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MURLEY,T.E. Office of Nuclear Reactor Regulation, Director (Post 870411

SUBJECT: Part 21 rept re diesel generator shutdown due to crankcase explosion.Caused by sub-surface casting defect from which matls loosened during engine operation trapped between piston skirt & liner.

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SUBJECT: Part 21 rept re diesel generator shutdown due to crankcase explosion.

DISTRIBUTION CODE: IE19D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 5
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COOPER-BESSEMER RECIPROCATING

F. Bruce Stolba
Vice President and General Manager

October 20, 1989

Our Ref: QCG-6422

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulations
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: KSV Standby Diesel/Generator
Pennsylvania Power and Light
Unit "C", Crankcase Explosion

In accordance with the requirements of the Nuclear Regulatory Commission, and in particular 10 CFR Part 21, we wish to inform you of a second incident which occurred recently in one of our engines used for driving standby power generators.

The engine in question is known as a KSV-16-T. The sixteen (16) cylinders of this engine type have a bore of 13.5 inches and a stroke of 16.5 inches. It is pure turbocharged and rated at 4000 KW at 600 RPM. The engine bears the Serial Number 7160 and is known as the "C" Unit at the Susquehanna Steam Electric Station of the Pennsylvania Power and Light Company.

On October 7, 1989, the "C" Diesel/Generator was in the first hour of a twenty-four hour run when it was shutdown normally following a crankcase explosion. It was subsequently determined that the 5 right piston and liner was the source of the explosion.

Attached is a copy of our report covering the incident, concerning which we have deduced that a casting defect in the piston skirt was the primary cause for the failure. We produce many tons of similar castings on a weekly basis and note that the observed defect is extremely rare. Therefore, we conclude that there is no generic impact as a result of the reported incident.

Lincoln Avenue
Grove City, Pennsylvania 16127
(412) 458-8000 Telex: 86-6613

IE19
1/1

Sincerely,

F. Bruce Stolba

FBS/gs

Attachment

cc: A. E. Bice - GC
D. T. Blizzard - GC
F. Czysz - P.P.& L.
T. O. Garrison - Odessa
B. C. Guntrum - C-E Oakland
B. K. Hall - GC

cc: T. W. Kearns - GC
W. H. A. Lambert - GC
W. Leishman - ESG Mt. Vernon
R. A. Miklos - GC
C. Rousselle - ESG New Orleans
B. R. Sedelmyer - GC
F. B. Stolba - GC
K. R. Young - ESG Houston

Walter Haass
U. S. Nuclear Regulatory Commission
One White Flint North
Mailstop 9D4
Washington, DC 20555

KSV Users Group: Mark Brutcher - Arizona Public Service
Todd Fiorenza - Carolina Power and Light
Terry O'Brien - Commonwealth Edison
Jim Cole - Houston Light and Power
Bob Legere - Louisiana Power and Light
Darren Dageforde - Nebraska Public Power District
Thomas Fannestock - Niagara Mohawk
Frank Czysz - Pennsylvania Power and Light

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QCG-6405 10/14/89

REPORT

Pennsylvania Power and Light Company
Standby Diesel/Generator
KSV-16-T S/N 7160 (Unit "C")
Crankcase Explosion - October 7, 1989

1.0 Introduction

1.1 On October 7, 1989 the "C" diesel was started at 22:28 hours on a twenty-four hour run. At 23:03 a fire alarm signal was transmitted to the Control Room and an operator observed smoke around crankcase doors following a crankcase explosion. The engine was shutdown through a normal shutdown cycle. It was noted that this crankcase explosion was more severe than previously experienced with a large quantity of lube oil having been displaced and the liquid completely blown out of the crankcase manometer.

1.2 This engine had run 26 hours since the last "eighteen month inspection " which took place November 1988 and was restarted November 22, 1988. Total running hours of 796.9 have accumulated.

1.3 An internal inspection of the crankcase revealed major distress to the number 5 right piston and liner. During a site visit on October 12, 1989, the following observations were made by A. Lambert.

2.0 Observations

2.1 The liner was very heavily damaged (burned and heat checked) in the lower half and for most of its circumference.

2.2 The piston skirt was extensively damaged with displaced skirt material tending to close over the lower oil ring which itself had suffered heavy wear on the "scraper" faces. Two "blow holes" towards the bottom of the skirt and located radially closer to one end of the piston pin than the other end were in evidence. One hole was fairly round and about 5/16" in diameter and the other somewhat larger and irregular in shape. From the bottom of the larger hole a crack ran straight down to the bottom of the skirt (a distance of approx. 3/4"). About 2-1/2" from the larger hole and further around the skirt towards the piston pin bore there was a large vertical crack. The readily visible portion of this crack ran up from the skirt bottom for about 3". Towards the top end of the crack and for a distance of approximately 1-1/4",the piston skirt material was gouged (burned) out leaving a "canyon" with the crack in evidence at the bottom. The piston had been cut on the horizontal centerline of the piston bore, and sectioned vertically as well so it was not possible to see the complete piston. The rings were not inspected.

2.3 The piston pin had seized in its bushing and the bushing had rotated in the piston. The pin and bushing were forcibly removed from the piston and the bushing removed by cutting (slotting) through the bale at one end. At the other end the bale was cracked through indicating an area of greater distress than the opposite end. This cracked bale was in line with the "blow" holes and cracks in the piston skirt described in paragraph 2.2 above. Approximately 50% of the total bushing surface was destroyed by excessive heat. The remaining 50% was an irregular but connected area between the two bales and in the loaded part of the bushing. This area was indeed "clear" and had sustained absolutely no damage.

2.4 The lower liner seal was distorted when trapped water boiled off and turned to steam.

2.5 The piston pin end caps had made no contact with the liner surface.

3.0 Discussion

3.1 The damage to the lower liner seal indicated that excessive heat was generated in the lower end of the liner. (See para. 2.4)

3.2 Quality Control procedures at the C-B manufacturing facility would have required a piston skirt with "blow" holes as described in paragraph 2.1, to be scrapped. Therefore, it is concluded that a casting defect was present below the machined outer surface of the piston skirt. Some of the material subsequently displaced from this area of the skirt would have "fallen" into the crankcase and some, no doubt, "rolled" between the liner and piston skirt. This is the most likely explanation for the "canyon" (or gouge) observed in the vertical crack adjacent to the large "blow" hole.

3.3 The majority of the liner distress was observed to be in the lower portion indicating that contact with the piston was greatest at its skirt area. (See para. 2.1)

3.4 Observations of the piston pin and bushing indicate very heavy loading in the upwards direction of the bales. This, together with the large undamaged portion of the normally loaded (down) area, is consistent with the rod pushing the piston upwards against a very heavy friction load - a load generated by heavy contact of the piston and liner. (See para. 2.4)

4.0 Conclusion

4.1 The primary area of failure was that of the piston skirt. The root cause appears to stem from a sub-surface casting defect from which material loosened during engine operation was trapped between the piston skirt and liner. This material was of sufficient dimension to roll up and down, destroy the lubrication and then generate sufficient heat to cause the piston skirt to expand and take up all available piston to liner clearance. Heavy rubbing of the piston skirt on the liner induced a further breakdown of the oil film leading to more heat being generated to the point of incandescence, which was the source of ignition for the crankcase explosion. (The lube oil vapor in the crankcase was the fuel which was ignited).

4.2 The damage to the piston pin and bushing is considered to be a secondary failure due to the abnormal loading described in paragraph 3.4.

W. H. A. Lambert
Manager, Quality Assurance
and Nuclear Operations

cc: R. J. Brager
A. E. Bice
D. T. Blizzard
W. O. Ferguson
B. C. Guntrum - C-E
B. K. Hall
M. J. Helmich
J. M. Horne
W. Leishman - MV
R. A. Miklos
M. A. Schleigh
B. R. Sedelmyer
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