

Part 21 (PAR)

Event # 48960

<b>Rep Org:</b> ENGINE SYSTEMS, INC		<b>Notification Date / Time:</b> 04/23/2013 16:32 (EDT)	
<b>Supplier:</b> ENGINE SYSTEMS, INC		<b>Event Date / Time:</b> 04/19/2013 (EDT)	
<b>Last Modification:</b> 04/23/2013			
<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> DAVID HILLS	R3DO
<b>HQ Ops Officer:</b> HOWIE CROUCH		JACK WHITTEN	R4DO
<b>Emergency Class:</b> NON EMERGENCY			
<b>10 CFR Section:</b>			
21.21(d)(3)(i) DEFECTS AND NONCOMPLIANCE			

# PART 21 REPORT - ESI REFURBISHED EMERGENCY DIESEL GENERATOR CYLINDER HEADS MAY HAVE VALVE KEEPER SEALS MISSING

The following information is a summary of a report faxed to the Operations Center from Engine Systems, Inc. (ESI) concerning a condition reportable under 10 CFR 21:

"Engine Systems Inc. (ESI) began a 10 CFR 21 evaluation on 02/19/13 following the failure analysis of a cylinder head returned by South Texas Project (STP). The cylinder head had been installed on an emergency diesel generator set at STP and, during routine prestart checks, oil was found leaking from the Kiene valve while barring over the engine. This cylinder head had been previously refurbished in 2004 under ESI's 10 CFR 50 Appendix B program. ESI's investigation revealed that the refurbished cylinder head was returned to the customer without keeper seals installed.

"The evaluation was concluded on 04/19/13 and it was determined that this issue is a reportable defect as defined by 10 CFR 21. Omission of the keeper seals from the cylinder head of the KSV emergency diesel generator set could allow engine lubricating oil to migrate through the cylinder head and into the combustion chamber during engine standby conditions. Presence of this oil could damage the engine to the point that it is unable to perform its safety related function."

ESI began dedicating refurbished cylinder heads in 2001 but the refurbishment scope did not include valve train components. Refurbishments that included valve train components were first shipped in 2003. Procedure steps were included in 2007 to verify valve keepers were installed. Therefore, only cylinder heads refurbished between 2003 and 2007 are affected. A review of purchase orders have determined that the following plants received a total of 26 cylinder heads that may not have valve keeper seals installed:

IE19  
NRR

04/23/2013

*U.S. Nuclear Regulatory Commission Operations Center Event Report*

Page 2

Part 21 (PAR)  
Byron Station - 3 heads  
South Texas Project - 21 heads  
Cooper Nuclear Plant - 2 heads

Event # 48960

Affected cylinder head part numbers are 10-KSV-11-3-RR, 12-KSV-11-3-RR AND 13-KSVR-11-6-RR.

ESI will be notifying affected customers.

\*\*\*\*\*

**ENGINE SYSTEMS, INC.**175 Freight Road  
Rocky Mount, NC 27804Telephone: 252/977-2720  
Fax: 252/446-1134**TELEFAX**

**Date:** April 23, 2013  
**Company:** NRC Operations Center  
**Fax Number:** 301/816-5151  
**Verification No.:** 301/816-5100  
**Reference:** Report No. 10CFR21-0108, Rev. 0  
**From:** Tom Horner  
**Page:** 1 of 7

---

Dear Sir:

Following this cover is a copy of our report 10CFR21-0108, Rev. 0, for a 10CFR21 reportable notification on a KSV cylinder head with missing keeper seals, cylinder head part numbers 10-KSV-11-3-RR, 12-KSV-11-3-RR, and 13-KSV-11-6-RR.

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. 10CFR21-0108

Rev. 0: 04/23/13

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

COMPONENT: KSV Cylinder Head with Missing Keeper Seals  
Head Part Numbers 10-KSV-11-3-RR, 12-KSV-11-3-RR, and 13-KSV-11-6-RR

SYSTEM: Emergency Diesel Generator

CONCLUSION: Reportable in Accordance With 10CFR21

Prepared By: \_\_\_\_\_

  
Engineering Manager

Date: \_\_\_\_\_

4/23/13

Reviewed By: \_\_\_\_\_

  
Quality Assurance Manager

Date: \_\_\_\_\_

4-23-13

Report No. 10CFR21-0108

Record of Revisions

Page: 1 of 1

REV	DATE	PAGE	DESCRIPTION
0	04/23/13		Initial issue.

Report No.	10CFR21-0108
Revision:	0
Date:	04/23/13
Page:	1 of 4

**Component:**

KSV cylinder head with missing keeper seals, cylinder head part numbers 10-KSV-11-3-RR, 12-KSV-11-3-RR, and 13-KSV-11-6-RR.

**Summary:**

Engine Systems Inc. (ESI) began a 10CFR21 evaluation on 02/19/13 following the failure analysis of a cylinder head returned by South Texas Project (STP). The cylinder head had been installed on an emergency diesel generator set at STP and, during routine prestart checks, oil was found leaking from the Kiene valve while barring over the engine. This cylinder head had been previously refurbished in 2004 under Engine Systems Inc. 10CFR50 Appendix B program. ESI's investigation revealed that the refurbished cylinder head was returned to the customer without keeper seals installed.

The evaluation was concluded on 04/19/13 and it was determined that this issue is a reportable defect as defined by 10CFR21. Omission of the keeper seals from the cylinder head of the KSV emergency diesel generator set could allow engine lubricating oil to migrate through the cylinder head and into the combustion chamber during engine standby conditions. Presence of this oil could damage the engine to the point that it is unable to perform its safety related function.

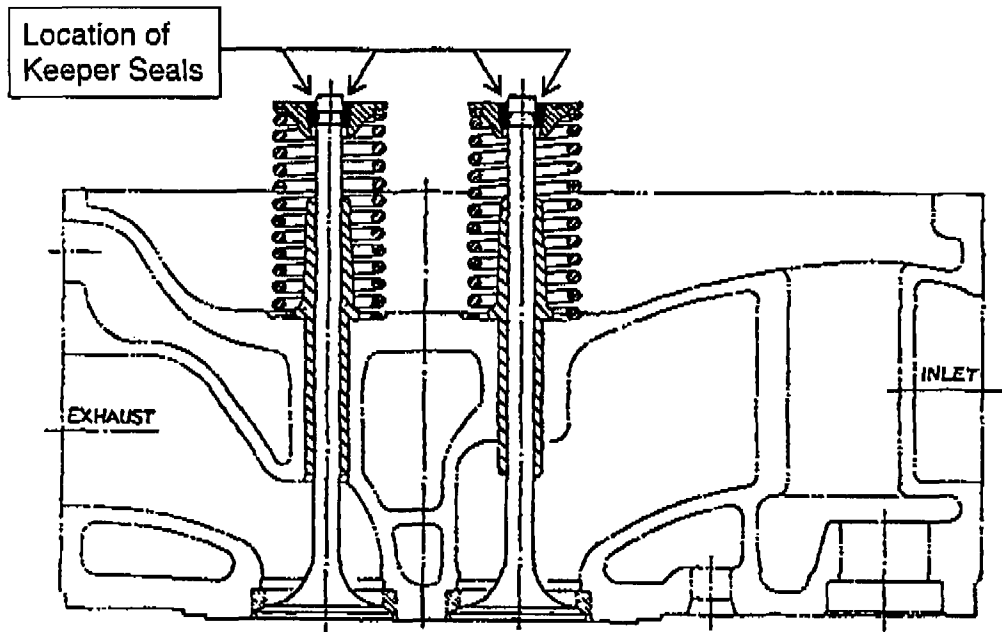
**Discussion:**

STP returned a cylinder head, P/N 12-KSV-11-3, S/N 8M1608, due to oil present in the power cylinder. It was reported that during routine prestart checks, STP opened all Kiene valves and manually barred over the engine. Excess lube oil was found leaking from the Kiene valve of this one cylinder head. This cylinder head had been remanufactured by Cameron Compression in Bethlehem, PA in 2004, under ESI's 10CFR50 Appendix B Quality Program.

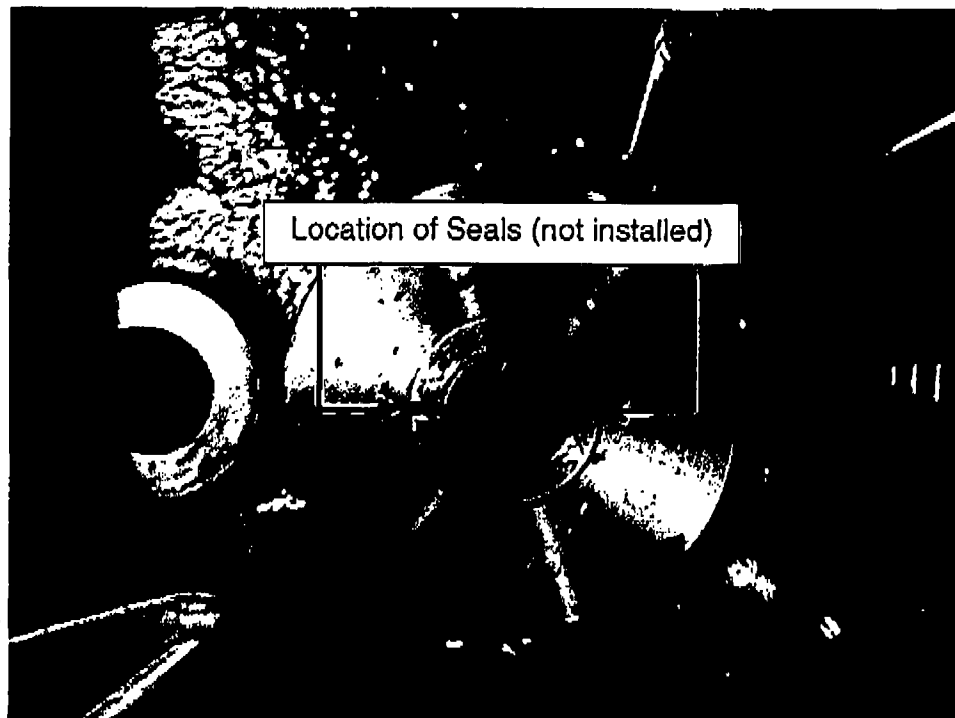
During the failure analysis investigation performed at the current Cameron facility in Casper, WY, it was noted that the intake and exhaust valve keeper seals, P/N W30C-1#1, were not installed. The purpose of the keeper seals is to deflect lube oil from draining into the cylinder head, and possibly the combustion chamber, during standby conditions. The source of this lube oil is the intake and exhaust rocker arms that are pressurized with heated lube oil during standby conditions to maintain the engine's fast start capability. The quantity of oil that travels through the rocker arms to the valve keeper area is dependent upon the component clearances within the rocker arm components. The absence of the valve keeper seals could allow a small amount of this lube oil to drain past the keepers, down the valve stem, through the valve guides and into the intake and exhaust ports of the cylinder head. In this particular case, the intake or exhaust valves were sufficiently open to allow oil to enter the cylinder (which is dependent upon the engine's position when it stops rotating following a shutdown). One or more cylinders on an engine will have open valves at any given position of the crankshaft, though not all cylinders are affected at the same time.

The seals are made of an elastomeric material in the form of a rectangular block and they are replaced during a rebuild as standard practice. Each cylinder head has eight seals (with two required for each valve and there are four valves per head). The seals are installed between the keeper halves on opposite sides of the valve stem. See figure and photo on the following page for a visual representation of the seal location.

Report No. 10CFR21-0108  
Revision: 0  
Date: 04/23/13  
Page: 2 of 4



**Figure 1: Showing Location of Keeper Seals**



**Photo 1: Showing Location of Keeper Seals**

Report No. 10CFR21-0108  
Revision: 0  
Date: 04/23/13  
Page: 3 of 4

### **Impact on Operability:**

Absence of the keeper seals could allow lube oil to leak through the valve guides, into the cylinder head, and into the combustion chamber during standby conditions. Excess oil in the combustion chamber could prevent the piston from stroking its full length during a compression or exhaust stroke causing hydraulic lock. This could cause catastrophic damage to the engine's power assembly components and render the engine inoperable.

### **Affected Users:**

ESI began dedicating remanufactured KSV cylinder heads starting in October 2001. The scope of many of these head rebuilds did not include the valve train components (valves, springs, keepers, keeper seals, etc); therefore these orders are not affected by this notification. After a review of each sales order that included the valve train components, ESI has determined there is a remaining quantity of 26 cylinder heads that may have been reassembled without the keeper seals. These are shown in the table below (note that the part numbers listed are the only part numbers affected by this notification).

Date Shipped	ESI IWO	Customer	Customer PO#	P/N	S/N	QTY.
May 2003	97227	Exelon-Byron	38571	10-KSV-11-3-RR	9M0507 8M2103	2
May 2004	110077	STP - South Texas Project	49208	12-KSV-11-3-RR	8M1608	1
March 2005	8000117	STP - South Texas Project	58227	12-KSV-11-3-RR	8K1102 8J1603 8L3001 7D2102 9C2703 8K2307 9A1310 8K2803 8M0407 8M1109 8M1604 8M1101 8J1606 8K2008 8M2106 8M0409 8M1108 8M2803 8M1105	19
March 2005	8000229	STP - South Texas Project	58227	10-KSV-11-3-RR	1A1702	1
Feb 2006	8000389	Exelon-Byron	84798	10-KSV-11-3-RR	8J1306	1
Feb 2007	8000857	NPPD-Cooper Nuclear	4500069477	13-KSV-11-6-RR	7A2108 6B1901	2
<b>Total Affected Cylinders Heads</b>						<b>26</b>



Report No. 10CFR21-0108  
Revision: 0  
Date: 04/23/13  
Page: 4 of 4

### **Corrective Action:**

ESI's current repair procedure includes a step to verify the keeper seals are installed and all orders since 2007 have included installation of the keeper seals; therefore, the issue has been corrected and is no longer active.

The STP cylinder head had been in-service for a number of years prior to this occurrence and this is the only instance of this type of oil leakage reported to ESI. Even though the probability for excessive oil leakage as a result of missing keeper seals appears to be quite low; any engine with an affected cylinder head could be subject to the same phenomenon. Depending upon the component clearances within the rocker arms (which provides the source of oil to the keeper) and the position of the camshaft (and thus the valve train) following an engine shutdown, oil could leak into the combustion chamber during standby. As a result, ESI has the following recommendations:

- **For those customers with affected cylinder heads already installed:**

Inspect the valve keepers for presence of the keeper seals. If seals are installed, no further action is required. If seals are not installed, it is recommended that a borescope inspection be performed to ensure no engine lube oil is in the combustion chamber. This inspection could be performed through the fuel injector bore or the Kiene valve passage (if equipment will allow).

If no oil is present, then there is assurance that oil is not being introduced into the combustion chamber during standby conditions. As a result, engine operability is not affected and any further work could be postponed until the next engine run. This inspection can be repeated after each engine run if desired until keeper seals are installed.

If oil is present, then immediate action is required to remove the oil and rework or replace the cylinder head. Reworking the head can be performed on-engine as follows: With the Kiene valve open, the engine should be barred over until the piston is at top dead center. By doing this the oil will be pushed out of the Kiene valve. Lock the barring device to maintain the piston at TDC and connect a pressure test set to the Kiene valve. This pressure will be used to hold the valves against the fire deck of the cylinder head. An applied pressure of 50 psig should be used; however higher pressures may be utilized as required to maintain the valve against the fire deck. Remove the rocker arms to access the top of the valves. Using a valve spring compressor (such as P/N LS-44-AA#7), compress the spring retainer enough to loosen the keepers and insert the keeper seals. Replacement keeper seals are available from ESI as dedicated components. Relieve the spring compressor and ensure the keeper seals are fully inserted between keepers and flush with the top of the keepers. Repeat for the remaining valves.

If desired, the entire cylinder head may be removed and replaced with a head that has the keeper seals installed. In this case, the removed head may be returned to ESI for rework.

- **For those customers with affected cylinder heads that are not installed:**

Inspect the valve keepers for presence of the keeper seals. If seals are installed, no further action is required. If seals are not installed, these heads must be reworked prior to installation. Customers may elect to perform rework in-house using replacement seals provided by ESI or the head may be returned to ESI for rework.