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): CRYSTAL RIVER UNIT 3

DOCKET NUMBER (2): 0 5 0 0 0 3 0 2

PAGE (3): 1 OF 0 8

TITLE (4): BROKEN STEM NUT IN "B" FEEDWATER MAIN BLOCK VALVE RESULTS IN A FEEDWATER TRANSIENT AND SUBSEQUENT REACTOR TRIP

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)
0 2	2 8	8 8	8 8	— 0 0 6 —	0 1	0 8	3 1	8 8	N/A	0 5 0 0 0
									N/A	0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 0 5 6

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)	X 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)	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: LARRY W. MOFFATT, NUCLEAR SAFETY SUPERVISOR

TELEPHONE NUMBER: AREA CODE 9 0 4 | 7 9 5 - 6 4 8 6

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	S J	2 0	C 6 8 4	Y					
B	T A	S O L	W 1 2 0	N					

SUPPLEMENTAL REPORT EXPECTED (14)

X YES (If yes, complete EXPECTED SUBMISSION DATE)   NO

EXPECTED SUBMISSION DATE (15): MONTH 1 1 DAY 3 0 YEAR 8 8

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

On February 28, 1988, Crystal River Unit 3 experienced a reactor trip during a power decrease from 99 percent to approximately 40 percent power. The trip was due to a Feedwater transient which resulted in high Reactor Coolant System pressure. The main turbine failed to automatically or remotely trip after the reactor trip, and operators manually opened the generator output breakers and manually shut the Main Steam Isolation Valves.

The cause of the Feedwater transient was a broken stem nut in the yoke of the "B" Feedwater main block valve. The cause of the failure of the turbine to automatically or remotely trip was a failed turbine trip solenoid, and a potential contributing factor was corrosion of the trip circuit power fuse and fuse holder.

The stem nut has been replaced with a nut manufactured on site in accordance with vendor instructions. The turbine trip solenoid and circuit fuse have been replaced, and the fuse holders have been cleaned. All new components were satisfactorily tested, as was the "A" Feedwater main block valve. A failure analysis has been performed on the stem nut and is being performed on the turbine trip solenoid.

IE22
1/1

EVENT DESCRIPTION

On Sunday, February 28, 1988, Crystal River Unit 3 (CR-3) was operating at 99 percent reactor power and generating 883 electric megawatts. The Integrated Control System (ICS) [JA] stations were in automatic and the "A" atmospheric dump valve (ADV) [SB,PCV] was manually isolated due to a small body to bonnet leak. A load reduction to approximately 40 percent power was begun at 1000 so troubleshooting of the main generator voltage regulator system [TL,RG] could begin. At approximately 45 percent power, the Feedwater (FW) main block valves (MBV's) [SJ,20] began to close (see Figure 1 for valve arrangement) as designed. After receiving the closed indication for both FW MBV's, a feedwater transient developed. Feedwater flow to the "B" steam generator (SG) [AB,SG] began to increase and remained excessive for approximately one minute. During this overfeed condition, the Reactor Coolant System (RCS) [AB] experienced a depressurization and cooldown, and reactor power increased to approximately 56 percent due to the colder water.

In an attempt to lessen the severity of the FW transient in progress, a control room operator opened the FW crossover valve FWV-28 [SJ,20] (see Figure 1). When this valve was opened, a "close" signal was also sent to the MBV's, as designed. Within seconds, the FW flow to "B" SG decreased such that an underfeed condition occurred. Approximately one minute later at 1149, a reactor trip occurred due to high RCS pressure on 2 out of 4 Reactor Protection System (RPS) [JC,CH] channels.

Upon receiving the reactor trip, the main turbine [TA,TRB] failed to automatically trip. Several attempts to remotely trip the turbine from the control room were also unsuccessful. Operators manually opened the generator output breakers [IB,BKR] to shed load and manually shut the Main Steam Isolation Valves (MSIV) [SB,ISV] to remove the steam supply to the turbine. Minutes later the turbine was manually tripped at the local trip mechanism.

Also, immediately following the reactor trip, an automatic actuation of the Emergency Feedwater System (EF) [BA] occurred due to a low level condition in the "B" steam generator. The "B" EF pump (steam-driven) [BA,P] automatically started as designed, and the "A" EF pump was manually started per procedure. This was due to two out of four Emergency Feedwater Initiation and Control (EFIC) [BA,CH] channels detecting the low level condition.

Since the MSIV's were shut, secondary pressure control was maintained using the "B" ADV and main steam safety valves (MSSV's) [SB,RV] on the "A" loop. Eventually, the "A" loop ADV was unisolated and used to control secondary pressure, and the MSSV's reseated with no problems.

CAUSE

The feedwater transient occurred due to erroneous indication of the "B" MBV position to the ICS. The cause of the erroneous indication for the "B" MBV position was a broken stem nut in the valve yoke discovered during troubleshooting. A failure analysis has been performed, and the failure mechanism has been identified as cyclic fatigue.

Investigation revealed the cause of the turbine failure to automatically or remotely trip was due to a faulty turbine trip solenoid. In addition, voltage fluctuations were observed in the turbine trip circuit during post event troubleshooting, which were due to a corroded fuse and fuse holder. A failure analysis is being performed on the faulty turbine trip solenoid to determine its failure mechanism.

The cause of the EF actuation was an actual low SG level condition in "B" steam generator. Only two EFIC channels detected a low SG level due to the actual level achieved and minor calibration differences between transmitters in the four EFIC channels.

EVENT ANALYSIS

At approximately 45 percent power during the load reduction, the FW MBV's began to close as designed. Due to the "B" MBV broken stem nut, the gear driven limit switches were no longer synchronized with valve stem travel. Thus the actual valve position was approximately two inches further open than indicated by the limit switch.

When the "B" MBV indicated closed to the control board operator and to the Integrated Control System (ICS), it was actually approximately two inches open. When ICS receives a MBV closed signal, it transfers control of the FW pump in that loop from a flow error signal to a signal based on differential pressure across the valves (see Figure 1). Since the "B" MBV was partially open, the "B" FW pump speed was increased to try to maintain the required differential pressure. This resulted in the overfeed condition.

Once the overfeed occurred, a large flow error signal resulted, since actual flow was much greater than desired flow. This signal within ICS stopped the "B" MBV in its partially open position as designed. Moments later when the operator opened the crossover valve, which sends a "close" signal to the MBV's, the "B" MBV actually went to the fully closed position, resulting in the underfeed condition and subsequent reactor trip.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
CRYSTAL RIVER UNIT 3	0 5 0 0 0 3 0 2	8 8	— 0 0 6	— 0 1	0 4 OF 0 8

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

Following the reactor trip, all rods inserted and shutdown margin was maintained. The failure of the turbine to automatically or remotely trip involved non-safety-related components, yet the safety-related MSIV's were used to effectively isolate the turbine steam supply and prevent an overcooling. The RPS and EF systems both functioned as designed based upon the input signals they received. The non-safety-related ICS also operated as designed based upon the input signals it received.

CORRECTIVE ACTIONS

The broken stem nut from the "B" MBV has been removed and replaced with a stem nut fabricated on-site using materials recommended by the valve manufacturer. The material used to fabricate the stem nut has subsequently been identified by the valve manufacturer as not the original material. A justification for continued operation with the installed stem nut until the next full closure of the valve has been performed. The installed stem nut will be replaced with a stem nut made from the original material following its next full closure. Both the "A" and "B" MBV's have been satisfactorily stroke tested and observed for proper operation. A failure analysis has been performed on the broken stem nut, and the mode of failure has been identified as cyclic fatigue.

The turbine trip solenoid was replaced with a new solenoid, which was then satisfactorily tested. The turbine trip circuit fuse was replaced and the fuse holders were cleaned. Evaluation of the cause of fuse corrosion will be made. A failure analysis will be performed on the failed trip solenoid, and is scheduled to be completed in October 1988.

FAILED COMPONENT IDENTIFICATION:

FWV-29 stem nut:
MFR. - Crane 18 x 16 x 18 L-900 U pressure seal gate valve
Material - ASTM - B147-8C
Operator - SMB-4T Limitorque
Part No. - 1431444-002

Turbine trip solenoid:
MFR. - Westinghouse
Part No. - 439A936601

PREVIOUS SIMILAR EVENTS

There have been several previous events involving a reactor trip, the most recent were reported in LER 87-09 and 87-11. The event described in LER 87-11 also involved a reactor trip with the failure of the turbine to automatically trip. The failure of the turbine to automatically trip was caused by the failure of a different component.

There have been several previous events involving the actuation of the Emergency Feedwater System, the most recent were reported in LER 88-01 and 88-02.

SPECIAL ATTACHMENT TO LER 88-006

Following the reactor trip of February 28, 1988, the NRC requested answers to several questions in a meeting with FPC management. The following responses are provided to assist in the assessment of the event.

ABBREVIATIONS USED IN THIS DOCUMENT AND ON LER 88-006 FIGURE 1:

SG -	Steam Generator	RCS -	Reactor Coolant System
FW -	Feedwater	T_{AVE} -	Average RCS Temperature
SU -	Startup	PSID -	Pounds Per in^2 Diff
SUCV -	Startup Control Valve	MSIV -	Main Steam Isol. Valve
SUBV -	Startup Block Valve	EFIC -	Emerg. Feed Initiation & Control
LL -	Low Load		
LLCV -	Low Load Control Valve	dP -	Differential Pressure
LLBV -	Low Load Block Valve	P&ID's -	Piping and Instrumentation Drawings
MBV -	Main Block Valve		
ICS -	Integrated Control System	psig -	Pounds per in^2 gauge

Questions and Responses:

1. Q - Explain ICS control of FW from 0% to 100% power.

   A - At 0% power, each SG is maintained at the low level limit setpoint of 30 inches, with one FW pump providing flow through the crossover valve (FWV-28) and through the "A" and "B" SUCVs to each SG. The FW pump speed is controlled to maintain 80 PSID across the SUCVs, selecting the lowest of the two loop dP signals for control to ensure adequate flow to each SG. As power is increased, the SGs are maintained at low level limits by increasing the flow through each SUCV and allowing RCS T_{AVE} to ramp up. When the ICS FW demand, based on power level, exceeds the FW demand for low level limits, the SG level is increased above the low level limit by modulating the SUCV further open. The RCS T_{AVE} will remain constant and the SG levels will increase with an increasing power demand. When the SUCV reaches 80% open, the LLBV opens. At a loop flow of 1.06 x 10^6 LBM/HR (approximately 90% on the SUCV), the LLCV is released to control, and the SUCV goes fully open.

   At approximately 35 - 40% power, the second FW pump is manually started, its speed manually increased until its dP equals that of the operating pump, and the crossover valve is closed. Each FW pump speed is now controlled to maintain the respective loop dP at 80 PSID across the SU and LL valves. At an individual loop FW demand of 50% each MBV is pulsed open for the first 15% of travel and then is run fully open. (The pulsing is stopped and the MBV is stopped in position if the flow error signal becomes greater than 10%. Valve motion is restarted when the flow error is less than 5%.) When the MBV closed limit switch changes state to indicate the valve is opening the LLCV is stopped in position and the ICS control transfers from dP control to flow control by varying FW pump speed. The FW flow control from this point up to 100% is accomplished by varying the FW pump speed based on changes in demanded load from the ICS.

For a power decrease from 100%, the scheme is essentially reversed. The FW flow is changed to correspond to a decreased load demand change by lowering the FW pump speeds. At an individual loop demand of 45%, each MBV is run closed to the 17% open position, and is pulsed closed the rest of the travel. (Again, as during a power increase, a greater than 10% flow error signal halts valve motion until flow error is less than 5%.) When the MBV closed limit switch contacts indicate that the valve is closed, the FW pump control is transferred back to dP control. The ICS is now controlling LLCV position to maintain 80 PSID across the SU and LL valves. At approximately 35% power, the crossover valve is manually opened and one of the two FW pumps is taken out of service. The operating FW pump again is controlled to maintain 80 PSID, selecting the lower of the two loop dP signals. When the LLCV goes closed due to decreasing demand and the SUCV is 80% open, the LLBV is closed. The SUCVs are used to control flow down to the point of reaching the low level limit in each SG. The low level limit is a constant signal in ICS which takes precedence over the FW demand signal if the low level limit signal is higher.

The interlock between the crossover valve and the MBV's is such that with the MBV's in "automatic," the MBV's will be run closed without pulsing, when the crossover valve is not fully opened. The crossover valve is normally used with only one FW pump, either during normal startups and shutdowns or in the event of the loss of one FW pump. The basis for closing MBV's with the crossover valve not closed is to limit the size of the available FW flow path so it is within the capability of a single FW pump.

2. Q - Is turbine trip on reactor trip safety related? Why/why not?
   A - It is not safety related. The MSIV's are safety related and are adequate to assure the safety function.

3. Q - Would installation of diverse turbine trip circuitry required by the ATWS Rule (10CFR50.62) have provided turbine trip given failure of the trip solenoid?
   A - No.

4. Q - Is the existing MFW flow control scheme, including flow paths, the original installed design? If not, describe the original design and the reasons for the design changes.
   A - The MFW flow control scheme is the original design.

5. Q - Provide P&ID's for the MFW system and ICS system schematics.
   A - Figure #1 of LER 88-006 shows the arrangement of the FW valves. Item #1 describes the ICS control of FW from 0% to 100% power. Additional drawings have been provided to the Project Manager.

6. Q - During the event, automatic trip of the turbine on reactor trip did not occur. Discuss how the plant would have responded if the operator had not taken prompt action to effectively isolate this turbine.
   A - The RCS temperature post-trip is a function of SG pressure. RCS post-trip temperature normally stabilizes at approximately 550°F. This temperature is the result of the turbine bypass valves controlling steam pressure at 1010 psig. Without operator action to trip the turbine, the RCS would have continued to cooldown. RCS temperature would have stabilized at approximately 532°F, as dictated by governor valves controlling pressure at 885 psig. Additional cooldown would have reduced pressurizer level an additional 90". Pressurizer level indication may have gone off scale low. However, the makeup system would have prevented emptying the pressurizer as well as restored level indication .

7. Q - How would this transient be categorized using the SPIP designation?
   A - The transient is given a B-1 designation. Both the "A" and "B" SG pressure fell below the Category A minimum of 925 psig to a value of 889 psig. This was due to the failure of the turbine to trip on the reactor trip. The "B" SG level went below the Category A minimum of 18 inches to a value of 16.7 inches. This was due to the fact the "B" SG was being underfed just prior to the trip and to the fact the FW pump speed was reduced to below the ICS minimum as a result of reduced steam supply when the reheat valves closed. The "B" SG level also went above the Category A maximum of 60 inches to a value of 70 inches. This was due to momentarily feeding the SG with both main FW and Emergency FW. All other secondary plant parameters and all primary plant parameters were within Category A limits.

8. Q - What, if any, SPIP recommendations would have prevented or mitigated the event? Are there any SPIP recommendations which could have had an adverse effect on the transient?
   A - None.

NRC Form 366A
(9-83)

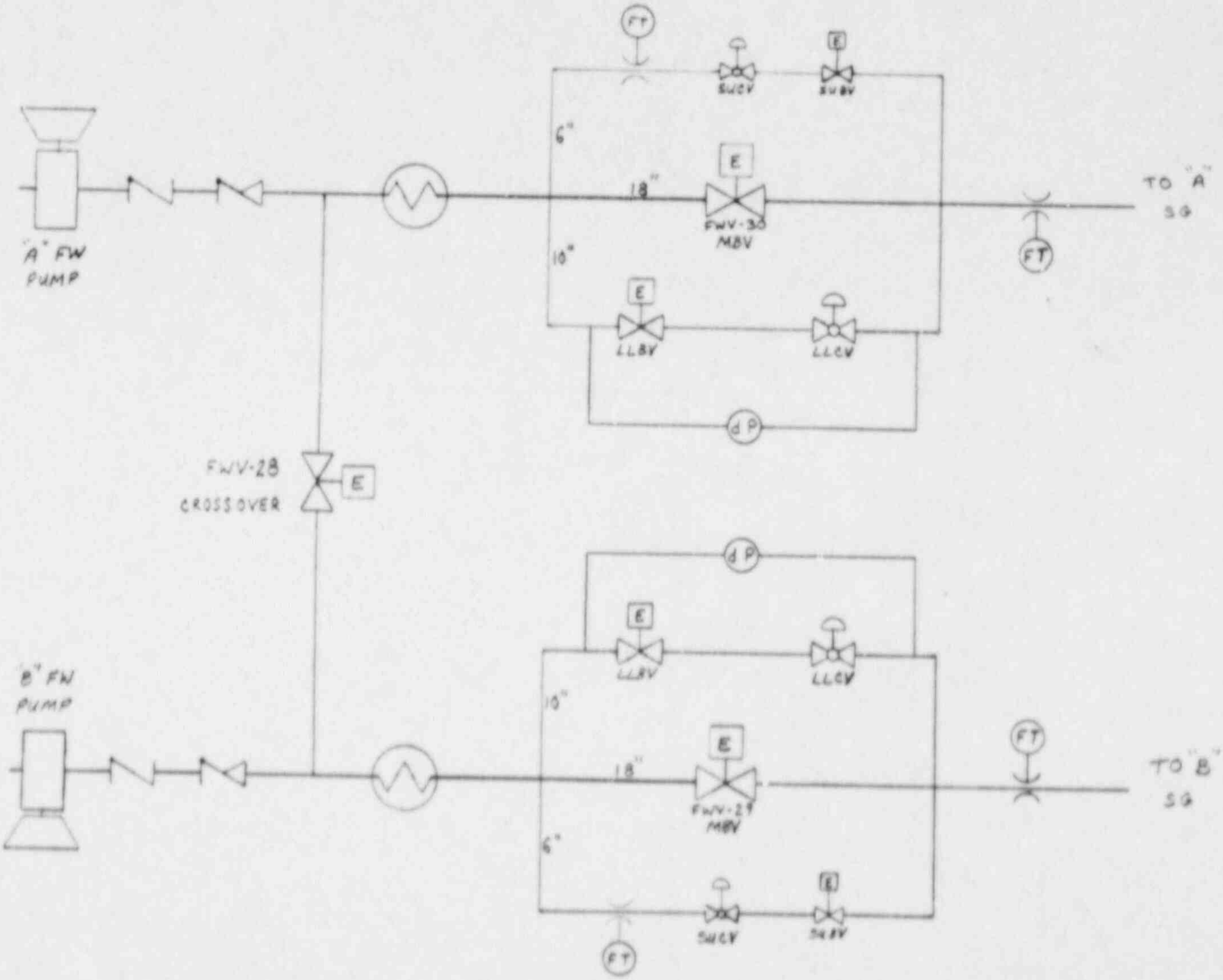
U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

APPROVED OMB NO. 3150-0104
EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
CRYSTAL RIVER UNIT 3	0 5 0 0 0 3 0 2	8 8	0 0 6	0 1	0 8 OF 0 8

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



NRC FORM 366A
(9-83)

Florida Power
CORPORATION

August 31, 1988
3F0888-25

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

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
Licensee Event Report No. 88-006-01

Dear Sir:

Enclosed is Licensee Event Report (LER) 88-006-01 which is provided in order to document that the submittal of LER 88-008 was not required by 10 CFR 50.73.

Should there be any questions, please contact this office.

Very truly yours,

Ken Wilson

Kenneth R. Wilson
Manager, Nuclear Licensing

WLR:mag

Enclosure

xc: Regional Administrator, Region II
Senior Resident Inspector

IE22
1/1

Post Office Box 219 • Crystal River, Florida 32629 • Telephone (904) 795-3802
A Florida Progress Company