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W3F1-2002-0050
A4.05
PR

May 22, 2002

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

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Licensee Event Report 02-005-00

Gentlemen:

Attached is Licensee Event Report (LER) 02-005-00 for Waterford Steam Electric Station Unit 3. This report provides details of a condition involving the temporary inability to achieve cold shutdown that occurred when two Shutdown Cooling System suction isolation valves (SI-405A(B)) failed to open. This condition is being reported pursuant to 10CFR50.73(a)(2)(v)(B) as an event or condition that could have prevented the fulfillment of the safety function of a system that is needed to remove residual heat from the reactor. The condition is also reportable under 50.73(a)(2)(vii)(B) as an event where a single cause or condition caused two independent trains to become inoperable in a single system designed to remove residual heat.

There are no commitments contained in this submittal. If you have any questions, please contact Oscar Pipkins at (504) 739-6707.

Very truly yours,

K.J. Peters
Director, Nuclear Safety Assurance

KJP/OPP/cbh
Attachment

cc: E.W. Merschoff, (NRC Region IV), N. Kalyanam, (NRC-NRR),
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NRC FORM 366 (7-2001)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)		Estimated burden per response to comply with this mandatory information collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Waterford Steam Electric Station, Unit 3	05000 382	1 OF 6

4. TITLE

Temporary Inability to Achieve Cold Shutdown With Both Trains of Shutdown Cooling Inoperable.

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME N/A	DOCKET NUMBER N/A
03	23	2002	2002	005	00	05	22	2002	FACILITY NAME N/A	DOCKET NUMBER N/A

9. OPERATING MODE	4
10 POWER LEVEL	0

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)		50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)	X	50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)	X	50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Oscar P. Pipkins, Senior Licensing Engineer	(504) – 739-6707

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FA CTURER	REPORTABLE TO EPIX
X	BP	BP-ISV	E334	Y					

14. SUPPLEMENTAL REPORT EXPECTED			15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X NO				

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

On March 23, 2002, at approximately 1005, the plant was in Mode 4 and Operations was attempting to lineup shutdown cooling for the Refuel 11 outage, when the emergency plan was entered (Alert declared), due to the inability to achieve cold shutdown. The condition occurred when two Shutdown Cooling System suction isolation valves (SI-405A(B)) failed to open when attempted from the Control Room. This rendered both trains of shutdown cooling inoperable. Following several attempts, valve SI-405A opened at 1137 and the other valve, SI-405B, opened at 1143 when the temperature differential across the valves decreased. Therefore, the valves failed to open over a period of approximately one and a half hours. It was later determined that the root cause of the event was thermal binding. Modifications have been made to increase the open stroke thrust for the subject valves. The safety significance of this event was negligible. This event did not compromise the health and safety of the general public. This event is considered a Safety System Functional Failure.

FACILITY NAME (1)	DOCKET (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Waterford Steam Electric Station, Unit 3	05000-382	2002	05	00	2 OF 6

TEXT *(If more space is required, use additional copies of NRC Form 366A) (17)*

REPORTABLE OCCURRENCE

The condition, as described below, resulted in a one and a half hour delay in opening valves (SI-405A(B)) required to align the plant for cold shutdown. This constituted a temporary inability to achieve cold shutdown. This condition is reportable under 10CFR50.73(a)(2)(v)(B) as an event or condition that could have prevented the fulfillment of the safety function of a system that is needed to remove residual heat from the reactor. The condition is also reportable under 50.73(a)(2)(vii)(B) as an event where a single cause or condition caused two independent trains to become inoperable in a single system designed to remove residual heat. The condition was reported to the NRC Operations Center via the Emergency Notification System (ENS) on Saturday, March 23, 2002 (EN# 38796) under 10CFR50.72(b)(3)(v)(B) reporting requirements, as an event or condition that, at the time of discovery, could have prevented the fulfillment of the Safety Function of a system that is needed to remove residual heat. The condition required entry into the Emergency Plan at the ALERT classification due to both shutdown cooling trains being inoperable and the inability to achieve or maintain Cold Shutdown.

INITIAL CONDITIONS

Just prior to discovery of the condition, Waterford 3 was in Mode 4 and Operations was attempting to lineup shutdown cooling to proceed to Mode 5 (cold shutdown). The Plant was in the process of cooling down for the Refuel (RF) 11 Outage.

EVENT DESCRIPTION

On March 23, 2002, with the plant in Mode 4, Operations was attempting to lineup shutdown cooling [BP] to proceed to Mode 5 (cold shutdown) for the Refuel 11 outage. Safety Injection (SI) valves SI-401A and SI-401B are motor operated 14-inch flex wedge valves that provide a second isolation boundary between the reactor coolant system [AB] and the lower pressure safety injection system. The breakers for these two valves had been closed and the valves had been opened. A Control Room Operator, with a peer checker attempted to open [BP-ISV] SI-405A, which is the 'A' Train, inside Containment reactor coolant loop suction isolation valve (in the line with SI-401A). This was an attempt to put the Low Temperature Over Pressure (LTOP) relief valves in service. The Control Room Operator took the control switch to the open position and held the switch there and monitored the Shutdown Cooling System mimic on the Plant Computer display for indication of a response from the valve. The Operator saw no response. He left the control switch for SI-405A in the open position and moved to the SI-405B ('B' Train inside Containment isolation valve) control switch. When actuated, the SI-405B valve did not show any indication of action. The green light in each control switch was illuminated which indicated that there was DC power to the solenoid valves. Both control switches stayed in the open position for 2 to 5 minutes and were then returned to the closed position. The SI-405A(B) valves are 14-inch flex wedge gate valves with hydraulic pneumatic actuators (Vendor Enertech). A hydraulic pump pressurizing the underside of the actuating piston opens the valves. Stored nitrogen acting on the top of the actuating piston closes the valves while hydraulic fluid is dumped from the underside. The valves have interlocks to prevent opening while pressure is above 386 psia. SI-401A(B) are the first valves off of the Reactor Coolant System (RCS) and SI-405A(B) are the second valves off of the RCS to align

shutdown cooling suction.

The Operator and his peer checker talked to the board operator that was monitoring RCS pressure to verify that RCS pressure was below permissive limits. At that time the control board indication for RCS pressure was 360 psi. RCS pressure was allowed to drift down as low as 330 psi to ensure that the pressure permissives were achieved.

A second attempt was made to open the SI-405A valve. The control switch was held in the open position for 40 seconds with no indication of movement. The SI-405B control switch was also held open for 40 seconds with no indication of movement.

An Operator was dispatched to the 480 volt AC breaker for the SI-405A hydraulic pump. Another Operator was dispatched to the 125 volt DC breaker for the SI-405A solenoid valves. The pump breaker was found in the closed position. The DC breaker was found in the closed position. The Operator at the SI-405A pump breaker said that he heard the sound of the contactor pick up as the Operator attempted to open the valve.

A third attempt was made to open both the SI-405A and SI-405B valves with the control switch held in the open position for one to two minutes.

A fourth attempt was made on both valves and the control switches were held in the open position for a full two minutes. The RCS pressure was at 330 psi for these attempts.

At 1005, unable to open either valve SI-405A or SI-405B, Operations declared both valves inoperable and entered Technical Specification 3.6.3.

At 1020, an ALERT emergency classification was declared due to both shutdown cooling trains being inoperable and the inability to achieve or maintain Cold Shutdown. The Operations Support Center (OSC) was activated at 1049. The Technical Support Center (TSC) was activated at 1050.

A team of Electricians, Instrumentation & Control Technicians, and Engineers were dispatched to troubleshoot the valves. Point to point checks of the circuits for SI-405A(B) valves were performed. All points and instruments checked out correctly and no problems were found.

The SI-401A(B) and SI-405A(B) valves receive their pressure permissives from different instruments. The setpoints of both sets of instruments were checked and determined to be accurate.

Approximately an hour and a half after opening the SI-401A(B) valves, personnel were staged at the motor control center for the hydraulic pump on SI-405A and a clamp-on ammeter was attached to monitor motor current. At 1137, the attempt to open the SI-405A valve was successful with no anomalies noted and 'A' train low temperature over pressure protection (LTOP) was in service. At

1143, SI-405B valve also opened when its control switch was taken to the open position and 'B' train LTOP was in service.

At 1150, Waterford 3 exited the ALERT emergency classification. At 14:47, the plant entered Mode 5 and exited Technical Specification 3.6.3 for SI-405A and SI-405B.

CAUSAL FACTORS

The root cause of the condition was determined to be thermal binding of valves SI-405A and SI-405B. The valves were stuck in the closed position due to the binding. Thermal binding can happen when a valve is closed hot and then opened relatively cold. Industry data shows that a temperature difference of approximately 150 °F is likely to induce thermal binding of flex-wedge gate valves. During the previous refueling outage, these valves were closed at approximately 275 °F and opened at approximately 165 °F. During Refuel 11, prior to attempting opening SI-405A(B), air voids in the piping associated with the Containment penetrations (#40 and #41) associated with SI-405A(B) were filled with approximately 80 °F water. This lowered the valve temperature to approximately 125 °F at the time of attempted opening. This increased the opening/closing temperature difference to approximately 150 °F. The valve actuator set-up for SI-405A(B) had little margin for opening thrust to overcome the thermal binding condition. The fact that SI-401A(B), on the upstream side of SI-405A(B), was open for nearly two hours raised the temperature of SI-405A(B) back to approximately 165 °F. This relieved the thermal binding condition and allowed SI-405A(B) to open. The air voids in the piping is being evaluated under the Corrective Action Program (CR-WF3-2002-0468 and CR-WF3-2002-0465).

There were two contributing causes for the valves failing to open:

One contributing cause was that the valve actuator nitrogen pressure was higher than prescribed as a result of an in-house vendor manual update error. Reviews indicate that the effective version of the temperature versus nitrogen pressure chart in the vendor technical manual was inadvertently replaced (in November 1995) with a superceded version of that chart. The chart had been revised by Waterford 3 in 1993 after an in-house calculation (EC-M91-076) was revised to reduce the nitrogen pressure that controls the valve actuator closing thrust and affects the opening thrust. The nitrogen set pressure at 105 °F was lowered from 1550 psig to 1400 psig. This change was done to accommodate a dead band issue on the hydraulic system and to increase the opening thrust. The revision to the calculation resulted in placing a 1400 psig temperature versus nitrogen pressure chart in the tech manual. This chart is used to charge the nitrogen system and provides the I & C Technician with a nitrogen pressure set value based on the ambient temperature at the valve. In November 1995, a revision to portions of the Waterford 3 vendor manual was issued. The vendor, not being aware of Waterford's revision of the subject chart, included a copy of the superceded chart in the revised manual. During the process of updating the vendor manual (onsite), the superceded (1550 psig) version of the temperature versus nitrogen pressure chart was placed back in the manual. If the proper (1400 psig) chart had been used for the charging of the nitrogen system during Refuel 10, the actuator would have had an additional 6,000 pounds of valve

opening thrust available to overcome the thermal binding. The opening margin with the 1550 psig nitrogen pressure and worst case conditions was only 2%. With 1400 psig nitrogen pressure, the margin would have been 31%. This cause is listed as only a contributing cause rather than as a root cause because the valves (405A(B)) had been successfully opened while preparing to go on shutdown cooling during other shutdowns, using the 1550 psig temperature versus nitrogen pressure chart (original chart).

The second contributing cause was inadequate consideration (during evaluation of Generic Letter 95-07) of the effects of lower than normal temperatures on thermal binding for the subject valves. The Generic Letter, "Pressure Locking and Thermal Binding in Power Operated Valves" identified the potential for gate valves to be subject to increased opening thrust requirements due to changing temperature conditions when valves are operated.

CORRECTIVE ACTIONS

Corrective actions taken to address thermal binding involved modifications to valve SI-405A(B) actuators to increase the open stroke thrust (ER-2002-0179). It was determined that a low nitrogen pressure of 1050 ± 25 psig is adequate to ensure closure of the valves. The new alarm setpoints have been established in the field. Diagnostic testing determined that the actuator changes have addressed the thermal binding loads. Data from normal preventive maintenance (PM) activities associated with the valve hydraulic actuators was reviewed to ensure that there are no actuator problems. Engineering validated design parameters in the field for valve (SI-405A(B)) actuator capability, valve packing loads etc. Furthermore, backfilling of voided piping for the two containment penetrations (40/41) associated with valves SI-405A(B) is being evaluated under the Corrective Action Program (CR-WF3-2002-0468 and CR-WF3-2002-0465).

To address the first contributing cause, personnel error in updating the vendor technical manual associated with the valves, Engineering will rebuild the Technical Manual (457001173 Volume II) to ensure that it contains complete and correct information. To address the second contributing cause, the Waterford 3 response to Generic Letter 95-07 will be reevaluated. These actions are being tracked under the Corrective Action Program (CR-WF3-2002-0546 and CR-WF3-2002-0468)

SAFETY SIGNIFICANCE

The safety significance of this event is negligible. Establishment of shutdown cooling was delayed approximately one and a half hours. This required additional use of the steam generators for cooling. However, the additional feedwater used to cool the reactor for that period of time was very small compared to the amount of feedwater available.

The impact of the event on Waterford 3 accident analyses was evaluated. The delay in initiating shutdown cooling could result in additional potentially radioactive steam being released to the atmosphere during a postulated accident. However, since the actual primary to secondary leak rate (which would be the source of radioactive steam) was negligible, the dose consequences of an

accident with a delay of shutdown cooling of 24 hours remain bounded by the FSAR analyses.

This condition was also evaluated for risk significance. Failure of shutdown cooling in a postulated Steam Generator tube rupture (SGTR) scenario with failure to isolate the ruptured Steam Generator is assumed to lead to core damage as a result of RWSP depletion. The core damage frequency (CDF) for the STGR sequence with both SI-405 valves failed is 7.9E-8. For the nominal SI-405 failure rates, the CDF is 2.5E-8. The difference between these values, 5.4E-8, represents the increase in instantaneous core damage risk as a result of the failure of the SI-405 valves. Calculating a core damage probability (CDP) increase yields $\Delta CDP_{SI\text{-}405A(B)\ failed} = 7.8 \times 10^{-11}$ for the 12.6 hour period of susceptibility (from start of the filling of the shutdown cooling suction line with cold RWSP water to when the valves actually opened). These risk increases are extremely small and far below the threshold of risk significance in industry guidance. Therefore, the failure of the SI-405 valves to open had a negligible risk impact.

This event is considered a Safety System Functional Failure (SSFF).

SIMILAR EVENTS

Another condition involving thermal binding was reported in LER 01-002-00. In that event, both the inside (PSL-303) and outside (PSL-304) Containment isolation valves for the Pressurizer steam space sample line failed to close when attempted from the Control Room. Evidence of internal binding (galling) of the valve was found. The root cause was determined to be inadequate design clearances to allow for thermal growth of internal valve components. That case involved a manufacturers valve defect (inadequate internal clearances) and was subsequently reported by the vendor (Flowserve Engineering) as a 10CFR Part 21. The current condition is not a repeat of that earlier condition.

ADDITIONAL INFORMATION

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [ ].