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February 14, 2014

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Subject: 10CFR21 Reporting of Defects and Non-Compliance -
Engine Systems, Inc. Report No. 10CFR21-0111, Rev. 0

Starting Air Pressure Regulator, Nordberg P/N 1776 506

Dear Sir:

The enclosed report addresses a reportable notification on a starting air pressure regulator, Nordberg P/N 1776 506, for Duke Energy Progress, Inc. - Brunswick Nuclear Plant.

A copy of the report has been mailed to our affected nuclear customer.

Please sign below, acknowledging receipt of this report, and return a copy to the attention of Document Control at the address above (or, fax to number 252/446-1134) within 10 working days after receipt.

Yours very truly,

ENGINE SYSTEMS, INC.

Susan Woolard

Susan Woolard
Document Control

Please let us know if ANY of your mailing information changes - name of recipient, name of company/facility, address, etc. Mark the changes on this acknowledgment form and send to us by mail or FAX to the number above.

RECEIVED: _____

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ENGINE SYSTEMS, INC.
175 Freight Road, Rocky Mount, NC 27804
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Report No. 10CFR21-0111
Rev. 0: 02/14/14

10CFR21 REPORTING OF DEFECTS AND NON-COMPLIANCE

COMPONENT: Starting Air Pressure Regulator
Nordberg P/N 1776 506

SYSTEM: Emergency Diesel Generator

CONCLUSION: Reportable in Accordance With 10CFR21

Prepared By: _____ (for Engineering Manager) Date: 2/14/14

Reviewed By: _____ Quality Manager Date: 2-14-14

REV	DATE	PAGE	DESCRIPTION
0	02/14/14		Initial issue.

Component:

Starting air pressure regulator (Nordberg P/N 1776 506).

Summary:

Engine Systems Inc. (ESI) began a 10CFR21 evaluation on 12/13/13 upon completion of a failure analysis performed on a pressure regulator part number 1776 506 (S/N 20776487) that was returned by Brunswick Nuclear Plant (BNP) following a failure that occurred during post-installation pressure testing on their emergency diesel generator set. The downstream pressure would not maintain its set point and began to equalize to the inlet pressure.

This evaluation was concluded on 02/10/14 and it was determined that this issue is a reportable defect as defined by 10CFR Part 21. The failure to regulate downstream pressure is attributed to an o-ring within the piston guide assembly of the pressure regulating valve that was improperly installed at the factory. Failure of the o-ring's pressure boundary allows inlet pressure to leak to the outlet pressure side eventually causing equalization to occur. This equalization is undesirable since it could lead to pressures that exceed the capabilities of the engine's downstream air start solenoid valve; thereby potentially preventing the diesel engine from starting during an emergency event and performing its safety related function.

Discussion:

BNP is the only known site that uses this particular part number pressure regulator for safety-related service. Within the starting air system there are two regulators, one for each starting air tank, that step down pressure from 350 psig to 250 psig. This nominal 250 psig air pressure is then supplied to the starting air solenoid valves which are actuated during an engine start to supply air for the starting air system. In the event the starting air supply exceeds 250 psig, of main concern is that the starting air solenoid valve is rated for a maximum pressure differential of 300 psid and any pressure 300 psig or greater (with zero downstream pressure) may prevent the valve from actuating.

The conclusion of ESI's failure analysis was that an o-ring within the piston guide assembly of the pressure regulating valve had been improperly installed at the factory. The o-ring was squeezed to the point that when the mating piston was inserted through the o-ring, material was shaved from the inside diameter of the o-ring, compromising its sealing capability. This debris ultimately migrated through the piston; however it was the damaged sealing surface of the o-ring that led to the regulator failure. See Figures 1 through 6 on the following pages for a visual depiction.

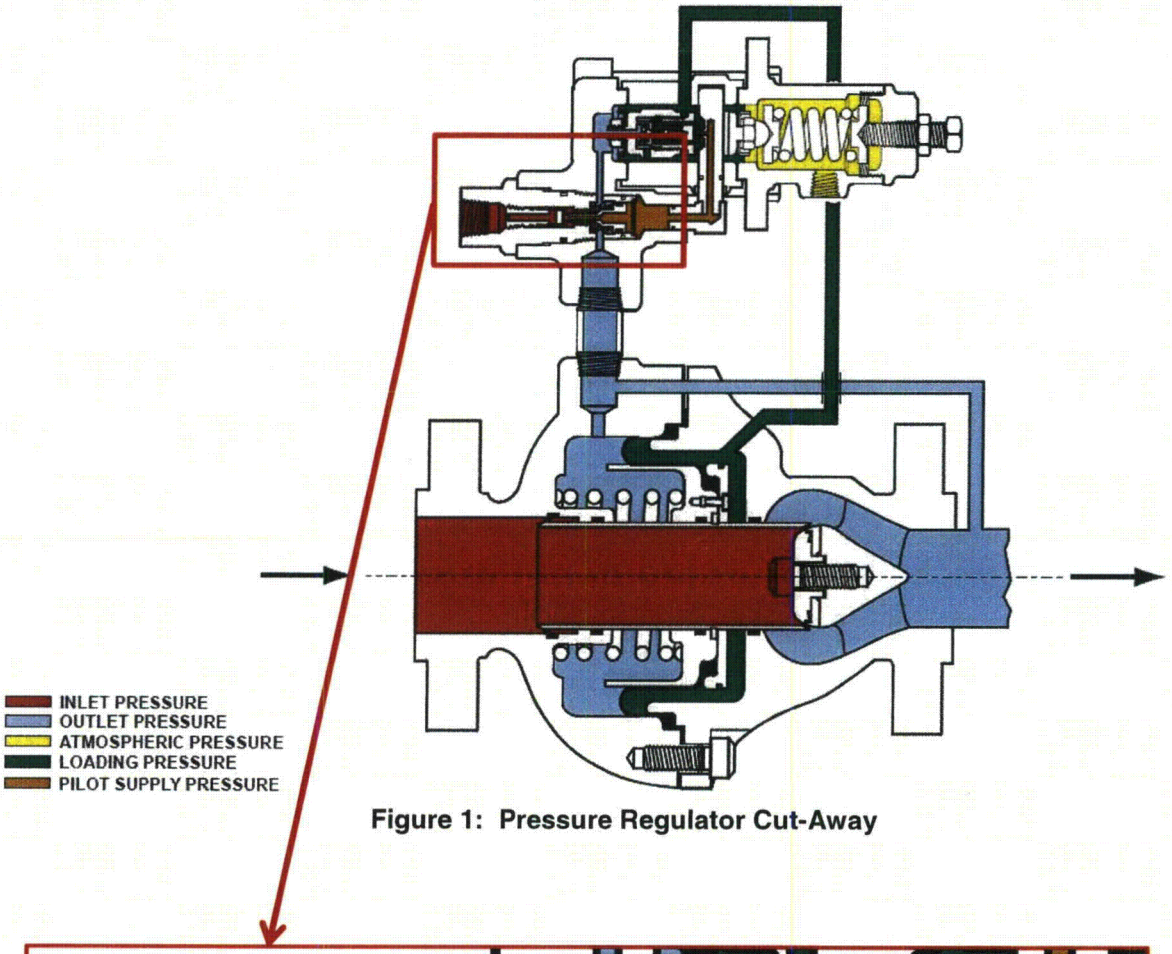

Figure 1: Pressure Regulator Cut-Away

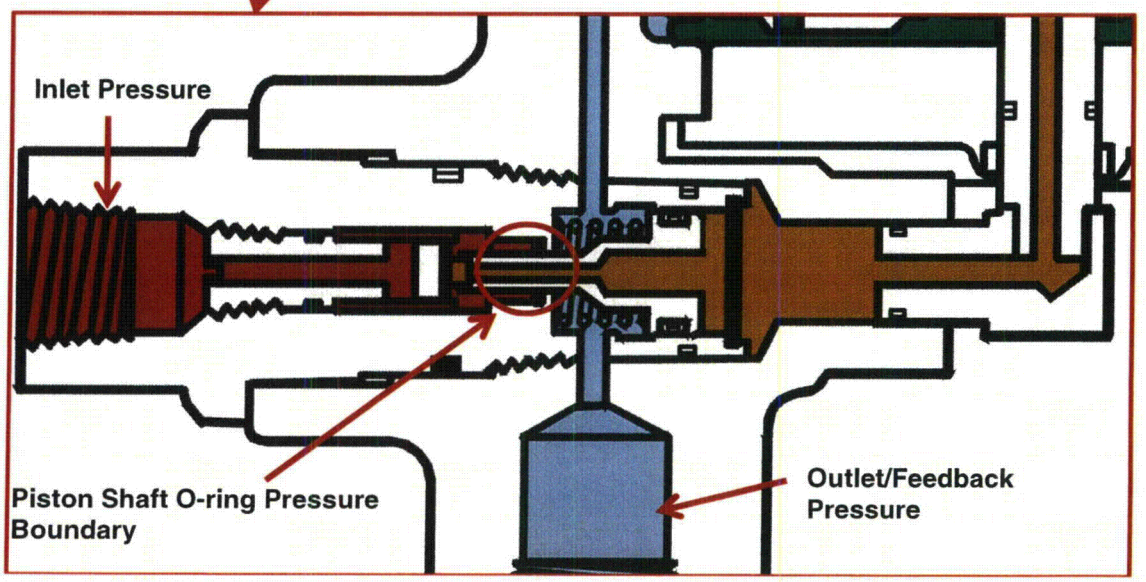

Figure 2: Close-up View of O-ring Location

Figure 3: Piston Guide Assembly

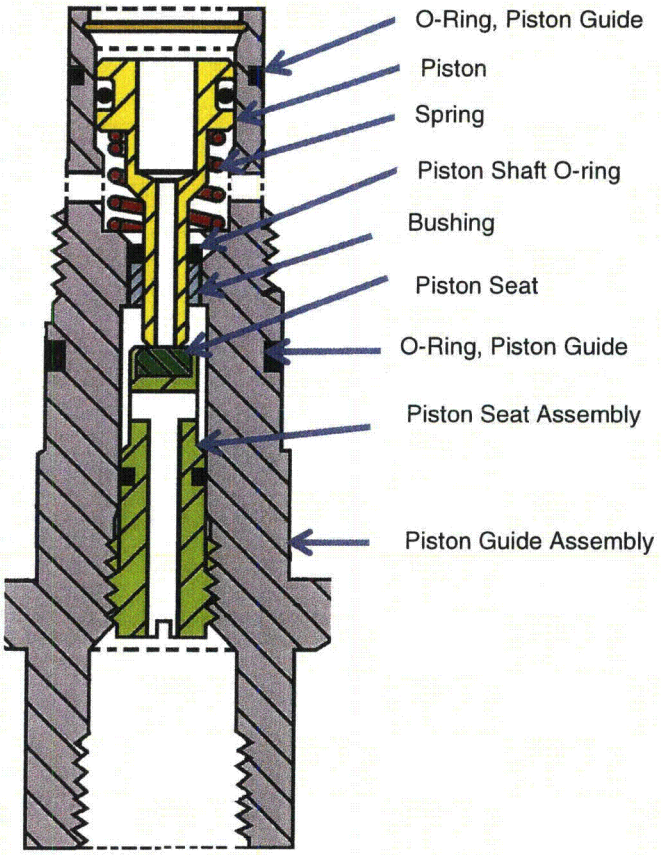

Figure 4: Piston Guide Assembly Section View

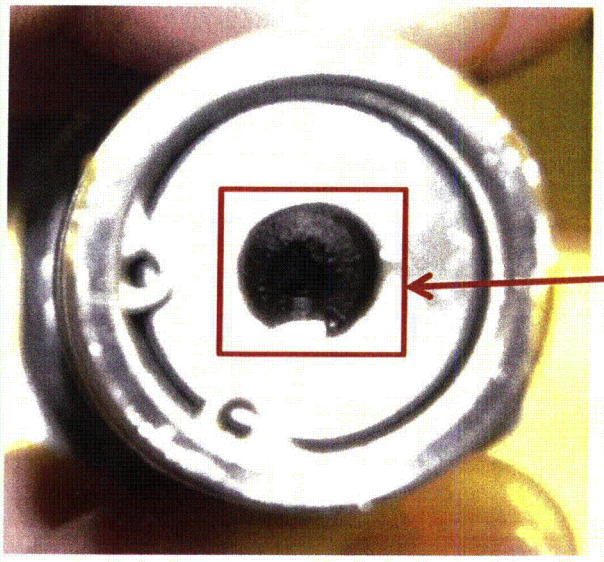

Figure 5: End View of Piston Guide Assembly

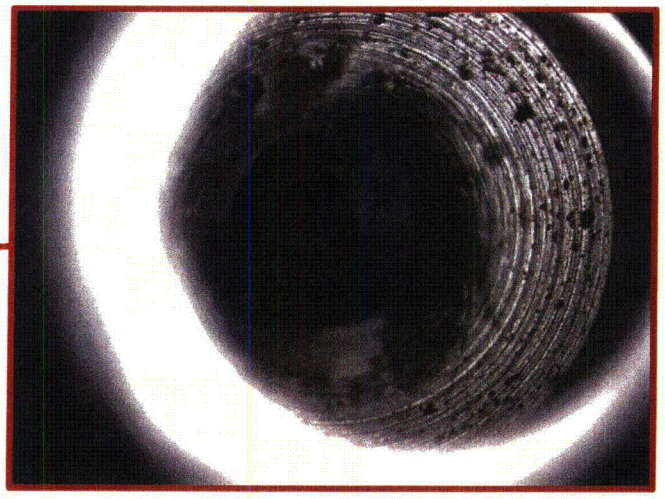

Figure 6: Close-up Showing O-ring Fragments

Root cause evaluation:

It has been determined that the piston shaft o-ring within the piston guide assembly of the pressure regulating valve had been improperly installed at the factory. During installation, the o-ring fits into a bore of the piston guide and rests against a shoulder within the bore. To form the o-ring groove, a bushing is then pressed into the bore. One end of the bushing is chamfered to aid in this installation process. It is ESI's determination that when this bushing was pressed into place, it was installed backwards such that the chamfered side was facing away from the o-ring meaning that the installation process required more force than typically utilized. This additional force resulted in the o-ring being squeezed (o-ring groove too narrow) which caused the inside diameter of the o-ring to decrease. During subsequent piston installation, the leading edge of the metal piston shaved material from the inside diameter of the o-ring. It is the seal between the o-ring and piston shaft that was compromised and ultimately resulted in failure of the regulator.

Evaluation of previous shipments:

ESI has supplied a quantity of 23 new regulators to BNP, the only nuclear customer to whom ESI has supplied these regulators. Of these 23 regulators, a quantity of 5 were subsequently refurbished by ESI as part of the normal overhaul process. The refurbished regulators are considered unaffected by this notification since, as part of the refurbishment activities, they not only are thoroughly inspected and cleaned but the refurbishment includes disassembling this portion of the piston guide assembly to remove the o-ring and re-install with a new, dedicated o-ring. No abnormalities have been noted as far as o-ring debris or installation difficulties during these refurbishment activities.

Of the remaining quantity, one of the regulators is the subject of this notification and a second regulator was returned to ESI at the same time. The second regulator was one that had been installed on the diesel generator set and was approaching the end of its service life. Inspection at ESI did not reveal this same o-ring issue and concerns with that regulator were attributed excess rust and installed service related conditions. The remaining 16 regulators listed in the table below are potentially affected and should be evaluated.

Date Shipped	ESI IWO	Customer PO#	S/N	QTY.
August 2007	3003234	00319437	18143228	1
February 2009	3005043	00400589	18838327	1
November 2009	3005733	00453448	19184569 19184570	2
April 2012	3008907	00586294	20400963	1
May 2012	3008907	00586294	20400964	1
September 2012	3009934	00622136	20776484	1
February 2013	3010544	00644942	20776485 20776488	2
August 2013	3011506	00685916	20776486	1
September 2013	3011506	00685916	R000180556 R000180558 R000180559 R000180560	4
November 2013	3011506	00685916	R000245080 R000245081	2

Total Potentially Affected	**16**

Corrective Action:

For regulators installed:

BNP should continue to monitor the outlet pressure from the regulator and verify the inlet and outlet pressures have not equalized. It is the position of ESI that any regulators that have been installed for more than two engine starting cycles and the downstream pressure remains at its set point; these regulators are acceptable and are not prone to this o-ring issue. Though ESI performed functional testing on 100% of the regulators prior to shipment (which includes a downstream equalization test), it is believed that the in-service conditions which exercise the regulator with higher flow rates would quickly exacerbate the condition to a point at which failure would be readily apparent.

Otherwise, the regulator should have an inspection performed to visually inspect for the o-ring damage. This requires disconnecting the pilot supply connection from the piston guide assembly and then removing (unscrewing) the piston guide assembly from the pilot valve. Then the piston seat should be removed (unscrewed) using a flat head screwdriver. A visual inspection of the interior of the piston guide assembly would then be performed to confirm no o-ring fragments. Additionally, manually actuate the piston to check for sluggishness, excessive binding, or slow re-coil (the piston is spring retract). If these inspections warrant further investigation, remove the snap ring that retains the piston and remove the piston to access the o-ring. If inspections confirm the o-ring is in acceptable condition, re-assemble in reverse order and continue with use. If the o-ring is damaged, return to ESI for refurbishment.

For regulators currently in BNP's inventory (not in service):

It is recommended that these regulators have an inspection performed either on-site or at ESI. Follow instructions per the paragraph above.

For future orders:

Going forward of this incident, prior to future shipments of the affected part, ESI will add additional steps to the dedication package. These steps will include disassembly provisions to verify the piston, o-ring, and bushing are installed correctly and no damage is present for each regulator supplied.