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December 16, 1994

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
Reporting of Licensee Event Report

Gentlemen:

Attached is Licensee Event Report Number LER-94-016-00 for Waterford Steam Electric Station Unit 3. This report is submitted as a Voluntary Licensee Event Report.

Very truly yours,

R.S. Starkey
Acting General Manager
Plant Operations

RSS/CJT/tjs
Attachment

cc: L.J. Callan, NRC Region IV
C.P. Patel, NRC-NRR
G.L. Florreich
J.T. Wheelock - INPO Records Center
R.B. McGehee
N.S. Reynolds
NRC Resident Inspectors Office
Administrator - LRPD

NRC FORM 366 (5-92)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 5/31/95
LICENSEE EVENT REPORT (LER) (See reverse side for required number of digits/characters for each block)		ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
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TITLE (4)
Lube Oil Flow to Emergency Diesel Turbocharger Under Loss of Control Air

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
07	21	94	94	--016--	00	12	16	94	N/A	05000

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR§: (Check one or more) (11)							
			20.402(b)		20.405(c)		50.73(a)(2)(iv)		73.71(b)
POWER LEVEL (10)	100		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)	X	OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
			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 (Include Are Code)
Michael Knebel, Emergency Diesel System Engineer	(504) 739-6602

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

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

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

Waterford 3 was informed by Cooper Energy Services ("Cooper" or "Cooper-Bessemer"), the vendor for the Emergency Diesel Generators (EDGs), that they could not locate documentation to prove that lube oil flow to a Cooper Model ET-18 turbocharger would be adequate upon loss of control air to assure that the turbocharger would survive a seven day run at full load. In response, Waterford 3 initiated a corrective action document, determined that the EDGs were operable, performed an engineering evaluation that confirmed the operability determination, and issued an Operations Standing Instruction to direct operator action to restore EDG control air pressure should it be lost. Additionally, the Cooper-Bessemer Owner's Group Technical Committee requested MPR Associates to perform test work on a Cooper Model ET-18 turbocharger. Test results indicate: (1) the Model ET-18 turbocharger can operate for at least seven days with a reduced oil-supply pressure, and (2) adequate time is available to take corrective action in the unlikely event control air is lost post-accident. This condition does not compromise the health and safety of the public. This is a Voluntary LER.

VOLUNTARY REPORT

This event is not reportable under the requirements of 10 CFR 50.72 and 10 CFR 50.73. However, Waterford 3 has elected voluntarily to submit this report. Waterford 3 believes that this event may be of generic interest to the NRC or to licensees with Model ET-18 turbochargers on diesel engines manufactured by Cooper Energy Services ("Cooper" or "Cooper-Bessemer").

INITIAL CONDITIONS

At the time this condition was identified, Waterford 3 was operating at approximately 100 percent power in Operational Mode 1 (Power Operation). Both Cooper Model KSV-16-T Emergency Diesel Generators (EDG; EIIS Identifier EK) were operable.

EVENT DESCRIPTION

The EDG system is arranged in two separate trains, Train A and Train B, each functionally identical to the other and capable of supplying all the power required by the various safety related loads. Each train performs its safety functions by starting on receipt of either a manual or automatic command signal, accelerating to rated speed, and accepting load as determined by the safety system requirements. The engine is started by compressed air, which is admitted to the cylinders in sequence. The engine will start to turn over and will accelerate under the pressure of the starting air. When sufficient speed is reached, fuel oil will be injected. The engine will begin to operate as a diesel and accelerate to a speed at which the starting air will be cut off. Further acceleration will bring the unit to its rated speed.

The engine draws its air for combustion of the fuel through an intake filter and a silencer downstream of the inlet to the turbocharger. The output of the turbocharger compressor is delivered to the left and right air intake manifolds through heaters/coolers, which ensure that the combustion air is at the correct temperature. Exhaust gases are discharged through the gas turbine part of the turbocharger to a silencer and thence to the outside air.

Lubricating oil is drawn from the engine sump by one of three pumps and delivered through a cooler, filter, and strainer to the engine bearing oil manifold. Part of the oil from the bearing manifold is diverted through a pair of filters and a pressure regulating valve (PCV-21) to the turbocharger bearings (see Figure 1). PCV-21 is biased by two times the blower discharge pressure. The bias signal is obtained from a 2:1 ratio relay which is supplied from the 30 psig engine control air header and driven by the blower discharge pressure. There is a 6 psig positive offset on the oil pressure regulator, so the actual oil pressure to the turbocharger is 6 psig at zero blower pressure, increases linearly to 35 psig at blower discharge pressure of 15 psig and is constant at 35 psig at higher discharge pressures.

While the diesel is running, PCV-21 will modulate to maintain turbocharger diesel lube oil pressure as described above. The differential pressure between turbocharger diesel lube oil pressure and combustion air header pressure is necessary to ensure that the pressurized inlet air stream does not enter the turbocharger bearing area and blow the lube oil away. In this scenario, the turbocharger bearings are susceptable to damage due to lube oil starvation. Too high of a differential pressure is not desirable, however, because excessive lube oil could get into the air stream and be carried to the intake manifolds.

Control air for operation of PCV-21 can come from two possible sources via high select shuttle valve PY-24. Normally, air from the left bank combustion air manifold enters a 2:1 ratio relay to throttle 30 psig control air going to the valve. If this air supply should be lost for some reason, the right bank combustion air manifold would then supply control air to PCV-21 via the shuttle valve.

In the event of a loss of control air pressure, high select shuttle valve PY-24 will change bias to one times blower discharge pressure. Thus at full engine load, the oil pressure to the turbocharger would drop from 35 psig under normal conditions to 21.7 psig upon loss of control air. Section 5 of the Cooper technical manual states, in part, "...if control air should be lost this pressure will reposition the shuttle valve and flow to the regulator, thus providing oil pressure to the turbocharger at a reduced but adequate rate."

By letter dated April 29, 1994, Cooper informed Waterford 3 that the above statement may be somewhat misleading. While reviewing their design files, Cooper failed to locate documentation to demonstrate that the lube oil flow to the Model ET-18 turbochargers would be adequate upon a loss of control air. This documentation was necessary to provide assurance that the turbocharger would survive a seven day run at full load with the lower oil pressure that would result from the control air loss.

In response to the Cooper letter, the EDG System Engineer initiated a corrective action document and immediately hand carried it to the Control Room. There, plant operators performed an operability assessment and determined that the EDGs were operable. Additionally, an engineering evaluation was conducted that confirmed the operability determination.

ANALYSIS OF THE EVENT

The engine control system is largely pneumatic, using starting air as the control medium. The unit control (including the generator and auxiliaries) is electrical, using DC Class 1E power from the associated division distribution panel. The control systems include provision for starting, operating, shutting down, and keeping the unit in readiness for starting as well as for monitoring the operating conditions (e.g., temperature, pressure, speed, voltage, load, etc.) and alarming or tripping as required on the occurrence of abnormal and dangerous conditions.

Each EDG has two dedicated starting air systems and associated valves and piping. Air systems are connected at the compressor discharge, but isolated by a normally closed valve. Each receiver is sized for five diesel engine starts without recharging. However, when in the emergency mode, the starting system will continue cranking until the engine starts or until both receivers are discharged. Should the diesel fail to start and a complete discharge of starting air occurs, a portable diesel driven air compressor can be temporarily connected to recharge the receivers. The starting air also supplies the engine pneumatic control system. Once started, however, the engine does not require air for continued operation. It does require air for automatic shutdown. The Starting Air system downstream of the compressors and dryers is Seismic Category I and Safety Class 3. This is a valid design since the accumulators are maintained with sufficient air for necessary EDG starts without reliance on the compressors and air dryers post-accident. Control air was assumed not to be necessary in the emergency mode of the EDG and therefore not required post accident.

A check valve located at the inlet connection to each receiver ensures that any failure of the piping or equipment in the compressor or air dryer systems will not immediately bleed the receiver, thus ensuring that starting air is always available. A pressure switch gives an alarm when the pressure falls below the 240 psig setpoint. The compressors are started and stopped by a pressure controller to maintain receiver pressure. The engine starting system air receivers and essential piping and valves are manufactured in accordance with ASME Boiler and Pressure Vessel code Section III Class 3 Summer 1973 Addenda.

If the 30 psig control air is lost while the EDG is operating in the test mode, the engine will automatically shut down, so there is no concern for the turbocharger bearing in this case. In the emergency mode, however, the shutdown feature is locked out. The engine control panel will still indirectly alarm the loss of control air since several shutdowns would be annunicated.

The Cooper disclosure that control air may be necessary to maintain long term lubrication of the turbocharger as discussed leads to the conclusion that a safety function may need to be assigned to maintaining EDG control air post-accident and that measures are necessary to ensure that EDG control air can be restored should it be lost.

In determining EDG operability in light of this situation, the following factors were taken into account:

1. Observations were made on the starting air compressor cycling frequencies. These frequencies were used to determine EDG starting air system losses and then to calculate durations for which the starting air accumulators could be expected to continue to support control air in the event the compressors were not available. A minimum initial pressure of 160 psig and a final pressure of 30 psig were used. The minimum initial pressure was selected based on two assumptions. First, although the air start receivers are sized for five EDG starts, this is a receiver sizing requirement, not a design requirement. Therefore, only one normal EDG start is assumed to be necessary. Second, after a single EDG normal start, with no recharging by the air start compressors, air start receiver pressures will be no lower than 160 psig. The final pressure of 30 psig was selected since this is the minimum required control air pressure for PCV-21. The resulting calculation determined a minimum of 6.9 hours for EDG Train A and 9.1 hours for EDG Train B.

2. Cooper stated in a letter faxed to Waterford 3 on July 21, 1994, that they "expect the turbocharger to operate satisfactorily with the reduced oil pressure for a period of at least 4 hours."

These two factors lead to the following conclusion: should EDG control air recharge capability be lost post-accident and an EDG is required to supply safety related loads, then adequate time is available -- 11 hours for Train A and 13 hours for Train B -- to take corrective action without damaging the turbocharger.

Although the air compressors and air dryers are non-safety related, they have a high degree of reliability inherent in their design. The air compressors and air dryers are Seismic Category 1. Additionally, the air compressors receive safety related power from Motor Control Centers 312A and 312B. Therefore, there is a high degree of assurance that they would in fact be available post-accident and that control air would not be lost. This is further substantiated by Waterford 3's understanding that Cooper has no knowledge of a turbocharger failure due to a loss of control air.

CAUSAL FACTORS

The root cause of this event is Cooper's failure to locate documentation that provides assurance that the ET-18 Turbocharger will survive a seven day run at full load with the lower oil pressure that would result from a loss of control air.

CORRECTIVE MEASURES

In addition to the corrective actions mentioned previously, an Operations Standing Instruction was initiated to direct operations personnel to restore EDG control air pressure by: (1) use of a portable diesel air compressor designated in the emergency operating instruction for "Station Blackout" to recharge the air start receivers as necessary, (2) use of a cross-connection to the instrument air system, and (3) use of portable nitrogen cylinders with pressure reducing regulators to recharge the air recievers.

The Cooper-Bessemer Owners Group Technical Committee requested MPR Associates to perform test work on a Cooper Model ET-18 turbocharger to determine its ability to operate successfully with significantly reduced lubricating oil supply pressures. In response, a 24-hour test was performed at the Summer Municipal Light Plant in Summer, Iowa where a Model ET-18 turbocharger is installed on a Cooper Model KSV 12-GDT diesel. The test involved starting the diesel engine and operating for approximately 1 hour to warm it up. Operators then manually adjusted the engine control air pressure supply to the turbocharger lubricating oil pressure regulator to reduce the normal lube oil pressure of 28 psig at rated load to pressures ranging from 20 to 14.5 psig. The diesel engine's turbocharger was run for a total of 24 consecutive hours with the reduced lube oil pressure. A portion of the test involved operation at varying load conditions.

According to MPR Associates, test results showed: (1) the turbocharger was able to maintain required intake manifold boost pressures under all conditions, (2) turbocharger speed did not vary at rated load by more than plus or minus 200 rpm, (3) turbocharger impeller axial clearance (a thrust bearing wear indication) did not vary by more than plus or minus 0.2 mils regardless of generator load, and (4) there were no indications of increases in wear metals before and after lube oil samples.

Given the test results, MPR Associates concluded that the testing demonstrated that during prolonged emergency mode operation, the Model ET-18 turbocharger is capable of operating satisfactorily in the event engine control air pressure is lost, and Cooper Model KSV 16-cylinder diesel engines are capable of supplying emergency electrical power at nuclear power plants.

After reviewing the test results, Cooper concluded in a letter dated December 8, 1994, that the Model ET-18 turbocharger can operate much longer than 24 hours with a reduced oil-supply pressure. Although the time of operation beyond 24 hours could not be explicitly determined, Cooper reasonably expects that time to be at least seven days. If operation for more than seven days is required, Cooper believes it would be prudent for plants to have compensatory measures in place in the event control air is lost. Furthermore, Cooper believes that the test results prove that there would be adequate time to take corrective actions without damage to the turbocharger provided the necessary controls are in place.

Waterford 3 will enter the test documentation and associated letters into the document control system for future retrieval. Additionally, Waterford 3 will continue to work with the Cooper-Bessemer Owner's Group to determine what additional corrective actions, if any, should be taken.

SAFETY SIGNIFICANCE

Potential impacts on post-acident response from this condition are considered minimal. No single failure can cause a loss of control air to both trains. Additionally, each train has reliable, redundant starting air systems of adequate capacity. Analyses indicate that the probability of one air receiver failing during a seven day period is 1.0E-4. The probability of two air receivers failing during a seven day period is 1.0E-5. Operations procedures already exist to accomodate use of the "Station Blackout" portable diesel air compressor. A Standing Instruction is in place that directs operations personnel to restore EDG control air pressure should it be lost. The established minimum accumulator durations for Instrument Air and Nitrogen accumulators that support safety-related air-operated valves is 10 hours in order to provide sufficient time for operator post-accident response. The minimum times that starting air accumulators could be expected to continue to support control air in the event the compressors are not available are enveloped by this duration. Therefore, this condition does not compromise the health and safety of the public.

SIMILAR EVENTS

No previous similar events were identified.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

(See reverse side for required number of digits/characters for each block)

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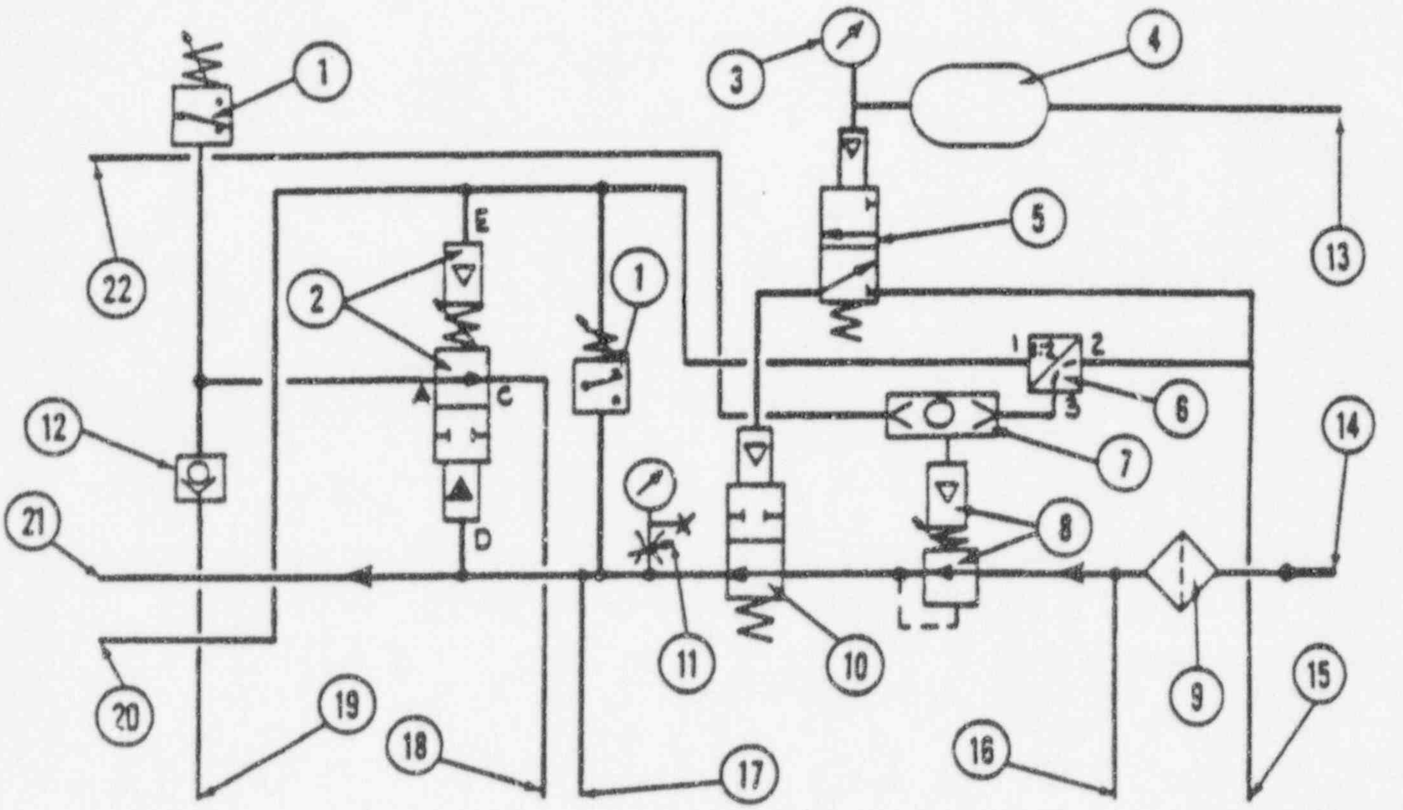
TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Figure 1 -- Turbocharger Lube Oil Schematic



1. Pressure Switch
2. Low L.O. Trip
3. Pressure Gauge
4. Volume Bottle
5. Post Lube Control
6. Ratio Relay
7. Shuttle Valve
8. Oil Pressure Regulator
9. Oil Filter
10. Post Lube Control Vlv.
11. Pressure Indicator and Needle Valve
12. Check Valve
13. From Fuel Control Air
14. L.O. Supply
15. From Control Air Header
16. To Trip Switches
17. To Pressure Gauge
18. To Lockout
19. From Control Air
20. From Combustion Air Manifold L.B.
21. To Turbo Bearings
22. From Combustion Air Manifold R.B.