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SUBJECT: Part 21 rept re KSV standby diesel generator rocker arm failure.

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R I D S / A D D S

COOPER-BESSEMER RECIPROCATING

F. Bruce Stolba
Vice President and General Manager

January 18, 1989

Our Ref: QCG-5310

Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Director of Inspection and Enforcement

Subject: KSV Standby Diesel Generator
Rocker Arm Failure
Arizona Nuclear Power Project,
Palo Verde, Arizona

On January 4, 1989, an exhaust valve rocker arm installed in a KSV-20-T engine (identified at Unit III A), broke at Palo Verde. Although the inlet and exhaust valve rocker arms are not designated as safety related components, we believe the intent of 10 CFR Part 21 should be met by reporting the incident to you.

Attached is a copy of our report reference QCG-5309 which details the occurrence, our analysis, and conclusions. Also enclosed is a copy of a letter addressed to the Louisiana Power and Light Company (Waterford III) advising the Utility of the incident and its impact upon their operation. Similar letters are currently being sent to the following plants:

Pennsylvania Power and Light - Susquehanna, Berwick, PA
Commonwealth Edison Company - Byron, Braidwood, Zion, IL
Nebraska Public Power - Brownville, Nebraska
Niagara Mohawk - Nine Mile Point 2, New York
Houston Lighting and Power Co. - South Texas Project, TX

Please note that we are reviewing the safety classification of rocker arms with a view to upgrading their status.

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

IE19
1/1

Sincerely,

F. Bruce Stolba

FBS/gs

Attachment

cc: D. T. Blizzard - GC
D. E. Brazeal - Tulsa
T. O. Garrison - Odessa
W. R. Haass - NRC
T. W. Kearns - GC
W. H. A. Lambert - GC
W. Simko - ANPP
J. R. Rasor - MV
C. Rousselle - NO
C. A. Robbins - MV
B. R. Sedelmyer - GC
K. R. Young - HOU
W. P. Purcell - ANPP
File: K-5f

REPORT

Arizona Nuclear Power Project

Exhaust Rocker Arm Failure

1.0 Introduction

1.1 At 02:50 hours on Wednesday, January 4, 1989, engine III A (SN-7188) was started for a four hour operability run. By 03:24 the engine was running at full load and all operating parameters were normal. At 06:02 the engine shutdown on "overspeed" and subsequent investigation revealed that the number 8 left exhaust rocker arm had broken.

1.2 Immediately prior to shutdown, excessive vibration of the air intake piping system was observed. This was causing the overspeed switch on the butterfly valve to trip and reset. Operating records attest to this cycling of the shutdown. Ultimately, an excursion of the shutdown valve occurred without immediate reset following. Thus the shutdown which was not an actual overspeed.

1.3 As the investigation into the failure mechanism progressed it was decided to visually inspect all of the rocker arms on units III A and IIIB for cracks. The exhaust rocker arm on 9 right, Unit III A was found to have a crack similar to the "original" crack on 8 left. On January 17 the other four engines at Palo Verde were inspected and no further rocker arms were found to have cracks.

1.4 The 8 left failure was initially examined by ANPP Engineering and Metallurgical personnel and a representative piece of the fractured surface sent to Cooper-Bessemer. The results of C-B's evaluation concurred with those of ANPP.

2.0 Failure Review and Analysis

2.1 It was immediately obvious that the point of origin of the fracture was an "old" crack. (See the attached sketch for details). Obvious because there was evidence of a yellow sealer paint on the fracture surface at the thinnest section of the push rod boss. This yellow sealer is applied prior to machining a casting such as the rocker arm, and is "touched-up" if necessary following machining. Therefore, the crack occurred during manufacturing.

2.2 It was noted that there was eccentricity of the "push rod end" bore. (Exaggerated in the sketch for the sake of illustration). At first the lack of symmetry, caused mainly by a casting core shift, was considered to have influenced the formation of the original crack. However, when the 9 right exhaust rocker arm was examined by ANPP, yellow paint was also found in the crack, but the wall thickness was considerably greater at approximately 5/16". The thickness of the failed specimen was approximately 3/16".

2.3 The exposed "push rod end" bore for the failed piece showed that the "push rod end", which is installed with an interference fit, had "worked" loose. There was evidence of both fretting and burnishing which suggests that the failure mechanism was that of impact loading with the final fracture following the original crack.

2.4 When the 9 right cracked rocker arm was examined by ANPP it was reported that the "push rod end" was tightly in place and had to be forcibly removed. It is, therefore, postulated that the 9 right did not fail because it had not lost its interference fit. ANPP also reported that the "push rod end" bore exhibited rings consistent with the "push rod end" being inserted in a "cocked" orientation.

2.5 A calculation for "hoop" stress, with no credit for the stiffness induced by the junction of the "boss" to the body of the rocker arm or the flat "top", was made. The purpose was to analytically determine at what wall thickness the casting would fracture with nominal interference fit. This thickness was found to approximate .160". It is concluded that for the failed specimen the interference was on or about nominal and that for the cracked (only) piece the interference was greater than nominal.

3.0 Conclusion

3.1 It is concluded from the foregoing (para. 2.0) that the castings were cracked during manufacture. The cause for the cracks being high stresses induced when the "push rod ends" were inserted.

W. H. A. Lambert
Manager
Quality Control

cc: M. A. Schleigh
R. J. Brager
D. T. Blizzard
R. A. Miklos
T. W. Kearns
J. M. Horne
W. O. Ferguson
B. R. Sedelmyer
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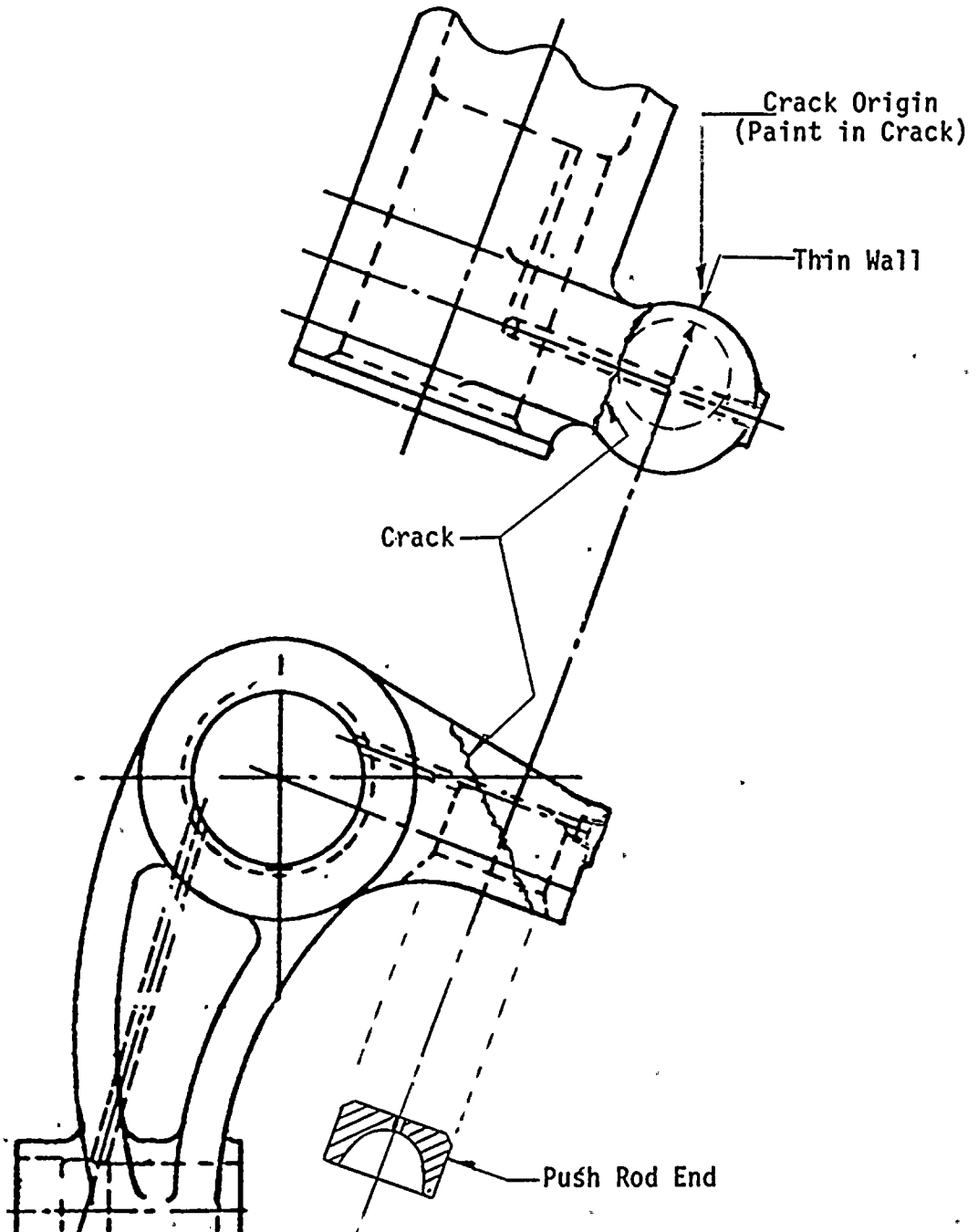

SKETCH SHOWING PORTION
OF EXHAUST ROCKER ARM
KSV-25-A

COOPER-BESSEMER RECIPROCATING

January 18, 1989

Our Ref: QCG-5314

Mr. R. A. Legere
Louisiana Power and Light Co.
P. O. Box B
Killona, LA 70066-0751

Dear Mr. Legere:

Subject: KSV Standby Diesel Generators
Rocker Arms

On January 4, 1989 an exhaust rocker arm broke on a unit at Arizona Nuclear Power Project, Palo Verde. The attached report details the incident, our analysis and conclusions. All inlet and exhaust rocker arms were subsequently inspected at Palo Verde where six (6), twenty (20) cylinder engines are installed. As a result we recommend that you also carry out a similar inspection as follows:

1. Remove the inspection door attached to the cylinder head hood by two bolts. It is not necessary to remove the hood.

2. With a mirror and flashlight check the bosses where push rods/valves engage the rocker arms for cracks. From the Palo Verde experience, cracks, if present, will be very evident.

3. Replace any rocker arm found to be cracked and report the replacement to Cooper-Bessemer.

Very truly yours,

W. H. A. Lambert
Manager, Q.C.

cc: C. Rousselle - NO
R. A. Miklos - GC
T. W. Kearns - GC
File: K-5f

WHAL/klj

Lincoln Avenue
Grove City, Pennsylvania 16127
(412) 458-8000 Telex 499-7257 A/B CBCORPGRCT