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# Loss of Vital AC Power and the Residual Heat Removal System During Mid-Loop Operations at Vogtle Unit 1 on March 20, 1990

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In the matter of Georgia Power Co. et al., Vogtle Units 1 & 2
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Date 07-06-95 Witness Mosbaugh

# APPENDIX I

## CALCON SENSOR FAILURE DATA

# APPENDIX I CONTENT

# APPENDIX I

## CALCON SENSOR FAILURE DATA

The inadvertent shutdown or trip of the emergency diesel generator at Vogtle was caused by malfunctions of a number of Calcon sensors. In an effort to determine if the experience with Calcon sensor problems is unique to Vogtle, failures of sensors at other plants were evaluated. The Nuclear Plant Reliability Data System (NPRDS) is a an electronic database designed to allow comparison of failure rates for similar equipment.

## 1 NUCLEAR PLANT RELIABILITY DATA SYSTEM

The NPRDS database is an industry wide system for monitoring the performance of selected nuclear power plant components that are important to safe and reliable plant operation. NPRDS is managed by the Institute of Nuclear Power Operations (INPO). The performance information is obtained from reports submitted by participating utilities for components that fail to perform their intended functions. These failure reports, along with information about the component design characteristics and operating history, are used by utilities in many different applications. Among the applications are (1) early identification of increasing failure trends or unusual failure patterns, (2) equipment reliability calculations, and (3) location of equipment spare parts.

The data contained in the NPRDS database is entered, as appropriate, in the following records:

- **Unit Record:** This record contains information about the nuclear power plant reporting to NPRDS, such as the name of the reactor supplier and the reactor power rating in thermal megawatts.

- **System Engineering Record:** This record contains information about a reportable system at a particular unit, such as an identification number of the system drawing and the date the system was put into service.

- **Component Engineering Record:** This record contains information about a piece of reportable equipment installed at a particular unit, such as the type of component, pump or valve, the date the component was placed in service, and the manufacturer of the component.

- **Component Failure Record:** This record contains information about a component failure at a particular unit, such as the date the failure occurred, the effect of the failure on the system and unit, and a description of the failure.

Data about the emergency diesel generator and support systems are reportable to NPRDS. Once the plant starts reporting failure data to the database, the system and component engineering records are submitted for all components. Engineering records are not submitted

for individual parts, "piece parts" of components. Component failure records are submitted when the component failure occurs. Piece parts that fail are not reported unless the failure causes the component to fail.

The following is a summary of NPRDS reporting guidelines:

- Engineering data for instrumentation components that perform an automatic control or safety function in any reportable system must be reported.

- Function failures on reportable components available for operation that occurred after January 1, 1984, or after a plant's commercial service date for plants placed in service after January 1, 1984, are reportable.

- Function failures that occur on components not available for operation (e.g., failures during maintenance that are as a result of the maintenance and are repaired before the component is again made available for operation) are not reportable.

- Function failures that are discovered during maintenance and are not a result of the maintenance are presumed to have occurred before the maintenance activity and are reportable.

- Function failures that are discovered when a component is available for operation or is being operated that are a result of previous maintenance activities are reportable.

The key to proper reporting of components and failures is the classification of an item as either a component or a piece part of a component. A function failure is a failure of the reportable component to perform its function. For example, if a reportable system uses a two-out-of-four sensor trip logic to shut down the system, the following apply:

- each sensor is a reportable component

- a sensor failure that does not cause a shutdown of the system is reportable as a sensor function failure

- two or more sensor failures that cause a shutdown of the system are each reportable as sensor function failures

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Information on reporting is found in the following INPO documents:[1]

- INPO 83-020, "NPRDS Reportable System and Component Scope Manual," Revision 3
- INPO 89-001, "NPRDS Reporting Guidance Manual"

## 2 INDUSTRY EXPERIENCE WITH CALCON SENSORS IN DIESEL GENERATOR TRIP CIRCUITS

The Vogtle emergency diesel generators were manufactured by Transamerica Delaval currently know as Imo, Delaval Inc., Enterprise Engine Division. Eleven operating nuclear plants have Delaval diesel generators. All Delaval diesel generators use sensors manufactured by Calcon in the engine pneumatic control system to trip the engine when various parameters are outside of specific limits.

The NPRDS reporting requirements for diesel generators are summarized in Table I.1. Some of the Calcon sensors are used in the diesel generator control logic to shut down the diesel generator when the various sensors actuate in any of the following operating modes:

- loss of off-site power actuation
- safeguard actuation
- normal actuation

When sensors are used in the control logic that is active in any of these actuation modes, the sensors and failures are reportable to NPRDS as components of the diesel generator. Six of the eleven nuclear plants reported engineering records for the Calcon sensors thus indicating Calcon sensor failures at these plants would be reported independent of the failures effect on the diesel generator.

There were thirty-two reports involving Calcon sensor failures in NPRDS. Thirty of the failures were reported as component failures of the Calcon sensors. The remaining two failures were reported as engine failures because the sensors were considered piece parts. These reports included thirteen emergency diesel generator trips during testing. Two of the failures were not attributed to Calcon sensor problems, but, because of the intermittent problem noted, could have been caused by the Calcon sensors. Twenty-four of the failure reports were for pressure sensors and eight of the failure reports were for temperature sensors. Failures have been reported by 5 of the 11 operating nuclear power plants which have emergency diesel generators with Calcon trip sensors.

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[1] Institute of Nuclear Power Operations (INPO) documents are referenced and summarized in this report with the permission of INPO. These INPO documents are classified under INPO copyright as Limited Distribution and are only available to INPO members and participants.

## Table I.1 NPRDS Scope of Reporting for Emergency Diesel Generators

For a diesel generator-powered, emergency power system, components in the following subsystems are reportable:

**Emergency Power System***

- engine
- engine governor
- generator
- generator output breaker

**Diesel Starting Air Subsystem**

- air start compressor
- air start compressor motor
- air start compressor motor circuit breaker

**Diesel Cooling Water Subsystem**

- surge tank
- circuit breakers in control circuits
- heat exchangers
- heaters
- instruments that provide an automatic control or safety function
- motors
- pumps
- valves
- valve operators

**Diesel Fuel Oil Subsystem**

- day tank
- circuit breakers
- filters
- instruments that provide an automatic control or safety function
- motors
- pumps
- valves
- valve operators

**Diesel Lube Oil Subsystem**

- circuit breakers
- filters
- heat exchangers
- heaters
- instruments that provide an automatic control or safety function
- motors
- pumps
- valves
- valve operators

* All components that control the normal, as well as emergency, starting and stopping of the diesel generator system; including all trips, even those bypassed during a loss of off-site power or a safeguard actuation, are reportable in this system.

Thirty-two failures of Calcon temperature and pressure sensors have been reported since January 1, 1984. The following are summaries of the failure report submitted by the plants to NPRDS:[2]

## 2.1 Grand Gulf (3/24/84)

During engineered safeguard features testing, the diesel generator failed to start. Cause of the failure to start is unknown. Subsequent attempts to duplicate the failure were unsuccessful. The diesel generator started and ran eleven subsequent times with no failures. The problem was reported as a diesel failure, but may have been caused by a sensor failure.

## 2.2 Grand Gulf (5/5/84)

A diesel generator would not start during a surveillance test. The engine rolled one revolution and stopped, apparently from a trip signal. The problem could not be duplicated. The diesel generator started and ran ten subsequent times with no failures. The problem was reported as a diesel failure, but may have been caused by a sensor failure.

## 2.3 Grand Gulf (4/27/85)

During a diesel generator maintenance retest, a pressure sensor was found to be leaking air. The leaking sensor could prevent the diesel engine from tripping on overspeed. The Calcon sensor (part number F-573-156) was found to have a dirty valve seat that allowed the valve to leak.

## 2.4 Catawba 1 (11/23/86)

A diesel generator tripped during an operability test. The Calcon low lube oil pressure sensor (Model B4400) was out of calibration.

## 2.5 Catawba 2 (5/11/87)

During a weekly operability test, the diesel generator tripped because of high cooling water temperature and high crankcase pressure sensor trip signals. Cause of the Calcon temperature sensor (part number F-573-330) being out of calibration was not determined. The Calcon crankcase pressure sensor (Model B4417) trip setpoint was out of calibration. Cause of the setpoint drift was not determined.

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### 2.6 Catawba 2 (5/12/87)

A diesel generator tripped because of a high crankcase pressure sensor trip signal. The Calcon crankcase pressure sensor (Model B4417) trip setpoint was found out of specification. Cause of the setpoint drift was not determined. The pressure sensor was replaced.

### 2.7 River Bend 1 (11/9/87)

During a refueling outage, a high jacket water temperature diesel generator trip signal was received from a Calcon temperature sensor (Model A3500). As a result of normal wear and aging, the sensor's integrity was compromised.

### 2.8 Catawba 1 (3/22/88)

A diesel generator tripped during an operability test. Failure could not be duplicated. The diesel engine started several times without failure. Cause later determined to be failure of a Calcon low lube oil pressure sensor (Model B4400).

### 2.9 Catawba 1 (4/12/88)

A diesel generator tripped during an operability test. Failure could not be duplicated. The diesel engine started several times without failure. Cause later determined to be failure of a Calcon low lube oil pressure sensor (Model B4400).

### 2.10 Catawba 2 (4/12/88)

A diesel generator tripped during surveillance testing. Two Calcon low lube oil pressure sensors (Model B4400) had failed. Both sensors were replaced. Evidence of corrosion was present on the sensors. Therefore, air compressor blowdown frequency was increased.

### 2.11 Catawba 1 (4/19/88)

A diesel generator tripped during an operability test. A Calcon pressure sensor (Model B4400) in the diesel generator control panel failed.

### 2.12 Catawba 1 (4/25/88)

A diesel generator tripped during an operability test. A Calcon pressure sensor (Model B4400) in the diesel generator control panel failed.

### 2.13 Catawba 1 (5/5/88)

A diesel generator tripped during an operability test. A Calcon pressure sensor (Model B4400) in the diesel generator control panel failed. Analysis of this sensor failure and

the previous sensor failures determined that a sensor design flaw existed. The design flaw was related to loss of sensor movement as a result of mechanical interference caused by tolerance stack-up. The Calcon Model B4400 sensors were replaced with Model B4400B sensors.

### 2.14 Catawba 2 (8/9/88)

Two Calcon low turbo lube oil pressure sensors (Model B4400B) were discovered with a trip setpoint out of specification. One Calcon low lube oil inlet pressure sensor (Model B4400B) was discovered out of specification. Cause of the setpoint drifts was not determined.

### 2.15 Catawba 1 (8/11/88)

Three diesel generator Calcon low lube oil pressure sensors (Model B4400B) were discovered with trip setpoints out of specification. One Calcon crankcase high pressure sensor (Model B4417) was discovered with a trip setpoint out of specification. Cause of the setpoint drifts was not determined.

### 2.16 Catawba 1 (8/15/88)

One diesel generator Calcon crankcase high pressure sensor (Model B4417) was discovered with a trip setpoint out of specification. One Calcon low turbo lube oil pressure sensor (Model B4400B) was discovered with a trip setpoint out of specification. One Calcon jacket cooling water temperature sensor (part number F-573-330) trip setpoint was found out of specification. Cause of the setpoint drifts was not determined.

### 2.17 Catawba 1 (10/25/88)

A diesel generator tripped during an operability test. A turbo lube oil Calcon pressure sensor was found to be venting continuously. Actual cause of sensor failure was not determined. The plant initiated a design modification request to replace all pneumatic devices in the diesel engine control system with electronic controls.

### 2.18 Catawba 1 (12/2/88)

One Calcon crankcase high pressure sensor (Model B4417) was discovered with a trip setpoint out of specification. One Calcon jacket cooling water temperature sensor (part number F-573-330) trip setpoint was found out of specification. Cause of the setpoint drifts was not determined.

### 2.19 Catawba 1 (12/19/88)

One diesel generator Calcon jacket cooling water temperature sensor (part number F-573-330) was discovered failed. Cause of the sensor failure was not determined.

### 2.20 Grand Gulf (3/25/89)

During a refueling outage maintenance run, a diesel generator tripped because of a high crankcase pressure sensor trip signal. The indication for crankcase pressure was normal. The cause of the trip signal was a cracked orifice on the crankcase pressure sensor (Model B3337A).

### 2.21 Shearon Harris (7/5/89)

A diesel generator tripped during the monthly surveillance test. A Calcon high temperature sensor (Model A-3500-W3) for lube oil tripped. The normal trip setpoint is 195 plus or minus 5 °F. The indicated lube oil temperature was 177 °F.

### 2.22 Catawba 1 (8/8/89)

A diesel generator tripped during functional testing following modification of the lube oil system. Two Calcon high temperature sensors (Model A3500-W3) for engine bearings tripped. The sensor failures were attributed to normal drift of the trip setpoint resulting from sensor age and constant vibration. The normal operating temperature is within 10 °F of the trip setpoint.

### 2.23 Shearon Harris (11/26/89)

A diesel generator low lube oil pressure sensor trip setpoint was found out of tolerance. The Calcon sensor (Model B4400) trip setpoint could not be adjusted in specification and the sensor was replaced. Cause for the sensor failure could not be found.

## 3 VOGTLE EXPERIENCE WITH CALCON SENSORS IN DIESEL GENERATORS TRIP CIRCUITS

Vogtle did not report the Calcon sensors as component engineering records to NPRDS. The NPRDS database also contained no diesel generator failure reports for Vogtle. The analysis of maintenance work orders indicated that Vogtle experiencd 69 Calcon sensor failures and they should have submitted approximately 39 failure reports to NPRDS (since the date of commercial operation). For Calcon sensor failures from 1985-1990, 47 were for temperature sensors and 14 were for pressure sensors. In 17 cases, the temperature sensor setpoints were discovered to be low during testing, the direction that can result in an unwarranted diesel generator trip. The Vogtle Calcon sensor failures as compared to the industry failures reported in NPRDS are summarized on Table I.2 for all Vogtle failures and Table I.3 for Vogtle failures reportable to NPRDS.

The following are summaries of the failures that occurred at Vogtle:

### 3.1 Vogtle 1 (8/14/85)

A Calcon lube oil pressure sensor (Model B4400) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.2 Vogtle 1 (8/17/85)

A Calcon jacket water high temperature sensor (Model A3500-W3) was discovered during construction acceptance testing with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.3 Vogtle 1 (8/17/85)

A Calcon lube oil low pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.4 Vogtle 1 (8/19/85)

A Calcon lube oil low pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.5 Vogtle 1 (8/19/85)

A Calcon jacket water low pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.6 Vogtle 1 (8/20/85)

A Calcon jacket water high temperature sensor (Model A-3500-W3) during construction acceptance test was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.7 Vogtle 1 (8/20/85)

A Calcon jacket water high temperature sensor (Model A-3500-W3) during construction acceptance testing was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.8 Vogtle 1 (8/24/85)

A Calcon low turbo oil pressure sensor (Model B4400) during construction acceptance testing was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.9 Vogtle 1 (10/28/85)

Three Calcon jacket water high temperature sensors (Model A-3500-W3) were discovered with a setpoint out of calibration low and were recalibrated. The cause of the setpoint drift was not determined.

### 3.10 Vogtle 1 (11/14/85)

A Calcon jacket water high temperature sensor (Model A-3500-W3) failed and was replaced. The cause of the failure was not determined.

### 3.11 Vogtle 1 (12/10/85)

A Calcon jacket water high temperature sensor (Model A-3500-W3) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.12 Vogtle 1 (12/11/85)

A Calcon jacket water high temperature sensor (Model A-3500-W3) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.13 Vogtle 1 (2/11/86)

A Calcon lube oil low pressure sensor (Model A-3500-W3) was found with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.14 Vogtle 1 (12/22/86)

A Calcon lube oil low pressure sensor (Model B4400) would not calibrate in specification and was replaced. The cause of the malfunction was not determined.

### 3.15 Vogtle 2 (1/24/88)

A Calcon vibration switch sensor (Model E4600) was found defective and replaced with new vibration switch. The cause of the malfunction was not determined.

### 3.16 Vogtle 2 (2/5/88)

A Calcon low tubo oil pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.17 Vogtle 2 (2/26/88)

A Calcon lube oil high temperature sensor (Model A-3500-W3) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.18 Vogtle 2 (4/13/88)

A Calcon vibration detector sensor (Model E4600) was replaced due to a defective switch. The cause of the defective switch was not determined.

### 3.19 Vogtle 2 (04/21/88)

A Calcon jacket water high temperature sensor (Model A-3500-W3) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.20 Vogtle 2 (4/24/88)

Three Calcon high jacket water temperature sensors (Model A-3500-W3) were discovered with setpoint out of specification low and were recalibrated. The cause of the setpoint drift was not determined.

### 3.21 Vogtle 2 (7/22/88)

Three Calcon jacket water high temperature sensors (Model A-3500-W3) were discovered with a setpoint out of calibration low and were recalibrated. The cause of the setpoint drift was not determined.

### 3.22 Vogtle 1 (9/30/88)

Three Calcon jacket water header outlet temperature sensors (Model A-3500-W3) were discovered with a setpoint out of calibration (2 high, 1 low) and were recalibrated. The cause of the setpoint drifts was not determined.

### 3.23 Vogtle 1 (10/10/88)

Ten Calcon bearing high temperature sensors were found to be defective and were replaced. The cause of the malfunction was not documented.

### 3.24 Vogtle 1 (10/18/88)

A Calcon jacket water high temperature sensor was discovered out of calibration high and was recalibrated. The cause of the calibration drift was not determined.

### 3.25 Vogtle 1 (10/19/88)

A Calcon jacket water high temperature sensor (Model A-3500-3W) was not working properly and was replaced. The reason for the switch malfunctioning was not documented.

### 3.26 Vogtle 1 (10/20/88)

A Calcon low lube oil pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.27 Vogtle 1 (10/20/88)

A Calcon jacket water header pressure sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.28 Vogtle 1 (10/21/88)

A Calcon low lube oil pressure sensor (Model B4400) was discovered with setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.29 Vogtle 1 (10/23/88)

Two Calcon normal trip pressure sensors (Model B4400) failed. One sensor would not respond and the other failed to reset within tolerance. The cause of the failures were not documented.

### 3.30 Vogtle 1 (10/26/88)

A Calcon jacket water header outlet temperature sensor (Model A-3500-W3) switch would not calibrate. The cause of the failure was not determined.

### 3.31 Vogtle 1 (10/30/88)

Two Calcon jacket water temperature sensors (Model A-3500-W3) were found to be defective and were replaced. The cause of the failures was not documented.

### 3.32 Vogtle 1 (10/31/88)

Two Calcon jacket water header outlet temperature sensors (Model A-3500-W3) were replaced. The reason was not documented.

### 3.33 Vogtle 2 (12/9/88)

A Calcon vibration sensor (Model E4600A) was malfunctioning causing the emergency diesel generator to trip. The sensor was replaced. The cause of the malfunction was not documented.

### 3.34 Vogtle 1 (11/19/89)

A Calcon high jacket water temperature sensor (Model A-3500-W3) was discovered with a setpoint out of calibration low and was recalibrated. The cause of the setpoint drift was not determined.

### 3.35 Vogtle 1 (12/5/89)

A Calcon lube oil pressure sensor (Model B4400) was found defective during a calibration check and was replaced with a new switch. The cause of the failure was not documented.

### 3.36 Vogtle 1 (1/3/90)

A Calcon turbo oil pressure sensor (Model B4400B) was venting and was replaced. Cause of the failure was not determined.

### 3.37 Vogtle 1 (1/25/90)

A Calcon lube oil temperature sensor (Model A-3500-3W) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.38 Vogtle 1 (1/25/90)

Three Calcon jacket water header outlet temperature sensors (Model A-3500-W3) were discovered with setpoints out of calibration high and were recalibrated. The cause of the setpoint drifts was not determined.

### 3.39 Vogtle 1 (3/3/90)

A Calcon jacket water low pressure trip sensor (Model B4400) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.40 Vogtle 1 (3/4/90)

A new Calcon high temperature main bearing sensor (Model 3434) switch was installed. The reason the new switch was needed was not documented.

### 3.41 Vogtle 1 (3/23/90)

Three Calcon jacket water header outlet temperature sensors (Model A-3500-3W) were checked for calibration. Two switches were found out of calibration. One switch did not pass the bubble test and was replaced. The other two were recalibrated.

### 3.42 Vogtle 1 (3/25/90)

A Calcon lube oil high temperature sensor (Model A-3500-3W) was discovered with a setpoint out of calibration high and was recalibrated. The cause of the setpoint drift was not determined.

### 3.43 Vogtle 1 (3/25/90)

A Calcon start logic air pressure sensor (Model B4400) was found malfunctioning during a surveillance procedure. The defective sensor was replaced The defective switch was subsequently tested satisfactorily. The cause of the malfunction was not determined.

## 4 OPERATING EXPERIENCE REPORTS OF CALCON SENSOR PROBLEMS

The industry has experienced some problems with Calcon pressure and temperature sensors as discussed in the 10 CFR Part 21 report submitted to the NRC by Imo Delaval, Inc., on April 29, 1988, and their addendum submitted on May 12, 1988. The initial report stated that recent field failures had occurred in air start valves and the lube oil pressure, jacket water temperature, and crankcase pressure sensors. Imo Delaval, Inc., requested that all spare sensors be returned to them. Although the report did not request that installed sensors be removed, the report did recommend implementing a surveillance plan. The addendum report discussed a problem with Calcon lube oil pressure sensor trip setpoints caused by stack-up of the mechanical dimension tolerances in the sensor. The report also stated tha. a new sensor configuration corrected the problem.

**Vogtle response:** When the Part 21 reports on Calcon sensors was received, the plant returned the spare parts stored in the warehouse to the diesel generator manufacturer. In addition, the reported problem with the sensors was evaluated as not representing a reportable condition as defined by 10 CFR 50.73 because the problem has no effect on the operability of the diesel generator. The problem was determined to impact the reliability of spare parts. The recommendation in the initial Part 21 report to implement a surveillance plan for the sensors was not evaluated.

**Table I.2 Total Vogtle Experience vs. Industry (NPRDS) Experience for Calcon Sensor Failures**

| | Number of Failures (Vogtle/Industry) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sensor Service | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Total |
| High Jacket Water Temperature | -/0 | 9/0 | 0/0 | 0/2 | 17/3 | 1/0 | 6/- | 33/5 |
| High Lube Oil Temperature | -/0 | 0/0 | 1/0 | 0/0 | 1/0 | 0/1 | 2/- | 4/1 |
| High Bearing Temperature | -/0 | 0/0 | 0/0 | 0/0 | 10/0 | 0/2 | 1/- | 11/2 |
| High Crankcase Pressure | -/0 | 0/0 | 0/0 | 0/2 | 0/3 | 0/1 | 0/- | 0/6 |
| Low Lube Oil Pressure | -/0 | 3/0 | 1/1 | 0/0 | 2/7 | 1/1 | 0/- | 7/9 |
| Low Turbo Oil Pressure | -/0 | 1/0 | 0/0 | 0/0 | 1/3 | 0/0 | 1/- | 3/3 |
| Low Jacket Water Pressure | -/0 | 1/0 | 0/0 | 0/0 | 1/0 | 0/0 | 1/- | 3/0 |
| High Vibration | -/0 | 0/0 | 0/0 | 0/0 | 3/0 | 0/0 | 0/- | 3/0 |
| Overspeed | -/0 | 0/1 | 0/0 | 0/0 | 0/0 | 0/0 | 0/- | 0/1 |
| Air Trip Valve (P3) | -/0 | 0/0 | 0/0 | 0/0 | 2/3 | 0/0 | 1/- | 3/3 |
| Unknown | -/2 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/- | 0/2 |
| Total | -/2 | 14/1 | 2/1 | 0/4 | 37/19 | 2/5 | 12/- | 67/32 |

**Table I.3 Vogtle Experience vs. Industry Experience for Calcon Sensor Failures Reportable to NPRDS**

| | Number of Failures (Vogtle/Industry) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sensor Service | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Total |
| High Jacket Water Temperature | -/0 | 0/0 | 0/0 | 0/2 | 10/3 | 1/0 | 6/- | 17/5 |
| High Lube Oil Temperature | -/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/1 | 2/- | 2/1 |
| High Bearing Temperature | -/0 | 0/0 | 0/0 | 0/0 | 10/0 | 0/2 | 1/- | 11/2 |
| High Crankcase Pressure | -/0 | 0/0 | 0/0 | 0/2 | 0/3 | 0/1 | 0/- | 0/6 |
| Low Lube Oil Pressure | -/0 | 0/0 | 0/1 | 0/0 | 2/7 | 1/1 | 0/- | 3/9 |
| Low Turbo Oil Pressure | -/0 | 0/0 | 0/0 | 0/0 | 0/3 | 0/0 | 1/- | 1/3 |
| Low Jacket Water Pressure | -/0 | 0/0 | 0/0 | 0/0 | 1/0 | 0/0 | 1/- | 2/0 |
| High Vibration | -/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/- | 0/0 |
| Overspeed | -/0 | 0/1 | 0/0 | 0/0 | 0/0 | 0/0 | 0/- | 0/1 |
| Air Trip Valve (P3) | -/0 | 0/0 | 0/0 | 0/0 | 2/3 | 0/0 | 1/- | 3/3 |
| Unknown | -/2 | 0/0 | 0/0 | 0/0 | 0/0 | 0/0 | 0/- | 0/2 |
| Total | -/2 | 0/1 | 0/1 | 0/4 | 25/19 | 2/5 | 12/- | 39/32 |