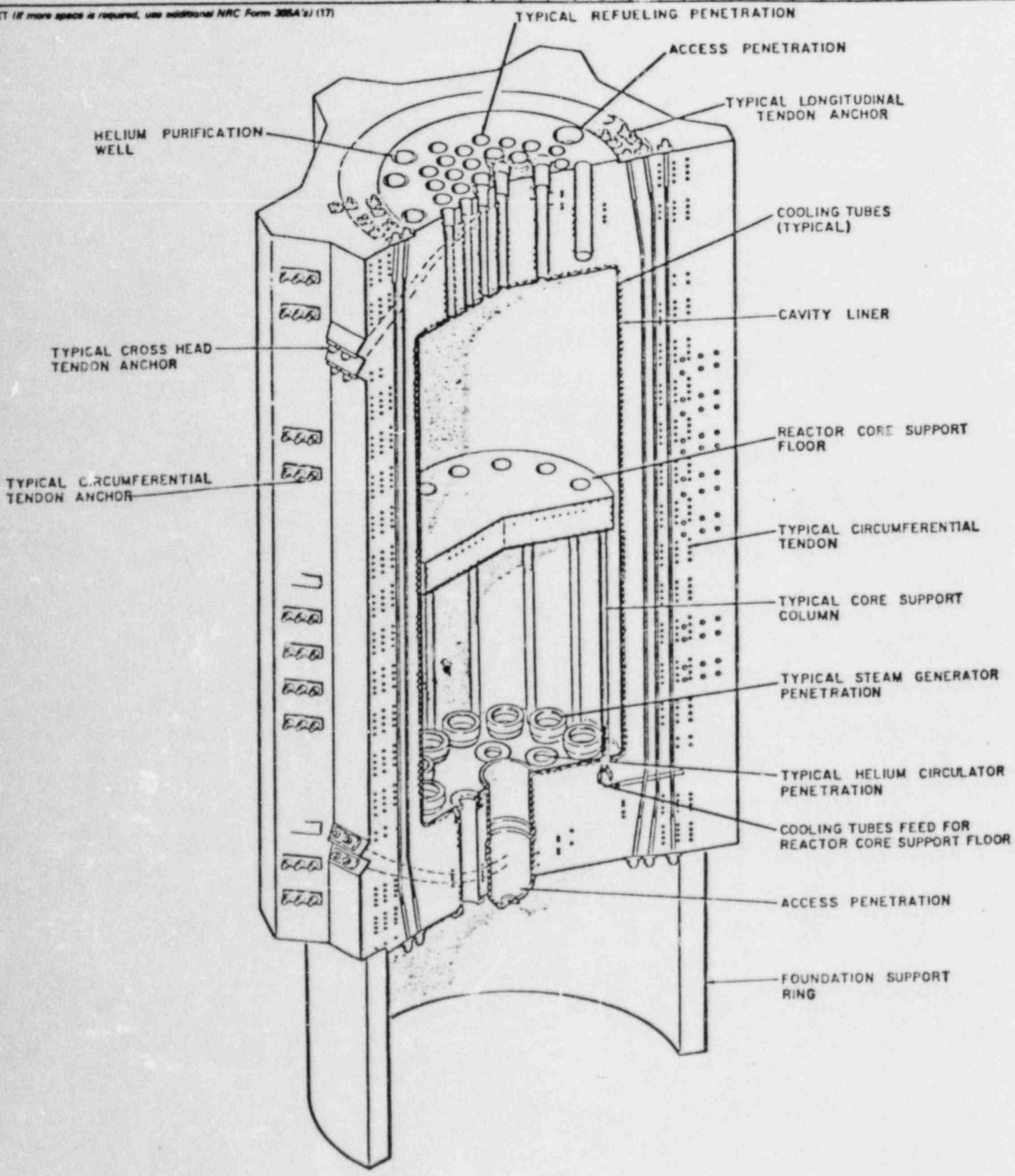

FIGURE 2

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
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TEXT (If more space is required, use additional NRC Form 366A's) (17)

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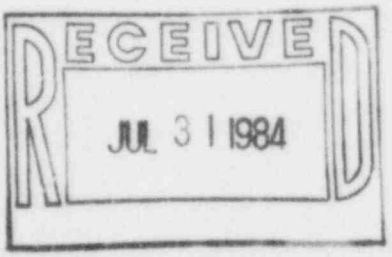
50-267

July 27, 1984
Fort St. Vrain
Unit #1
P-84239



Mr. E. H. Johnson, Chief
Reactor Project Branch 1
Region IV
Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

REFERENCE: Facility Operating License
No. DPR-34

Docket No. 50-267

Dear Mr. Collins:

Enclosed please find a copy of Licensee Event Report No. 50-267/84-005, Supplemental Report, submitted in the interests of operational information.

Very truly yours,

Don Warembourg
Manager, Nuclear Production

DWW/djm

Enclosure

cc: Director, MIPC

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