

Part 21 (PAR)

Event # 49001

<b>Rep Org:</b> ENGINE SYSTEMS, INC		<b>Notification Date / Time:</b> 05/03/2013 16:49 (EDT)	
<b>Supplier:</b> ELECTRO-MOTIVE DIESEL		<b>Event Date / Time:</b> 05/03/2013 (EDT)	
<b>Last Modification:</b> 05/03/2013			
<b>Region:</b> 1	<b>Docket #:</b>		
<b>City:</b> ROCKY MOUNT	<b>Agreement State:</b> Yes		
<b>County:</b>	<b>License #:</b>		
<b>State:</b> NC			
<b>NRC Notified by:</b> TOM HORNER		<b>Notifications:</b> GORDON HUNEGS	R1DO
<b>HQ Ops Officer:</b> PETE SNYDER		KATHLEEN O'DONOHUE	R2DO
<b>Emergency Class:</b> NON EMERGENCY		ERIC DUNCAN	R3DO
<b>10 CFR Section:</b>		MARK HAIRE	R4DO
21.21(d)(3)(i) DEFECTS AND NONCOMPLIANCE		PART 21 REACTORS	EMAIL

## PART 21 REPORT - FUEL INJECTORS FAILED PRESSURE TEST

The following is a summary of information received via fax:

"Engine Systems Inc. (ESI) began a 10CFR21 evaluation on 02/19/13 upon pressure leakage testing of three (3) fuel injectors, part number 40084720 (s/n 11K23136, 12K20318 & 12K20385), that were returned by TVA-Browns Ferry because they failed a pressure test at the site prior to installation in the engine. Another fuel injector was later returned by TVA (s/n 12K20330) for the same reason. On 3/11/13, ESI received a fuel injector (s/n 12H23003) from First Energy-Davis Besse because the injector failed their on-site pressure leakage test. The pressure test specifies applying 2000 psi to the fuel injector and verifying the pressure does not fall below 1500 psi after 30 seconds.

"TVA has been working with ESI to evaluate the reported deviation. ESI has also been working with EMD and EMD's fuel injector supplier to determine the cause of the injector leakage. All parties involved were not able to complete the deviation evaluation within the 60 day time period specified in 10CFR Part 21; therefore, TVA issued an interim report to the NRC about this issue on March 22, 2013 [NRC EN No. 48844]. This report is a follow-up to TVA's interim report.

"This evaluation was concluded on 05/02/13 and it was determined that this issue is a reportable defect as defined by 10CFR Part 21. The fuel injector pressure leakage has been attributed to debris that entered the injectors during assembly of the filter elements into the injector body at the manufacturer. A leaking or otherwise improperly functioning fuel injector could affect the load carrying capability of the diesel engine. Fuel dilution of the engine lubricating oil could also occur as a result of a leaking fuel injector. Either of these conditions could impact the operability of the diesel engine and thereby prevent the diesel generator from performing its safety related function."

IE19  
NRR

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The following licensees may potentially be affected: FP&L-St. Lucie, Energy Northwest-Columbia, Nextera-Point Beach, Exelon-Dresden, TVA-Browns Ferry, First Energy-Davis Besse, Dominion Va. Power-Surry, Entergy-ANO, and First Energy-Beaver Valley.

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**ENGINE SYSTEMS, INC.**

175 Freight Road  
Rocky Mount, NC 27804

Telephone: 252/977-2720  
Fax: 252/446-1134

**TELEFAX**

**Date:** May 3, 2013  
**Company:** NRC Operations Center  
**Fax Number:** 301/816-5151  
**Verification No.:** 301/816-5100  
**Reference:** Report No. 10CFR21-0109, Rev. 0  
**From:** Tom Horner  
**Page:** 1 of 8

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Dear Sir:

Following this cover is a copy of our report 10CFR21-0109, Rev. 0, for a 10CFR21 reportable notification on EMD fuel injectors, part number 40084720 and 40099335.

A copy of this report will be mailed to the NRC Document Control Desk and to our affected nuclear customers.

Should you have questions, please let us know.

Sincerely,

ENGINE SYSTEMS, INC.

Tom Horner  
Quality Assurance Manager



**ENGINE SYSTEMS, INC.**

175 Freight Road, Rocky Mount, NC 27804

Telephone: 252/977-2720

Fax: 252/446-1134

**Report No. 10CFR21-0109**

**Rev. 0: 05/03/13**

**10CFR21 REPORTING OF DEFECTS  
AND NON-COMPLIANCE**

**COMPONENT:** EMD Fuel Injectors  
P/N 40084720 & 40099335

**SYSTEM:** Emergency Diesel Generator

**CONCLUSION:** Reportable in Accordance With 10CFR21

Prepared By:   
Engineering Manager

Date: 5/3/13

Reviewed By:   
Quality Assurance Manager

Date: 5-3-13

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REV	DATE	PAGE	DESCRIPTION
0	05/03/13		Initial issue.

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**Component:**

EMD Fuel Injectors (P/N 40084720 & 40099335).

**Summary:**

Engine Systems Inc. (ESI) began a 10CFR21 evaluation on 02/19/13 upon pressure leakage testing of three (3) fuel injectors, part number 40084720 (s/n 11K23136, 12K20318 & 12K20385), that were returned by TVA-Browns Ferry because they failed a pressure test at the site prior to installation in the engine. Another fuel injector, was later returned by TVA (s/n 12K20330) for the same reason. On 3/11/13, ESI received a fuel injector (s/n 12H23003) from First Energy-Davis Besse because the injector failed their on-site pressure leakage test. The pressure test specifies applying 2000 psi to the fuel injector and verifying the pressure does not fall below 1500 psi after 30 seconds.

TVA has been working with ESI to evaluate the reported deviation. ESI has also been working with EMD and EMD's fuel injector supplier to determine the cause of the injector leakage. All parties involved were not able to complete the deviation evaluation within the 60 day time period specified in 10CFR Part 21; therefore, TVA issued an interim report to the NRC about this issue on March 22, 2013. This report is a follow-up to TVA's interim report.

This evaluation was concluded on 05/02/13 and it was determined that this issue is a reportable defect as defined by 10CFR Part 21. The fuel injector pressure leakage has been attributed to debris that entered the injectors during assembly of the filter elements into the injector body at the manufacturer. A leaking or otherwise improperly functioning fuel injector could affect the load carrying capability of the diesel engine. Fuel dilution of the engine lubricating oil could also occur as a result of a leaking fuel injector. Either of these conditions could impact the operability of the diesel engine and thereby prevent the diesel generator from performing its safety related function

**Discussion:**

The standard holding pressure and leakage test specified for the EMD fuel injectors requires applying 2000 psi to the fuel injector and verifying the pressure does not fall below 1500 psi after 30 seconds. This test is performed on an Injector Tester designed specifically for this purpose. See Figure 1 below.

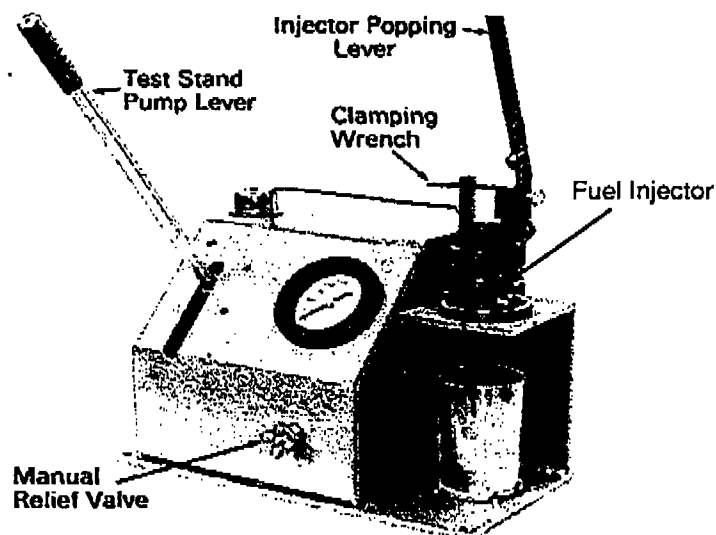


Figure 1: EMD Fuel Injector Tester

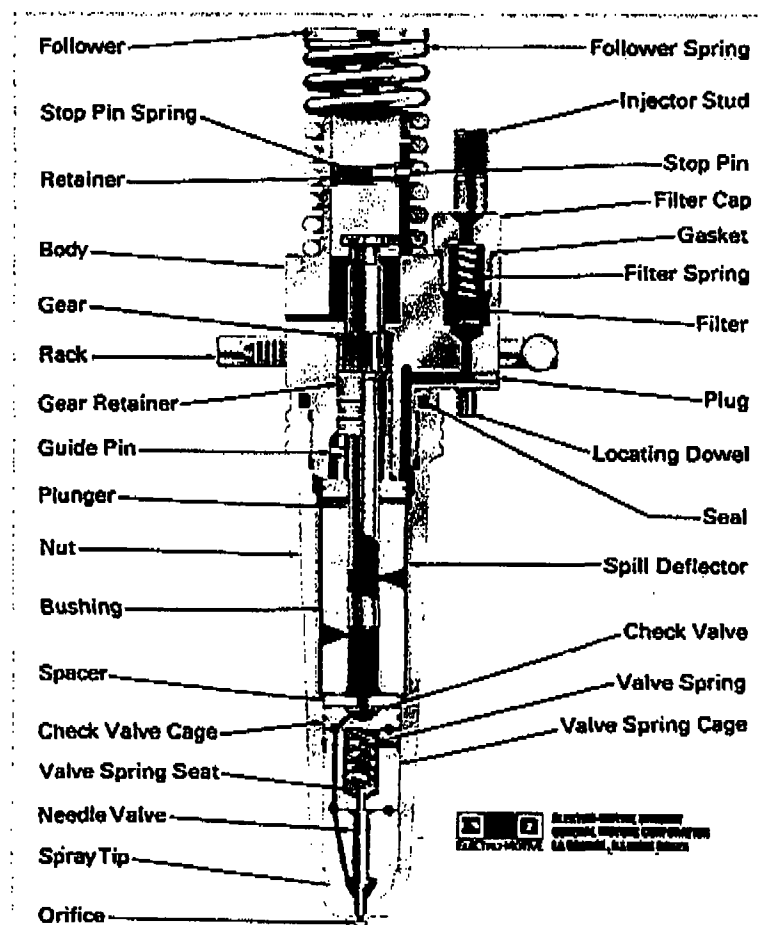
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ESI performed the pressure test on all of the returned injectors, results are summarized below.

Serial Number	Part Number	Customer	Initial ESI Pressure Test Results
11K23136	40084720	TVA-BF	Leakage exceeded the allowable
12K20318	40084720	TVA-BF	Leakage exceeded the allowable
12K20385	40084720	TVA-BF	Leakage exceeded the allowable
12K20330	40084720	TVA-BF	Leakage within the allowable
12H23003	40084720	Davis-Besse	Excessive leakage, would not build up sufficient pressure to perform test

The three TVA injectors with excessive pressure leakage (11K23136, 12K20318 & 12K20385) were sent to EMD's supplier, Interstate-McBee (I-M), for a failure investigation with ESI oversight. The pressure test was repeated at I-M and this time all three TVA injectors passed.

All of the fuel injectors were subjected to a disassembly inspection (either at I-M or ESI). Two P/N 40084720 fuel injectors (12K20404 & 13A23943) from a non-nuclear customer were also subjected to a disassembly inspection; these would not build up pressure during the pressure test (similar to the Davis-Besse injector). A typical cutaway view of the fuel injector is provided below for reference. A summary of the inspection findings are provided on the following page.



.. Cut-away of EMD Fuel Injector

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### Summary of Inspection Findings

- TVA injectors (S/N 12K20318, 12K20385, & S/N 12K20330)
  - Non-metallic material was found along the plunger/bushing, spacer, check valve cage, valve spring cage, and the nozzle. The material was very small and difficult to see by the naked eye. Using a video microscope, the material was identified as small strands of fiber similar to nylon string. In some instances, the material was so small that it would disintegrate when moved around. A larger piece was found within injector s/n 12K20385, located in the nozzle oil passage.
- TVA injector (S/N 11K23136)
  - This injector only had one trace strand of non-metallic material on the outside of the bushing. Unlike the other TVA injectors above, no material was found along the plunger/bushing, spacer, check valve cage, valve spring cage, or nozzle.
- Davis-Besse injector (S/N 12H23003)
  - Metallic material was found between the nozzle and the spring body cage and at the interior of the nozzle. The debris found in the nozzle was flattened at one end, indicating it was trapped between the nozzle tip and the needle valve preventing the needle valve from achieving a proper seal.
- Non-nuclear customer injectors (S/N 12K20404 & 13A23943)
  - Metallic material was found in both of the fuel injectors. The material was a very small strand of wire that resembled the wire mesh of the injector filter elements. Parts of the wire were also flattened indicating that it was compressed between two surfaces, i.e. the needle valve and nozzle tip, which would prevent the needle valve from seating. S/N 13A23943 also contained a small piece of metallic material that resembled casting flash.

The testing performed during this evaluation demonstrated that the injector leakage resulting from non-metallic debris was different than leakage that occurred from metallic debris.

- The non-metallic debris causes only short term leakage and the debris will eventually pass through the injector without compromising overall operability; this occurred with all of the injectors returned by TVA. All injectors reportedly leaked during site pressure testing, one (1) of these passed the pressure test upon receipt testing at ESI and the others passed subsequent pressure testing. Inspection of these injectors determined some minor, non-metallic, debris (string like) was present; no metallic debris was found. These injectors were also able to build up sufficient pressure to perform the pressure test.
- Fuel injectors with metallic debris exhibit significant leakage (the leakage is such that the injectors are not able to build sufficient pressure to enable the pressure leakage test to be performed). Even after multiple pressure test attempts, the condition is repeatable (the debris does not pass through the injector) and injector operability is compromised.



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### **Root cause evaluation:**

It has been determined that the debris entered the fuel injectors during assembly of the filter elements into the injector body at the manufacturer. Inspection of the filter element storage container revealed an excess of metallic and nonmetallic contaminants. The metallic material resembled the wire like material found in the injector nozzles; this was determined to be pieces of the injector filter material (0.004" diameter wire). There was also nonmetallic material present in the container as well; this is suspected to originate from packaging materials.

### **Evaluation of previous shipments:**

Based on a review of pressure test results for fuel injector shipments since 2009, ESI has determined that the introduction of debris began with fuel injectors manufactured in May 2012 and only affects new fuel injectors. The test results for rebuilt fuel injectors did not indicate any changes had occurred. Rebuilt fuel injectors are not processed through the injector manufacturer (Interstate-McBee); therefore, this substantiates the determination in the root cause evaluation section of this report that the debris entered the fuel injectors during assembly of the filter elements into the injector body at the manufacturer.

The fuel injector serial number contains the year and month of manufacture as follows:

- The 1<sup>st</sup> and 2<sup>nd</sup> digits represents the last 2 digits of the year (12 indicates 2012)
- The 3<sup>rd</sup> digit represents the month; A-M indicates Jan-Dec respectively (letter I is not used).
- Example: 12H2 3003 was manufactured in August 2012.

ESI has made shipments of new fuel injectors with 2012 serial numbers containing the "12B", "12E", "12H" and "12K" prefix; indicating Feb, May, Aug & Oct 2012 manufacture. For conservatism, all fuel injectors with serial numbers beginning with "12" are considered suspect.

### **Affected Users:**

A listing of customers that were shipped new EMD fuel injectors with 2012 serial numbers is provided below. Note: most serial numbers are not consecutive in the range list.

ESI Sales Order	Part Number	Customer	Customer P.O.	Serial Number Range	C-of-C Date	Qty
3009576	40084720	FP&L-St. Lucie	0203198	12B20428 - 12B20603	4/10/2012	28
3009588	40084720	Energy Northwest-Columbia	00335326	12B20429 - 12B20602	2/13/2012	31
3009667	40099335	PGS Enrique-Almaraz	N2012/032	12E20645 - 12E20668	8/21/2012	24
3009888	40084720	Nextera-Point Beach	020307153	12B20432 - 12E20560	5/10/2012	13
3010118	40084720	Exelon-Dresden	703, rel. 12330	12E20504 & 12E20546	6/19/2012	2
3010164	40084720	TVA-Browns Ferry	424011	12E20497 - 12E20563	7/18/2012	21
3010214	40084720	First Energy-Davis Besse	42401210	12H22986 - 12H23267	10/2/2012	25
3010392	40084720	TVA-Browns Ferry	453328	12K20309 - 12K20547	11/12/2012	112
3010456	40084720	Dominion Va. Power-Surry	4500015328	12H22984 - 12H24171	10/12/2012	42
3010641	40084720	Entergy-ANO	10365519	12H22988 - 12H24122	12/10/2012	4
3010655	40084720	Nextera-Point Beach	02314687	12H22987 - 12H24140	12/7/2012	4
3010981	40084720	First Energy-Beaver Valley	45415892	12H22993 - 12H23268	3/12/2013	6

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**Corrective Action:**

- Fuel injectors installed on engine:

There have not been any reported failures of installed fuel injectors. Affected users with installed fuel injectors having serial numbers beginning with "12" should continue to monitor the performance of the diesel engine during surveillance test runs. Routine lube oil sampling to detect fuel oil dilution is recommended as well as normal monitoring of cylinder temperatures during engine operation. A temperature differential between cylinders of more than +/- 200 °F could indicate a fuel injector problem and further evaluation to determine the actual cause would be necessary. Many engines are equipped with thermocouples in the exhaust manifold risers for measuring the exhaust gas temperature of each cylinder. For engines without installed thermocouples, an infrared or contact type temperature measuring device can be used (follow the manufacturer's operating instructions specific to the device utilized).

- Fuel injectors in inventory:

Affected users with fuel injectors having serial numbers beginning with "12" in their inventory should return these to ESI for evaluation to ensure they do not contain the suspect debris.

- To prevent recurrence of this issue, the following is being implemented:

- The fuel injector manufacturer has implemented a work instruction to ensure cleanliness of the filter elements and the corresponding container in which the elements are placed prior to being issued for insertion into the fuel injector. This container will also be labeled to indicate that it has been through the cleanliness process.
- ESI will add an additional injector pressure test requirement for all EMD fuel injectors supplied on nuclear safety related sales orders. The additional test will be performed by ESI after calibration/performance testing is completed. This will be implemented for new and rebuilt fuel injectors as an additional verification of injector performance/operability prior to shipment to the customer.