BALTIMORE GAS & ELECTRIC CO.

CUSTOMER ORDER NO. 85380GS

F.M. CONTRACT 35-734133

200 HOUR RATING QUALIFICATION TEST REPORT

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ENGINEERING REPORT

SUBJECT: BALTIMORE GAS & ELECTRIC CO.
F.M. CONTRACT 35-734133

DATE: January 25, 1994

PREPARED BY: G. Monahan

REPORT TITLE: 200 HOUR RATING QUALIFICATION TEST REPORT

APPROVED BY: Terry Miller

PURPOSE

The purpose of the 200 Hour Rating Qualification Test was to prove that the emergency diesel engines at Baltimore Gas & Electric Co. (after conversion to turbo blower series) can operate at the following load rating:

3500 kW @ 900 rpm - 200 hour rating

This is net kW load after subtracting all parasitic loads; i.e., engine driven pumps.

DISCUSSION

The engine used for the test was Baltimore Gas & Electric (F.M. Contract 70C026) engine S/N 38D885002TDSM12. This engine was converted to turbo blower series configuration and completely rebuilt with new power components, including cylinder liners, main bearings, pistons, piston rings.

The engine was given a complete inspection during the rebuild. This inspection included checking for wear, improper assembly, broken springs, etc. Also, bearing clearances and end float and gear backlash were checked. Injection pumps were inspected and recalibrated. All components were found to be in good condition and ready for the test.

To wear in the new power components, the engine was given the Wearing In Run per Engineering Dwg. 16 113 660. Following the wear-in, the Standard Final Acceptance Run per Engineering Instructions 4406FM was performed. Rated load for these tests was the continuous rating of 3000 kW at 900 rpm. The engine was then visually inspected.

The generator used for the test is a Louis Allis Model TGZDJ S/N 502564R1. Efficiency curves for this generator are included in Appendix D. All test instrumentation was calibrated prior to tests and a list of instrumentation used is included in Appendix D.

RESULTS OF 200 HOUR RATING TEST

The endurance test at the 200 hour rating was commenced on December 8, 1993. The test engine was loaded to 4869 net bhp at 900 rpm. This load is the required horsepower to generator 3500 net kW at 0.8 lagging power factor.

The test engine operated at 4869 net hp for 207 hours on a continuous basis. A complete line of engine data was recorded each hour and firing pressures were measured once every 8 hours. See Appendix C for engine test logs. During this period, no engine shutdown occurred due to engine failure or malfunction.

The engine was shut down three times during the test. The first shutdown occurred after the first 24 hours, when the engine was shut down in order to replace a test indicator cock (firing pressure test valve) which was stuck in the open position. After 35 hours, the engine was shut down to repair an oil leak at the generator bearing thermocouple. And after 85 hours, the engine was shut down to inspect the generator bearing insulation monitoring device brush. The total elapsed time during the 3 shutdowns was approximately 4 hours.

RESULTS OF POST-TEST INSPECTION

After the test, all power components were removed and the engine was inspected for signs of wear or distress. Post-test inspection charts of the power components are included in Appendix B. Results of the inspection are summarized below.

LINERS

All liner bores were inspected and were well within the condemnable limit of 8.145 inches diameter. Several cylinders showed an increase in diameter of approximately .001" in the exhaust port area. Cylinder #12 showed some elongation of the bore of up to .002" in the athwartship direction. This evidence of somewhat accelerated wear is as expected under the increased rating run during this test.

PISTONS AND PISTON RINGS

Visual inspection of the pistons showed no areas of significant distress. Piston ring gaps on upper and lower pistons increased by up to .016". Although they were well within the condemnable limits, the piston compression rings were replaced for the 2000 hour test. No compression rings or oil control rings were broken.

PISTON WRIST PINS, INSERT BUSHINGS, AND CONNECTING ROD BUSHINGS

Visual inspection of these parts revealed no signs of unusual wear and all pieces were reinstalled.

PISTON PIN FLOATING BUSHINGS

The upper piston pin floating bushings were inspected and reinstalled. Some minor wear was indicated by a slight reduction in O.D. and increase in I.D. No extrusion of the bushing was indicated by inspecting the bushing length.

MAIN AND CONNECTING ROD BEARINGS

Inspection of the aluminum bearings showed significant distress on both connecting rod and main bearings. All upper and lower connecting rod bearings were replaced. All upper main bearings and #4, #10 and #13 lower main bearings were replaced. The bearings that were removed were out of specification on bearing crush and free spread.

CONCLUSIONS

The test engine operated for 207 hours at the 200 hour contract rating of 3500 kW. The tests were completed without engine malfunction or failure and, therefore, the engine's capability to operate at the proposed ratings was successfully demonstrated.

The condition of the power components after the test showed some accelerated wear as expected due to the increased loading. None of the parts were worn to the extent of causing reduction in load carrying capacity of the engine.

APPENDIX A

F.M. CONTRACT 35-734133
BALTIMORE GAS & ELECTRIC CO.
INCREASED RATING QUALIFICATION TEST

REFERENCE: (A) F.M. CONTRACT 35-734133
BALTIMORE GAS & ELECTRIC CO. ORDER NO. 85380GS

(B) F.M. CONTRACT 35-700026

(C) BG&E SPECIFICATION SP451, REV. 2

I. GENERAL TEST REQUIREMENTS

A. THE ENGINE USED FOR THE SUBJECT TEST WILL BE BALTIMORE GAS & ELECTRIC (F.M. CONTRACT 700026) ENGINE S/N 38D885002TDSM12. THIS ENGINE WILL BE CONVERTED TO TURBO BLOWER SERIES CONFIGURATION, REBUILT WITH NEW POWER PARTS AND INSPECTED TO ENSURE THAT ALL COMPONENTS ARE IN GOOD WORKING CONDITION.

B. TEST INSTRUMENTATION USED FOR THE TEST MUST BE WITHIN THE CALIBRATION DATE ISSUED BY THE QUALITY CONTROL DEPARTMENT.

C. TEST LOGS USED SHALL BE FORM BF4445. A MINIMUM OF 1 COMPLETE LINE OF DATA SHALL BE RECORDED FOR EACH HOUR OF ENGINE OPERATION. FIRING PRESSURES SHALL BE RECORDED ONCE EVERY 8 HOURS OF ENGINE OPERATION. THE FOLLOWING ENGINE PARAMETERS SHALL BE RECORDED:

AIR RECEIVER PRESSURE
AIR RECEIVER TEMPERATURE
CRANKCASE VACUUM
EXHAUST TEMPERATURE (CYLINDER)
EXHAUST TEMPERATURE (COMBINED)
EXHAUST PRESSURE FROM TURBOCHARGER
FUEL OIL HEADER PRESSURE
FUEL CONSUMPTION
JACKET WATER TEMP. TO ENGINE
JACKET WATER TEMP. FROM ENGINE
LUBE OIL PRESSURE, PUMP DISCHARGE
LUBE OIL PRESSURE, UPPER HEADER

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REV NO.	CHANGE ORDER NO.	DATE	DESCRIPTION	CHK'D BY
0	PC5404	10-04-93	INITIAL RELEASE	JC

Coltec Industries
Fairbanks Morse
Engine Division

REL. NO. PC5404	10/04/93	ASSY. OR LO.	
DR. BY G. MONAHAN	9/29/93	SCALE	
CHK'D. BY	/ /	HEAT TR.	
MAT'L			
APPV.	CAST.	MAT'L.	
	MACH.	ENGR. T. Miller	
	WELD.		
SHEET SIZE A	DWG. NO. 10 560 978	SHEET 1 OF 4	

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LUBE OIL TEMPERATURE, TO ENGINE
LUBE OIL TEMPERATURE, FROM ENGINE
TURBO COMPRESSOR DISCHARGE TEMP.
TURBO SPEED

DURING ALL TESTS, THE FOLLOWING PARAMETERS SHALL BE HELD TO WITHIN THE LIMITS AS SPECIFIED BELOW. ALL OTHER PARAMETERS ARE RECORDED FOR INFORMATION ONLY.

AIR RECEIVER TEMPERATURE	-	130-180°F
JACKET WATER TEMP. FROM ENGINE	-	160-185°F
LUBE OIL TEMP. FROM ENGINE	-	175-195°F

D. ENGINE RATING INFORMATION

RATING	% CONTINUOUS RATING	KW GEN. LOAD	GEN. EFF. @ 0.8 P.F.	BHP NET	RPM
30 MINUTE	120%	3600	96.4	5008	900
200 HOUR	117%	3500	96.4	4869	900
2000 HOUR	110%	3300	96.4	4591	900
CONTINUOUS	100%	3000	96.3	4178	900
3/4	75%	2250	95.7	3153	900
1/2	50%	1500	94.5	2129	900

E. THE GENERATOR USED FOR THIS TEST WILL BE A LOUIS ALLIS MODEL TGZDJ S/N 502564R1. GENERATOR WILL RUN ON-LINE WITH WISCONSIN POWER AND LIGHT COMPANY AND BE LOADED AT APPROXIMATELY 0.8 POWER FACTOR. SWITCHGEAR, EXCITER, ELECTRICAL GAUGE PANEL AND ALL AUXILIARY EQUIPMENT WILL BE NORMAL PRODUCTION TEST EQUIPMENT.

F. ALL ADDITIONS OF LUBE OIL SHALL BE RECORDED DURING THE 2000 HOUR TEST. THE HOUR METER READING AND THE QUANTITY OF OIL ADDED SHALL BE RECORDED ON THE TEST LOG.

II. PREPARATION FOR TEST

A. THE ENGINE IS TO BE COMPLETELY REBUILT WITH NEW POWER COMPONENTS FOR THIS TEST. THE FOLLOWING NEW PARTS WILL BE INSPECTED AND CHARTED BEFORE INSTALLATION AND AGAIN AFTER COMPLETION OF ALL TESTS.

PART NO. OR B/M	QTY.	NAME
16605621	1	BEARINGS - MAIN, COMPLETE SET
16609595	12	LINER ASSEMBLY
16204302	24	NOZZLE - INJECTION
16609599	12	PISTON ASSEMBLY - LOWER
16609598	12	PISTON ASSEMBLY - UPPER

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B. A COMPLETE VISUAL INSPECTION OF THE ENGINE WILL BE PERFORMED BEFORE COMMENCING THE TESTS. THIS INSPECTION WILL BE PERFORMED UNDER THE SUPERVISION AND DIRECTION OF THE R&D DEPARTMENT.

C. AFTER REASSEMBLY AND FINAL INSPECTION, THE ENGINE SHALL BE GIVEN THE STANDARD F.M. WEARING IN RUN PER PROCEDURE 4404FM. FOLLOWING THE WEAR-IN, THE STANDARD FINAL ACCEPTANCE RUN PER PROCEDURE 4406FM SHALL BE PERFORMED. RATED LOAD FOR THESE TESTS IS THE CONTINUOUS RATING OF 3000-KW AT 900 RPM. UPON COMPLETION OF THE FINAL ACCEPTANCE TEST, THE ENGINE SHALL BE GIVEN A VISUAL POST-TRIAL INSPECTION. ANY LEAKS OR OTHER MALFUNCTION OF THE ENGINE OR SYSTEM SHALL BE REMEDIED AT THIS TIME.

III. ENDURANCE TEST @ 2000 HOUR RATING

A. THE ENGINE IS TO BE LOADED TO 3300 KW AT 900 RPM AND RUN ON A CONTINUOUS BASIS FOR 2000 HOURS. ANY FORCED SHUTDOWN DURING TEST WHICH REQUIRES ACCESS TO INTERNAL PARTS OF THE CRANKCASE WILL REQUIRE REVIEW BY ENGINEERING, Q.A., PRODUCT SERVICE AND CUSTOMER PRIOR TO CONTINUING TEST. ANY OTHER FORCED SHUTDOWN SHALL BE REPAIRED, IDENTIFIED ON TEST LOG, AND TEST RESUMED.

B. FOLLOWING THE 2000 HOURS OF CONTINUOUS OPERATION, THE ENGINE IS TO BE SHUT DOWN AND GIVEN A VISUAL INSPECTION UNDER THE DIRECTION OF THE R&D DEPARTMENT. THIS INSPECTION SHALL INCLUDE: FEELER GAUGE CHECK OF MAIN AND CONN. ROD BEARINGS, FEELER GAUGE CHECK OF WRIST PIN BUSHINGS, AND VISUAL INSPECTION OF PISTONS AND LINERS.

C. ACCEPTANCE OF THIS TEST WILL BE BASED ON THE ABILITY OF THE ENGINE TO CARRY THE 3300 KW LOAD FOR THE PRESCRIBED 2000 HOURS. CONDITION AND WEAR OF ENGINE COMPONENTS ARE NOT TO BE GROUNDS FOR REJECTION OF THE TEST.

IV. ENDURANCE TEST @ 200 HOUR RATING

A. THIS TEST IS TO BE RUN ONLY UPON THE SUCCESSFUL COMPLETION OF THE TEST AND INSPECTION SPECIFIED IN PARA. III.

B. THE ENGINE IS TO BE LOADED TO 3500 KW AND THIS LOAD MAINTAINED FOR A PERIOD OF 200 HOURS. ANY FORCED SHUTDOWN DURING TEST WHICH REQUIRES ACCESS TO INTERNAL PARTS OF THE CRANKCASE WILL REQUIRE REVIEW BY ENGINEERING, Q.A., PRODUCT SERVICE AND CUSTOMER PRIOR TO CONTINUING TEST. ANY OTHER FORCED SHUTDOWN SHALL BE REPAIRED, IDENTIFIED ON TEST LOG, AND TEST RESUMED.

C. UPON COMPLETING 200 HOURS AT 3500 KW, THE ENGINE IS TO BE SHUT DOWN. THE TEST IS CONSIDERED ACCEPTABLE IF THE ENGINE COMPLETES 200 HOURS OPERATION AT 3500 KW.

V. DISASSEMBLY AND INSPECTION

A. THE ENGINE IS TO BE DISASSEMBLED FOR REINSPECTION OF THE POWER PARTS LISTED IN PARA. II.A. THESE PARTS SHALL BE COMPLETELY CHARTED AND PHOTOGRAPHED. ANY PARTS THAT HAVE EXCEEDED THE WEAR LIMITS AS PUBLISHED IN THE F.M. INSTRUCTION MANUAL "ENGINE WEAR LIMIT CHART" SHALL BE MARKED TO INDICATE THEIR CONDITION. THE CONDITION OF THE POWER PARTS IS NOT TO BE GROUNDS FOR REJECTION OF EITHER ENDURANCE TEST.

B. IN ADDITION TO THE INSPECTION OF THE POWER COMPONENTS, A COMPLETE VISUAL INSPECTION OF THE ENGINE IS TO BE CONDUCTED UNDER THE SUPERVISION OF THE R&D DEPARTMENT. ANY SIGNS OF WEAR OR OTHER ABNORMALITIES ARE TO BE NOTED ON THE TEST LOGS.

C. ALL TEST LOGS, INSPECTION CHARTS AND PHOTOGRAPHS ARE TO BE SUBMITTED TO PRODUCT ENGINEERING FOR ISSUANCE OF THE FINAL TEST REPORT.

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