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Technical Report

No. 13322

210-HP DIESEL ENGINE ENDURANCE AND PERFORMANCE TESTING WITH FIRE RESISTANT DIESEL FUEL

OCTOBER 1987

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Four-hundred-hour endurance and performance tests were conducted at the U.S. Army Tank-Automotive Command on a production DT 466, 210-hp Navistar Diesel Engine with fire resistant diesel fuel (FRDF). The FRDF contained 10.2 to 13.2 volume percent tap water. The purpose of these tests was to determine the effects of fuel-water macroemulsion on engine starting, engine fuel-wetted parts, engine power output, deposit, wear and oil degradation. The results of these tests indicated that under laboratory-controlled conditions, there are no engine starting problems, deposits, oil degradation or abnormal wear.

A significant loss in horsepower (12 percent) occurred at the start of the 400-hour test when the engine ran with FRDF containing 10.4% volume water. A significant loss in horsepower (13.36 percent) occurred at the end of the 400-hour test when the engine ran with FRDF containing 12% volume water.

A significant increase (18 percent) in specific fuel consumption occurred at the start of cont.

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dynamometer, emulsifier, diesel fuel (DF2).

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the test when the engine ran with FRDF containing 10.4 percent volume water. The specific fuel comsumption increased to 23.91 percent when the engine ran at the end of the 400-hour test with FRDF containing 12 percent volume water.

The delivery valve gasket of the fuel injection pump failed due to erosion caused by the FRDF.

The engine maximum torque occurred at 1,940 rpm with FRDF versus 1,800 rpm with DF2.

SUMMARY

The following includes pertinent product information.

- Engine:

The test engine is a diesel, 6-cylinder in line, 210-hp, 2,600-rpm, direct injection, turbocharged, after cooled, model DT 466, serial number 176482. It is manufactured by Navistar International, USA.

- Dynamometer:

Made by Eaton, model no. 1014WIG, serial no. 67637-1, power range 250 hp, speed range 1,800 to 6,000 rpm.

- Mixer:

Manufactured by Milton Roy Company. The mixer consists of the following subsystems:

-DF2 pump of 91 gph outlet flow and 35 psi outlet pressure
-water pump of 10.5 gph outlet flow and 35 psi outlet pressure
-surfactant pump of 10.5 gph outlet flow and 35 psi outlet pressure

- Motor

The motor which drives the pumps is manufactured by Reliance Electric Company. The motor's performance specifications are as follows: 1.5 hp, 3 phase, 1,725 rpm, 230/460 volts.

- Fire Resistant Diesel Fuel (FRDF):

The FRDF is specified for this test to contain 78% volume DF2, 12% volume surfactant and 10% volume tap water; however, due to the in-line blending system's inability to regulate the water level at the specified 10% volume, the actual test percentage volume of the water ranged from 10.2 to 13.2.

PREFACE

This work was funded by an intra-Army order for reimbursable service, USA, Belvoir, RDE Center. The FRDF and engine lubricant laboratory analyses were conducted by Belvoir Fuels and Lubricants Research Facility (SWRI).

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1.Ø. INTRODUCTION

The test program and report were conducted and prepared by the U.S. Army Tank-Automotive Command Propulsion Systems Division and laboratory. The report details performance and durability tests using Fire Resistant Diesel Fuel (FRDF). The objective of the FRDF program is to develop a future fuel that will reduce the vulnerability of military vehicles to fire, decrease the number of vehicles lost and repair costs, and increase crew survivability.

2.Ø. OBJECTIVE

The objective of this project is to evaluate the performance and endurance of a medium-sized, unmodified commercial production diesel engine of 2ØØ-hp range tested with FRDF. The FRDF contains tap water of 1Ø.2 to 13.2 percent volume.

Another objective of this project is to inspect the fuel-wetted parts of the fuel injection system and engine, and determine the effect of the water in the fuel on these parts.

3.Ø. CONCLUSIONS

The FRDF was tested with an engine and a fuel injection system designed to operate with diesel fuel. The engine did pass the 4ØØ-hour endurance test with the exception of the delivery valve gasket. The delivery valve gasket failed at the 388th hour of endurance testing. This failure was due to the FRDF chemical attack on the gasket's copper material.

The storage stability of the FRDF lasted for 2 weeks. The mixer did not give the intended mixing ratio. The tap water ratio in the FRDF varied between 1Ø.2 to 13.2 percent volume.

4.Ø. RECOMMENDATIONS

In order to benefit from the FRDF's positive characteristics and make the negative characteristics acceptable, the FRDF research and development program should continue. Continuation of the laboratory's engine testing and initiation of field vehicle tests per planned mission profile are essential for the success of this program.

Other issues which should be addressed are:

- Storage life improvement of the FRDF,
- Design improvement of the blending system of the FRDF,
- Incorporation of a fuel heating device into the vehicle fuel system for cold-weather operation with FRDF below Ø $^{\circ}$C.

- Redesign of the engine and fuel injection system parts which failed and/or eroded because of the use of FRDF, and
- Development of a logistics support plan.

5.0. DISCUSSION

5.1. Test Program

The purpose of the DT-466 Navistar Diesel Engine 400-Hour Durability and Performance Test with FRDF is to determine the effects of tap water blended with diesel fuel on the performance and durability of the engine's fuel injection system (fuel pump and injectors), pistons, rings, cylinders, cylinder head and valves, and to detrmine how a rated performance and proven durability of a commercial diesel engine will change. Test location was Building 212, Cell no. 1, TACOM. See Tables 5-1 through 5-16 for detailed test equipment and test program information.

Table 5-1. Engine Specification

Engine Model: DT 466, S/M 467-TM2U176482
Rated full-load power, without fan, with air cleaner: 210 hp at 2,600 rpm
Number of Cylinders: 6-cylinder in line
Type: 4 stroke per cycle, compression - ignition, turbocharged
Bore: 4.301 in.
Stroke: 5.350 in.
Displacement: 466.4 $in.^3$
Compression ratio: 16.3:1
Dry Engine Weight: 1,400 lbs
Firing Order: 1-5-3-6-2-4
Lubricating Oil: MIL-L-21040 - Grade 15W40
Fuel Injection Pump: MW, S/N 24581842

Table 5-2. FRDF and DF2

1. Planned percentages of the FRDF are:

   78% DF2
   10% tap water
   12% Surfactant (Emulsifier)

2. Due to the faulty functioning of the mixer during the mixing process, the percentages were different from those planned above. The actual test percentages of the FRDF mixture are stated in the tables of this report.

3. Fuel to be used for break-in, initial and final performance test is DF2.

4. Fuel to be used in the 400-hour durability and performance tests is FRDF.

Table 5-3. Dynamometer Specification

Made by Eaton
Model No.: 1014WIG
Serial No.: 67637-1
Power Range: 250 hp
Speed Range: 1,800 to 6,000 rpm
Torque Arm: 21.008 in.
DC Excitation: 220 volts - 2.6 amps
59 OHMs and 20 ^{o}C
Water Requirements: 18 GPM max. at 35 psi min. and 100 psi max.

Table 5-4. Test Cell Preparation and Tests Outline

- In cell no. 1, install DT 466 diesel engine together with cooling water tower and dynamometer. Install instrumentation, temperature and pressure thermocouples and probes. Use the existing Elwood recording data system.

- Install all required pressure lines, speed and load cells connections, fuel throttle lever, shut-off lever, aneroid assembly, exhaust and intake air connections; provide emergency fuel shutoff and warning lights. Shut down system for critical temperature, pressure and rpm limits on engine and dynamometer. Engine blow-by volume and pressure is to be recorded during full power performance. Engine's air, oil, coolant, temperature, pressure and exhaust gas temperature will be monitored and recorded.

- Test cell air depression: 1.2 in H_2O max.

Outline of Tests

1. Prepare engine for performance and endurance tests, install instrumentation, calibration of instrumentation and equipment, engine operating limits, adjustment and instrumentation checkout.

2. Break in run with DF2 (see Table 5-10).

3. Test for performance, full and part loads with DF_2 (Table 5-12).

4. Test for performance, full and part loads with FRDF (Table 5-13).

5. Run 400-hour NATO durability test with FRDF. Part- and full-load data are from FRDF performance data (see Table 5-13).

6. At the end of each 100-hour durability test, check the engine for full-load performance.

7. At the conclusion of the 400-hour durability run, test the engine for full- and part-load performance on FRDF and DF2.

8. For maintenance procedures refer to Section 2-4 of the NATO standard diesel and spark ignition engines laboratory test, Jan 84 (see Appendix A).

- At the start of each test, record the barometric pressure, temperature and relative humidity.

- At the conclusion of performance tests with DF2 fuel, test the engine with FRDF to obtain full-load performance data. Follow the same procedures followed with DF2 fuel and record full- and part-load performance using Table 5-13.

Table 5-5. Safety Shutdown Parameters

Parameter	Engine Shutdown
Coolant temperature measured at rear of cylinder head	210°F max
Engine blow - by at rated power	6 cu ft/min max
Exhaust temperature, turbine inlet	1350°F max
Exhaust temperature, turbine outlet	1150°F max
Oil gallery pressure:	
Cycle test	10 PSI min
Full load test	30 PSI min
Crankcase pressure	6" H20 max
Overspeed	3200 RPM max
Underspeed	600± 25 RPM
Oil temperature	265°F max

- The restriction measured at full load and rated speed in the fuel line between the primary filter and the fuel supply pump should not exceed 6 inches of Hg.
- The engine blow-by thru the breather at rated speed and power of 2600 RPM and 210 HP is 6 CFM at 6 inches of H_2o maximum.
- The test air cleaner flow at rated engine's power speed is 1100 CFM.

Table 5-6. Temperature Ranges of the Thermocouples

Thermocouple	Range	Accuracy
	°F	
Air, cell ambient	60-120	±2
Air, cleaner inlet	60-120	±2
Air, cleaner outlet	60-120	±3
Air from Turbocharger	60-300	±3
Fuel spillback after pump	60-150	±3
Exh. outlet (before and after turbo)	500-1700	±5
Exhaust ports	500-1700	±5
Fuel (before fuel pump)	60-120	±3
Fuel at secondary filter	60-150	±10
Coolant, engine-outlet and inlet	120-250	±3
Cooling water tower, inlet	35-100	±3
Cooling water tower, outlet	35-250	±3
Engine oil	60-300	±3
Instrumentation bath	150-250	±3

Table 5-7. Pressure Ranges of the Transducers

Pressure Range	Transducer	Data Point
-4.16 in H_2O	.15 PSI	Cell depression
-27.76 in H_2O	1.0 PSI	Air before turbo
27.76 in H_2O	1.0 PSI	Air cal. orifice
27.76 in H_2O	1.0 PSI	Air crankcase
83.30 in H_2O	3.0 PSI	Exhaust after turbo
61.23 in Hg	30.0 PSI	Air after turbo
61.23 in Hg	30.0 PSI	Exhaust before turbo
30.0 PSI	30.0 PSI	Fuel after engine filters
30.0 PSI	30.0 PSI	Fuel pump spillback
30.0 PSI	30.0 PSI	Fuel injectors spillback
100.0 PSI	100.0 PSI	Oil engine gallery
100.0 PSI	100.0 PSI	Coolant engine in
100.0 PSI	100.0 PSI	Coolant engine out
100.0 PSI	100.0 PSI	Cooling water tower in
300.0 PSI	300.0 PSI	Dyno water in

Table 5-8. Warning—Shutdown Temperatures

Data Point	Temp °F	Warning °F	Shutdown °F
Air ambient in test cell	77±5		
Air before air cleaner	77±5		
Air after air cleaner			
Air after turbo			
Oil sump		255	265
Oil Gallery		255	265
Oil after turbo		255	265
Fuel before engine filters	86±4		
Fuel after engine filters			
Fuel spillback (combined)			
Coolant engine in			
Coolant engine out	205±4	210	215
Cooling water in (tower)			
Cooling water out (tower)			
Dyno water out		140	145
Reference bath			
Exhaust port No. 1		1300	1350
Exhaust port No. 2		1300	1350
Exhaust port No. 3		1300	1350
Exhaust port No. 4		1300	1350
Exhaust port No. 5		1300	1350
Exhaust port No. 6		1300	1350
Exhaust before turbo - front		1300	1350
Exhaust before turbo - rear		1300	1350
Exhaust after turbo		1100	1150

Table 5-9. Warning--Shutdown Pressures

Data Point	Pressure	Warning	Shutdown
Air cell depression			
Air before turbo (T)	-10±2" H_2O		
Air before turbo (S)			
Air calibrated orifice			
Air crankcase		4" H_2O	6" H_2O
Exhaust after turbo (S)	16±2" H_2O	20" H_2O	25" H_2O
Air after turbo (boost)			
Exhaust before turbo			
Fuel before engine filter			
Fuel spillback (inj + pump)			
Oil engine gallery		12 PSI	10 PSI
Coolant engine in			
Coolant engine out			
Cooling water tower in		40 PSI	30 PSI
Dyno water in		10 PSI	8 PSI
Fuel after engine filters			

Table 5-10. Engine Break-in Run

Break-in Period No.	Time/Minutes	Engine Speed	Full Load BHP	Torque
1	15	1200	91	398
2	15	1300	106	428
3	30	1400	120	450
4	30	1500	136	476
5	30	1600	150	492
6	30	1700	163	504
7	30	1800	174	508
8	30	1900	183	506
9	30	2000	190	499
10	30	2100	196	490
11	30	2200	201	476
12	30	2300	204	466
13	30	2400	207	452
14	30	2500	208	437
15	30	2600	210	424
16	30	1700	163	504
17	30	1800	174	508
18	30	1900	183	506
19	30	2400	207	452
20	30	2500	208	437
21	30	2600	210	424

During the break-in period, check engine for leaks, operation of instrumentation, recording and printout systems; maintain the temperature and pressure listed in the above warning shutdown table.

Run engine break-in test with full load using DF2 fuel.

Continually monitor engine parameter versus the operating limits stated in its safety shutdown parameters. The engine's blow-by volume and pressure should not exceed 360 cu ft/hr or 6 CFM and 6 inches of water at rated engine speed and power of 2,600 rpm and 210 hp.

Shut down the engine for diagnosis and repair if the blow-by exceeds allowed maximum or if the other operating parameters' limits are exceeded. The engine break-in should be conducted as shown above.

For each break-in period, record complete data on log sheet.

Table 5-11. Initial Engine Performance Test with DF2 Fuel

For initial engine performance test use DF2 fuel. Test the engine for performance and record the data as follows:

- Full-load performance test

  -The full-load (full-rack) performance test, bhp, fuel consumption, torque, bmep and bsfc data, will be recorded at a seven-speed setting, two of these settings at the rated torque speed of 1,800 rpm and the rated hp speed of 2,600 rpm.

  -The seven speed settings are to start at 1,400 rpm with increments of 200 rpm for each setting.

  -For each setting, the engine should be run for a sufficient time to allow the operating parameters to stabilize.

- Part-load performance test of 85%, 70%, 50% and 25% of the full load

  -Using throttle control and the dynamometer, test the engine and record complete data for each of the four part-load settings of 85%, 70%, 50% and 25% of the full-load test.

  -Each part-load setting is to be tested with the above established seven speed settings, starting at 1,400 rpm and ending at 2,600 rpm with 200-rpm increments.

No correction factor will be applied and the test results must include air cell temperature, atmospheric and cell pressure and humidity.

- Go to Table 5-12.

Table 5-12. Development of Part-Load Performance Data from Full-Load 100% Performance Run for DF2 Fuel

LOAD	RPM	TORQUE
100%	1400	455
	1600	493
	1800	517
	2000	496
	2200	459
	2400	447
	2600	422
85%	1400	387
	1600	419
	1800	439
	2000	422
	2200	390
	2400	380
	2600	359
70%	1400	318
	1600	345
	1800	362
	2000	347
	2200	321
	2400	313
	2600	295
50%	1400	227
	1600	246
	1800	258
	2000	248
	2200	229
	2400	223
	2600	211
25%	1400	114
	1600	123
	1800	129
	2000	124
	2200	115
	2400	112
	2600	105

Table 5-13. Development of Part-Load Performance Data from Full-Load 100% Performance Run for FRDF

- At the conclusion of performance tests with DF2 fuel, test the engine with FRDF to obtain full-load performance data. Follow the same procedures followed with DF2 and record full- and part-load performance using the following table:

LOAD	RPM	TORQUE
100%	1400	383
	1600	407
	1800	431
	2000	429
	2200	410
	2400	399
	2600	371
85%	1400	327
	1600	346
	1800	366
	2000	364
	2200	348
	2400	339
	2600	315
70%	1400	268
	1600	285
	1800	301
	2000	300
	2200	287
	2400	279
	2600	259
50%	1400	191
	1600	203
	1800	215
	2000	214
	2200	205
	2400	199
	2600	195
25%	1400	96
	1600	102
	1800	108
	2000	107
	2200	102
	2400	100
	2600	93

Table 5-14. 400-Hour NATO Endurance Test with FRDF

The endurance test duration is 400 hours divided into four periods of 100 hours each. At the completion of each period, the engine shall be submitted to a full-load performance check.

Each 100-hour period is to comprise ten (10) hour cycles. Each 10-hour cycle will be carried out in accordance with the following program:

Program of 10 Hour Cycle

Subcycle	% Rated Speed	% Load	Duration in Hours
1	IDLE 660± 25 RPM	0	½
2	100 2600 RPM	100	2
3	2900± 25 RPM (GOVERNED SPEED)	0	½
4	75 1950 RPM	100	1
5	IDLE-------100 660± 25 2600 RPM	0-----100 4 MIN 6 MIN	2
6	60 1560 RPM	100	½
7	IDLE 660± 25 RPM	0	½
8	2700± 25 RPM (GOVERNED SPEED)	70	½
9	MAX TORQUE SPEED 1800 RPM	100	2
10	60 1560 RPM	50	½

NOTE: Conduct the maintenance, oil change, oil and fuel filter change and data recording; per Part II of NATO Standard Diesel and Spark Ignition Engines Laboratory Test (Revised Jan 84) Section 2-4, Page 32. (See Appendix B.)

Table 5-15. Instruments and Equipment

- Instruments to be Used in the Test Program

  -Elwood data acquisition system to be used for data gathering.

  -Load cell to be used for measuring torque.

  -Digital Elwood fuel weigh system to be used for measuring fuel.

  -Cooling tower system.

  -Engine blow-by measuring system.

  -Oil bath temperature.

- Calibration of Instruments and Equipment

  -The instrumentation and equipment used in the test cell will be calibrated prior to the start of the test and within ranges specified in previous paragraphs of this report.

- Further instructions will be given by the engineer when it is necessary during the test.

- Daily before every start up of testing, check coolant and oil levels and check for loose bolts, nuts, brackets, harnesses and cracks. Correct the problem and report it to the project engineer. Record the above in the log book in detail.

- Air-operated torque wrench should not be used on rotating engine parts.

- Provide high-visibility transparent fuel line near control room window.

Table 5-16. Test Samples and Test Conclusion

- FRDF and Oil Samples

1. Each 50 hours of durability testing, take 8 ounces of fuel sample at the mixer for laboratory analysis at Belvoir Fuels and Lubricants Research Facility (SWRI).

2. Take 2 ounces of oil sample before starting endurance test and every 50 hours thereafter from oil gallery.

3. Check engine oil level and appearance at completion of every shift or before engine is started for a new day of tests.

4. Record data during the last five minutes of each of the endurance periods listed in test schedule.

- Test Conclusion

1. At the conclusion of the 400-hour durability test disassemble and inspect the following:

    -Fuel injection pump
    -Injectors
    -Engine's rotating and reciprocating parts

2. Prepare report.

The end of test program.

5.2. Performance Analysis for Engine Operation with DF2 vs. FRDF

5.2.1. Horsepower (hp) Loss and Specific Fuel Consumption (SFC) Increase due to the Engine Operation with DF2 vs. FRDF with 10.4 Percent Volume Added Tap Water. (See Table 5-17.)

208 - 183 = 25 hp

208 hp = maximum engine rated hp with DF2, and 0-hour endurance

183 hp = maximum engine rated hp with FRDF containing 10.4% added tap water, full load and at 0-hour endurance

25 hp = lost hp due to the use of FRDF

$\frac{25 \times 100}{208}$ = 12% of hp decrease

0.484 - 0.410 = 0.074

0.484 $\frac{lb}{hp\text{-}hr}$ = specific fuel consumption rate with FRDF containing 10.4% volume added tap water, 100% engine load, rated rpm and at 0-hour endurance

0.410 $\frac{lb}{hp\text{-}hr}$ = specific fuel consumption rate with DF2, 100% engine load, rated rpm and at 0-hour endurance.

0.074 $\frac{lb}{hp\text{-}hr}$ = specific fuel consumption increase due to the use of FRDF

$\frac{0.074 * 100}{0.410}$ = 18% of SFC increase due to the use of FRDF with 10.4% volume added tap water.

5.2.2. Horsepower Loss and SFC Increase due to Engine Operation with DF2 vs. FRDF with 12 Percent Volume Added Tap Water (see table 5-17).

202 - 175 = 27 hp

202 hp = maximum engine hp with DF2 and 400-hour endurance

175 hp = maximum engine hp with FRDF containing 12% volume added tap water and at 400-hour endurance

27 hp = lost hp due to the use of FRDF with 12% volume added tap water.

$\frac{27 \times 100}{202}$ = 13.36% of hp decrease

$0.513 - 0.414 = 0.099 \frac{lb}{hp-hr}$

$0.513 \frac{lb}{hp-hr}$ = specific fuel consumption rate with FRDF containing 12% volume added tap water, 100% engine load, rate rpm and at 400-hour endurance

$0.414 \frac{lb}{hp-hr}$ = specific fuel consumption rate with DF2, 100% engine load, rated rpm, and at 400-hour endurance.

$0.099 \frac{lb}{hp-hr}$ = specific fuel consumption increase due to the use of FRDF with 12% volume added tap water

$\frac{0.099 * 100}{0.414}$ = 23.91% of SFC increase due to the use of FRDF with 12% added tap water

5.2.3. Horsepower and SFC Losses using FRDF at the End of 400-Hour Endurance Test with FRDF.

183 - 175 = 8 hp

$\frac{8 * 100}{183}$ = 4.37 % of hp decrease tested with FRDF at the end of the 400-hour endurance test with FRDF

$0.513 - 0.484 = 0.029 \frac{lb}{bhp-hr}$

$\frac{0.029 * 100}{0.484}$ = 5.99% ≐ 6% of SFC increase at the end of 400-hour endurance test

Table 5-17. Brake Horsepower and Brake Specific Fuel Consumption of the Engine Using DF2 and FRDF

Fuel	Engine % Load	Rated Engine rpm	Engine Endurance hrs	Added % Vol water	hp	bsfc $\frac{lb}{hp-hr}$	% hp decrease	% SFC increase
DF2	100	2,600	0	0	208	.410	0	0
DF2	100	2,600	400	0	202	.414	2.88	1
FRDF	100	2,600	0	10.4	183	.484	12	18
FRDF	100	2,600	400	12	175	.513	13.36	23.91

5.3. Inspection Results

5.3.1. Fuel Injection System Inspection. At the conclusion of the 400-hour NATO cycle test, the fuel injection system was disassembled for visual and dimensional inspection. The visual inspection showed the following:

- The nozzles were in good condition except for signs of heat buildup on the guide portion of the nozzle valve stem.
- The plungers, barrels, springs and delivery valves were in good condition.
- The delivery valve gasket (second rear) failed at 388 hours of durability testing, causing a fuel leak outside the pump. The failed valve gasket was replaced by a new one and the test continued.
- The remaining gaskets eroded to their near outside diameter, but completed the test without fuel leak.
- The gasket's erosion was caused by the chemical attack of the oleic acid, contained in the FRDF on the copper material gaskets.
- The clamping forces on the failed and eroded gaskets were adequate, based on the amount of knife edge deformation on the discharge fittings.
- The fuel lines and remaining parts of the fuel injection system were in good condition.

5.3.2. Nozzles Opening Pressure Inspection.

- The design specification of the nozzle opening pressure is 3,600 to 3,750 psi and the service specification of the opening pressure is 3,000 to 3,250 psi.
- Test nozzles' opening pressures after engine endurance tests were within the service specification limits as in Table 5-18.

5.3.3. Engine Inspection. At the conclusion of the 400-hour NATO cycle test, two pistons of the engine (numbers one and three) were removed from the crankcase and all valves removed from the cylinder head for visual and dimensional inspection. The visual inspection showed the following:

- Piston pressure ring faces exhibited slight wear rate, however, they were still in satisfactory condition.
- Pistons and valves were in good condition with no evidence of chemical erosion or corrosion.

Table 5-18. Nozzles' Opening Pressure Inspection (PSI)

Nozzle Number	Opening Pressure
1	3,280
2	3,430
3	3,400
4	3,500
5	3,320
6	3,470

NOTE: These opening pressures fall within the service opening pressure range.

- The carbon deposit levels on these parts were light to moderate.

- The remaining parts were in good condition.

5.4. Oil and Filter Changes

Oil, oil filter and fuel filter changes were performed five times during the engine test. Changes were performed at the end of the break-in test and after each 100-hour durability test.

5.5. Horsepower and Torque versus rpm

- The maximum horsepower with FRDF occurred at 2,500 rpm and continued nearly constant throughout 2,600 rated engine rpm on most of the performance curves.

- The maximum rated horsepower with DF2 occurred at 2,600 rpm.

- The maximum torque with FRDF occurred at 1,940 rpm.

- The maximum rated torque with DF2 occurred at 1,800 rpm.

See the tables (5-19 through 5-85) and figures (5-1 through 5-41) contained in this report for more information on performance test data.

Table 5-19. Performance Test Data(100% Load, DF2, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

DIESEL FUEL (DF2)

ENDURANCE TEST HOURS: 0

TOTAL OPERATING HOURS: 28

RPM	lB-FT	BHP	$\frac{lB}{HR}$	$\frac{lB}{BHP-HR}$	BMEP
1400	455	121	45.0	0.371	147.2
1600	493	150	52.6	0.350	159.0
1800	517	177	64.1	0.361	167.3
2000	496	188	68.1	0.362	160.5
2200	471	197	73.8	0.384	148.5
2400	442	202	79.48	0.393	143.0
2600	422	208	85.3	0.410	136.5
2888					

Table 5-20. Performance Test Data (85% Load, DF2, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

85% LOAD

DIESEL FUEL (DF2)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 31

RPM	lB-FT	BHP	$\frac{lB}{HR}$	$\frac{lB}{BHP-HR}$	BMEP
1400	386	103	37.4	Ø.365	124.9
1600	419	127	44.7	Ø.349	135.5
1800	439	150	53.3	Ø.354	142.Ø
2000	422	160	58.1	Ø.361	136.5
2200	401	168	60.8	Ø.370	126.8
2400	380	173	68.56	Ø.396	122.9
2600	439	177	73.Ø	Ø.412	116.1
2888					

Table 5-21. Performance Test Data (70% Load, DF2, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

70% LOAD

DIESEL FUEL (DF2)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 34

RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
1400	317	84	28.4	Ø.336	102.5
1600	346	105	36.2	Ø.344	111.9
1800	362	124	44.1	Ø.355	117.1
2000	347	132	48.1	Ø.364	112.2
2200	329	138	51.2	Ø.381	103.8
2400	313	143	56.36	Ø.395	101.2
2600	295	145	61.8	Ø.423	95.4
2888					

Table 5-22. Performance Test Data (50% Load, DF2, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

50% LOAD

DIESEL FUEL (DF2)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 37

RPM	lB-FT	BHP	$\frac{lB}{HR}$	$\frac{lB}{BHP-HR}$	BMEP
1400	227	60	22.3	Ø.368	73.4
1600	246	74	27.8	Ø.370	79.6
1800	257	88	32.6	Ø.370	83.1
2000	248	94	36.4	Ø.385	80.2
2200	236	99	38.4	Ø.400	74.1
2400	223	101	42.9	Ø.421	72.1
2600	211	104	46.7	Ø.447	68.2
2888					

Table 5-23. Performance Test Data (25% Load, DF2, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

25% LOAD

DIESEL FUEL (DF2)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 4Ø

RPM	lB-FT	BHP	$\frac{lB}{HR}$	$\frac{lB}{BHP-HR}$	BMEP
14ØØ	113	3Ø	13.3	Ø.441	36.5
16ØØ	123	37	16.4	Ø.437	39.8
18ØØ	129	44	18.Ø	Ø.4Ø7	41.7
2ØØØ	124	47	21.8	Ø.462	4Ø.1
22ØØ	118	49	23.3	Ø.483	37.2
24ØØ	112	51	27.2	Ø.531	36.2
26ØØ	1Ø5	51	3Ø.Ø	Ø.577	33.9
2888					

Table 5-24. Performance Test Data (100% Load, FRDF, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

FIRE RESISTANT DIESEL FUEL (FRDF)

ENDURANCE TEST HOURS: 0

TOTAL OPERATING HOURS: 43

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	383	102	43.3	0.424	123.9
1600	407	124	52.5	0.422	131.7
1800	431	147	62.5	0.425	139.4
2000	429	163	69.1	0.422	138.8
2200	419	175	76.9	0.439	132.6
2400	399	182	82.1	0.450	129.1
2600	371	183	88.9	0.484	120.0
2888					

FRDF CONTENT:

78. VOL % DF2

11.6 VOL % SURFACTANT (EMULSIFIER)

10.4 VOL % Detroit Tap Water

Table 5-25. Performance Test Data (85% Load, FRDF, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

85% LOAD

FIRE RESISTANT DIESEL FUEL (FRDF)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 46

RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
1400	321	85	33.6	Ø.392	103.8
1600	348	105	44.1	Ø.416	112.6
1800	363	124	52.2	Ø.420	117.4
2000	365	138	55.9	Ø.434	118.1
2200	351	147	65.4	Ø.444	113.5
2400	339	154	72.Ø	Ø.464	109.6
2600	317	156	77.2	Ø.492	102.5
2895	40	22	28.2	1.Ø11	12.9

FRDF CONTENT:

78 VOL % DF2

11.6 VOL % SURFACTANT (EMULSIFIER)

10.4 VOL % WATER

Table 5-26. Performance Test Data (70% Load, FRDF, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

70% LOAD

FIRE RESISTANT DIESEL FUEL (FRDF)

ENDURANCE TEST HOURS: 0

TOTAL OPERATING HOURS: 49

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	266	70	29.3	0.413	86.0
1600	287	87	35.4	0.427	92.8
1800	302	103	43.9	0.424	97.7
2000	299	113	50.3	0.441	96.7
2200	291	120	54.8	0.455	92.8
2400	279	127	60.4	0.473	90.2
2600	260	128	65.7	0.510	84.1
2895					

FRDF CONTENT:

78 VOL % DF2

11.6 VOL % SURFACTANT (EMULSIFIER)

10.4 VOL % WATER

Table 5-27. Performance Test Data (50% Load, FRDF, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

50% LOAD

FIRE RESISTANT DIESEL FUEL (FRDF)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 52

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	188	50	23.1	Ø.461	60.8
1600	200	60	27.5	Ø.451	64.7
1800	215	73	33.7	Ø.457	69.5
2000	214	81	38.7	Ø.475	69.2
2200	205	85	41.4	Ø.481	66.3
2400	200	91	46.9	Ø.513	64.7
2600	186	92	51.2	Ø.556	60.1
2895					

FRDF CONTENT:

78 VOL % DF2

11.6 VOL % SURFACTANT (EMULSIFIER)

10.4 VOL % WATER

Table 5-28. Performance Test Data (25% Load, FRDF, 0-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

25% LOAD

FIRE RESISTANT DIESEL FUEL (FRDF)

ENDURANCE TEST HOURS: Ø

TOTAL OPERATING HOURS: 55

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	96	25	13.5	Ø.526	31.Ø
1600	101	30	15.8	Ø.514	32.6
1800	106	36	19.5	Ø.537	34.3
2000	107	40	23.6	Ø.579	34.6
2200	103	43	26.4	Ø.611	33.3
2400	100	45	30.4	Ø.665	32.3
2600	95	46	33.2	Ø.706	30.7
2895					

FRDF CONTENT:

78 VOL % DF2

11.6 VOL % SURFACTANT (EMULSIFIER)

10.4 VOL % WATER

Table 5-29. Performance Test Data (100% Load, FRDF, 100-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 100 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 100

TOTAL OPERATING HOURS: 158

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	378	100	44.2	0.438	122.3
1600	402	122	53.1	0.433	130.0
1800	431	147	63.7	0.431	139.4
2000	438	166	72.7	0.436	141.7
2200	419	175	78.8	0.448	135.5
2400	391	178	83.9	0.469	126.5
2600	365	180	89.5	0.495	118.1
2895					

FRDF CONTENT:

78 VOL % DF2

10.2 VOL % SURFACTANT (EMULSIFIER)

11.8 VOL % WATER

Table 5-30. Performance Test Data (100%, FRDF, 200-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 200 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 200

TOTAL OPERATING HOURS: 261

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	360	95	43.3	0.452	116.4
1600	382	117	51.9	0.446	123.6
1800	407	139	61.7	0.442	131.7
2000	415	158	70.3	0.444	134.2
2200	401	167	77.3	0.460	129.7
2400	382	174	83.5	0.478	123.6
2600	358	177	89.1	0.503	115.8
2895					

FRDF CONTENT:

78 VOL % DF2

10.2 VOL % SURFACTANT (EMULSIFIER)

11.8 VOL % WATER

Table 5-31. Performance Test Data (100% Load, FRDF, 300-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 300 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 300

TOTAL OPERATING HOURS: 364

RPM	LB-FT	BHP	$\frac{1B}{HR}$	$\frac{LB}{BHP-HR}$
1400	369	98	44.7	0.454
1600	397	121	53.3	0.440
1800	423	144	62.9	0.436
2000	427	162	72.1	0.443
2200	412	172	78.5	0.455
2400	390	178	84.5	0.474
2600	356	176	89.5	0.507
2895				

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-32. Performance Test Data (100% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 400 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 467

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	376	100	44.0	0.438	121.6
1600	403	122	53.2	0.433	130.4
1800	423	144	62.8	0.433	136.8
2000	425	161	71.0	0.438	137.5
2200	409	171	77.6	0.452	132.3
2400	388	177	83.6	0.471	125.5
2600	353	175	89.9	0.513	115.8
2895					

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-33. Performance Test Data (85% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

85% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 400 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 470

RPM	LB-FT	BHP	LB-HR	LB / BHP-HR	BMEP
1400	327	87	37.7	0.432	105.8
1600	346	105	45.5	0.431	111.9
1800	365	125	54.2	0.433	118.1
2000	366	139	62.0	0.444	118.4
2200	349	150	67.5	0.450	112.9
2400	339	154	74.4	0.480	109.6
2600	316	156	80.6	0.515	102.2
2895					

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-34. Performance Test Data (70% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

70% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 400 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 473

RPM	LB-FT	BHP	$\frac{1B}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	268	71	31.9	0.446	86.7
1600	285	86	38.1	0.438	92.2
1800	298	102	45.6	0.443	97.0
2000	299	114	52.1	0.456	97.0
2200	291	122	56.8	0.472	92.8
2400	279	127	63.0	0.494	90.2
2600	260	128	68.8	0.537	84.1
2895					

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-35. Performance Test Data (50% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

50% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 400 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 476

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	193	51	24.3	0.472	62.4
1600	204	62	29.2	0.469	66.0
1800	214	73	34.5	0.470	69.2
2000	215	81	39.5	0.482	69.5
2200	210	88	43.3	0.492	66.3
2400	200	91	49.3	0.539	64.7
2600	185	92	53.7	0.586	59.8
2895					

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-36. Performance Test Data (25% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

25% LOAD

PERFORMANCE TEST DATA WITH FIRE RESISTANT

DIESEL FUEL (FRDF) AFTER 400 HOURS OF ENDURANCE

TESTS WITH THE SAME FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 479

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	94	25	14.7	0.574	31.0
1600	102	31	18.5	0.595	33.0
1800	105	36	21.7	0.591	34.6
2000	105	40	25.3	0.620	34.6
2200	103	43	28.3	0.655	33.3
2400	100	46	31.7	0.689	32.0
2600	93	46	36.0	0.782	30.0
2895					

FRDF CONTENT:

78 VOL % DF2

10 VOL % SURFACTANT (EMULSIFIER)

12 VOL % WATER

Table 5-37. Performance Test Data (100% Load, DF2, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH DIESEL FUEL (DF2)

AFTER 400 HOURS OF ENDURANCE TESTS WITH FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 482

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	457	121	45	0.369	147.8
1600	495	150	54.6	0.361	160.1
1800	509	174	62.3	03.58	164.7
2000	489	186	66.7	0.358	158.2
2200	464	194	72.0	0.370	150.1
2400	438	200	77.9	0.389	141.7
2600	408	202	83.6	0.414	130.4
2895					

Table 5-38. Performance Test Data (85% Load, DF2, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

85% LOAD

PERFORMANCE TEST DATA WITH DIESEL FUEL (DF2)

AFTER 400 HOURS OF ENDURANCE TESTS WITH FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 485

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	387	103	37.0	0.359	125.5
1600	417	127	45.7	0.358	135.5
1800	438	150	53.6	0.356	142.0
2000	420	160	58.1	0.361	136.5
2200	399	167	61.5	0.376	126.2
2400	379	173	68.6	0.395	122.9
2600	358	177	73.9	0.415	116.1
2895	36	19	25.8	1.302	11.6

Table 5-39. Performance Test Data (70% Load, DF2, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

70% LOAD

PERFORMANCE TEST DATA WITH DIESEL FUEL (DF2)

AFTER 400 HOURS OF ENDURANCE TESTS WITH FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 488

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	318	84	30.4	0.358	102.9
1600	345	105	37.2	0.353	111.6
1800	360	123	44.5	0.360	116.4
2000	347	132	48.4	0.366	112.2
2200	331	139	51.9	0.374	103.8
2400	313	142	58.0	0.402	101.2
2600	296	146	62.6	0.427	95.7
2895					

Table 5-40. Performance Test Data (50% Load, DF2, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

50% LOAD

PERFORMANCE TEST DATA WITH DIESEL FUEL (DF2)

AFTER 400 HOURS OF ENDURANCE TESTS WITH FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 491

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	226	60	22.1	0.368	73.1
1600	246	75	28.0	0.373	79.6
1800	258	88	32.8	0.371	83.4
2000	247	94	36.1	0.383	79.9
2200	237	99	39.0	0.394	73.7
2400	222	101	43.6	0.429	71.8
2600	211	104	48.2	0.461	68.2
2895					

Table 5-41. Performance Test Data (25% Load, DF2, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

25% LOAD

PERFORMANCE TEST DATA WITH DIESEL FUEL (DF2)

AFTER 400 HOURS OF ENDURANCE TESTS WITH FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 494

RPM	LB-FT	BHP	$\frac{1B}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	113	30	13.2	0.438	36.5
1600	124	37	16.5	0.436	40.1
1800	128	43	19.39	0.451	41.4
2000	124	47	22.2	0.470	40.1
2200	117	49	24.3	0.496	37.2
2400	112	51	28.15	0.552	36.2
2600	105	52	31.2	0.611	33.9
2895					

Table 5-42. Performance Test Data (100% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

100% LOAD

PERFORMANCE TEST DATA WITH LOWER WATER PERCENTAGE

IN FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 497

RPM	LB-FT	BHP	$\frac{1B}{HR}$	$\frac{LB}{BHP-HR}$	BMEP
1400	408	108	44.3	.407	
1600	437	133	54.0	.405	
1800	463	158	63.9	.402	
2000	453	172	70.6	.409	
2200	432	180	76.3	.421	
2400	411	187	83.3	.443	
2600	382	189	87.6	.463	
2888	37	20	28	1.415	

FRDF CONTENT:

78 VOL % DF2

11.8 VOL % SURFACTANT (EMULSIFIER)

10.2 vOL % WATER

Table 5-43. Performance Test Data (50% Load, FRDF, 400-Hour)

PERFORMANCE TEST DATA

DT-466 NAVISTAR DIESEL ENGINE S/N 176482

50% LOAD

PERFORMANCE TEST DATA WITH LOWER WATER PERCENTAGE

IN FRDF

ENDURANCE TEST HOURS: 400

TOTAL OPERATING HOURS: 500

RPM	LB-FT	BHP	$\frac{LB}{HR}$	$\frac{LB}{BHP-HR}$
1400	191	50	23.2	.455
1600	204	62	28.1	.452
1800	212	73	33.2	.450
2000	213	81	37.1	.458
2200	209	88	41.5	.483
2400	200	91	46.4	.507
2600	185	92	50.6	.552
2888				

FRDF CONTENT:

78 VOL % DF2

11.8 VOL % SURFACTANT (EMULSIFIER)

10.2 VOL % WATER

Table 5-44. Performance Test Data (Lubricating Oil Consumption)

DT-466 NAVISTAR DIESEL ENGINE

ENGINE LUBRICATING OIL CONSUMPTION RATE DURING 400 HOUR ENDURANCE TEST WITH FIRE RESISTANT DIESEL FUEL (FRDF)

DATE	ENDURANCE TEST, HOURS	QUANTITY ADDED, LBS	CUMULATIVE OIL CONSUMPTION, LBS	OIL CONSUMPTION RATE, LB/HR
8-11-86	0	0	0	0
	30	2.00	2.00	0.066
	50	2.25	4.25	0.085
	70	1.50	5.75	0.082
9-17-86	100	2.25	8.00	0.080
	150	3.50	11.50	0.076
	180	1.50	13.00	0.072
	190	2.00	15.00	0.079
9-29-86	200	2.25	17.25	0.086
	220	2.50	19.75	0.089
	230	2.50	22.25	0.096
	250	2.50	24.75	0.099
	260	1.25	26.00	0.100
	280	2.25	28.25	0.101
10-11-86	300	2.25	30.50	0.1016
	340	0.50	31.00	0.091
	360	1.00	32.00	0.088
	370	1.25	33.25	0.089
	380	1.75	35.00	0.0921
	397	1.50	36.50	0.0919
11-4-86	400	2.00	38.50	0.0962

Table 5-45. Performance Test Data (at the end of 10-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 10-Hour Endurance Test

Endurance Test Hours 10

Total Operating Hours 65

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5.5	--	3.1	--	1.2
100	100 2600 RATED	372	184	90.6	0.491	120.3
0	110	39	21	30.3	1.412	12.6
100	75	421	156	67.8	0.433	136.2
100	60	391	116	50.1	0.431	126.5
70	105	265	138	73.0	0.528	85.7
100	69 MAX T. SPD	422	144	61.9	0.428	136.5
50	60	185	54	26.1	0.475	59.8

FRDF CONTENT:

78 VOL% DF2

11.6 VOL% SURFACTANT (EMULSIFIER)

10.4 VOL% WATER

Table 5-46. Performance Test Data (at the end of 20-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 20-Hour Endurance Test

Endurance Test Hours 20

Total Operating Hours 75

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5		3.1		1.6
100	100 2600 RATED	372	184	90.1	0.488	120.6
0	110	35	19	30.3	1.572	11.3
100	75	431	159	68.6	0.428	139.4
100	60	397	117	51.1	0.433	128.4
70	105	263	136	75.7	0.562	85.1
100	69	422	144	61.7	0.426	136.5
50	60	185	54	26.4	0.480	59.8

FRDF CONTENT:

78 VOL% DF2

11.6 VOL% SURFACTANT (EMULSIFIER)

10.4 VOL% WATER

Table 5-47. Performance Test Data (at the end of 30-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 30-Hour Endurance Test

Endurance Test Hours 30

Total Operating Hours 85

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	4.5	--	3.4	--	1.1
100	100 2600 RATED	365	180	91.0	0.502	118.1
0	110	35	19	30.5	1.583	11.3
100	75	423	156	68.1	0.434	136.8
100	60	397	117	50.8	0.430	128.4
70	105	251	130	70.7	0.540	81.2
100	69	434	148	63.5	0.426	140.4
50	60	188	55	25.9	0.464	60.8

FRDF CONTENT:

78 VOL% DF2

10.4 VOL% SURFACTANT (EMULSIFIER)

11.6 VOL% WATER

Table 5-48. Performance Test Data (at the end of 40-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 40-Hour Endurance Test

Endurance Test Hours 40

Total Operating Hours 95

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	3	--	3.9	--	0.9
100	100 2600 RATED	371	183	90.6	0.492	120.0
0	110	36	19	30.3	1.531	11.6
100	75	426	158	68.25	0.432	137.8
100	60	397	117	50.3	0.426	128.4
70	105	260	135	72.0	0.531	84.1
100	69	420	143	61.6	0.428	135.9
50	60	188	55	23.65	0.430	60.8

FRDF CONTENT:

78 VOL% DF2

11.6 VOL% SURFACTANT (EMULSIFIER)

10.4 VOL% WATER

Table 5-49. Performance Test Data (at the end of 50-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 50-Hour Endurance Test

Endurance Test Hours 50

Total Operating Hours 105

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	7	--	3.4	--	2.2
100	100 2600 RATED	373	184	90.3	0.490	120.7
0	110	39	21	30.1	1.433	12.6
100	75	438	162	70.0	0.430	141.7
100	60	398	118	50.9	0.430	128.7
70	105	264	137	71.9	0.522	85.4
100	69	409	140	60.5	0.431	132.3
50	60	184	55	25.6	0.47	59.8

FRDF CONTENT:

78 VOL% DF2

11.6 VOL% SURFACTANT (EMULSIFIER)

10.4 VOL% WATER

Table 5-50. Performance Test Data (at the end of 60-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 60 Hour Endurance Test

Endurance Test Hours 60

Total Operating Hours 115

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	8		3.7		2.5
100	100 2600 RATED	343	169	84.0	0.494	110.9
0	110	36	19	30.4	1.535	11.6
100	75	315	116	52.3	0.447	101.9
100	60	403	119	51.3	0.428	130.4
70	105	271	140	74.1	0.526	87.6
100	69	436	149	63.8	0.427	141.0
50	60	183	53	25.5	0.43	60.1

FRDF CONTENT:

78 VOL% DF2

8.8 VOL% SURFACTANT (EMULSIFIER)

13.2 VOL% WATER

Table 5-51. Performance Test Data (at the end of 70-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 70 Hour Endurance Test

Endurance Test Hours 70

Total Operating Hours 125

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	3		3.1		0.9
100	100 2600 RATED	368	182	90.2	0.495	119.0
0	110	35	19	30.5	1.583	11.3
100	75	441	163	70.6	0.431	142.7
100	60	410	121	52.1	0.428	132.6
70	105	252	131	73.5	0.560	81.5
100	69	452	154	65.7	0.424	146.2
50	60	188	55	26.5	0.475	60.8

FRDF CONTENT:

78 VOL% DF2

11.4 VOL% SURFACTANT (EMULSIFIER)

10.6 VOL% WATER

Table 5-52. Performance Test Data (at the end of 80-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 80-Hour Endurance Test

Endurance Test Hours 80

Total Operating Hours 135

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE			3.1		
100	100 2600 RATED	368	182	89.8	0.492	119.0
0	110	35	19	30.6	1.589	11.3
100	75	435	161	69.8	0.432	140.7
100	60	394	116	50.2	0.429	127.4
70	105	261	135	71.28	0.528	84.4
100	69	429	146	63.7	0.433	138.8
50	60	186	54	26.2	0.478	60.1

FRDF CONTENT:

78 VOL% DF2

11.4 VOL% SURFACTANT (EMULSIFIER)

10.6 VOL% WATER

Table 5-53. Performance Test Data (at the end of 90-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 90-Hour Endurance Test

Endurance Test Hours 90

Total Operating Hours 145

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5		3.4		1.6
100	100 2600 RATED	366	181	90.3	0.498	118.4
0	110	37	20	30.8	1.513	11.9
100	75	438	162	70.1	0.431	141.7
100	60	398	118	50.6	0.428	128.7
70	105	269	140	71.3	0.509	87.0
100	69	428	146	63.1	0.430	138.4
50	60	185	54	25.6	0.465	59.8

FRDF CONTENT:

78 VOL% DF2

10.7 VOL% SURFACTANT (EMULSIFIER)

11.3 VOL% WATER

Table 5-54. Performance Test Data (at the end of 100-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 100 Hour Endurance Test

Endurance Test Hours 100

Total Operating Hours 158

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	1		3.7		0.3
100	100 2600 RATED	363	179	90.3	0.502	117.4
0	110	35	19	31.0	1.631	11.3
100	75	438	162	70.4	0.432	141.7
100	60	396	117	50.9	0.433	128.1
70	105	273	141	75.1	0.530	88.3
100	69	437	149	64.4	0.430	141.4
50	60	187	55	26.3	0.475	60.5

FRDF CONTENT:

78 VOL% DF2

10.2 VOL% SURFACTANT (EMULSIFIER)

11.8 VOL% WATER

Table 5-55. Performance Test Data (at the end of 110-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 110-Hour Endurance Test

Endurance Test Hours 110

Total Operating Hours 168

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5		3.7		1.6
100	100 2600 RATED	362	179	89.6	0.499	117.1
0	110	38	20	31.2	1.494	12.2
100	75	423	157	69.1	0.439	136.8
100	60	391	116	50.7	0.436	126.5
70	105	266	137	72.2	0.523	86.0
100	69	424	145	63.3	0.435	137.2
50	60	186	55	26.1	0.472	60.1

FRDF CONTENT:

78 VOL% DF2

10.2 VOL% SURFACTANT (EMULSIFIER)

11.8 VOL% WATER

Table 5-56. Performance Test Data (at the end of 120-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 120-Hour Endurance Test

Endurance Test Hours 120

Total Operating Hours 178

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5		3.7		1.6
100	100 2600 RATED	361	178	88.46	0.497	116.8
0	110	36	19	29.5	1.553	11.6
100	75	431	159	69.3	0.433	139.4
100	60	390	115	50.7	0.437	126.2
70	105	266	137	73.9	0.537	86.0
100	69	426	145	63.2	0.433	137.8
50	60	185	54	26.0	0.473	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-57. Performance Test Data (at the end of 130-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-Hour Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 130-Hour Endurance Test

Endurance Test Hours 130

Total Operating Hours 188

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	7		3.5		2.2
100	100 2600 RATED	363	179	87.1	0.485	117.4
0	110	39	21	30.3	1.415	12.6
100	75	420	155	67.9	0.436	135.9
100	60	393	116	50.8	0.435	127.1
70	105	251	130	72.5	0.555	81.2
100	69	429	147	63.6	0.432	138.8
50	60	185	54	26.3	0.479	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-58. Performance Test Data (at the end of 140-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 140-Hour Endurance Test

Endurance Test Hours 140

Total Operating Hours 198

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	7	—	3.5	—	2.2
100	100 2600 RATED	363	179	87.4	0.486	117.4
0	110	36	19	29.7	1.564	11.6
100	75	427	158	70.1	0.442	138.1
100	60	382	113	50.0	0.440	123.6
70	105	269	139	74.4	0.532	87.0
100	69	424	145	63.6	0.437	137.2
50	60	183	54	26.0	0.478	59.2

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-59. Performance Test Data (at the end of 150-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 150-Hour Endurance Test

Endurance Test Hours 150

Total Operating Hours 208

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5	—	3.7	—	1.6
100	100 2600 RATED	359	177	89.4	0.503	116.1
0	110	29	15	29.5	1.844	9.3
100	75	424	157	69.2	0.439	137.2
100	60	388	115	50.6	0.438	125.5
70	105	259	134	75.5	0.561	83.8
100	69	420	144	63.3	0.440	136.0
50	60	179	53	25.9	0.487	57.9

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-60. Performance Test Data (at the end of 160-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 160-Hour Endurance Test

Endurance Test Hours 160

Total Operating Hours 218

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	4	—	3.9	—	1.2
100	100 2600 RATED	357	176	89.5	0.506	115.5
0	110	40	22	32.0	1.450	12.9
100	75	419	155	68.6	0.440	135.5
100	60	387	114	50.9	0.443	125.2
70	105	260	134	75.3	0.557	84.1
100	69	423	144	63.7	0.439	136.8
50	60	187	55	26.4	0.480	60.5

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-61. Performance Test Data (at the end of 170-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 170-Hour Endurance Test

Endurance Test Hours 170

Total Operating Hours 228

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	4	—	3.9	—	1.2
100	100 2600 RATED	357	176	89.9	0.508	115.5
0	110	38	20	32.2	1.538	12.2
100	75	427	158	70.3	0.443	138.1
100	60	382	113	50.3	0.443	123.6
70	105	267	139	74.1	0.532	86.4
100	69	415	141	63.3	0.445	134.2
50	60	185	54	26.8	0.487	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-62. Performance Test Data (at the end of 180-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 180-Hour Endurance Test

Endurance Test Hours 180

Total Operating Hours 238

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	5	—	3.6	—	1.6
100	100 2600 RATED	356	176	89.7	0.509	115.2
0	110	35	19	31.4	1.625	11.5
100	75	425	157	70.2	0.445	137.5
100	60	386	114	50.5	0.440	124.9
70	105	262	135	74.4	0.547	84.7
100	69	421	144	63.5	0.440	136.2
50	60	186	55	26.5	0.474	60.1

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-63. Performance Test Data (at the end of 190-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 190-Hour Endurance Test

Endurance Test Hours 190

Total Operating Hours 248

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	4	—	3.7	—	1.2
100	100 2600 RATED	356	176	89.6	0.508	115.2
0	110	36	19	31.7	1.599	11.6
100	75	428	158	70.2	0.441	138.4
100	60	384	113	50.6	0.443	124.2
70	105	248	128	74.1	0.575	80.2
100	69	421	144	63.5	0.439	136.2
50	60	183	54	26.8	0.493	59.2

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-64. Performance Test Data (at the end of 200-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 200-Hour Endurance Test

Endurance Test Hours 200

Total Operating Hours 261

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	3	—	3.4	—	0.9
100	100 2600 RATED	357	176	89.6	0.506	115.5
0	110	40	21	30.8	1.469	12.9
100	75	415	154	68.2	0.442	134.2
100	60	379	112	49.6	0.440	122.6
70	105	260	135	74.5	0.551	84.1
100	69	407	139	62.6	0.447	131.7
50	60	184	54	26.9	0.491	59.5

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-65. Performance Test Data (at the end of 210-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 210-Hour Endurance Test

Endurance Test Hours 210

Total Operating Hours 271

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.0	—	—
100	100 2600 RATED	354	175	89.6	0.511	114.5
0	110	33	18	31.3	1.724	10.6
100	75	423	156	69.4	0.442	136.8
100	60	387	114	50.9	0.443	125.2
70	105	259	134	74.3	0.551	83.8
100	69	427	146	64.4	0.440	138.1
50	60	185	54	27.1	0.492	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-66. Performance Test Data (at the end of 220-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 220-Hour Endurance Test

Endurance Test Hours 220

Total Operating Hours 281

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.1	—	—
100	100 2600 RATED	356	176	89.8	0.509	115.2
0	110	34	18	32.1	1.711	11.0
100	75	427	158	70.0	0.441	138.1
100	60	391	116	51.3	0.441	126.5
70	105	259	134	74.5	0.552	83.8
100	69	423	144	66.9	0.441	136.8
50	60	186	55	27.1	0.493	60.1

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-67. Performance Test Data (at the end of 230-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 230-Hour Endurance Test

Endurance Test Hours 230

Total Operating Hours 291

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.8	—	—
100	100 2600 RATED	356	176	89.8	0.509	115.2
0	110	39	21	32.3	1.503	12.6
100	75	429	159	69.9	0.439	138.8
100	60	399	118	51.6	0.435	129.1
70	105	261	135	74.7	0.551	84.4
100	69	434	148	64.7	0.434	140.4
50	60	189	56	27.5	0.489	61.1

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-68. Performance Test Data (at the end of 240-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 240-Hour Endurance Test

Endurance Test Hours 240

Total Operating Hours 301

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.4	—	—
100	100 2600 RATED	359	177	89.3	0.502	116.1
0	110	37	20	31.8	1.562	11.9
100	75	426	158	69.2	0.437	137.8
100	60	393	116	51.0	0.436	127.1
70	105	261	135	74.4	0.549	84.4
100	69	433	148	64.5	0.434	140.1
50	60	184	54	26.7	0.488	59.5

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-69. Performance Test Data (at the end of 250-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 250-Hour Endurance Test

Endurance Test Hours 250

Total Operating Hours 311

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	359	177	89.3	0.502	116.1
0	110	38	20	32.1	1.534	12.2
100	75	429	159	69.6	0.437	138.8
100	60	401	119	51.7	0.433	129.7
70	105	250	130	71.4	0.548	80.8
100	69	435	149	64.6	0.433	140.7
50	60	186	55	26.8	0.484	60.1

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-70. Performance Test Data (at the end of 260-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 260-Hour Endurance Test

Endurance Test Hours 260

Total Operating Hours 321

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	352	174	89.5	0.513	113.9
0	110	37	20	31.8	1.567	11.9
100	75	408	151	68.2	0.449	132.0
100	60	387	115	50.4	0.438	125.2
70	105	260	134	72.4	0.539	84.1
100	69	408	139	61.9	0.442	132.0
50	60	172	51	25.8	0.505	55.6

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-71. Performance Test Data (at the end of 270-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 270-Hour Endurance Test

Endurance Test Hours 270

Total Operating Hours 331

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	--
100	100 2600 RATED	355	175	89.0	0.506	114.8
0	110	38	21	30.4	1.447	12.0
100	75	421	156	68.8	0.439	136.2
100	60	393	116	50.3	0.433	127.1
70	105	261	135	73.6	0.544	84.4
100	69	428	146	63.6	0.433	138.4
50	60	185	54	26.6	0.484	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-72. Performance Test Data (at the end of 280-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 280-Hour Endurance Test

Endurance Test Hours 280

Total Operating Hours 341

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	358	177	89.0	0.502	115.8
0	110	37	20	31.3	1.560	11.9
100	75	416	154	68.1	0.441	134.6
100	60	393	116	51.1	0.437	127.1
70	105	257	132	74.3	0.559	83.1
100	69	421	144	63.3	0.438	136.2
50	60	185	54	27.0	0.745	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-73. Performance Test Data (at the end of 290-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 290-Hour Endurance Test

Endurance Test Hours 290

Total Operating Hours 351

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	--	--	--	--	--
100	100 2600 RATED	359	177	89.9	0.505	116.1
0	110	33	18	32.0	1.768	10.6
100	75	423	157	69.4	0.441	136.8
100	60	387	114	50.4	0.439	125.2
70	105	260	134	74.6	0.555	84.1
100	69	418	143	61.5	0.429	135.2
50	60	185	54	27.2	0.494	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-74. Performance Test Data (at the end of 300-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 300-Hour Endurance Test

Endurance Test Hours 300

Total Operating Hours 364

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	351	173	88.3	0.507	113.5
0	110	35	19	31.5	1.640	11.3
100	75	398	147	66.5	0.450	128.7
100	60	384	113	50.0	0.438	124.2
70	105	259	133	75.2	0.562	83.8
100	69	405	138	60.9	0.439	131.0
50	60	178	52	26.6	0.502	57.6

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-75. Performance Test Data (at the end of 310-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 310-Hour Endurance Test

Endurance Test Hours 310

Total Operating Hours 374

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	--	--	--	--	--
100	100 2600 RATED	356	176	89.6	0.508	--
0	110	30	16	30.9	1.875	--
100	75	427	158	69.8	0.440	--
100	60	392	116	50.6	0.434	--
70	105	256	132	72.2	0.544	--
100	69	409	140	60.8	0.434	--
50	60	181	54	26.0	0.481	--

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-76. Performance Test Data (at the end of 320-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 320-Hour Endurance Test

Endurance Test Hours 320

Total Operating Hours 384

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	352	174	88.6	0.508	113.9
0	110	32	17	30.2	1.744	10.3
100	75	417	154	68.3	0.441	134.9
100	60	385	114	50.6	0.442	124.5
70	105	248	128	71.3	0.555	80.2
100	69	415	142	62.4	0.439	134.2
50	60	180	53	26.5	0.495	58.2

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-77. Performance Test Data (at the end of 330-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 330-Hour Endurance Test

Endurance Test Hours 330

Total Operating Hours 394

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	354	175	88.8	0.506	114.5
0	110	30	16	30.5	1.854	9.7
100	75	421	156	68.8	0.439	136.2
100	60	387	114	50.7	0.441	125.2
70	105	266	137	74.2	0.540	86.0
100	69	415	142	62.6	0.440	134.2
50	60	183	54	26.4	0.485	59.2

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-78. Performance Test Data (at the end of 340-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 340-Hour Endurance Test

Endurance Test Hours 340

Total Operating Hours 404

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	—	—	—
100	100 2600 RATED	354	175	88.9	0.507	114.5
0	110	35	19	30.9	1.611	11.3
100	75	419	155	68.8	0.442	135.5
100	60	411	152	68.1	0.446	132.9
70	105	262	135	75.6	0.559	84.7
100	69	424	145	63.2	0.435	137.2
50	60	186	55	26.9	0.486	60.1

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-79. Performance Test Data (at the end of 350-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 350-Hour Endurance Test

Endurance Test Hours 350

Total Operating Hours 414

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	2	--	2.8	—	0.6
100	100 2600 RATED	356	176	88.6	0.502	115.2
0	110	30	16	31.0	1.937	9.7
100	75	426	158	69.7	0.440	137.8
100	60	391	116	50.8	0.437	126.5
70	105	259	133	74.6	0.557	83.8
100	69	424	145	63.5	0.436	137.2
50	60	182	54	26.8	0.495	58.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-80. Performance Test Data (at the end of 360-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 360-Hour Endurance Test

Endurance Test Hours 360

Total Operating Hours 424

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	--	--	4	--	--
100	100 2600 RATED	354	175	89.0	.508	114.5
0	110	29	15	30.2	1.895	9.3
100	75	425	157	69.5	0.440	137.5
100	60	388	115	50.6	0.439	125.5
70	105	267	137	74.6	0.545	86.4
100	69	417	142	62.3	0.438	134.9
50	60	187	55	27.7	0.498	60.5

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-81. Performance Test Data (at the end of 370-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 370-Hour Endurance Test

Endurance Test Hours 370

Total Operating Hours 434

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.9	—	—
100	100 2600 RATED	353	174	88.2	.504	114.2
0	110	35	19	30.8	1.604	11.3
100	75	417	154	67.8	0.438	134.9
100	60	390	115	50.0	0.431	126.2
70	105	259	133	74.0	0.557	83.8
100	69	418	143	66.0	0.432	135.2
50	60	168	49	45.2	0.508	54.3

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-82. Performance Test Data (at the end of 380-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 380-Hour Endurance Test

Endurance Test Hours 380

Total Operating Hours 444

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	—	—	3.5	—	—
100	100 2600 RATED	358	177	88.0	.496	115.8
0	110	35	19	30.6	1.593	11.3
100	75	426	158	68.8	0.434	137.8
100	60	396	117	50.7	0.430	128.1
70	105	263	135	73.9	0.544	85.1
100	69	422	144	62.0	0.428	136.5
50	60	172	51	25.0	0.489	55.6

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-83. Performance Test Data (at the end of 390-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 390-Hour Endurance Test

Endurance Test Hours 390

Total Operating Hours 454

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	--	--	4.0	--	--
100	100 2600 RATED	353	174	88.5	.506	114.2
0	110	36	19	30.7	1.615	11.6
100	75	416	154	68.0	0.440	134.6
100	60	387	115	50.5	0.439	125.2
70	105	246	127	72.6	0.569	79.6
100	69	426	145	62.7	0.432	137.8
50	60	185	54	26.6	0.484	59.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

NOTE: DELIVERY VALVE GASKET OF THE FUEL INJECTION PUMP FAILED AT 388 DURABILITY TEST HOUR

Table 5-84. Performance Test Data (at the end of 400-Hour)

DT-466 Navistar Diesel Engine, S/N 176482

Program of 10-hours Endurance Test with Fire Resistant Diesel Fuel (FRDF)

Performance Data were Printed-out at the End of 400-Hour Endurance Test

Endurance Test Hours 400

Total Operating Hours 467

% LOAD	% RPM	LB-FT	BHP	LB/HR	LB/BHP-HR	BMEP
0	26 IDLE	--	--	3.5	--	--
100	100 2600 RATED	356	176	89.0	.505	115.2
0	110	34	18	30.0	1.661	11.0
100	75	432	160	70.6	0.440	139.7
100	60	393	116	50.8	0.438	127.1
70	105	258	133	73.3	0.551	83.4
100	69	431	147	63.7	0.433	139.4
50	60	188	55	26.7	0.485	60.8

FRDF CONTENT:

78 VOL% DF2

10 VOL% SURFACTANT (EMULSIFIER)

12 VOL% WATER

Table 5-85. Properties of Reference Diesel Fuels

Property		No. 7225	No. 8821
Specification Type		MIL-F-46162A(MR)-II	Fed. Spec. VV-F-800b-DF-2
Gravity, °API at 15.5°C		36.1	35.2
Density, g/mL at 15.5°C		0.844	0.848
Flash Point, PMCC, °C(°F)		60 (140)	72 (161)
Fire Point, °C(°F)		91 (196)	84 (183)
Cloud Point, °C(°F)		-21 (-6)	-1 (30)
Pour Point, °C(°F)		-24 (-11)	-10 (14)
Kinematic Viscosity, cSt at 40°C		2.2	3.2
Accelerated Stability (ASTM D 2274), mg/100 mL		0.6	2.7
Total Acid No., mg KOH/g		0.01	0.03
Steam Jet Gum, mg/100 mL		3.9	3.2
Sulfur, wt%		0.35	0.47
Copper Strip Corrosion (ASTM D 130)		1A	1A
Carbon, wt%		86.8	86.7
Hydrogen, wt%		13.2	13.3
Heat of Combustion (Gross), J/kg (Btu/lb)		45.1×10^6 (19,427)	45.7×10^6 (19,670)
Heat of Combustion (Net), J/kg (Btu/lb)		42.5×10^6 (18,283)	42.8×10^6 (18,450)
Hydrocarbon Types, FIA, vol%	saturates	---	69.1
	aromatics	---	29.4
Hydrocarbon Types, HPLC, wt%	saturates	72.5	74.1
	aromatics	27.5	25.9
Aromatic Ring Carbon, UV, wt%	mononuclear	7.08	7.50
	dinuclear	11.47	6.54
	trinuclear	0.31	0.36
	total	18.86	14.40
Cetane No.		48	51
Distillation (ASTM D 86), °C(°F)			
Initial Boiling Point		166 (331)	183 (362)
10% Distilled		219 (426)	225 (437)
50% Distilled		244 (471)	282 (539)
90% Distilled		296 (565)	331 (628)
End Point		358 (676)	361 (682)

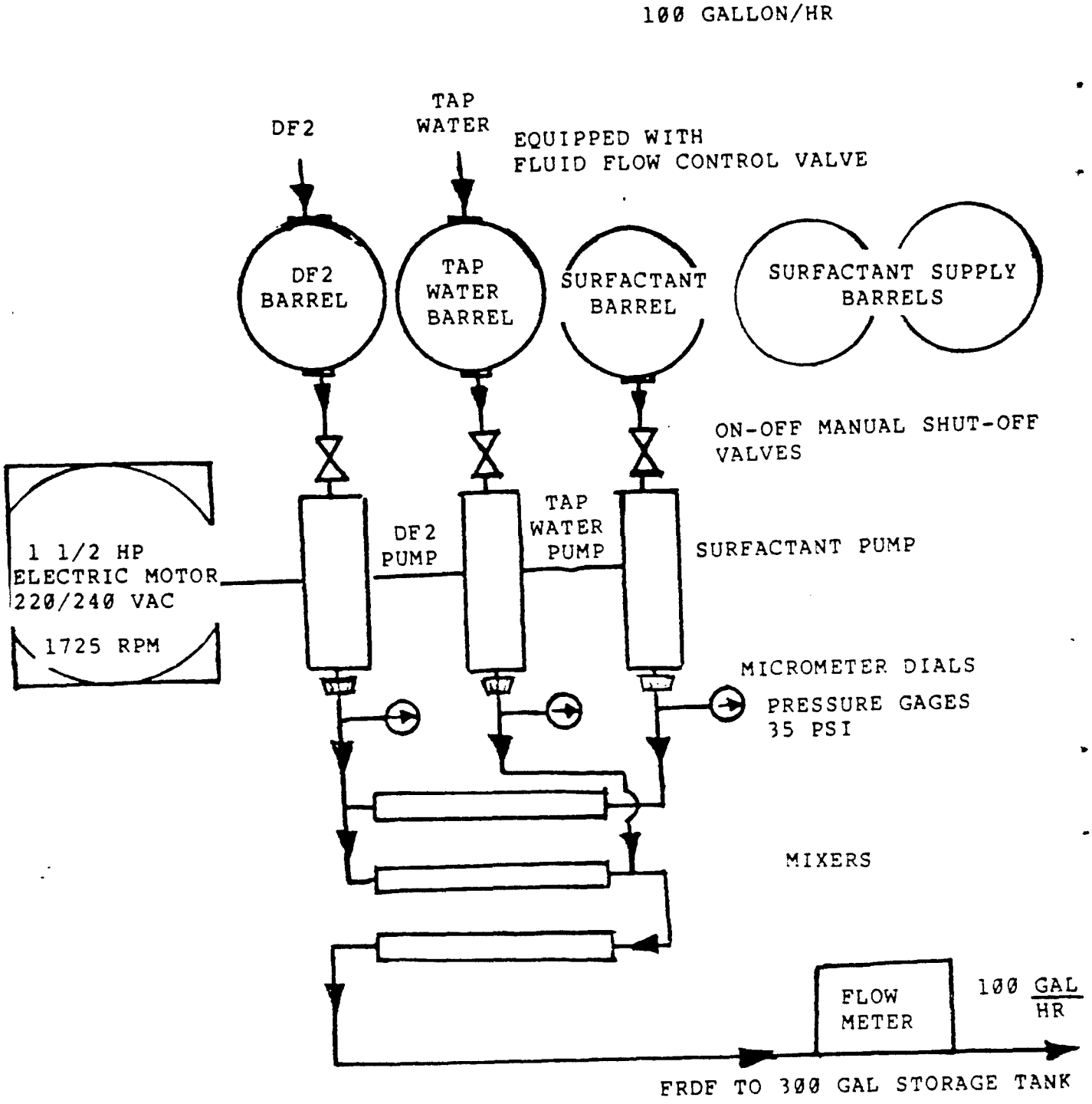
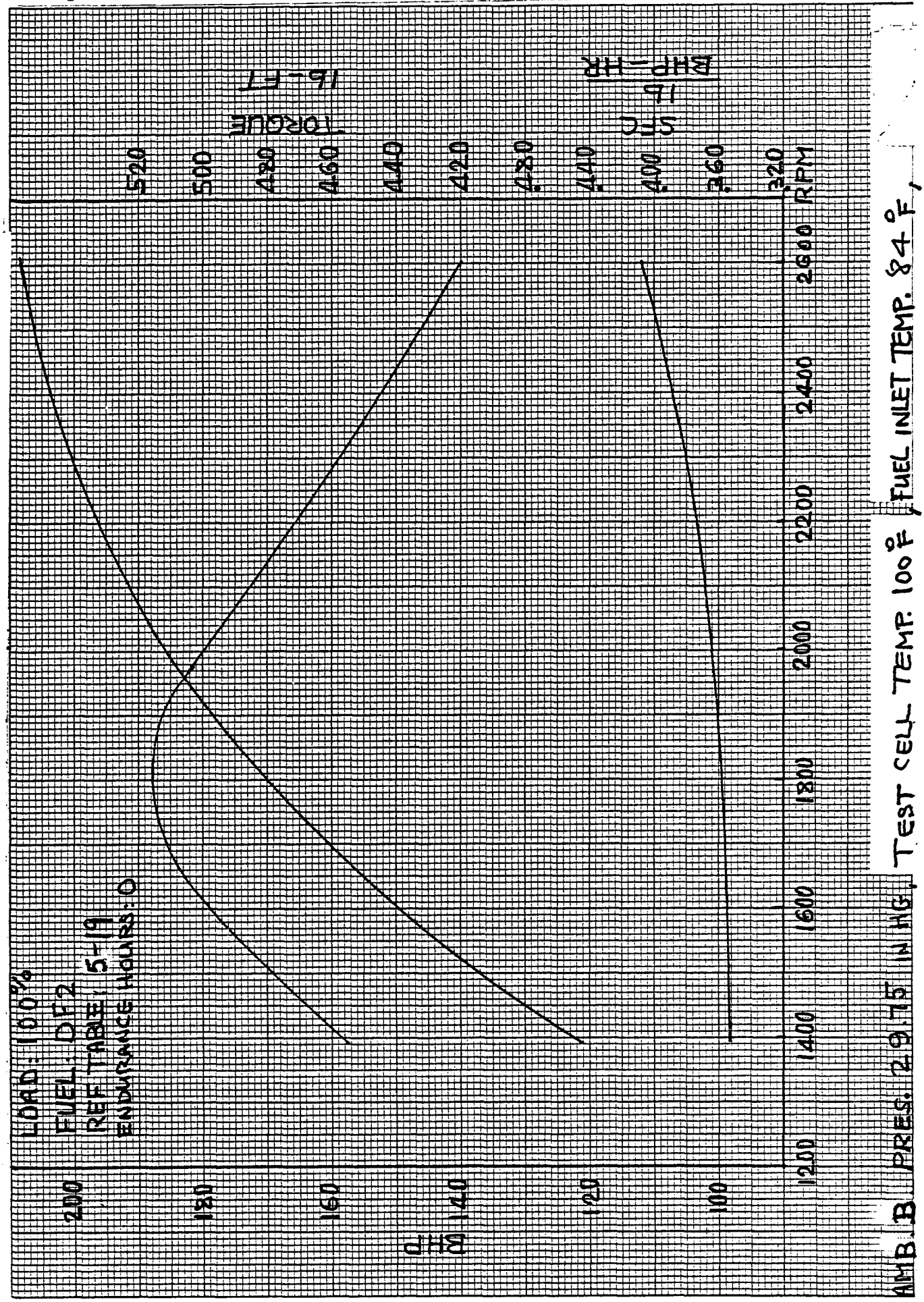


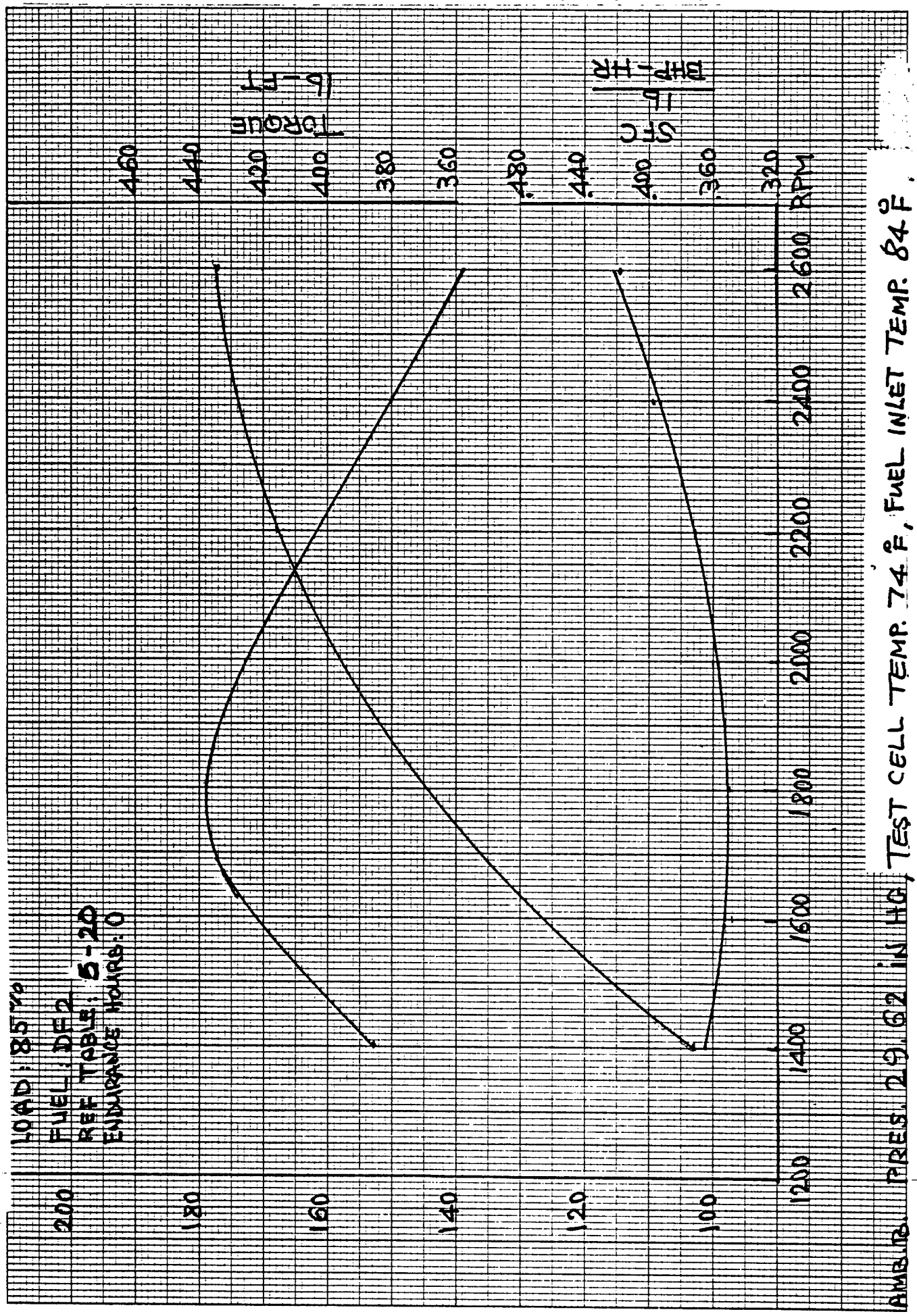
Figure 5-1. Schematic Flow Diagram of FRDF Blending System

Figure 5-2. Performance Test Diagram (100% Load, DF2, 0-Hour)



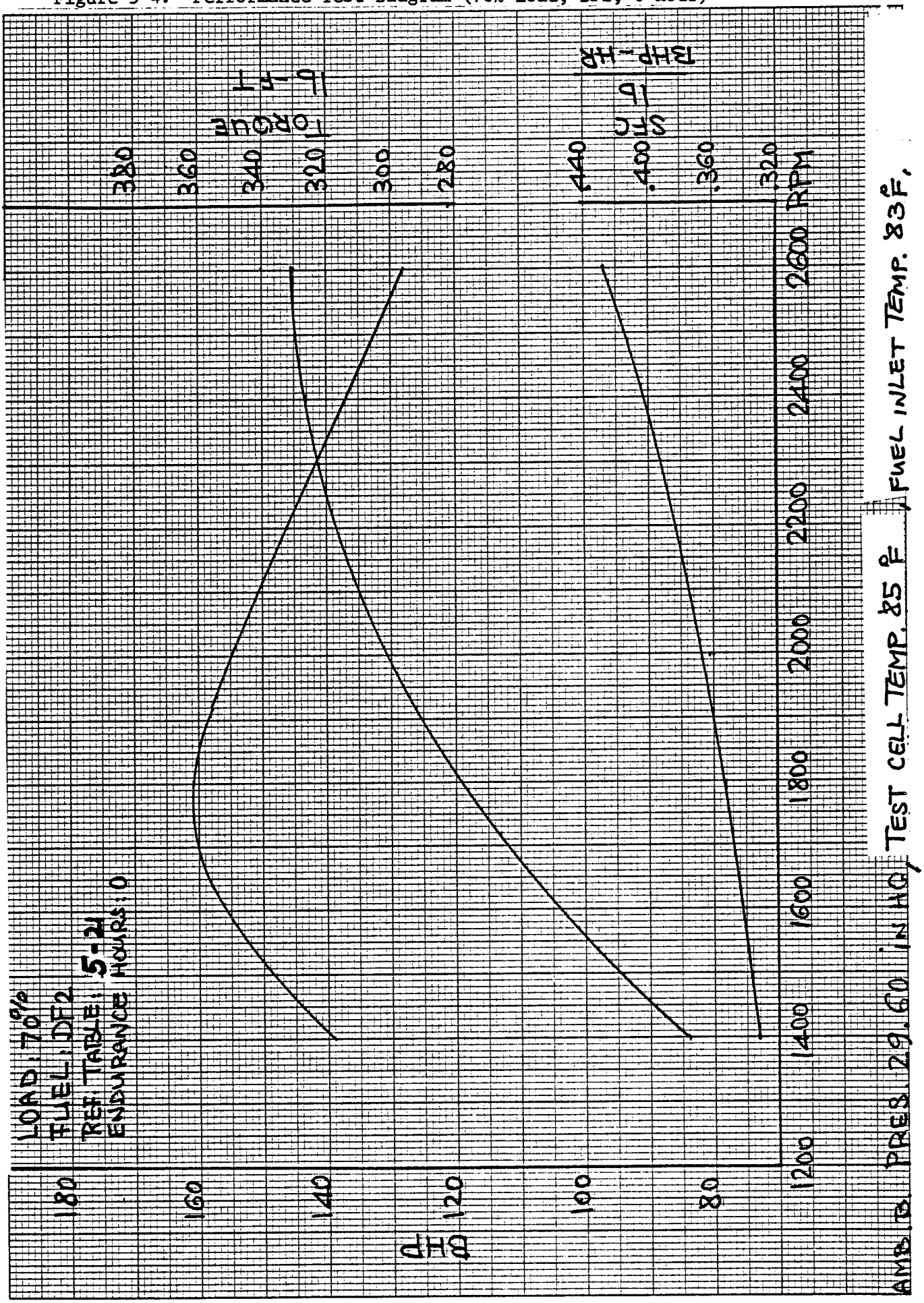
46 1323
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-3. Performance Test Diagram (85% Load, DF2, 0-Hour)



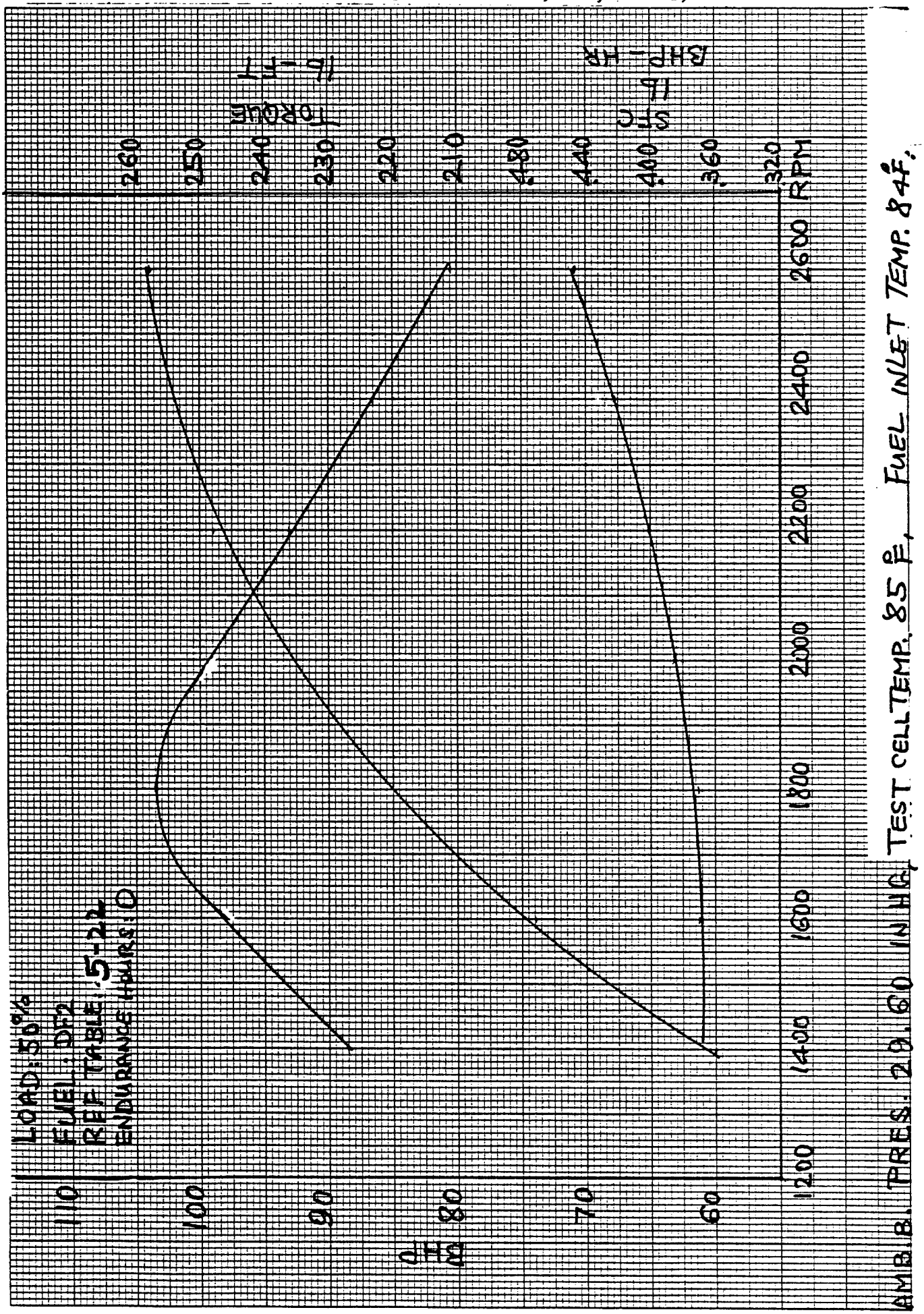
K·E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-4. Performance Test Diagram (70% Load, DF2, 0-Hour)



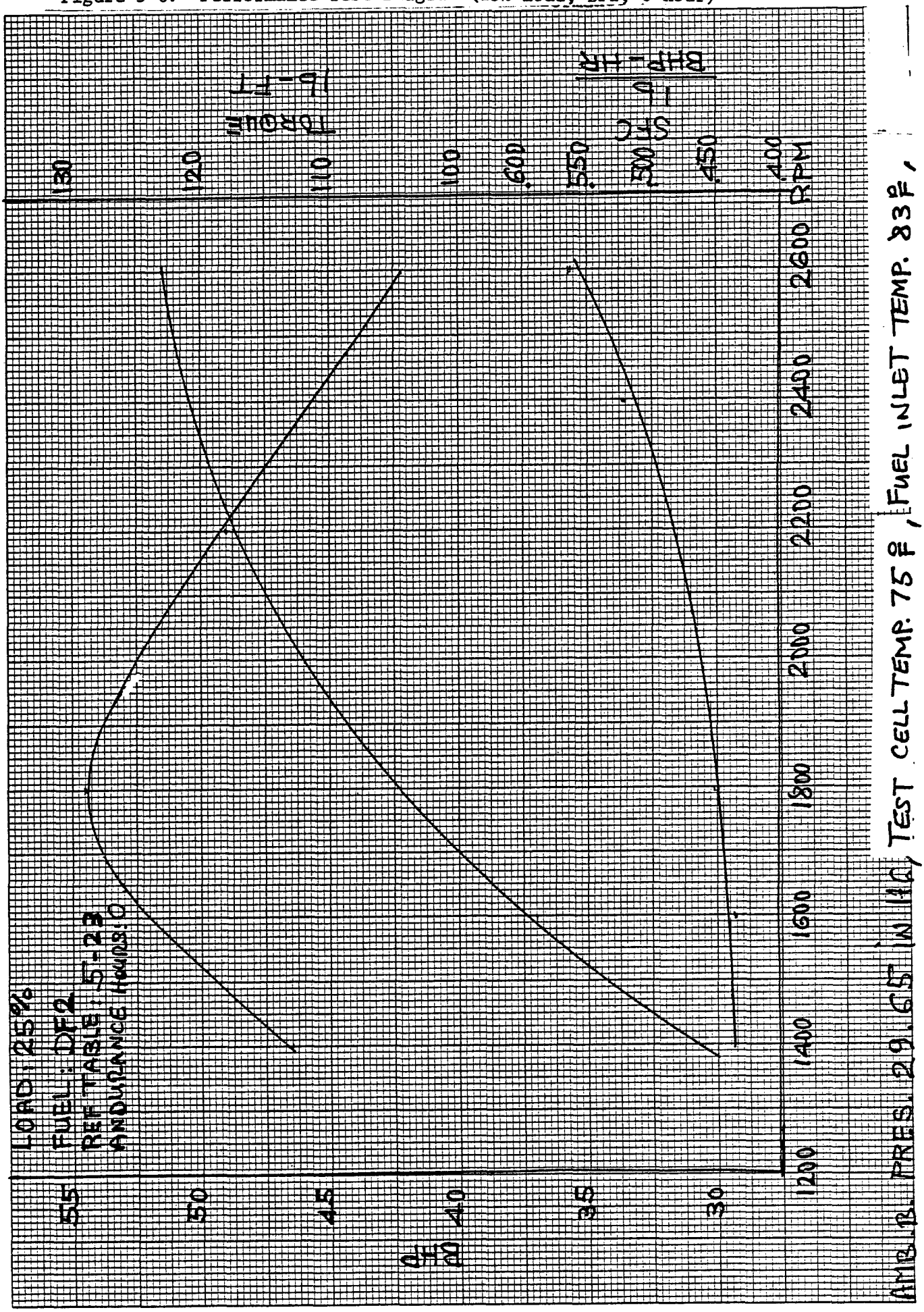
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-5. Performance Test Diagram (50% Load, DF2, 0-Hour)



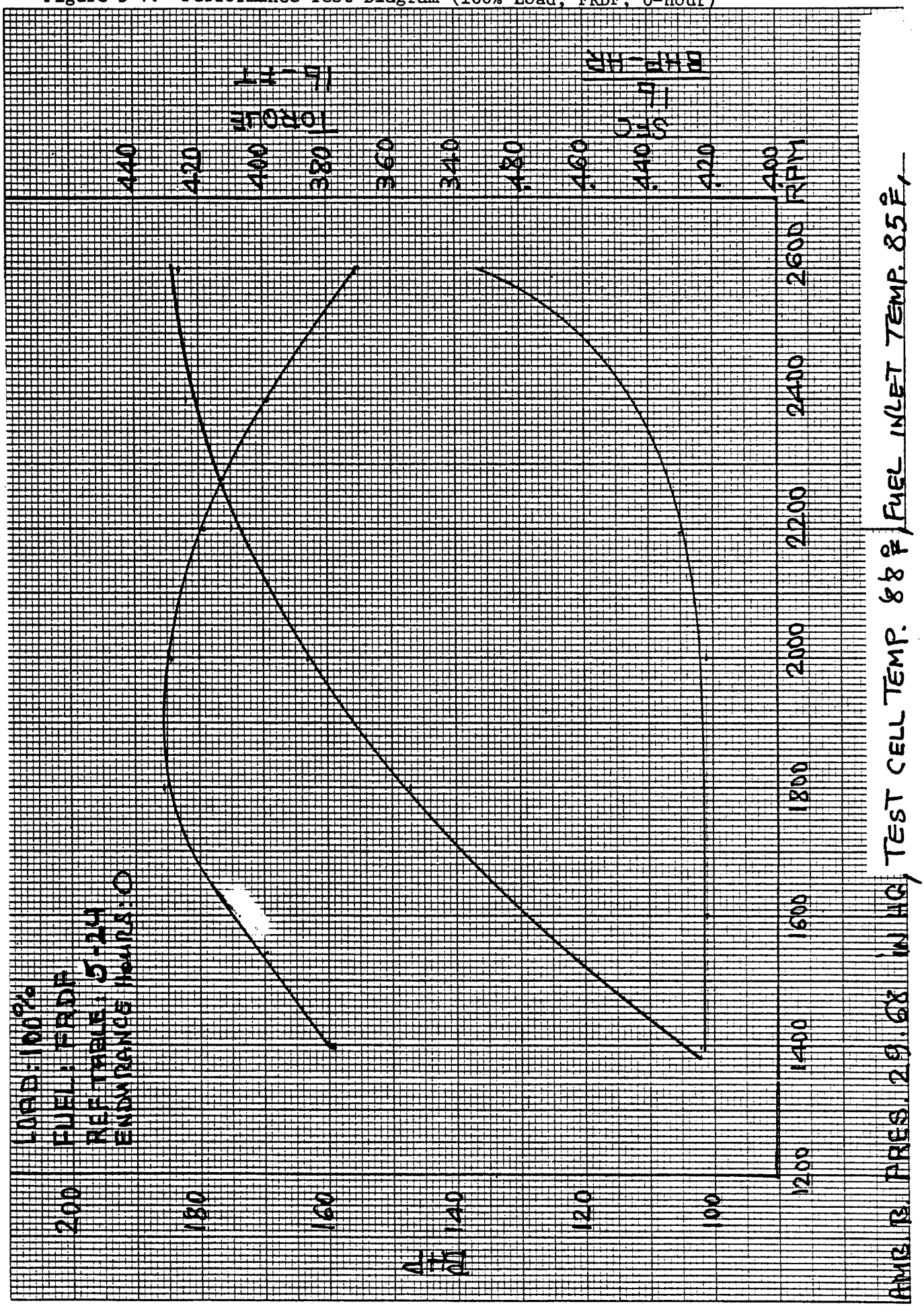
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-6. Performance Test Diagram (25% Load, DF2, 0-Hour)



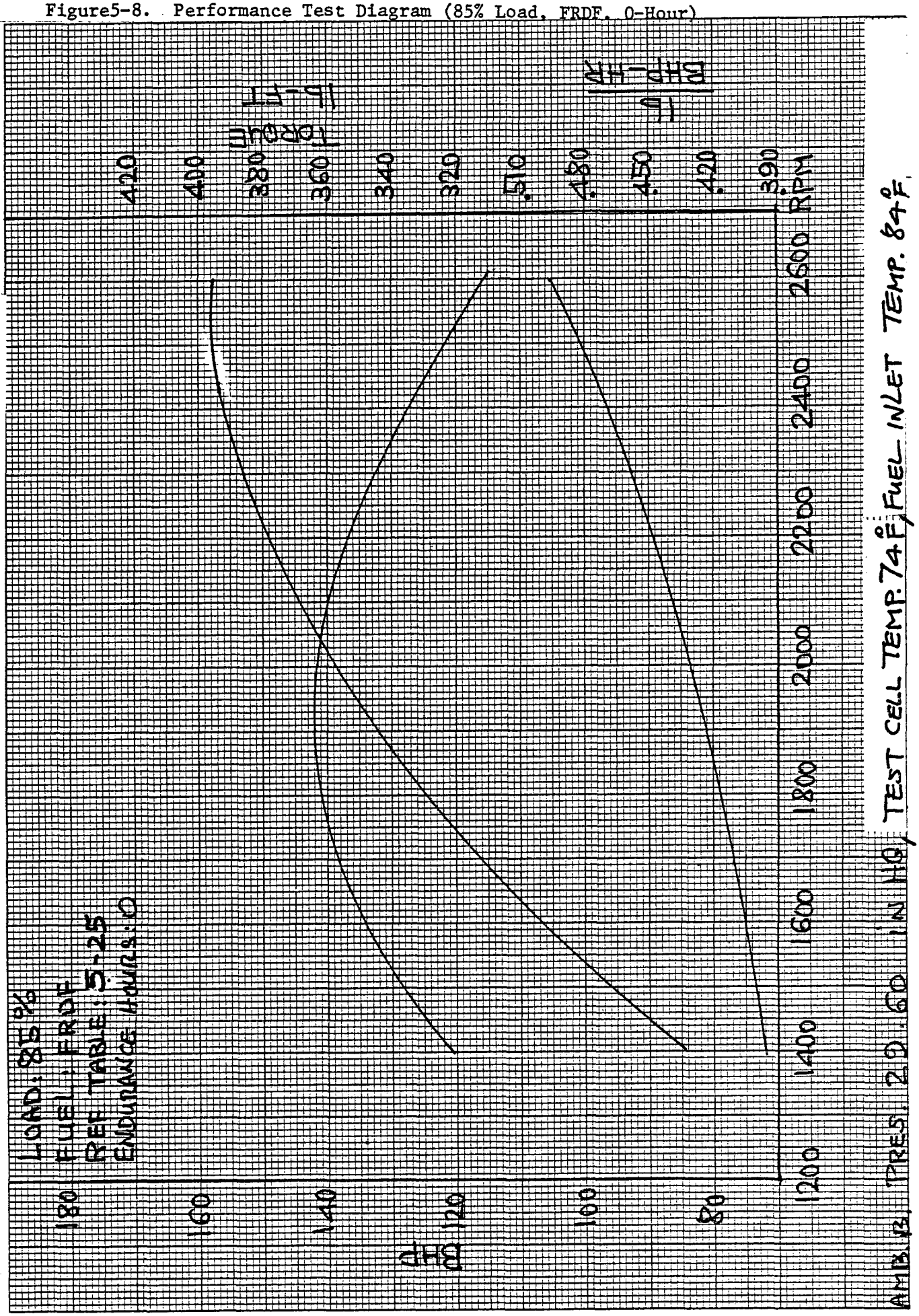
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-7. Performance Test Diagram (100% Load, FRDF, 0-Hour)



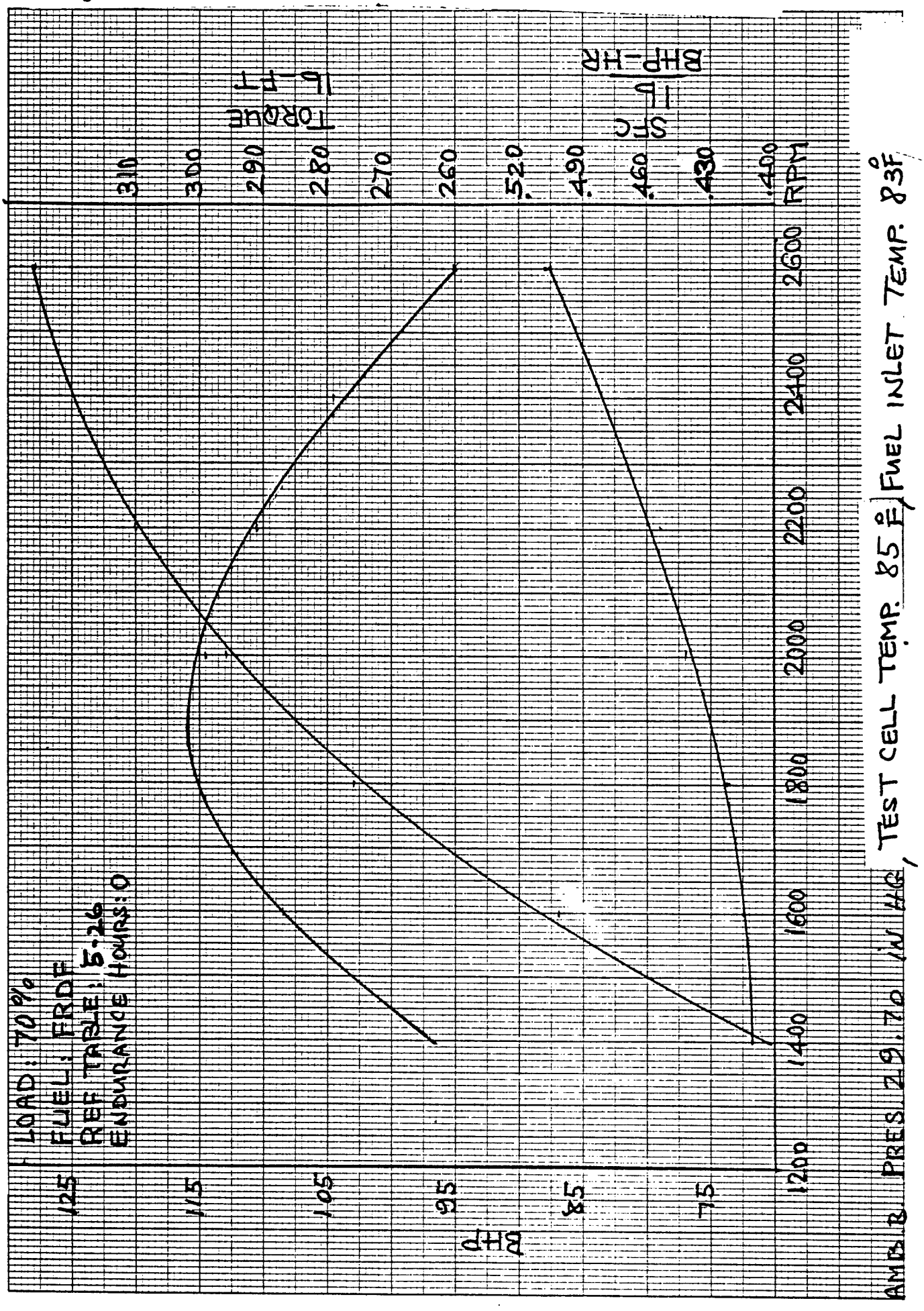
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure5-8. Performance Test Diagram (85% Load, FRDF, 0-Hour)



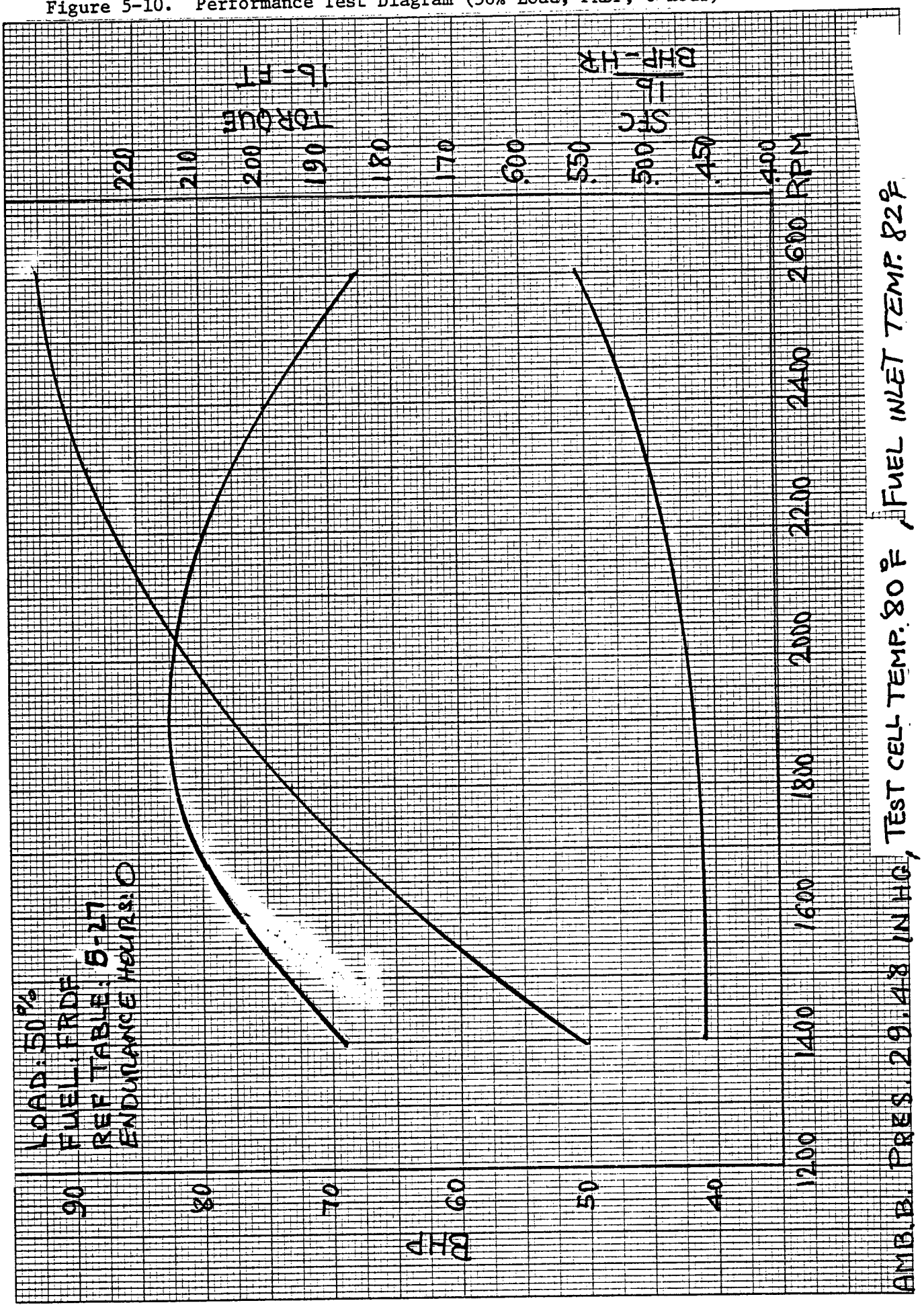
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
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Figure 5-9. Performance Test Diagram (70% Load, FRDF, 0-Hour)



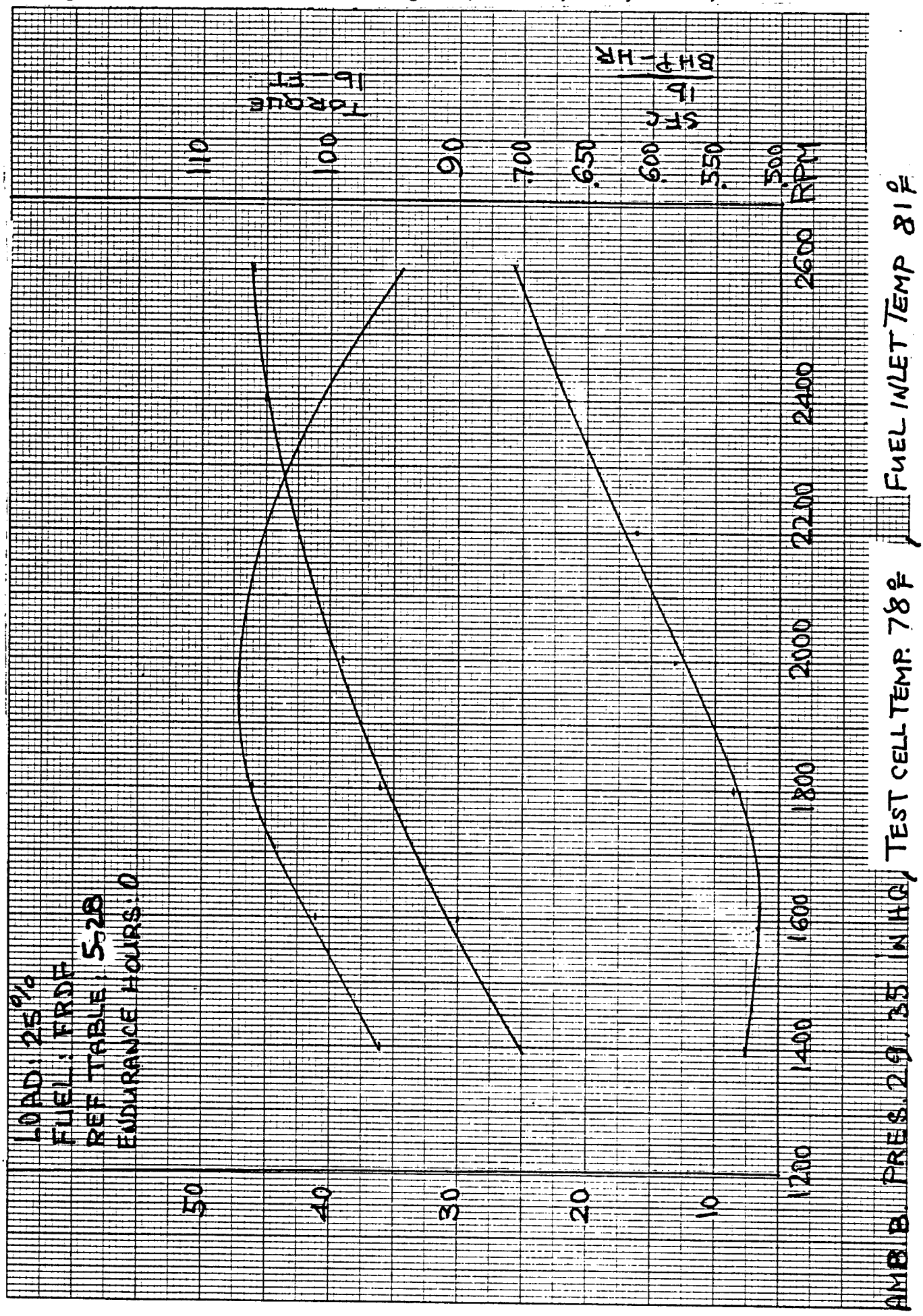
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-10. Performance Test Diagram (50% Load, FRDF, 0-Hour)



K+E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-11. Performance Test Diagram (25% Load, FRDF, 0-Hour)



K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-12. Performance Test Diagram (100% Load, FRDF, 100-Hour)

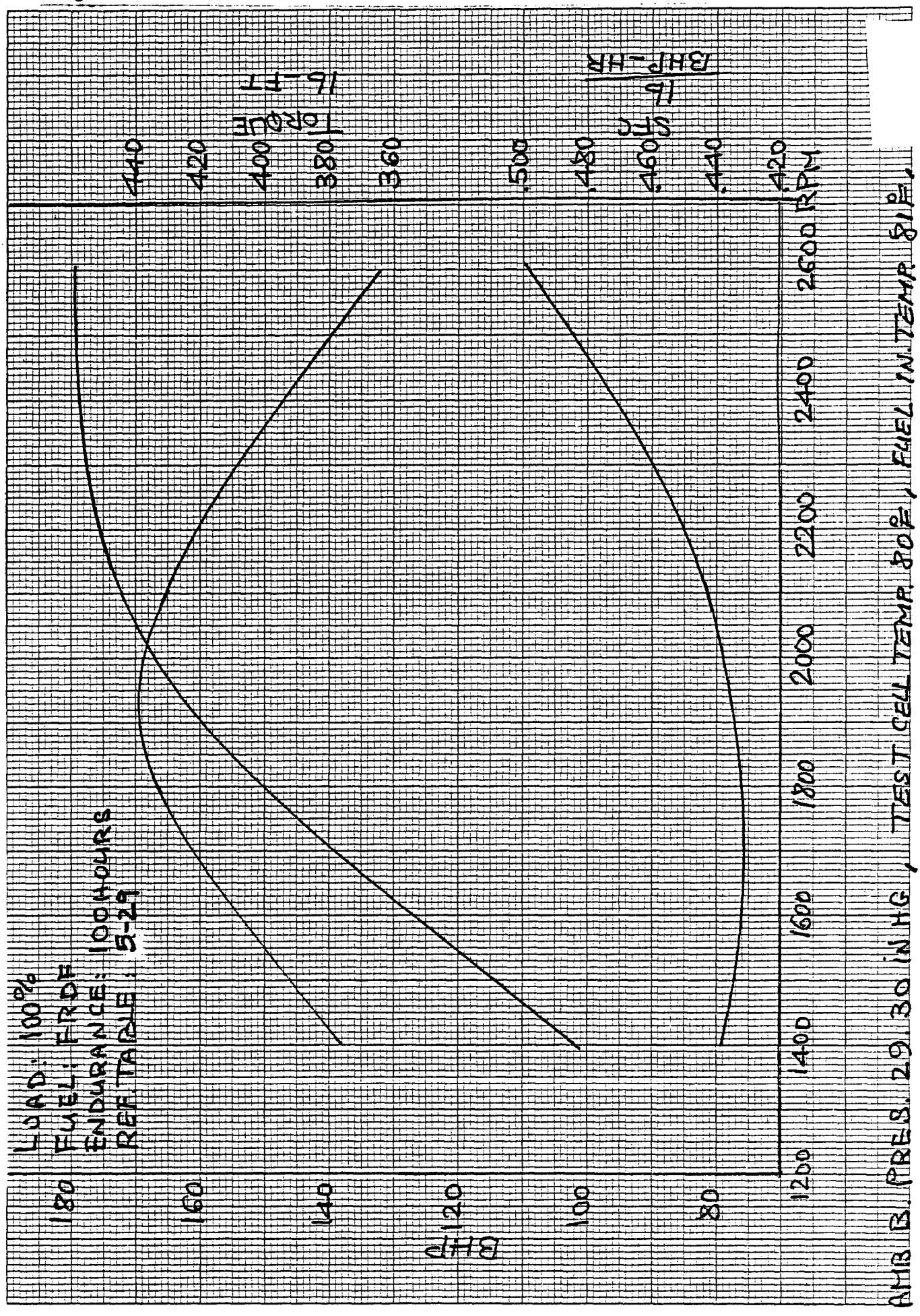
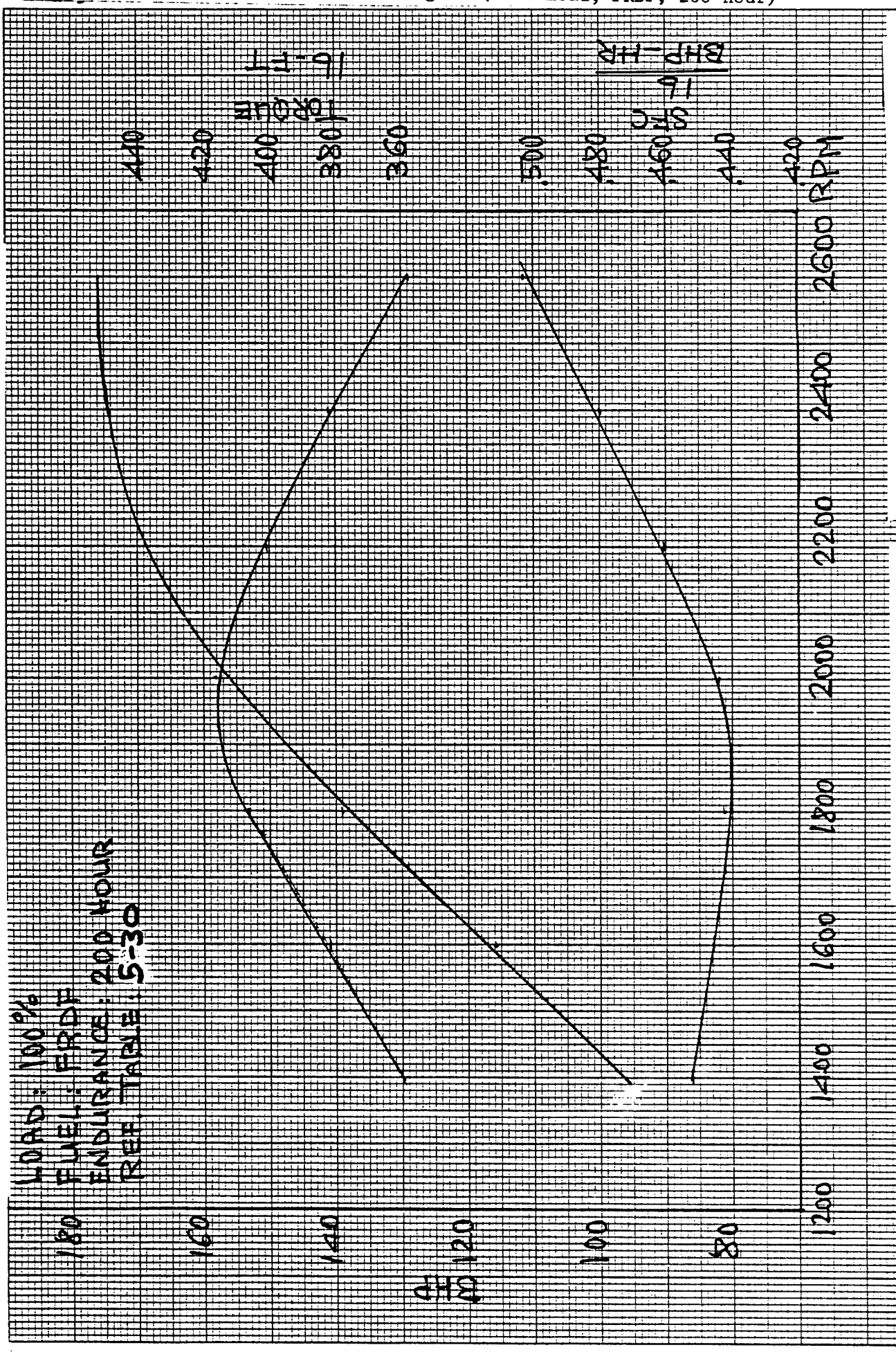
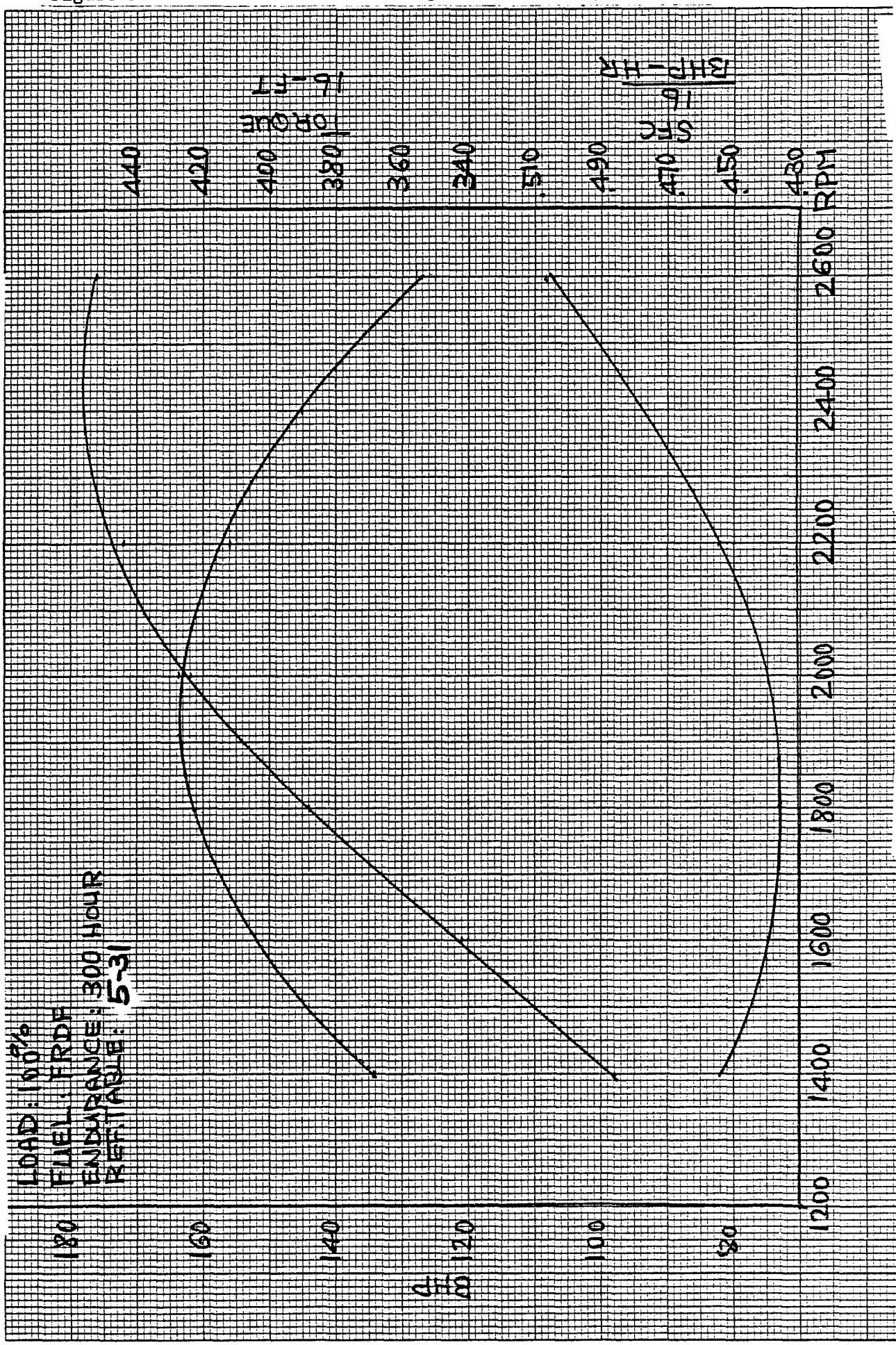


Figure 5-13. Performance Test Diagram (100% Load, FRDF, 200-Hour)



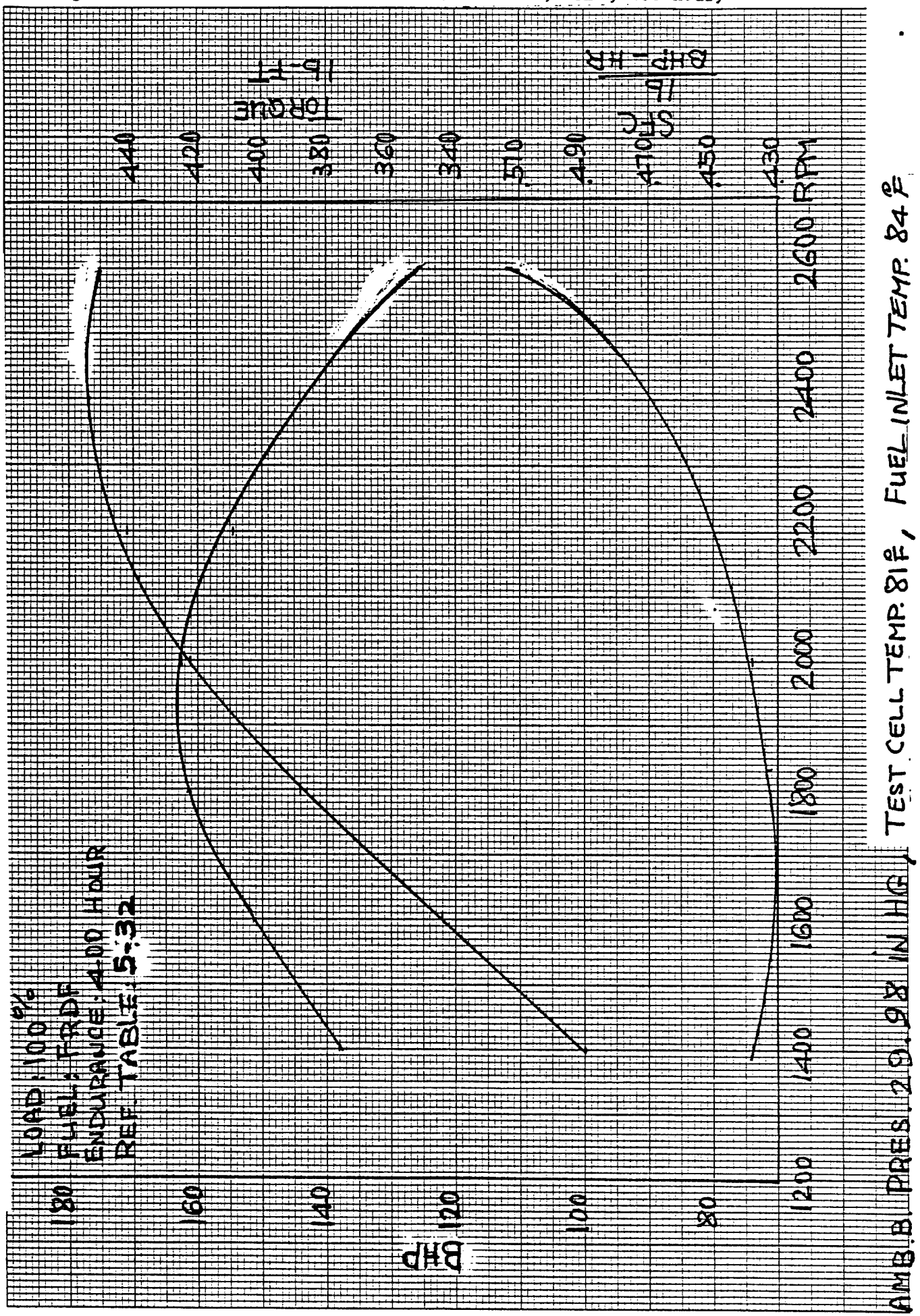
K•E 10 X 10 TO ½ INCH 2 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
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Figure 5-14. Performance Test Diagram (100% Load, FRDF, 300-Hour)



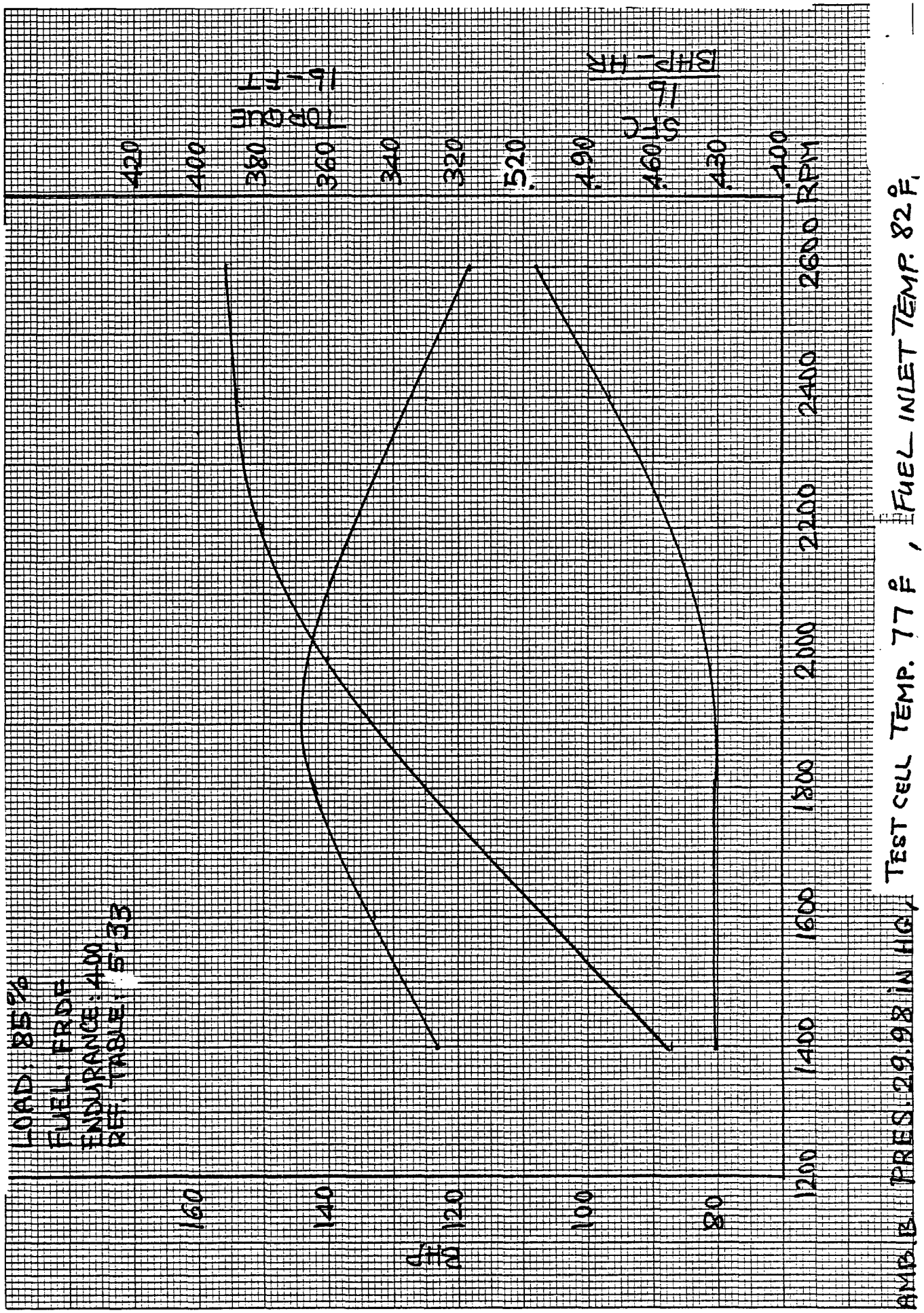
K&E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-15. Performance Test Data (100% Load, FRDF, 400-Hour)



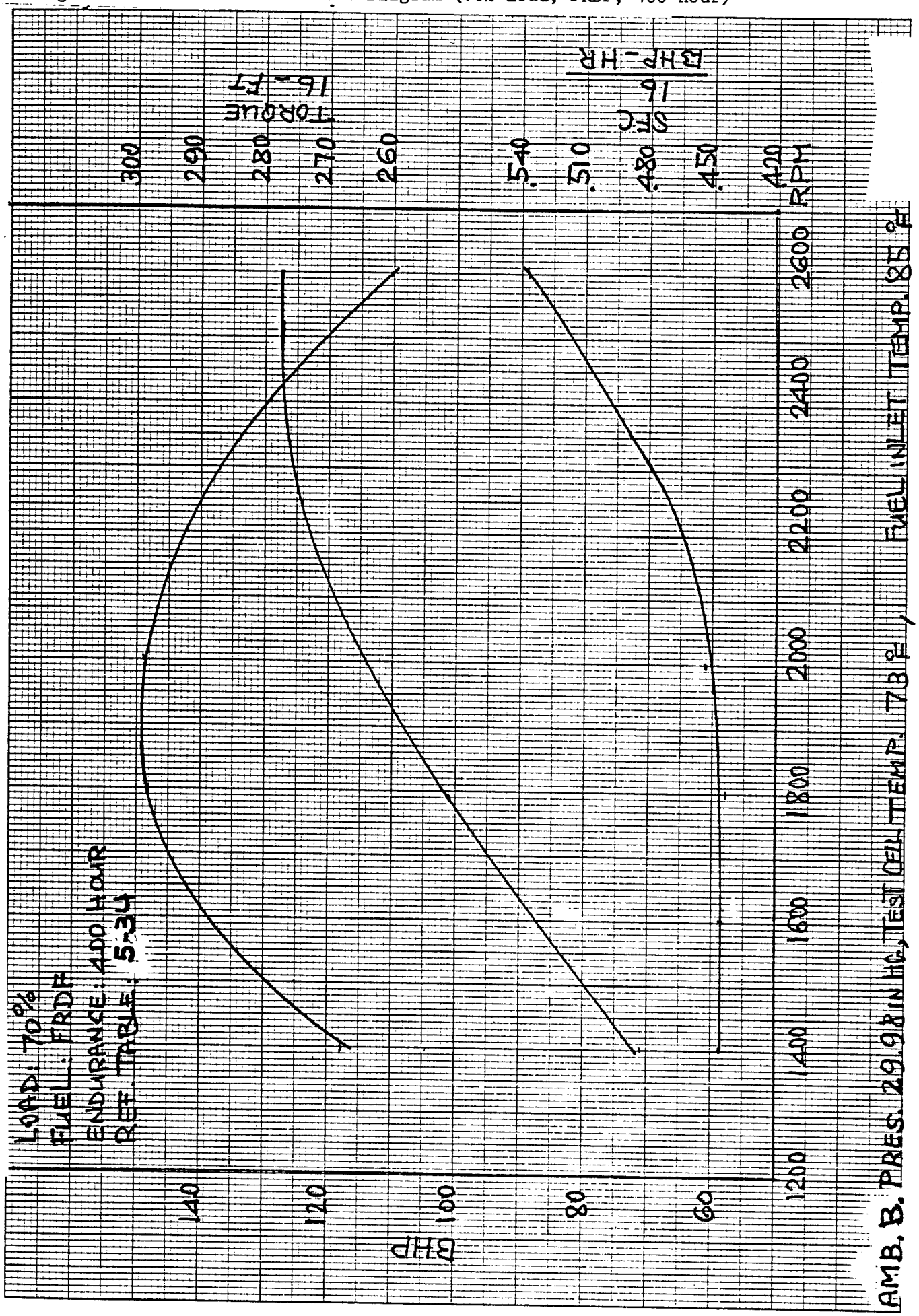
K•E 10 X 10 TO ¼ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-16. Performance Test Diagram (85% Load, FRDF, 400-Hour)



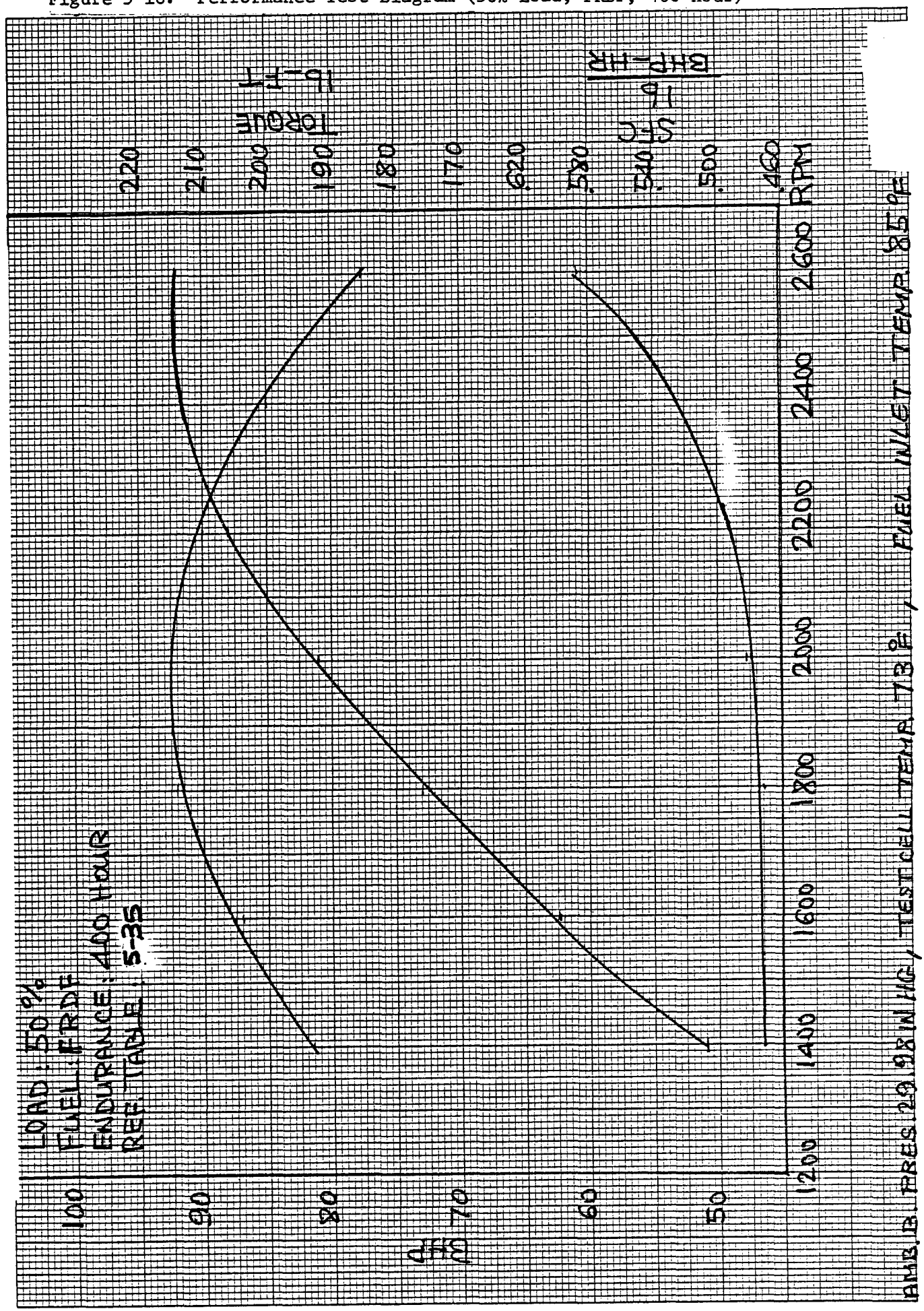
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-17. Performance Test Diagram (70% Load, FRDF, 400-Hour)



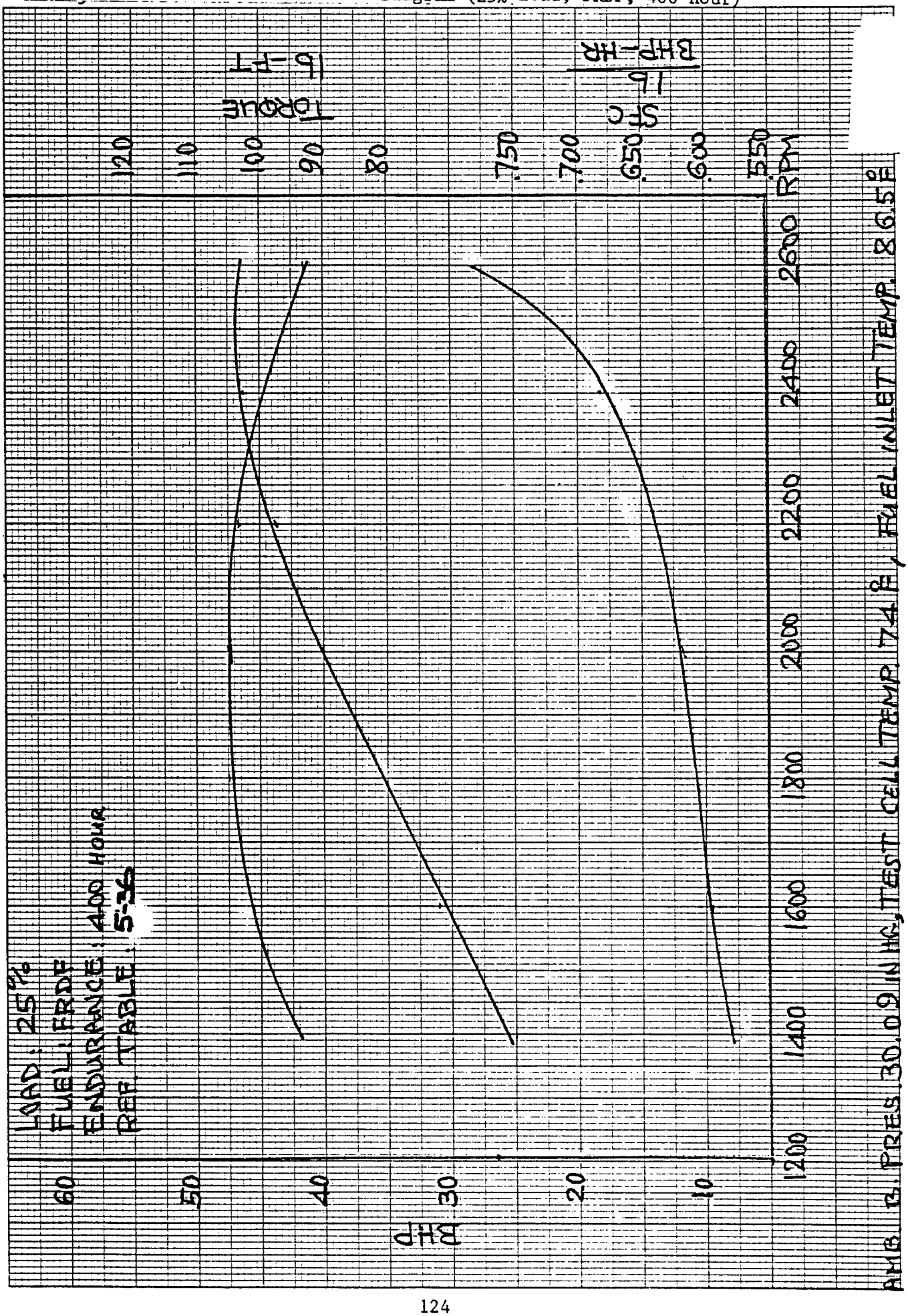
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-18. Performance Test Diagram (50% Load, FRDF, 400-Hour)



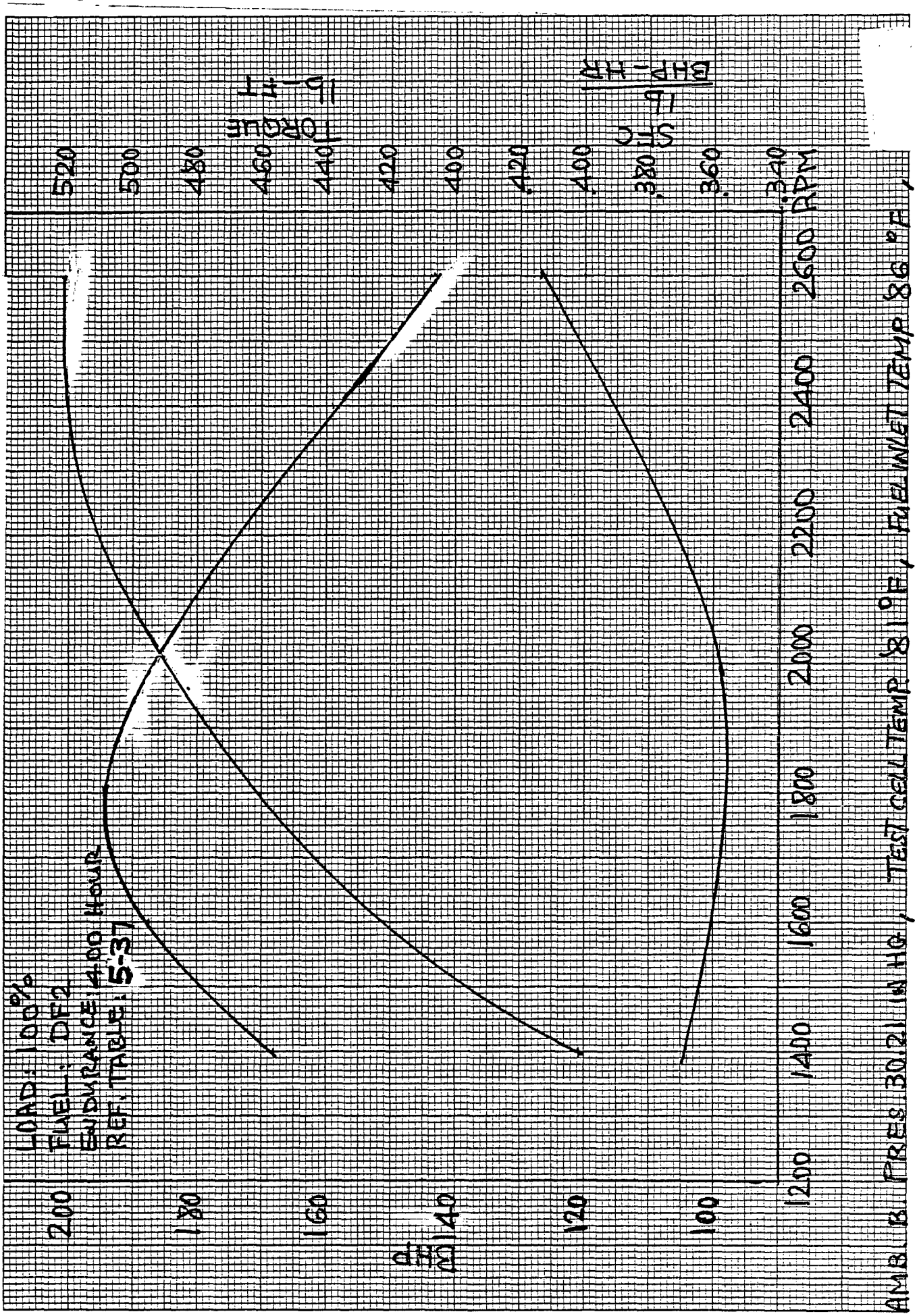
46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-19. Performance Test Diagram (25% Load, FRDF, 400-Hour)



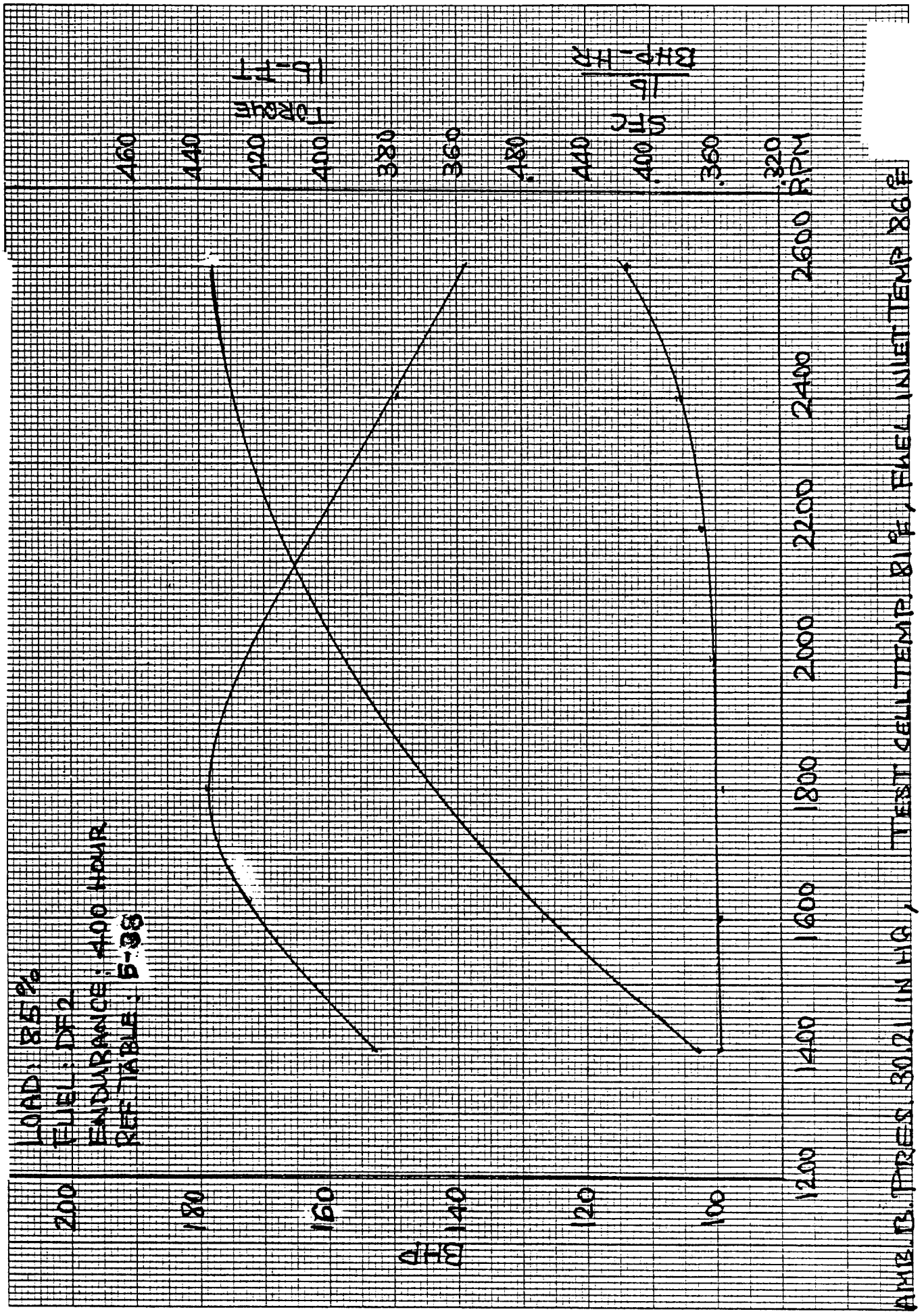
K•E 10 X 10 TO ½ INCH 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-20. Performance Test Diagram (100% Load, DF2, 400-Hour)



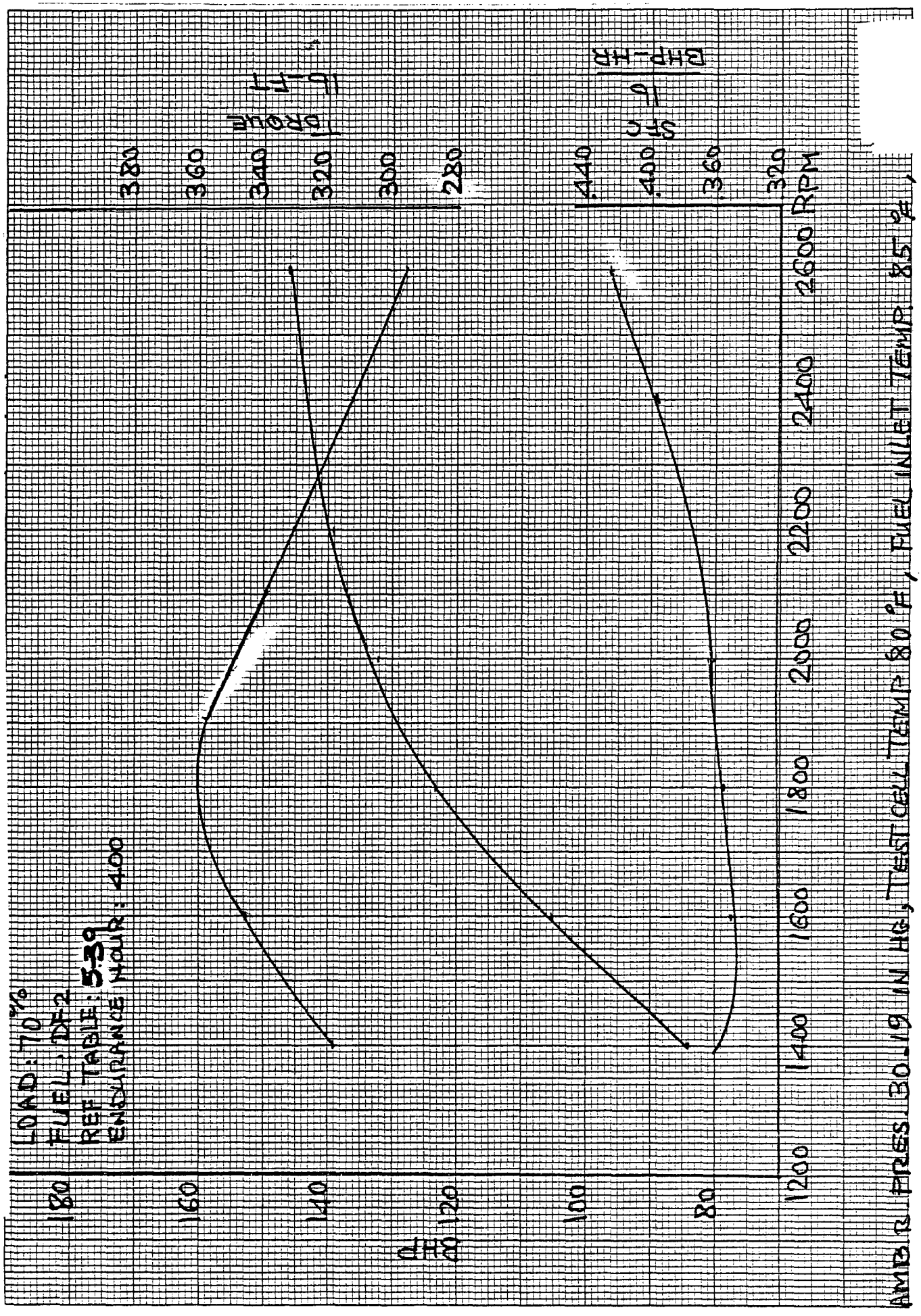
46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Figure 5-21. Performance Test Diagram (85% Load, DF2, 400-Hour)



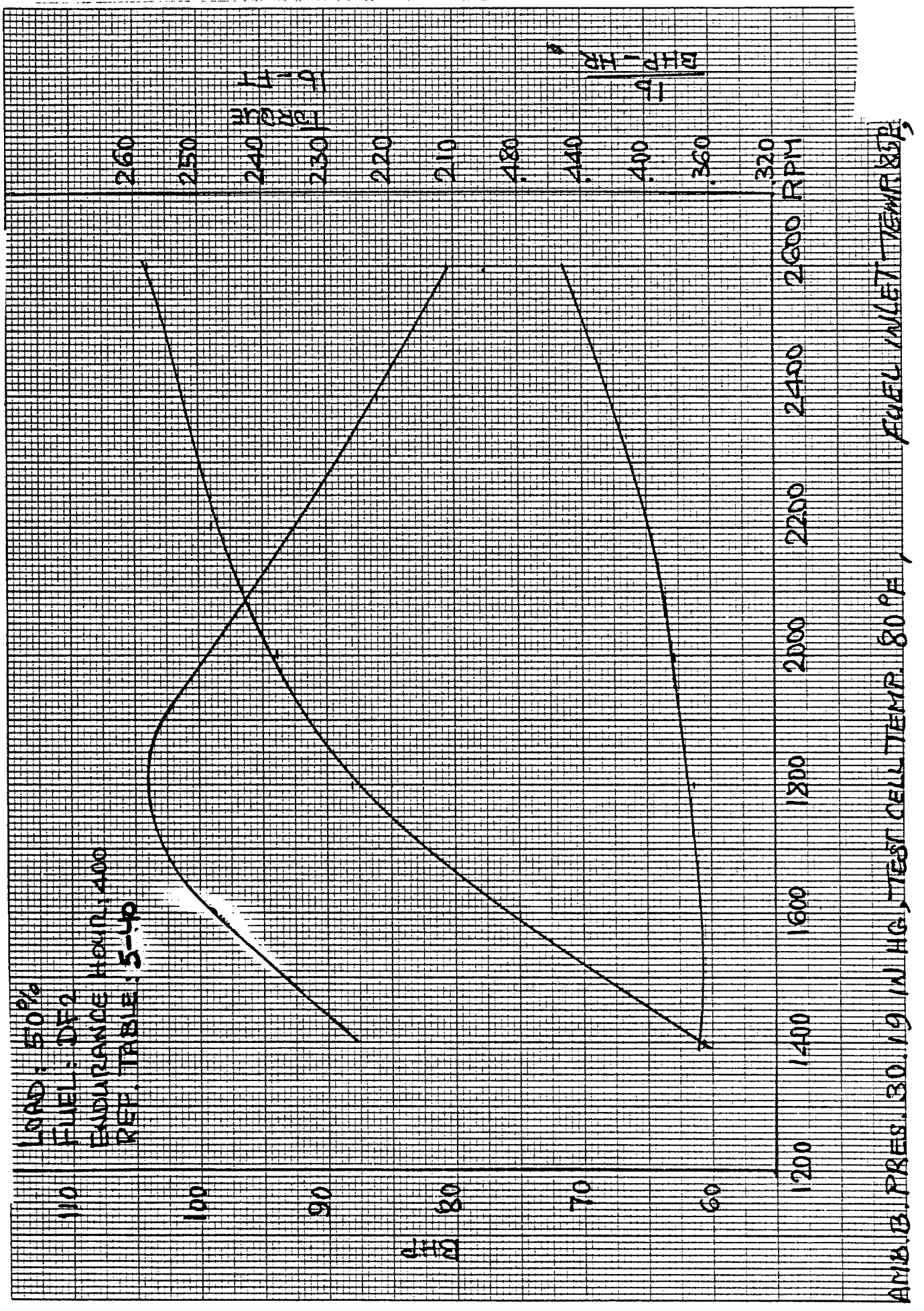
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-22. Performance Test Diagram (70% Load, DF2, 400-Hour)



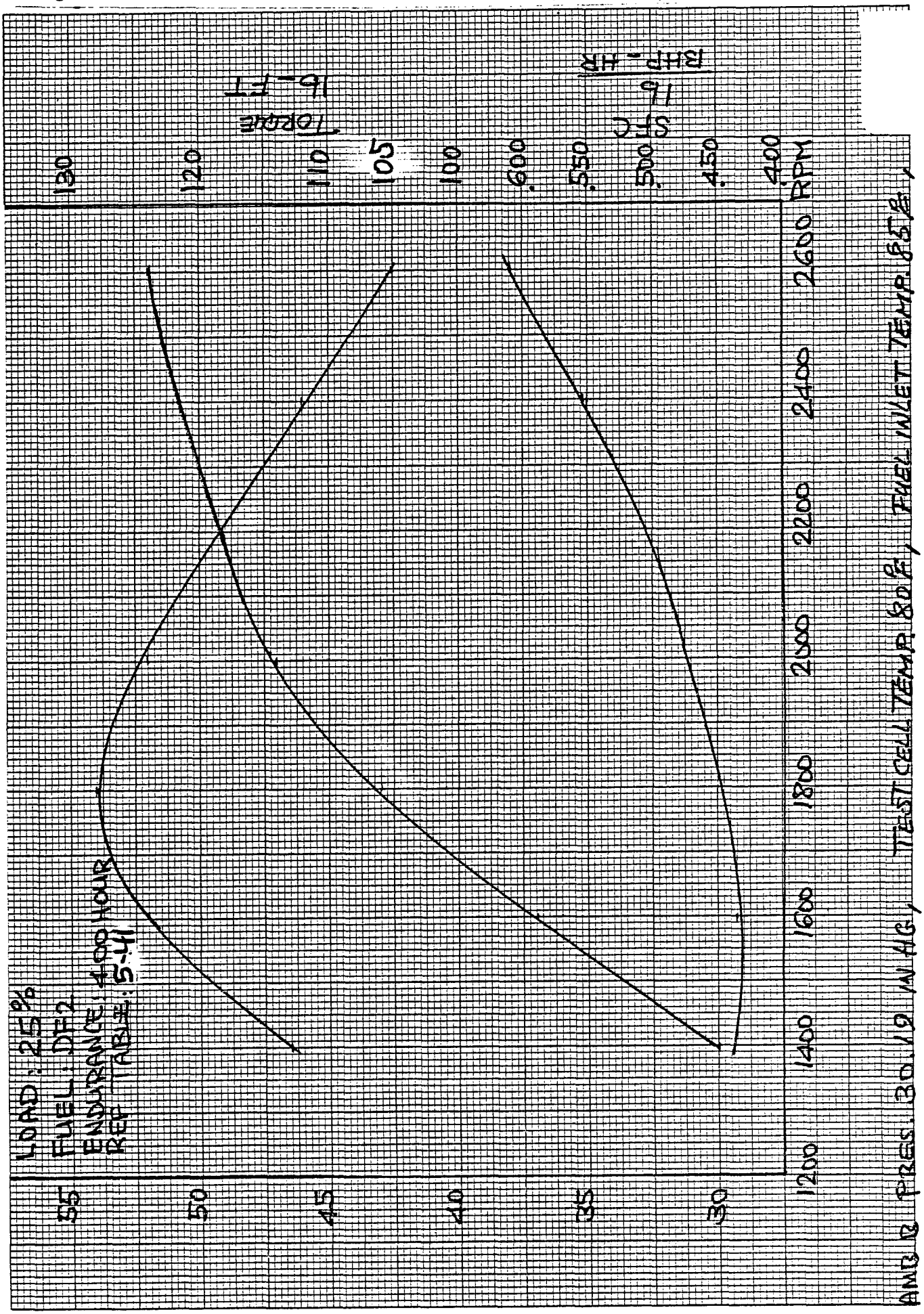
K&E 10 X 10 TO 1/2 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-23. Performance Test Diagram (50% Load, DF2, 400-Hour)



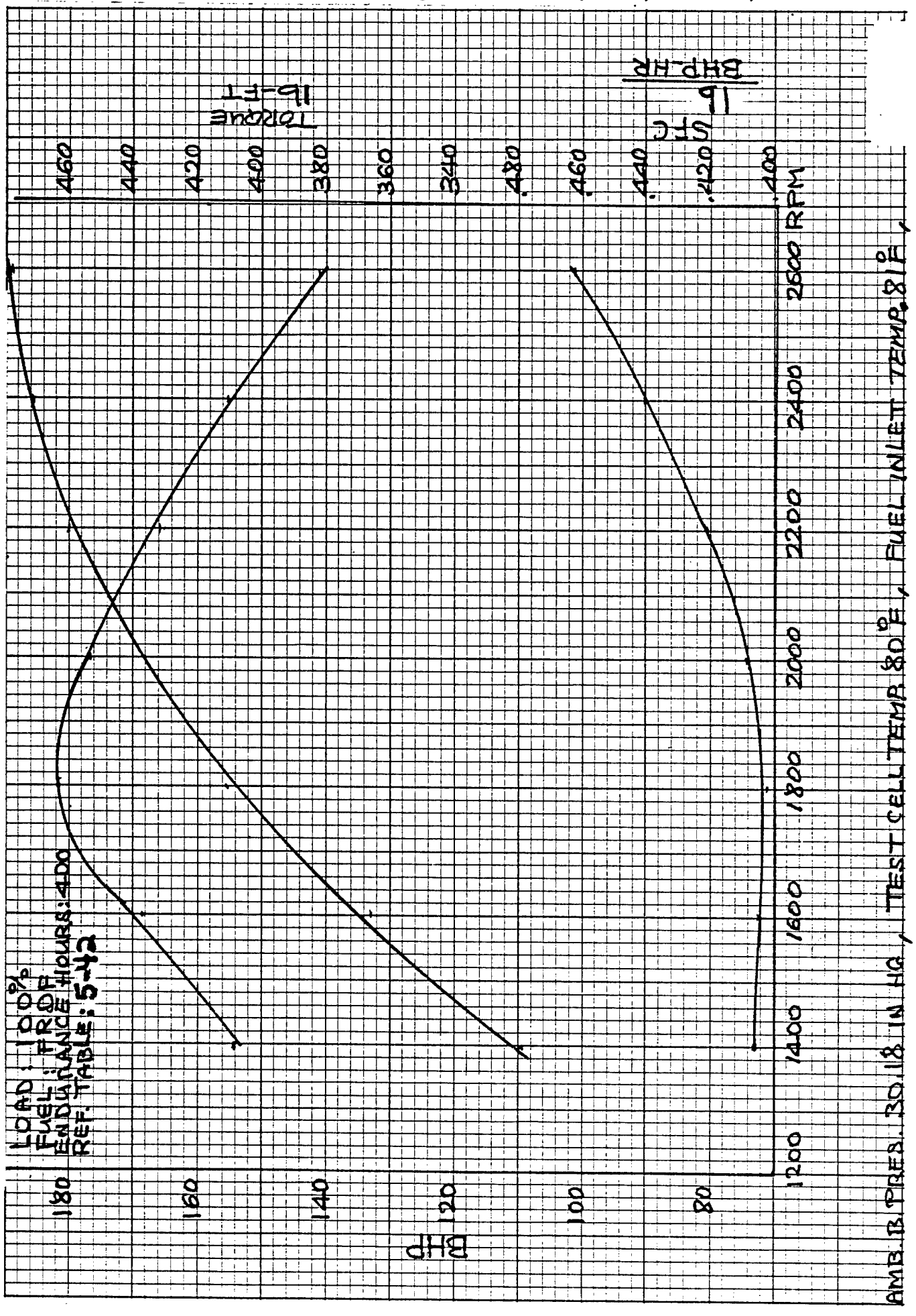
K•E 10 X 10 TO ½ INCH 2 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-24. Performance Test Diagram (25%, DF2, 400-Hour)



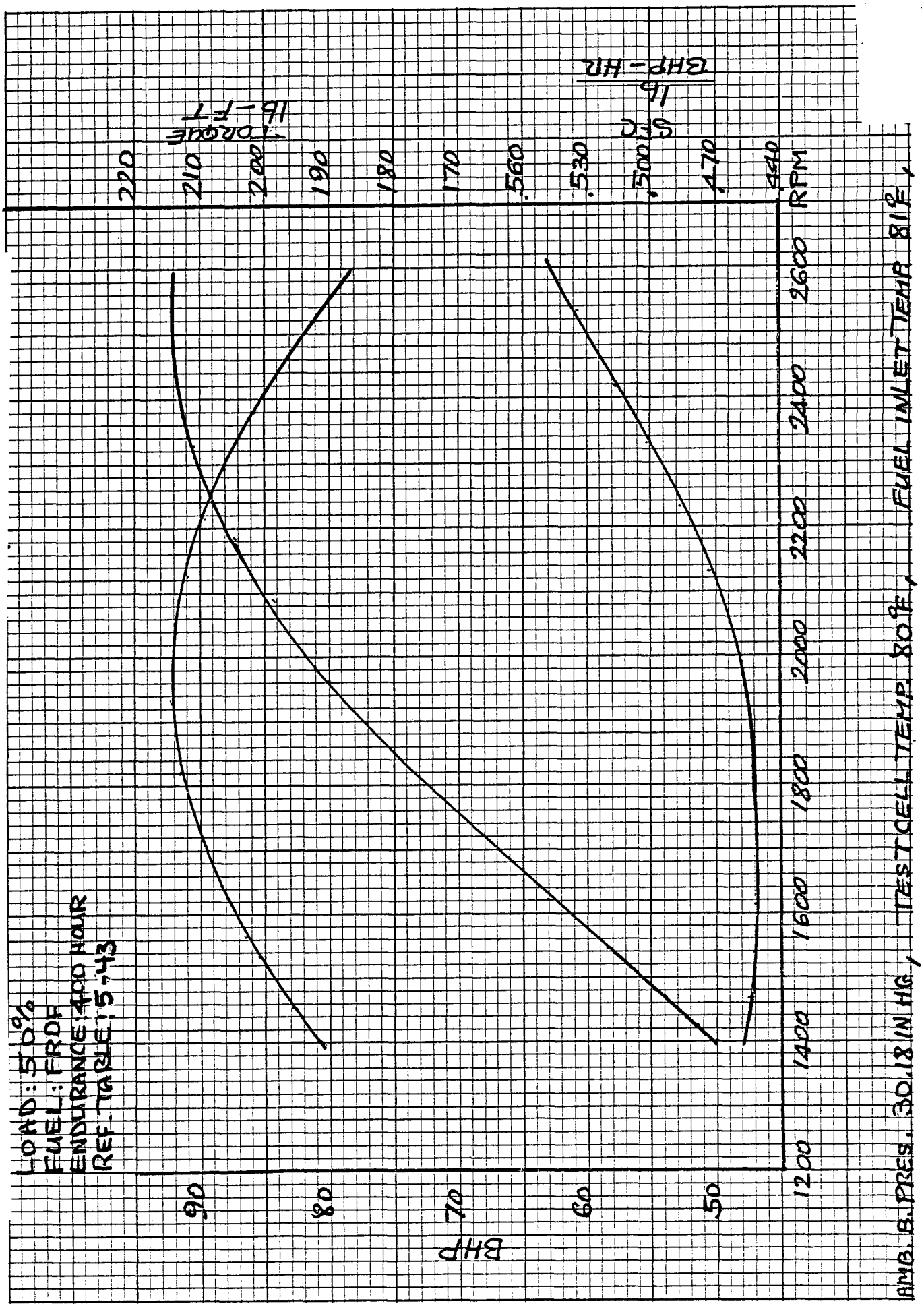
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1323

Figure 5-25. Performance Test Diagram (100% Load, FRDF, 400-Hour)



FP1.10M-10 X 10 TO 1 INCH
5TH LINE ACCENTED, 10TH HEAVY

Figure 5-26. Performance Test Diagram (50% Load, FRDF, 400-Hour)



FP:LOM-10 X 10 TO 1 INCH
5TH LINE ACCENTED, 10TH HEAVY

Figure 5-27. Performance Test Diagram (HP at 100% Load for DF2 and FRDF)

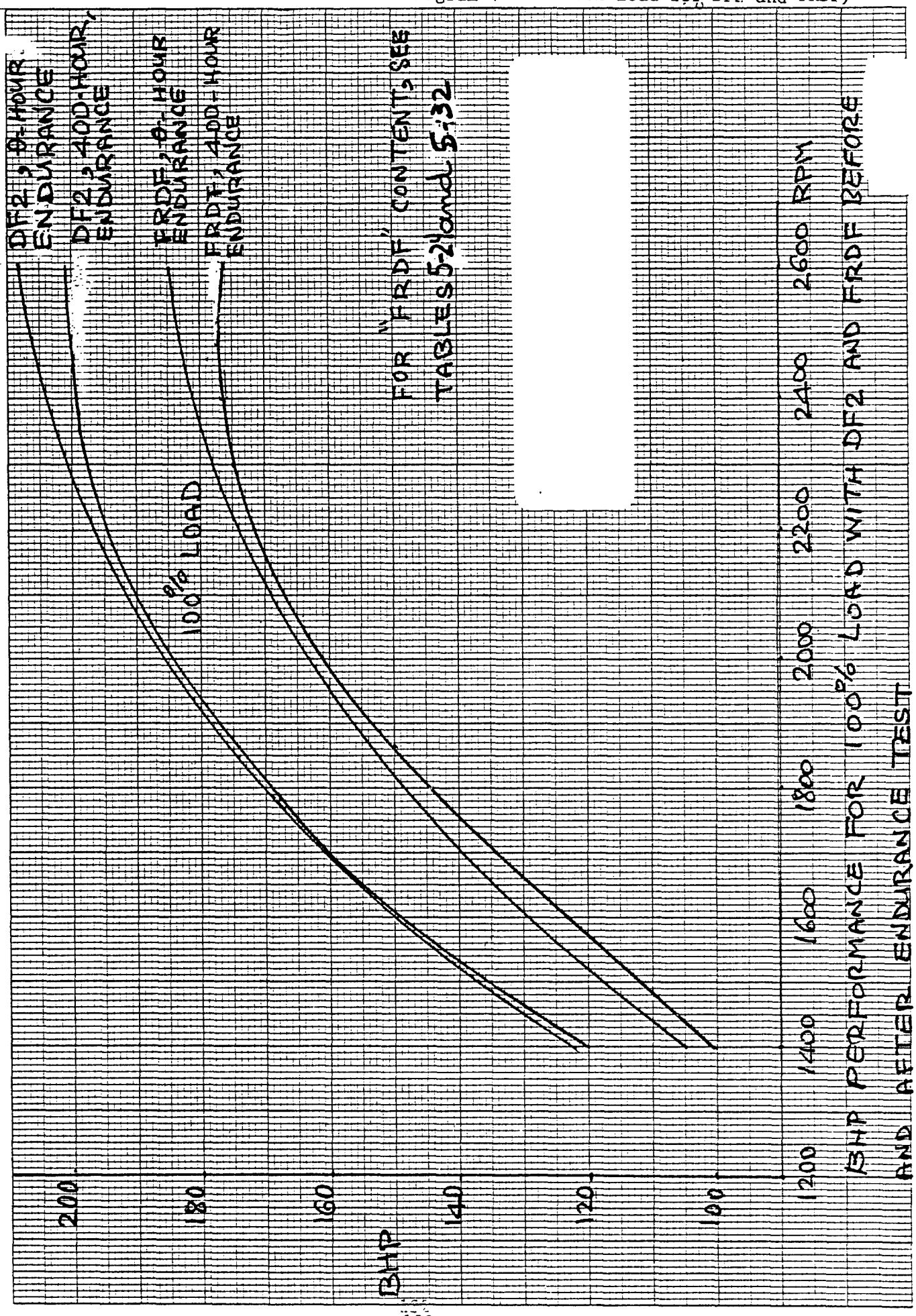


Figure 5-28. Performance Test Diagram (SFC at 100% for DF2 and FRDF)

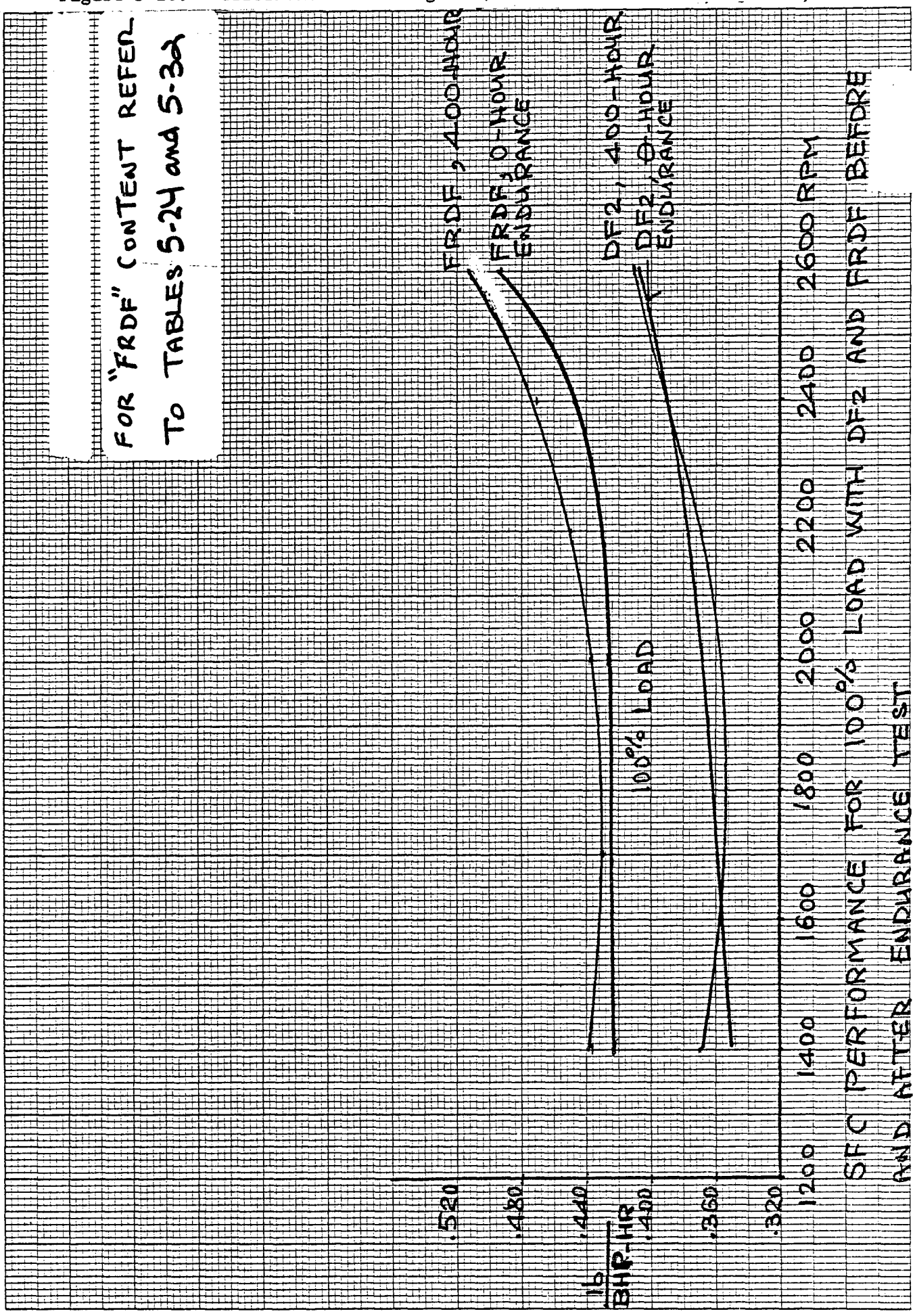


Figure 5-29. Performance Test Diagram (Torque at 100% Load for DF2 and FRDF

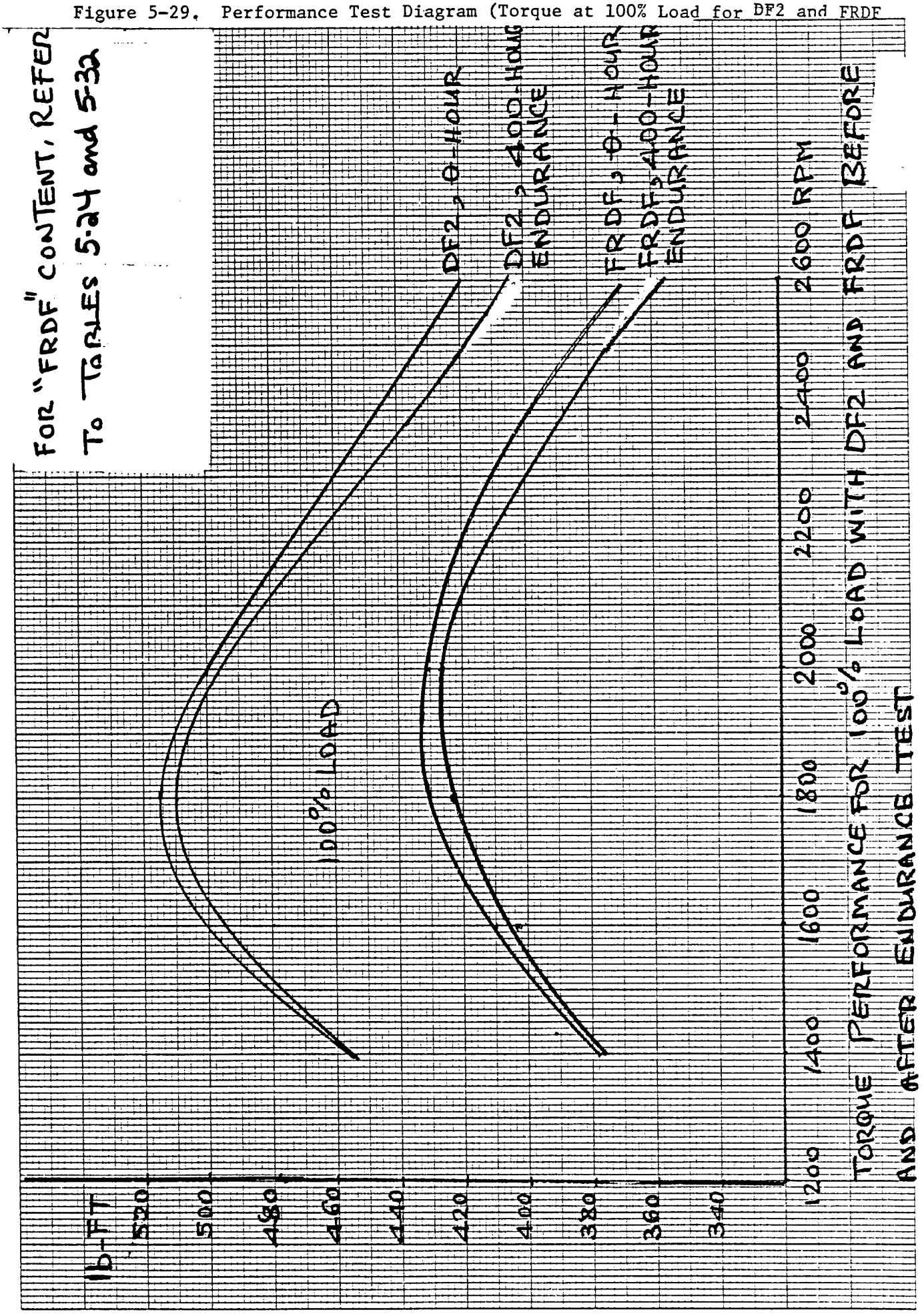


Figure 5-30. Performance Test Diagram (HP at 85% Load for DF2 and FRDF)

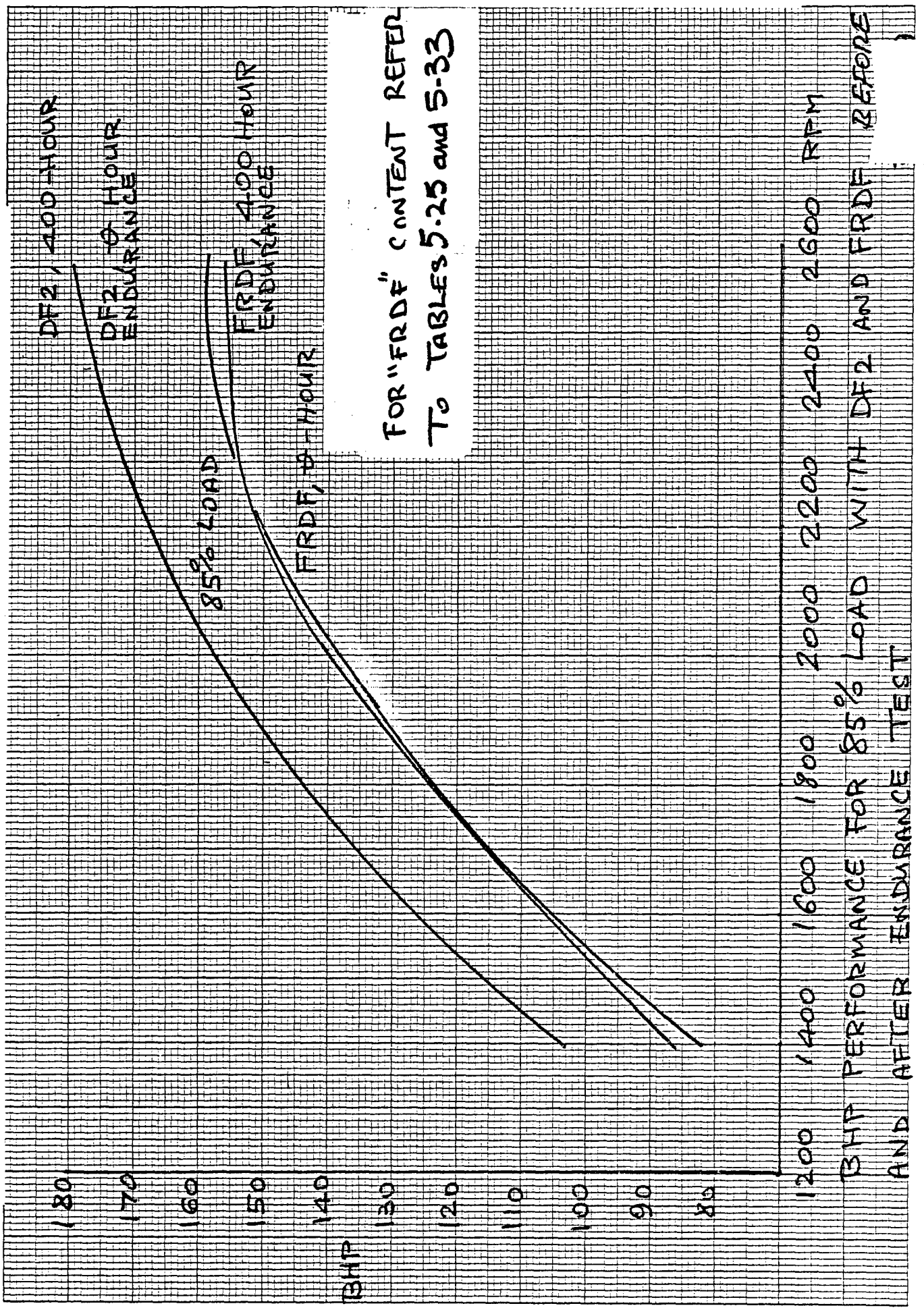


Figure 5-31. Performance Test Diagram (SFC at 85% Load, for DF2 and FRDF)

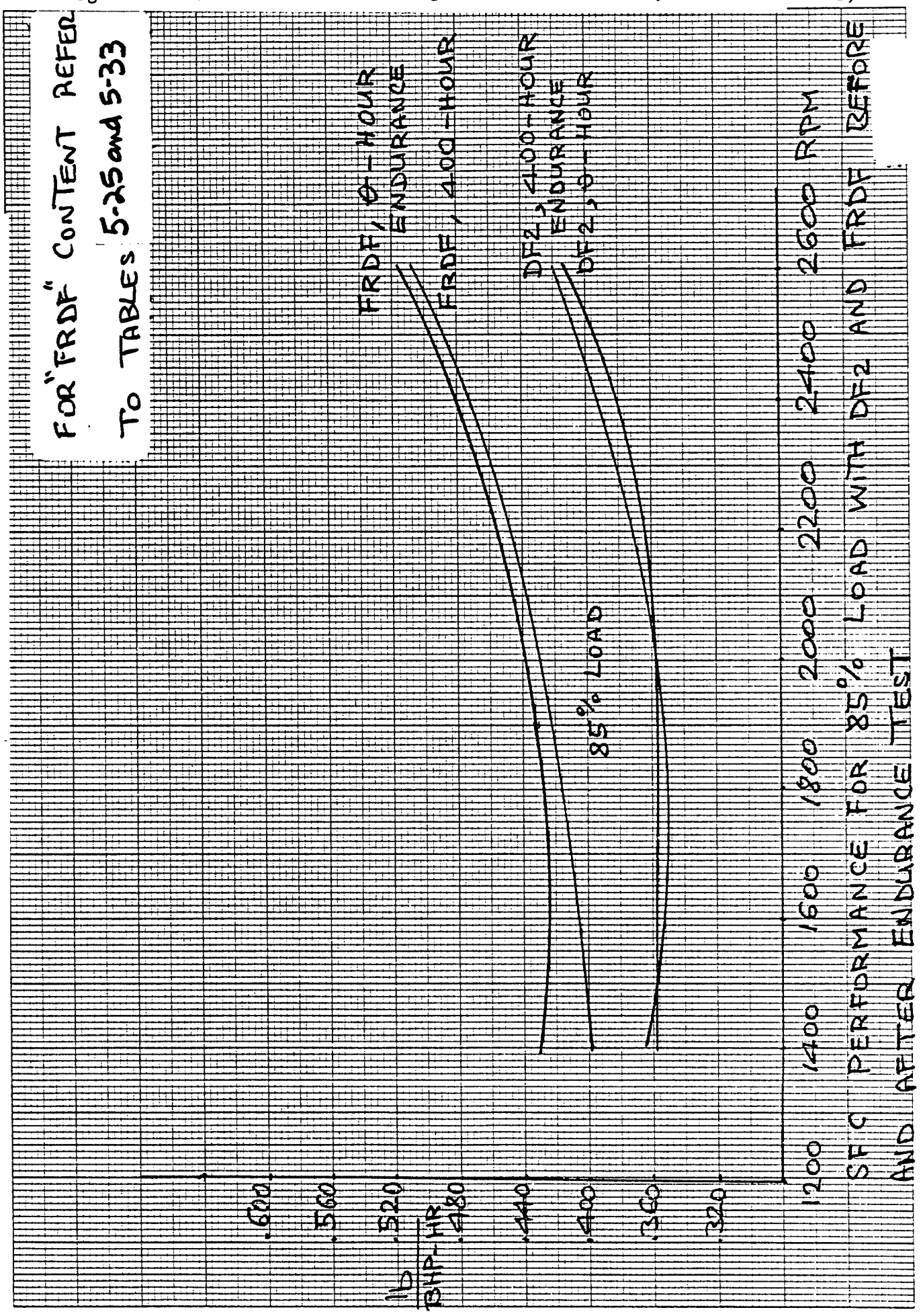


Figure 5-32. Performance Test Diagram (Torque at 85% Load, for DF2 and FRDF)

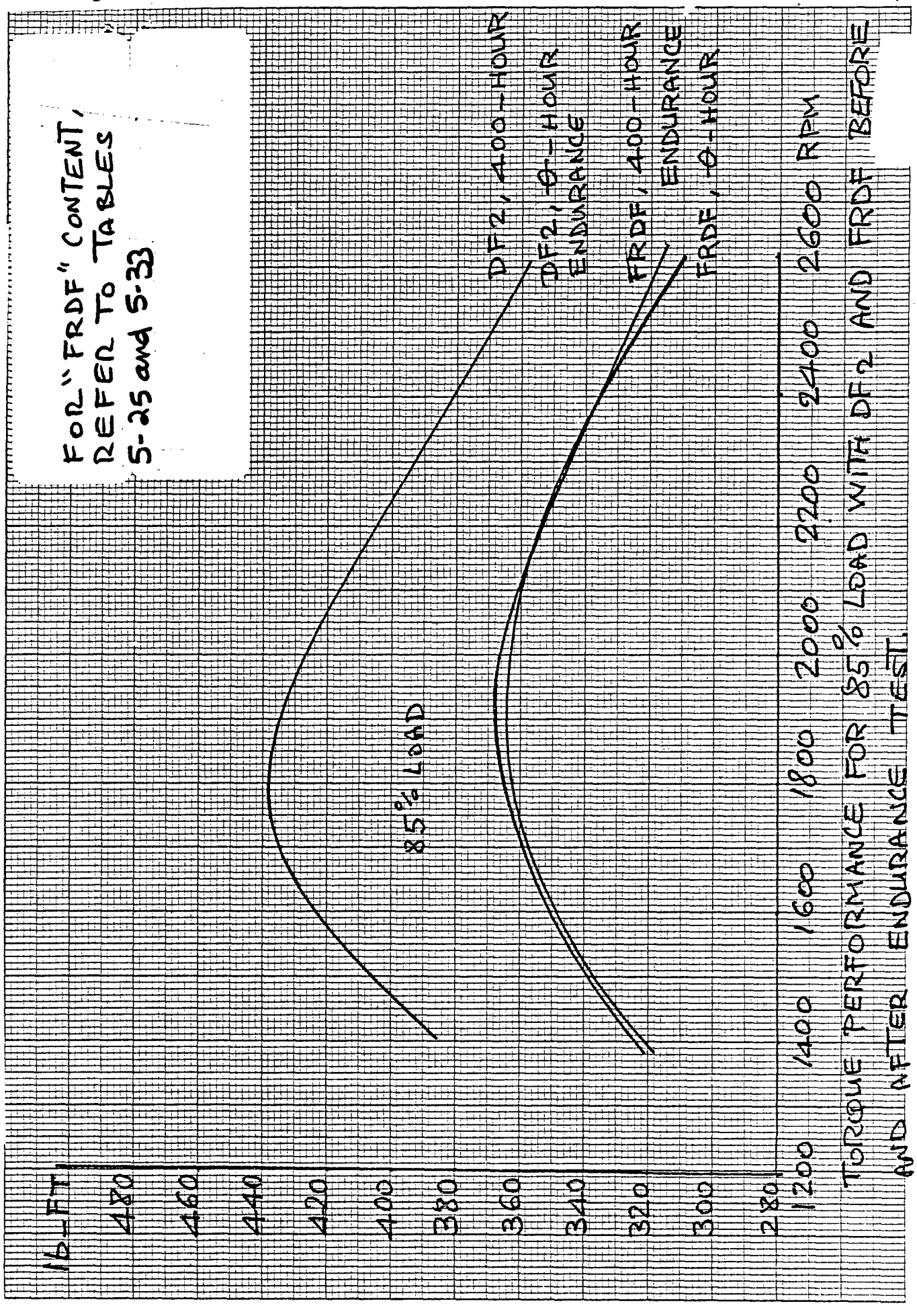


Figure 5-33. Performance Test Diagram (HP at 70% Load, for DF2 and FRDF)

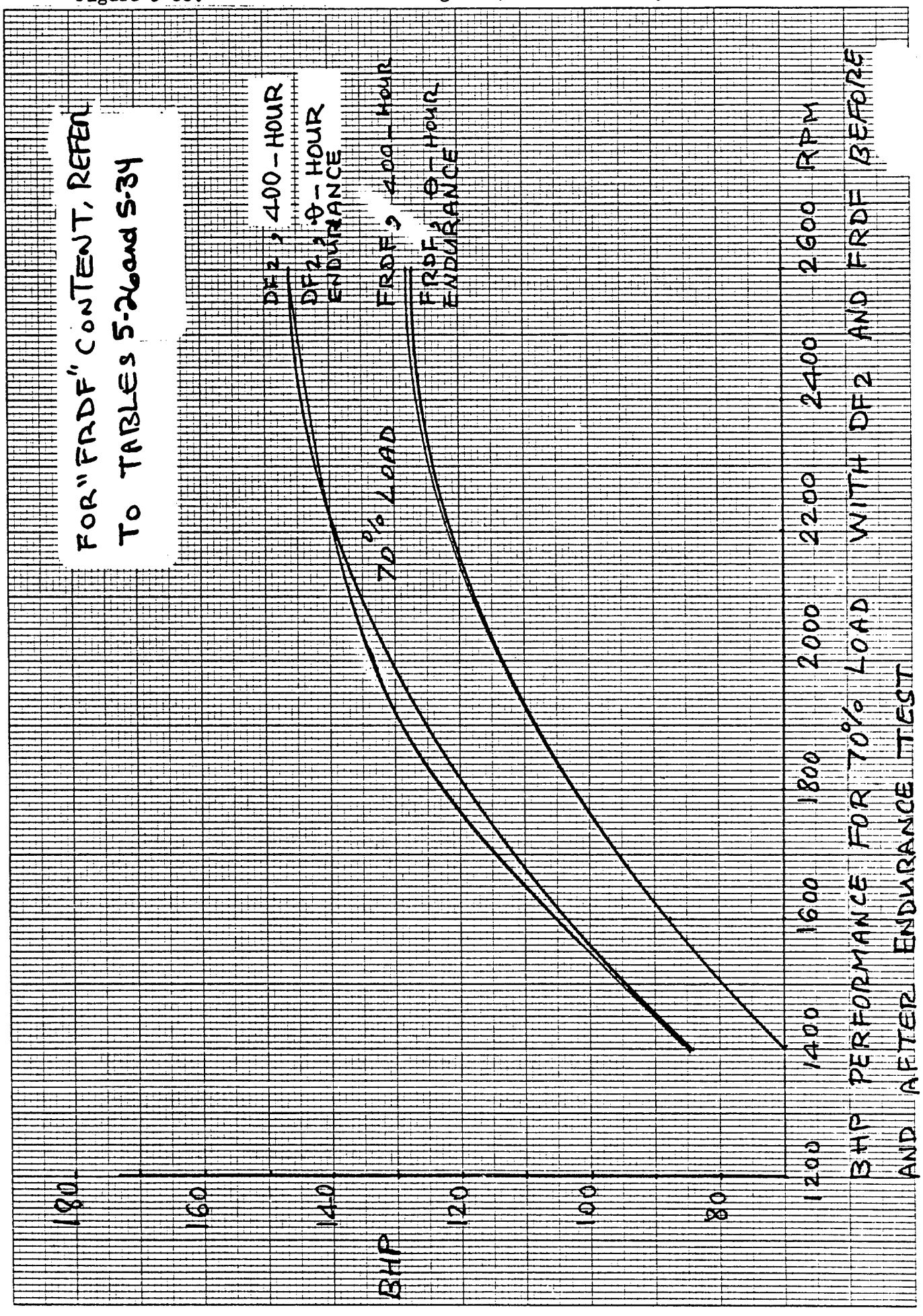


Figure 5-34. Performance Test Diagram (SFC at 70% Load, for DF2 and FRDF)

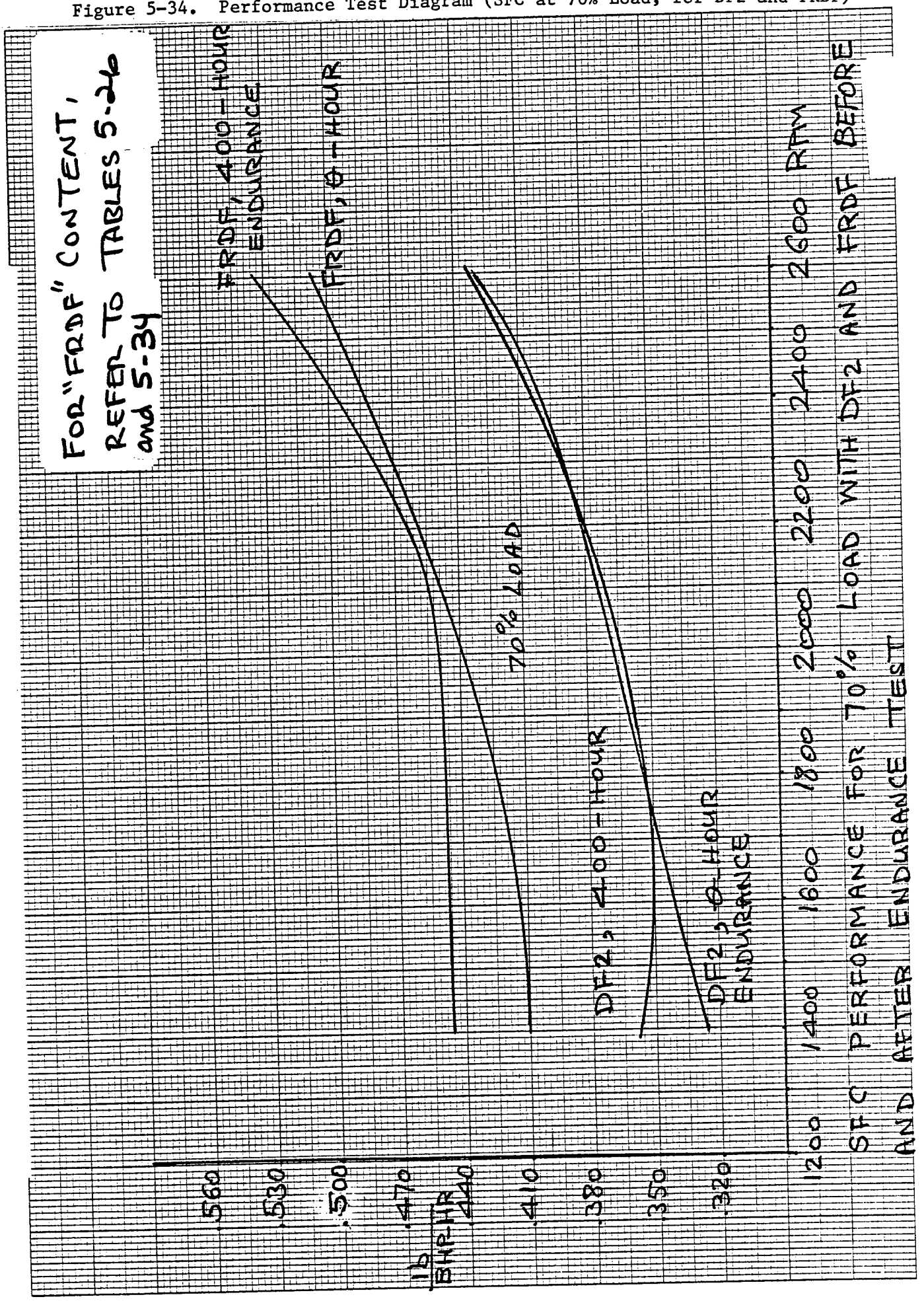


Figure 5-35. Performance Test Diagram (Torque at 70% Load, for DF2 and FRDF)

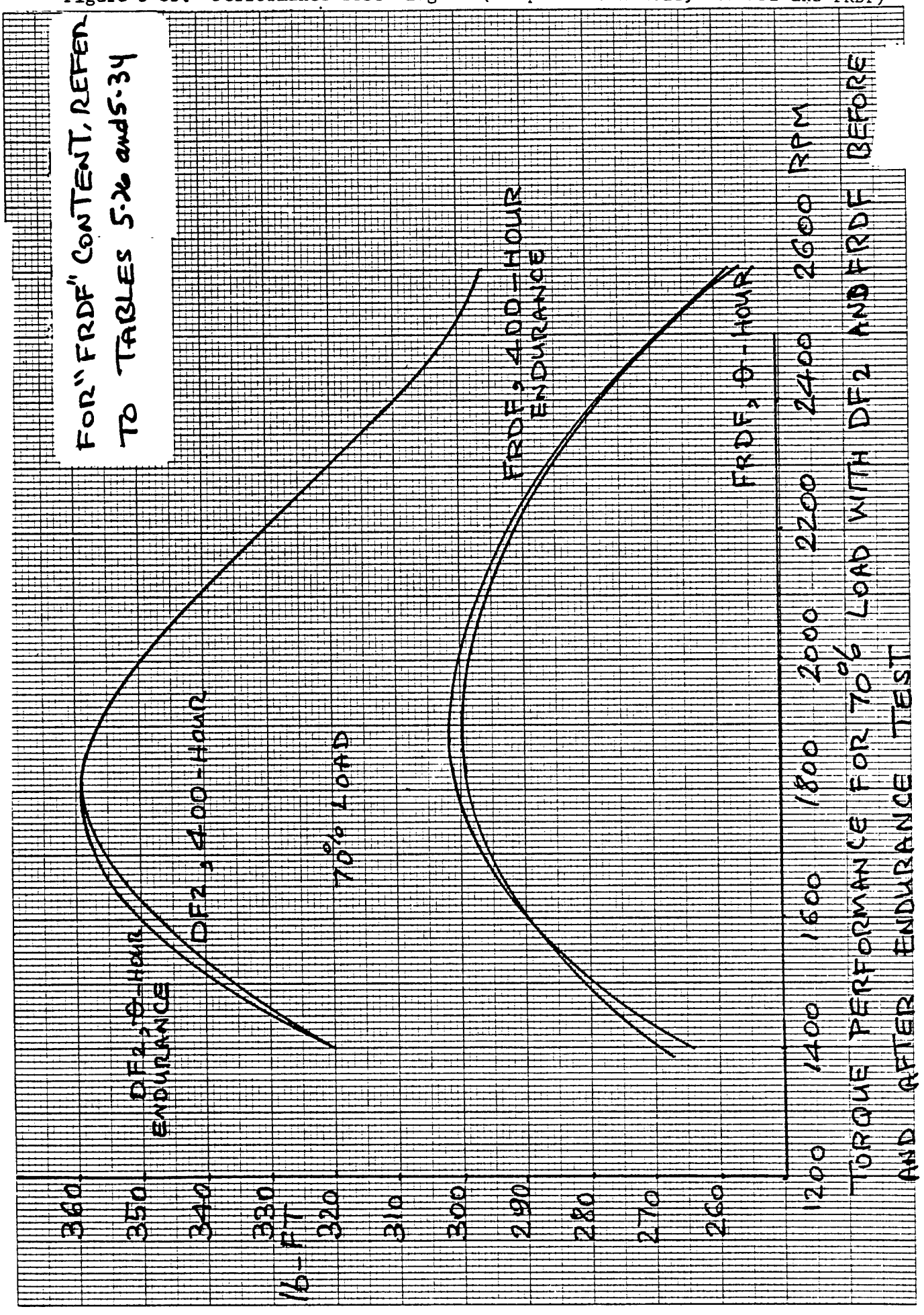


Figure 5-36. Performance Test Diagram (HP at 50% Load for DF2 and FRDF)

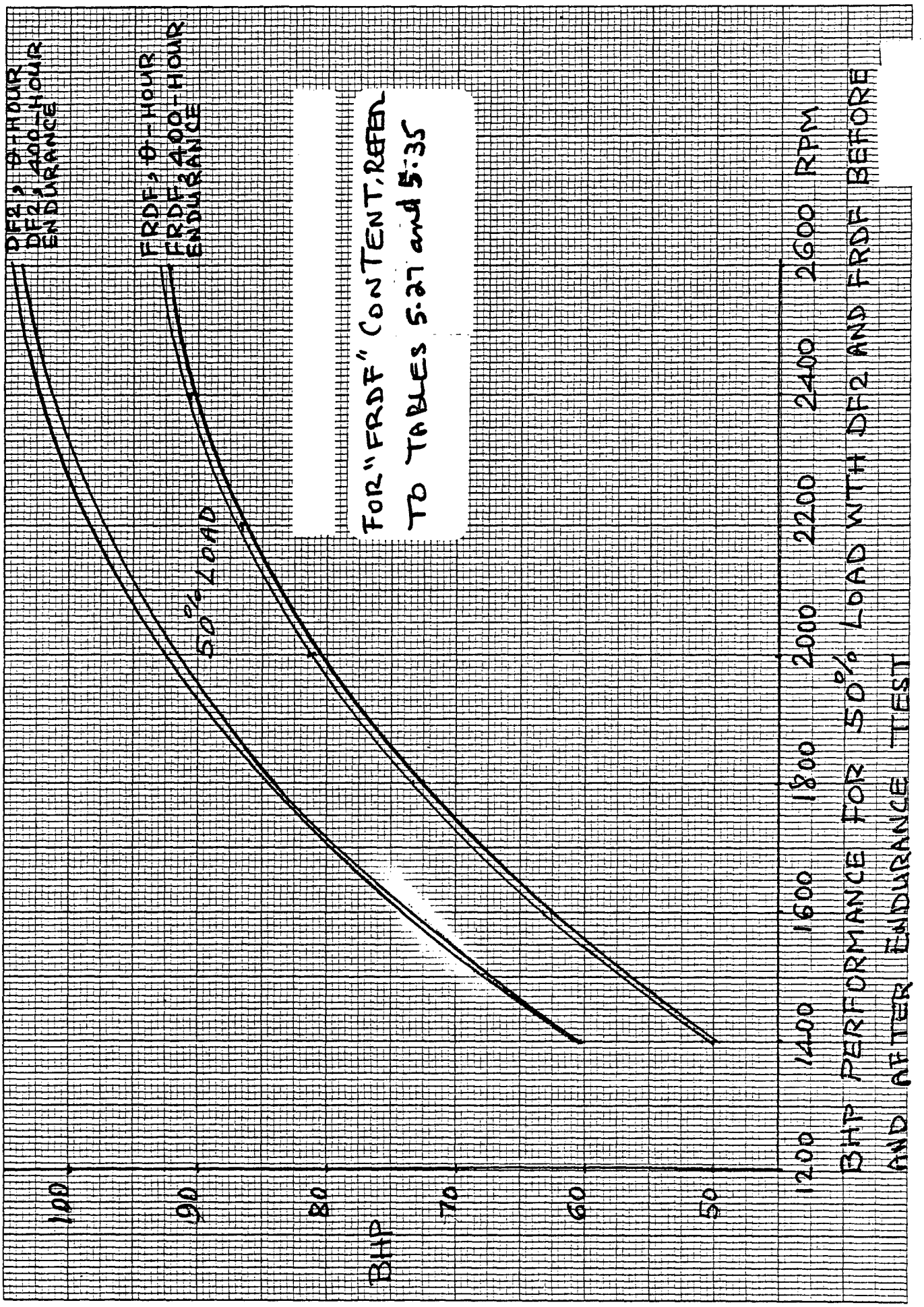


Figure 5-37. Performance Test Diagram (SFC at 50% Load for DF2 and FRDF)

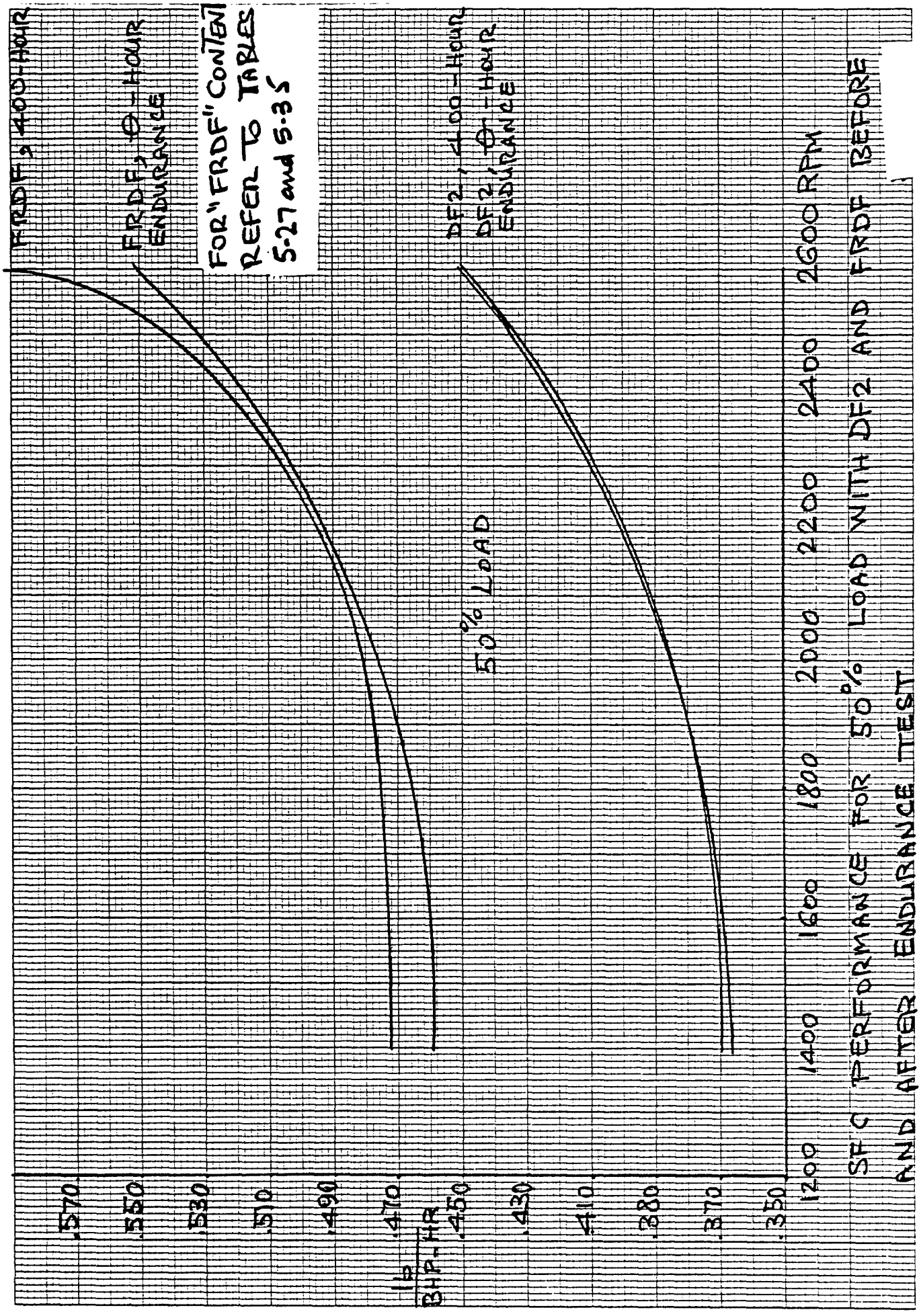


Figure 5-38. Performance Test Diagram (Torque at 50% Load for DF2 and FRDF)

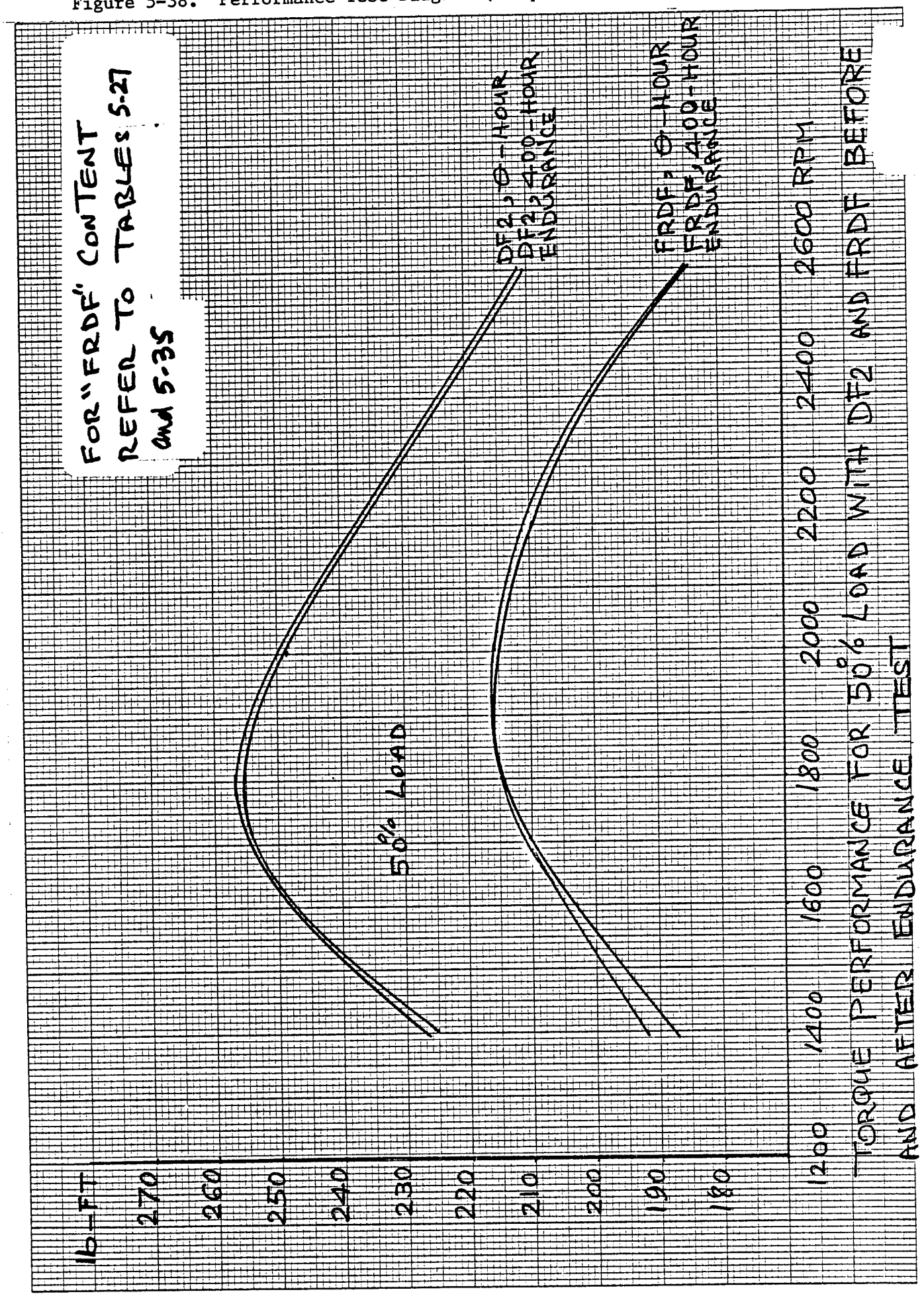


Figure 5-39. Performance Test Diagram (HP at 25% Load for DF2 and FRDF)

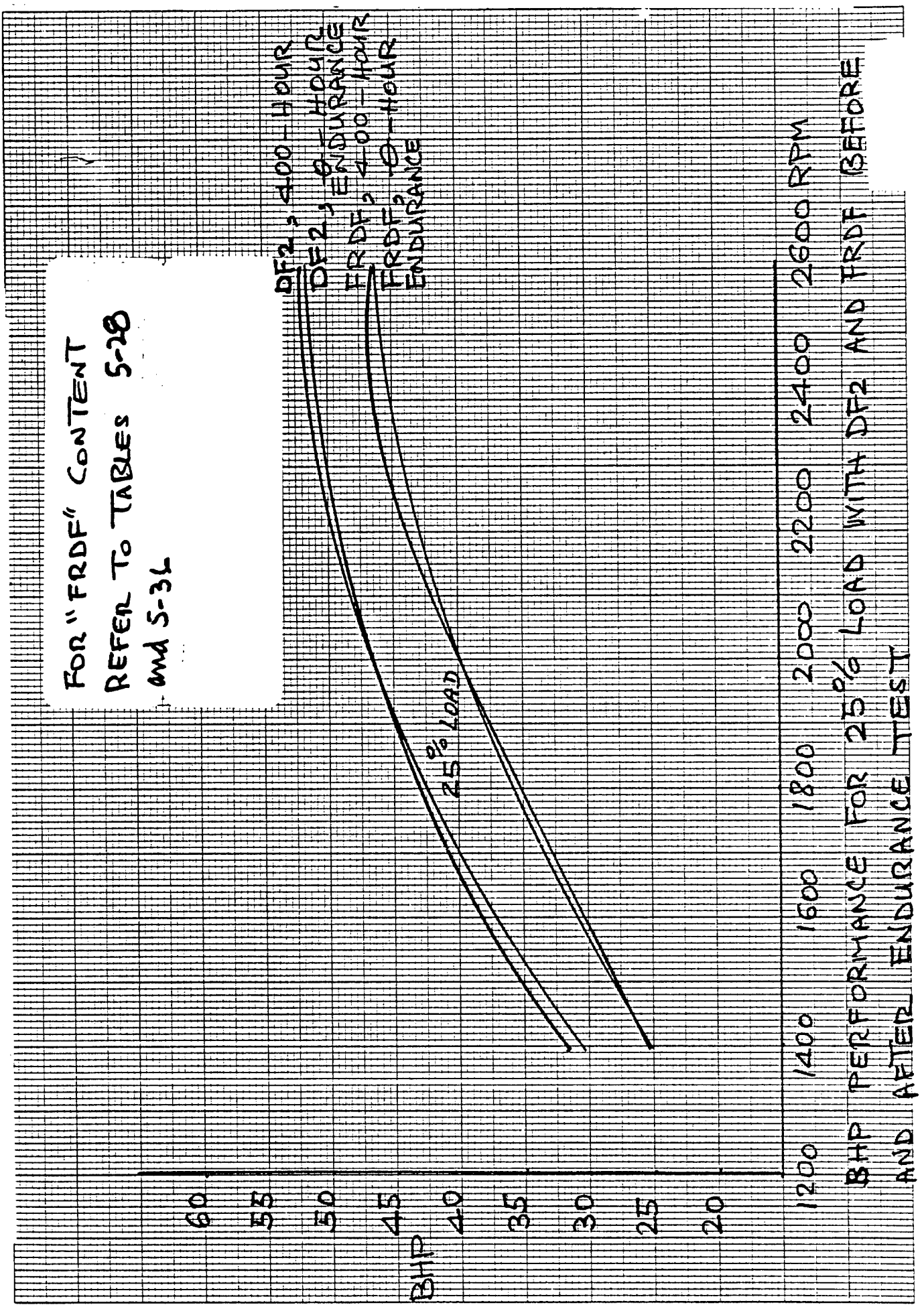


Figure 5-40. Performance Test Diagram (SFC at 25% Load for DF2 and FRDF)

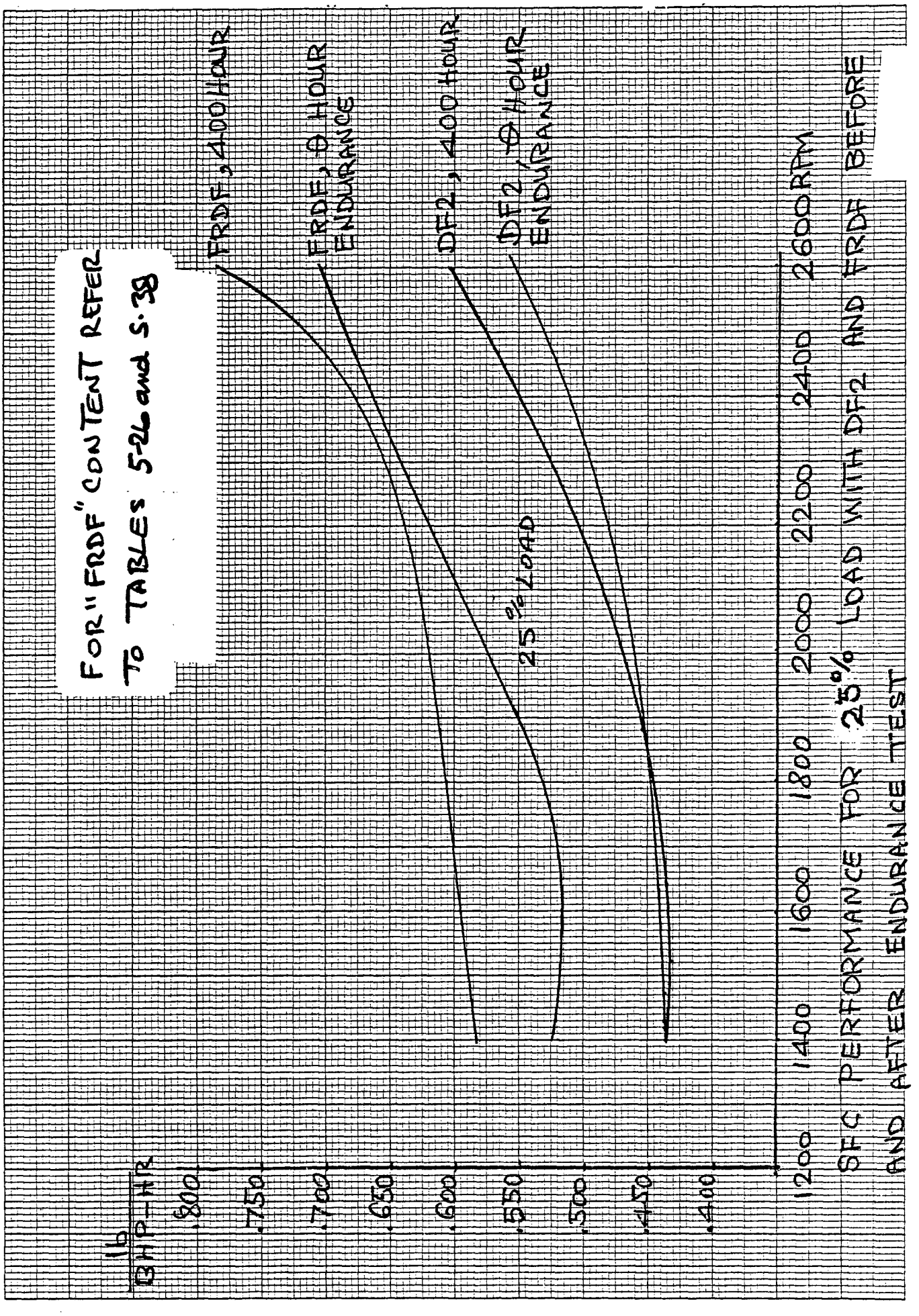
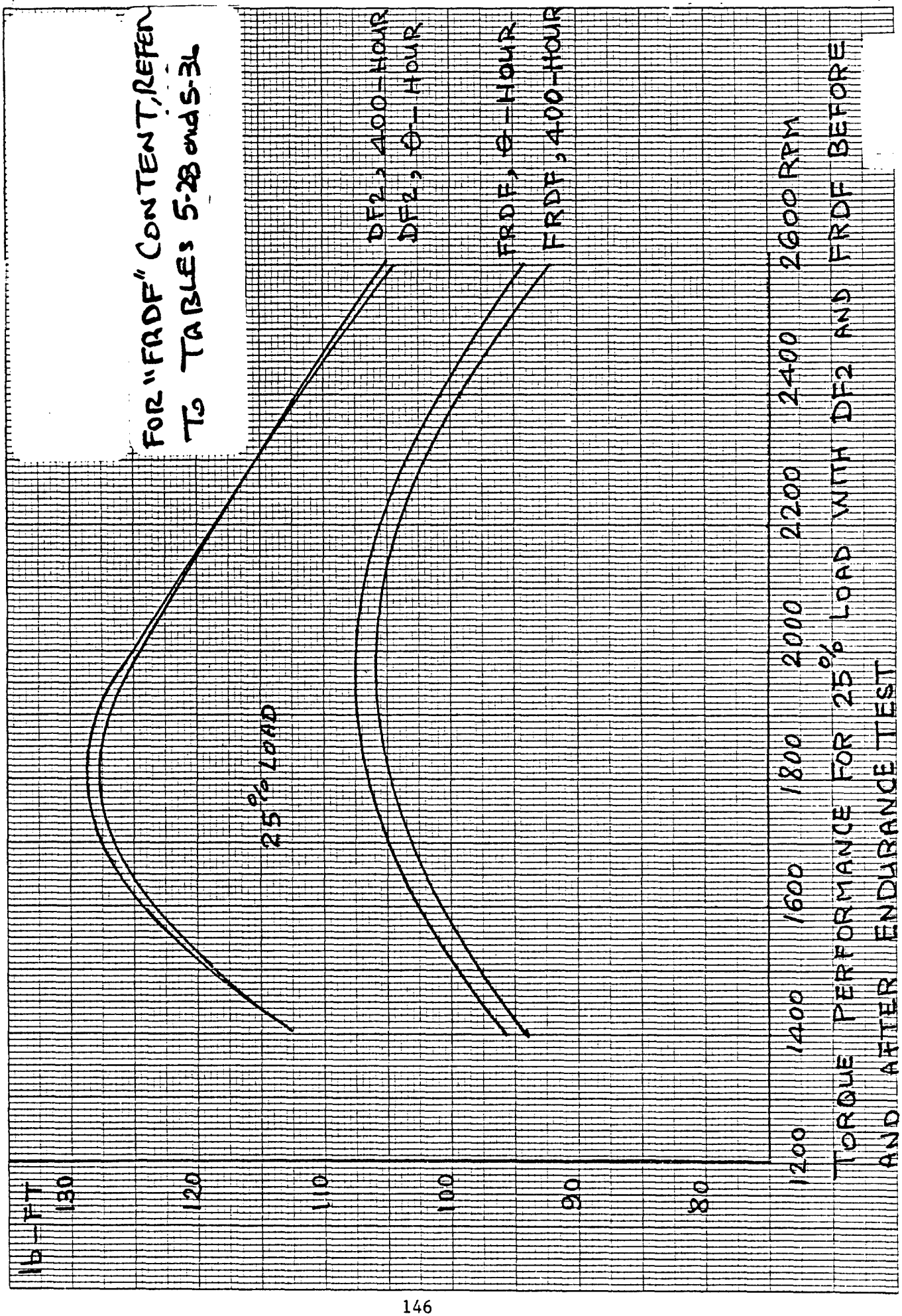


Figure 5-41. Performance Test Diagram (Torque at 25% Load for DF2 and FRDF)



APPENDIX A

ANALYSIS OF FUELS AND LUBRICANTS

BELVOIR FUELS AND LUBRICANTS RESEARCH FACILITY (SwRI)
6220 CULEBRA ROAD – P.O. DRAWER 28510 PH:512-684-5111 SAN ANTONIO, TEXAS 78284

BFLRF

File: 02-8341-113
29 July 1987

Commander
U.S. Army Belvoir Research, Development and Engineering Center
Attn: STRBE-VF, Mr. M.E. LePera
Fort Belvoir, Virginia 22060-5606

Subject: **Analysis of the Fuels and Lubricants Used in the TACOM FRF Durability Test**

Dear Sir:

Enclosed you will find the results of the analysis conducted at Belvoir Fuels and Lubricants Research Facility (SwRI) on the fuels and lubricants used in the FRF durability test. Brief interpretative discussions are also included.

If you have further questions, please do not hesitate to call.

Very truly yours,

S.J. Lestz
Director

B.R. Wright
Manager
Special Projects

SJL/BRW/lap (BRW1.N)

Enclosure

cf: U.S. Army Belvoir Research, Development and Engineering Center, Attn: STRBE-VF, Mr. F.W. Schaekel
Commander, U.S. Army Tank-Automotive Command, Propulsion Systems Division, Attn: AMSTA-RGE, Mr. M. Mekari, Warren, MI 48397-5000

400-HOUR NATO CYCLE EVALUATION OF FIRE-RESISTANT FUEL (FRF) CONDUCTED AT USATACOM

This report summarizes the results of analysis on the fire-resistant fuel (FRF) that was utilized in the 400-hour NATO cycle test to evaluate the engine compatibility with the water-containing fuel. Oil samples taken at 50-hour intervals were also analyzed for fuel dilution or engine distress related to the use of this special fuel blend.

The concern over the water content of the fuel stemmed from the fact that the regulation of the in-line blender was difficult to maintain constant. Therefore, if power loss is being calculated based on water content, precise control of water content was mandatory.

Fuels

TABLE 1 summarizes the results of water analysis that was conducted at Belvoir Fuels and Lubricants Research Facility (BFLRF) at Southwest Research Institute.

TABLE 1. Water Analyses of FRF Samples

Analysis Date	Sample ID	Water Content, vol%
08-29-86	TACOM Blend 07-30-86	10.4
08-29-86	TACOM Blend 08-25-86	11.6
09-09-86	57/57/73	13.2
09-09-86	57/70/73 Top of Tank	10.6
09-09-86	57/70/73 Bottom of Tank	11.8
09-09-86	From Cell	10.8
09-18-86	09-12-86 57/57/73	11.3
09-18-86	09-16-86 57/62/74	12.0
10-06-86	10-03-86 57/62/74	13.2
12-03-86	Mixer 57/50/74	10.2
12-03-86	Engine Filter 57/62/73	12.6

It is obvious from the water analysis data that the water content initially blended into the fuel did not remain constant and that there was some separation/enrichment at various positions in the fuel-handling system.

TABLE 2 shows the analysis conducted on the two batches of base fuel that were used throughout the testing. The fuel used on this program was procured as DF-2. Specifications for MIL-F-46162B are also included for ready comparison.

Lubricants

Samples of the used lubricant were withdrawn every 50 hours throughout the test duration. These samples were analyzed for changes that commonly occur during extended engine test hours. Basically, there were very few changes that could be identified and none were significant. Unfortunately, samples of the new oil were not available to allow direct comparisons; however, since only minimal changes throughout the test duration were noted, new oil comparisons cannot be considered critical to the overall assessment of the lubricant analysis. The following tables and graphs show the tests that were conducted and the results that were obtained. TABLE 3 shows the results obtained for changes in viscosity, acid and base number. It was not possible to correlate these numbers with make-up since that information was not available. Basically, there were no significant changes in viscosity. The acid number and base number did not show significant changes that would indicate stressing of the oil. Even though the base number did not indicate a high base number, no major reductions (showing acid formation) were observed. TABLE 4 shows the metals that were found in the used oil samples. The iron was low indicating no serious wear problems in cylinder liners and pistons. The bearing materials (primarily lead and copper) showed no distress in the highly loaded bearing areas. There was no significant change in additives as shown in the barium, phosphorous and zinc concentrations.

The next eight graphs are spectrum taken from the infrared analysis of the samples. There are a number of verifications and indications from reviewing these spectra. Basically, there did not appear to be heavy soot loading since there was no major baseline displacement. Moisture or coolant (as diluents) do not appear in the sample and lubricant oxidation (chemical breakdown) does not appear on the spectrum.

In summary, analyses of the lubricant samples taken every 50 hours do not show any indications that the engine was being stressed or that contaminants were entering the oil sump.

TABLE 2. Analysis of DF-2 Test Fuels

Properties	MIL-F-46162B Requirements	ASTM Test Method	TACOM 07-29-86	TACOM 08-21-86
Density, kg/L at 15°C	Report	D 287	0.8489	0.8479
Gravity, °API	NR (a)	D 287	35.1	35.3
Flash point, °C	Report	D 93	75.0	67.2
Distillation, °C		D 86		
Initial boiling point	Report		--	--
10% recovered	Report		--	--
50% recovered	245-285		--	--
90% recovered	330-357		--	--
95% recovered	350-375		--	--
End point	385 max		--	--
Sulfur, wt%	0.95-1.05	D 2622	0.22	0.29
Accelerated stability, total insolubles, mg/100 mL	1.5 max	D 2274	--	--
Cetane index (b)	40-45	D 976	--	--
Cetane number (b)	40-45	D 613	--	--
Kinematic viscosity at 40°C, cSt	1.9-4.1	D 445	2.35	2.47
Cloud point, °C	-13 max	D 2500	-25	-18
Pour point, °C	-18 max	D 97	-28	-19
Particulate contamination, mg/L (0.8 µm filter)	10 max	D 2276 (Appendix A2)	--	--
Volume filtered, L	1		--	--
Ash, wt%	0.02 max	D 482	--	--
Carbon residue, 10% bottoms, wt%	0.20 max	D 524	--	--
Neutralization No. mg KOH/g	0.2 max	D 974	--	--
Copper corrosion at 50°C	1 max	D 130	--	--
Net heat of combustion, Btu/lb	Report	D 240	18313	18283
Aromatics, vol%	Report	D 1319	--	--
Carbon, %			86.86	86.85
Hydrogen, %			12.99	13.04

(a) NR = No Requirement.
(b) ND = Not Determined.

TABLE 3. Used Oil Analysis

Samples	Kinematic Viscosity at 40°C	Kinematic Viscosity at 100°C	VI	TAN	TBN
50 hrs	95.87 cSt	12.72 cSt	129	3.49	4.53
100 hrs	101.70 cSt	13.53 cSt	133	3.60	4.34
150 hrs	103.84 cSt	13.37 cSt	127	3.22	4.02
200 hrs	110.44 cSt	13.83 cSt	125	3.35	3.43
250 hrs	108.62 cSt	13.75 cSt	126	3.13	4.40
300 hrs	115.21 cSt	14.53 cSt	128	3.48	3.71
350 hrs	108.90 cSt	13.70 cSt	125	2.99	4.01
400 hrs	112.98 cSt	14.38 cSt	129	3.11	3.48

(BRWI.L)

TABLE 4. Metals Found in Used Oil Samples

SPONSOR CODE: TACOM TEST:

OIL CODE: FRF Test DATE:

METALS IN PPM

LN	HRS	Fe	Cr	Pb	Cu	Sn	Al	Ni	Sb	Ag	Mn	Si	B	Na	Mo	Mg	Ca	Ba	P	Zn
476E	50	16	<1	2	16	2	2	<1	<1	<1	1	9	99		<1	610		<1	1436	1667
177E	100	29	<1	6	45	6	2	1	<1	<1	1	10	93		<1	648		<1	1519	1761
478E	150	15	<1	1	22	3	2	<1	<1	<1	1	8	94		<1	591		<1	1483	1718
479E	200	24	<1	3	44	5	2	<1	<1	<1	1	8	87		<1	627		<1	1495	1807
480E	250	13	<1	2	21	3	1	<1	<1	<1	<1	7	95		<1	600		<1	1471	1779
481E	300	23	<1	7	35	2	3	1	<1	<1	1	7	96		<1	647		<1	1549	1827
482E	350	12	<1	3	16	3	2	<1	<1	<1	1	6	98		<1	586		<1	1468	1732
483E	400	22	<1	4	32	4	2	<1	<1	<1	1	7	95		<1	621		<1	1500	1807

(BRW I.L.)

SPECTRUM NO. 3372 9

DATE

SAMPLE 50 mm

SOURCE

STRUCTURE

PATH .025 mm

SOLVENT

CONCENTRATION neat

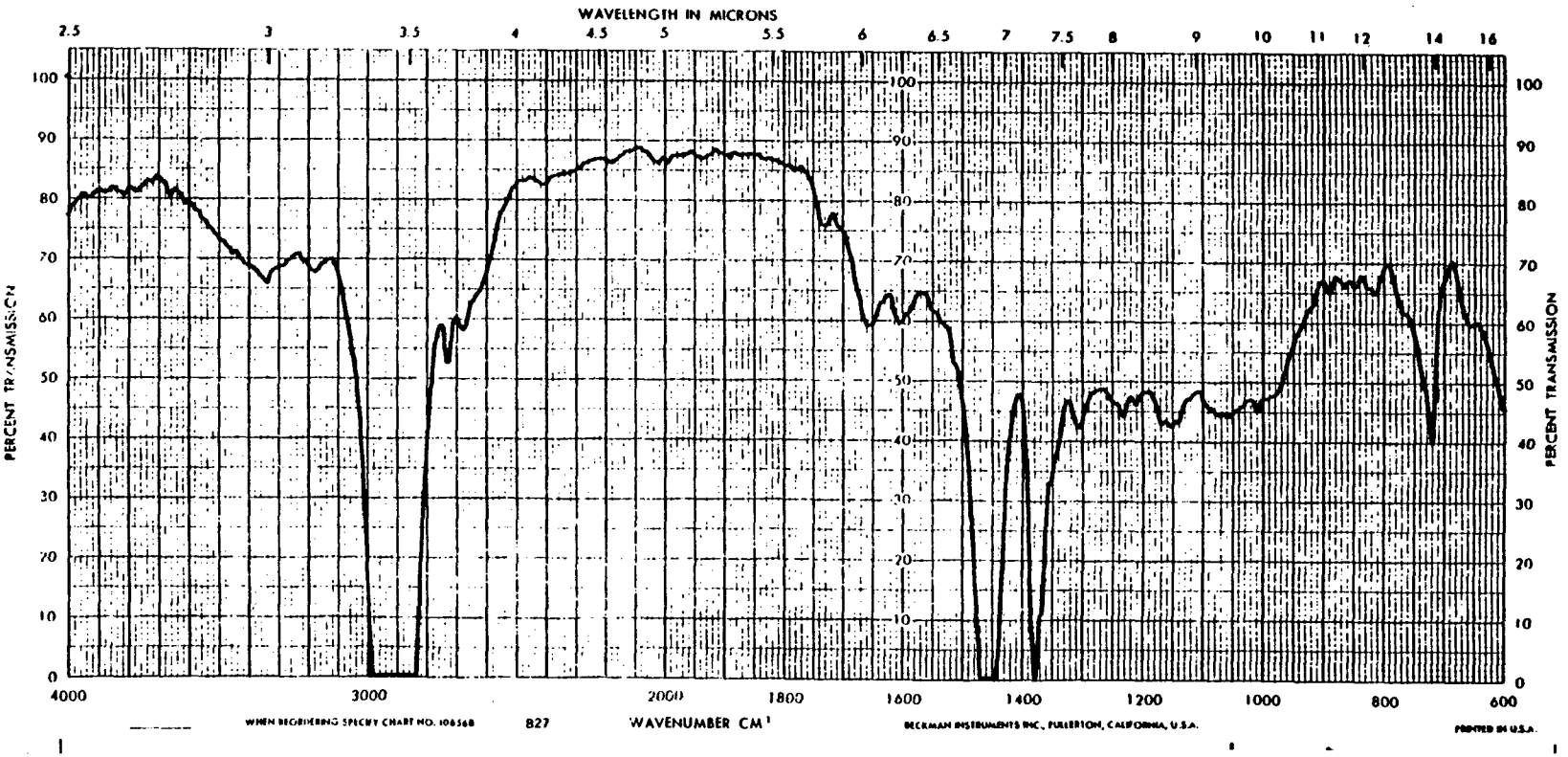
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Beckman

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(BRW1.L)

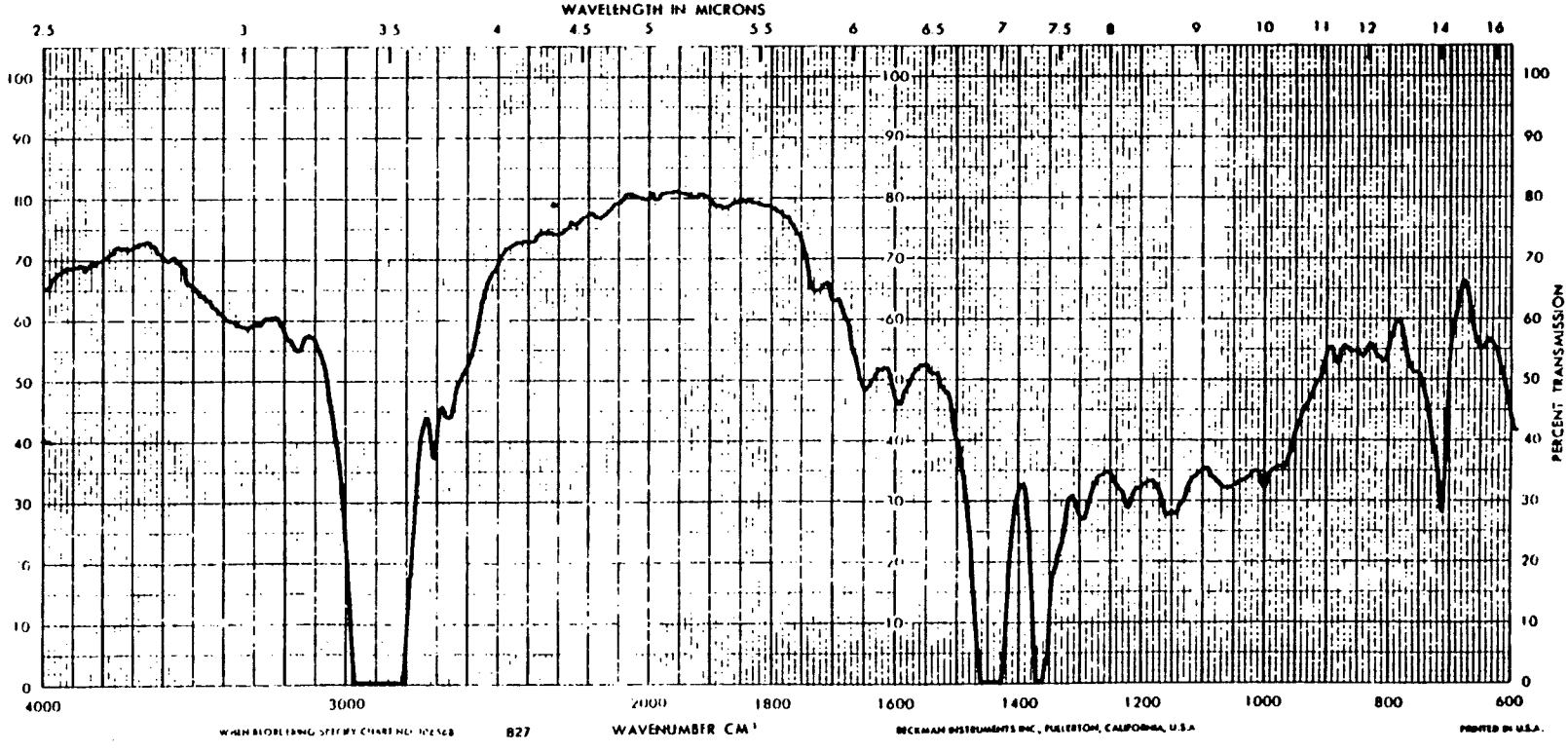
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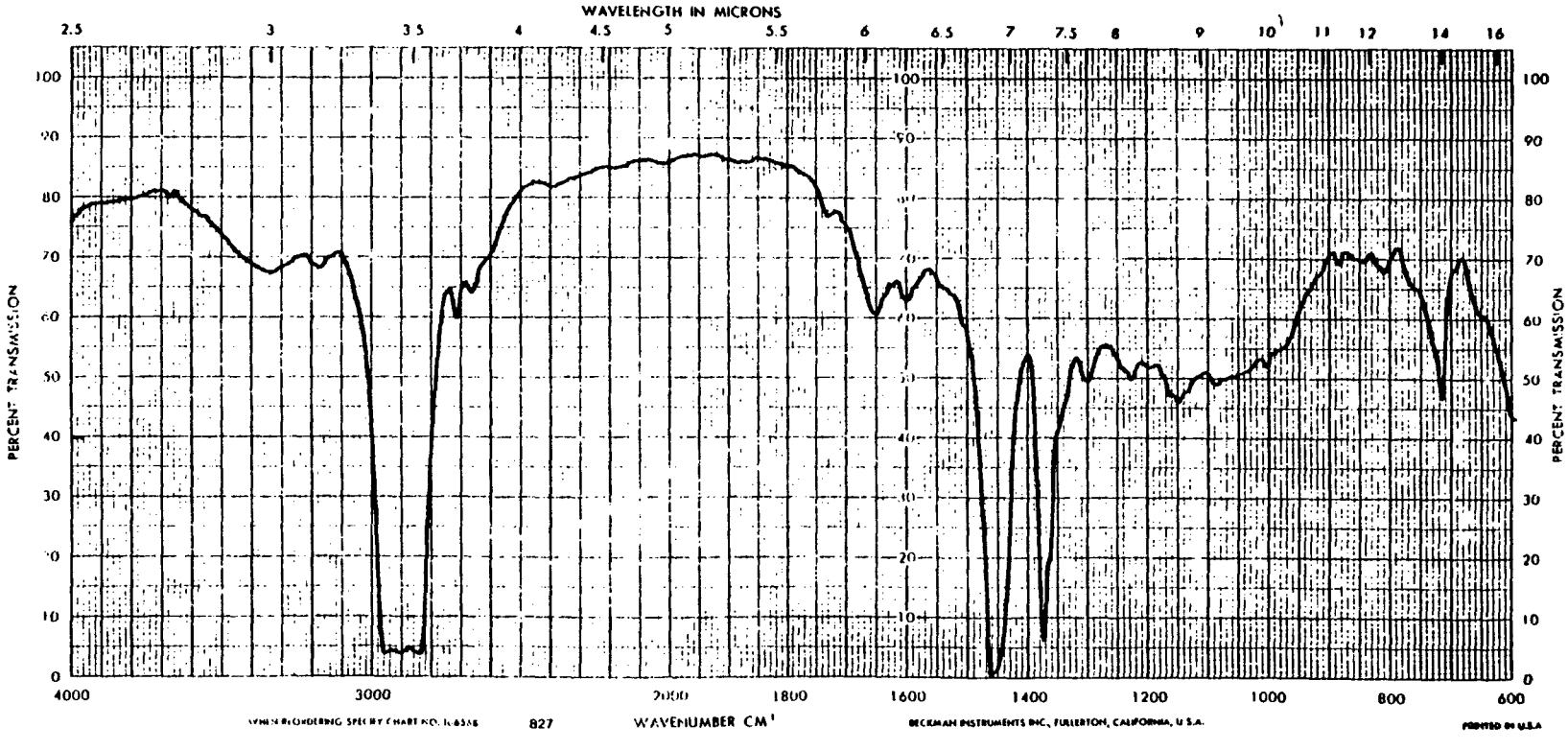
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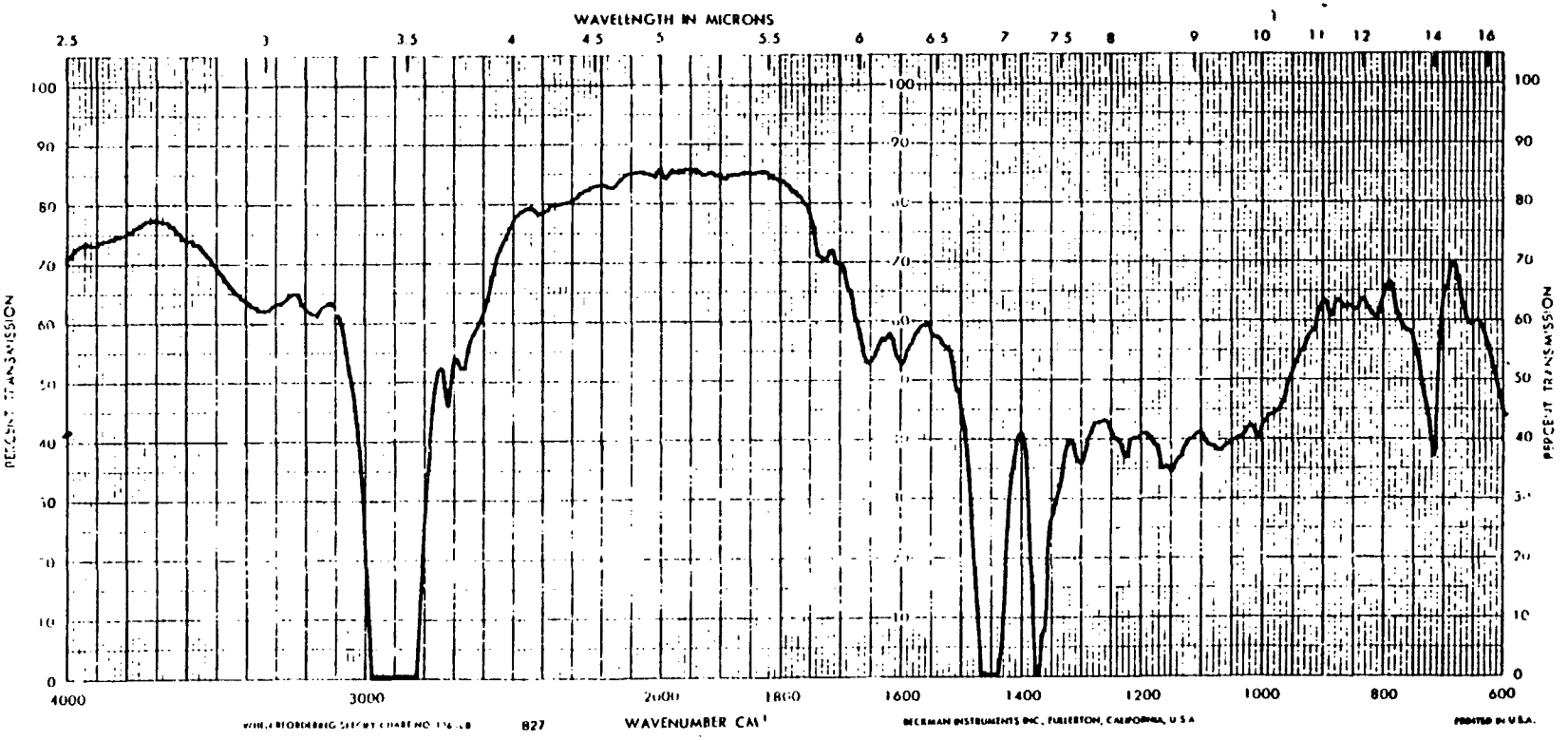
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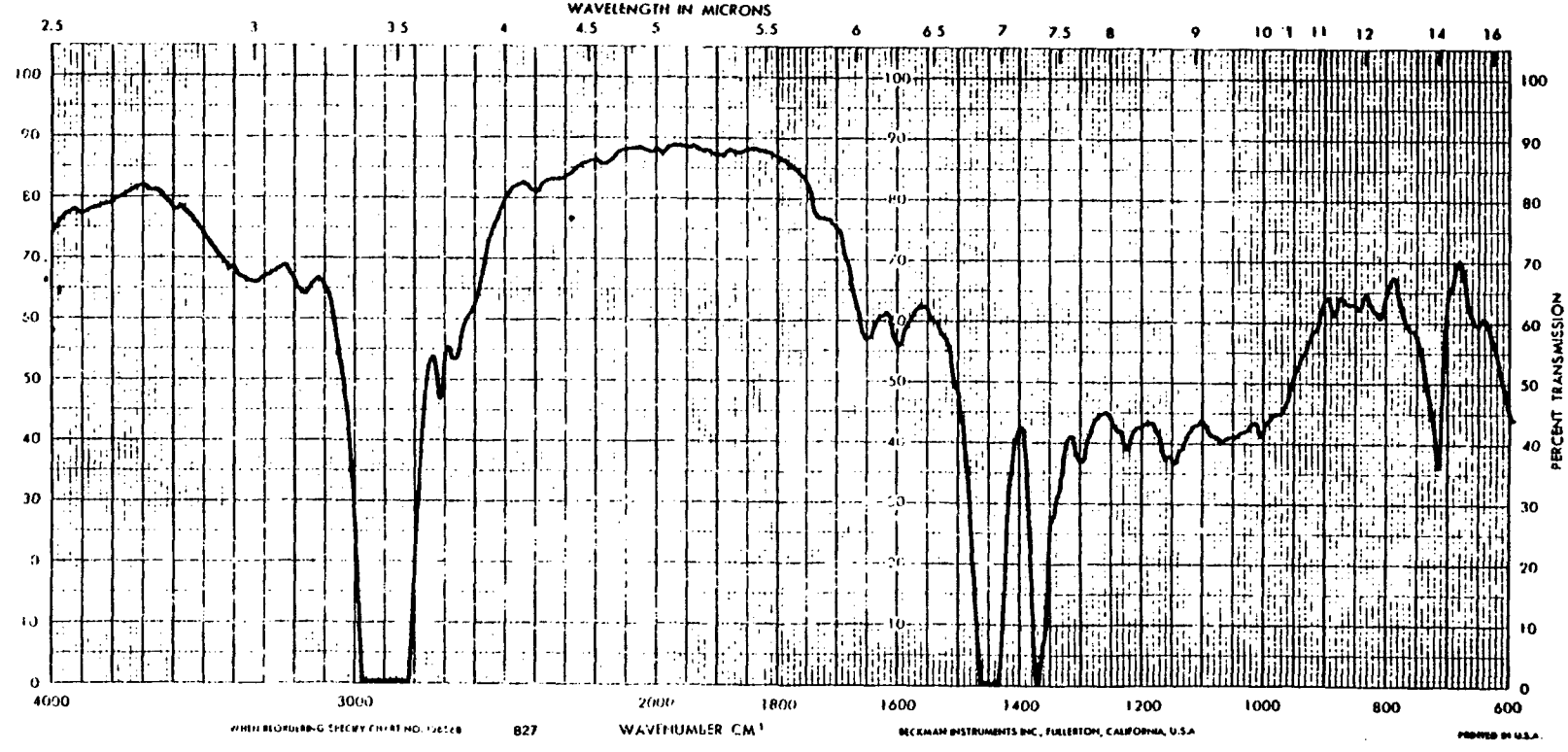
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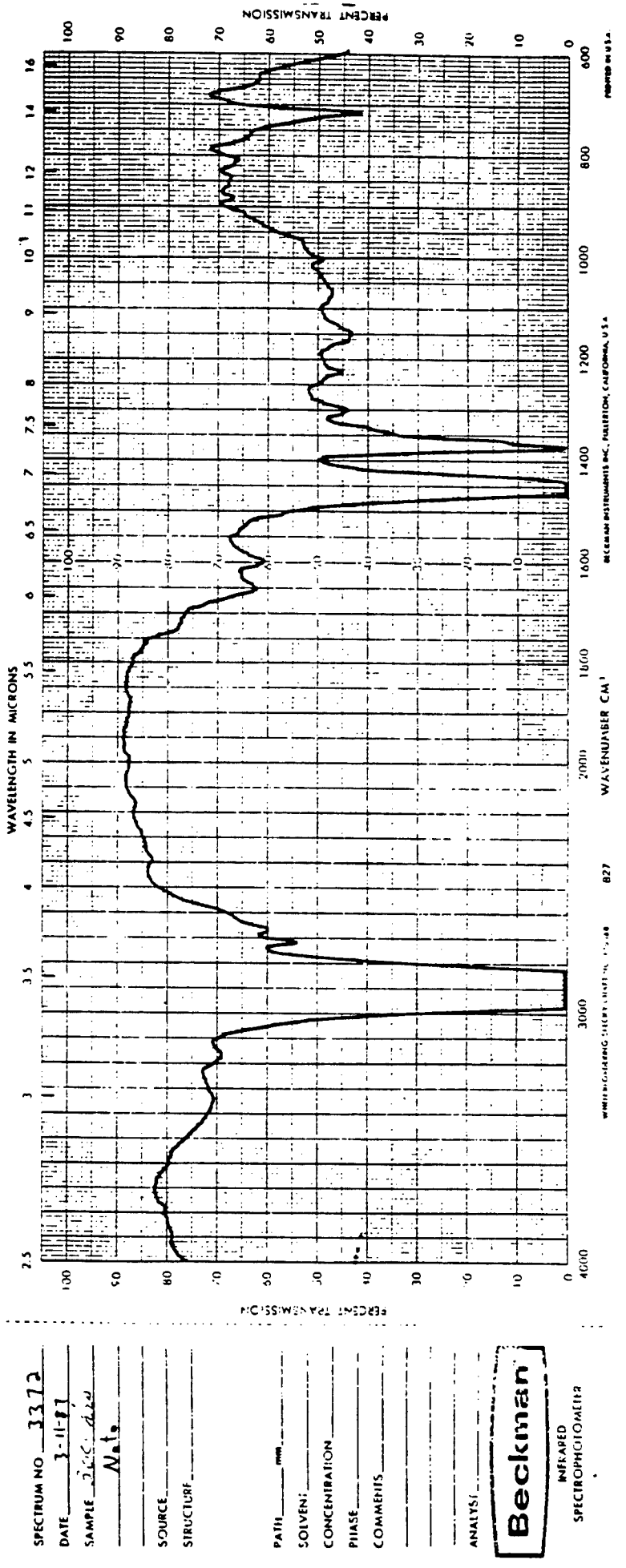
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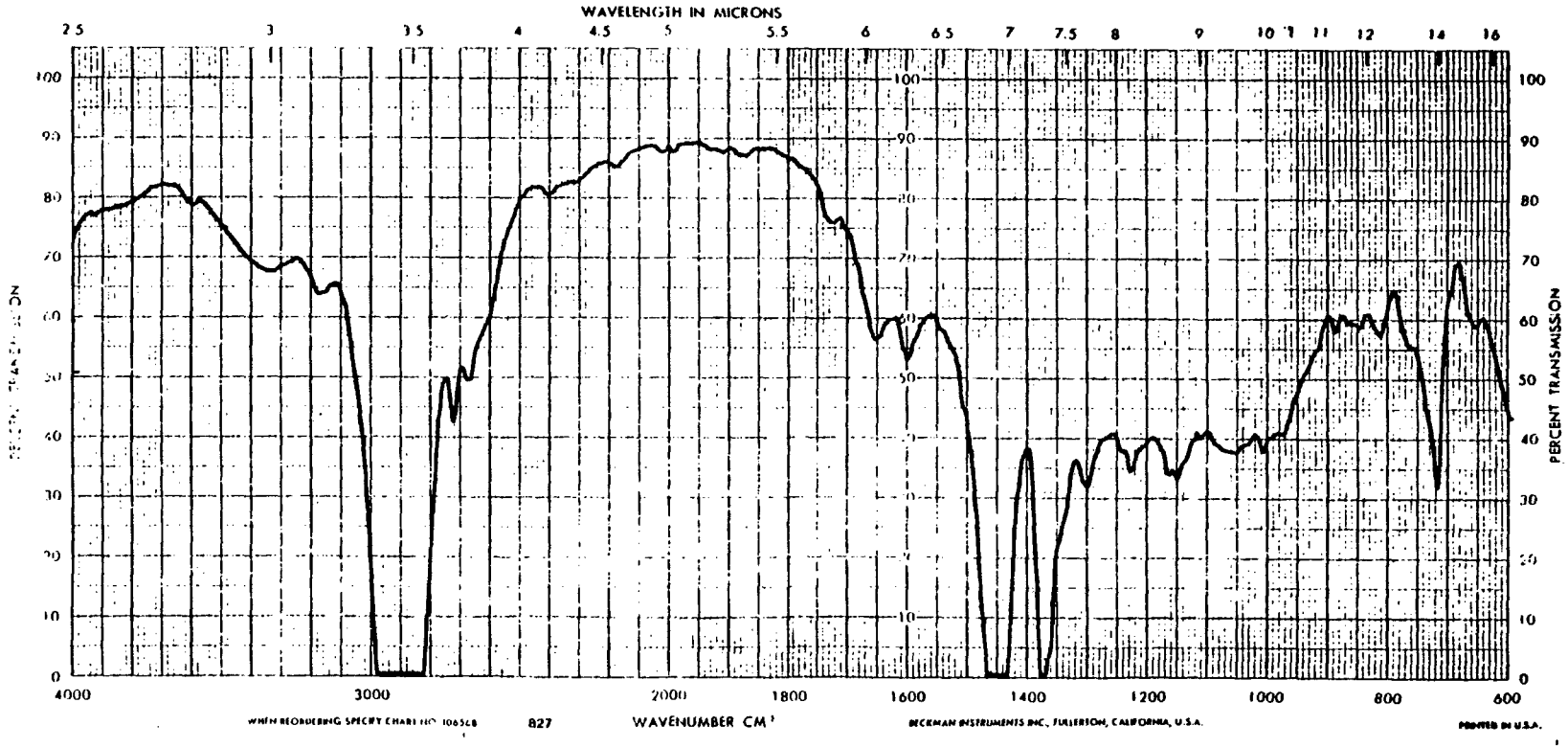

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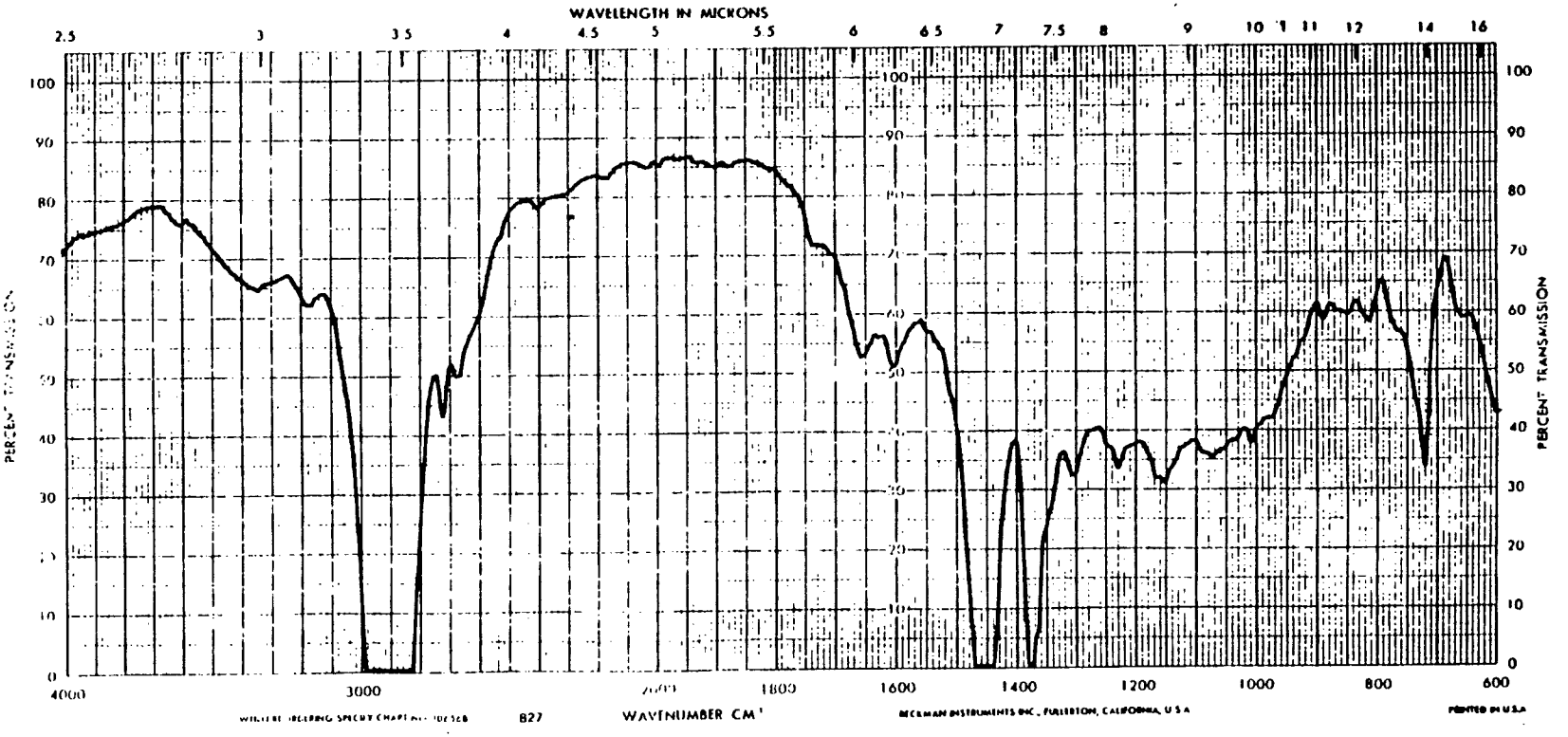
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APPENDIX B

NATO STANDARD DIESEL AND SPARK IGNITION ENGINE LAB TEST SPECIFICATIONS

P A R T II

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NATO STANDARD DIESEL AND SPARK IGNITION ENGINES LABORATORY TEST

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AEP-5

JUNE 80 ISSUE

JAN 84 REVISED

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NATO UNCLASSIFIED

CHAPTER I

GENERAL - DEFINITIONS

SECTION 1-1 - GENERAL

The purpose of this document is to define a test method and standard conditions to enable all NATO countries to conduct tests using an identical method or to analyze the tests conducted in the laboratories of other NATO countries on the basis of this method.

The method described below is independent of existing national test methods, which may be used for supplementary testing.

When an engine has met the requirements of the tests under the present code, its power rating should be indicated as follow : Rated Power ... kW (... metric HP) at ... r.p.m., in accordance with NATO AEP 5 - june 80 issue.

SECTION 1-2 - FIELD OF APPLICATION

These test requirements are applicable to all military vehicles fitted with Diesel or Spark ignition engines.

SECTION 1-3 - DEFINITIONS

A major failure is a failure of any part or component of the engine assembly that leads to a final stoppage of the engine or that brings about a loss of power which cannot be rectified to give at least 95 % of rated power, within the scope of normal maintenance and adjustement.

Any major failure will lead to termination of the test and any retest must start at 0 hour.

Major failures and corrective action are to be reported to the proper National Authority.

A minor failure is a failure which leads to a loss of power or degradation of the operation of the engine and which it is possible to remedy within the scope of normal maintenance and adjustment. If 95 % of the rated power cannot be obtained after normal maintenance then the test will be terminated.

The minor failures and the measures taken to overcome them must be included in the report.

The suitability of an engine for NATO AEP 5 is to be the responsibility of the National Authorities after completion of the 400 hours test and consideration of the final condition of the engine.

NOTE : The measurement units must are to be in accordance with the Système International

CHAPTER 2

TEST REQUIREMENTS

SECTION 2-1 - GENERAL COMPOSITION AND ORDER OF TEST

2.1.1. Engine reception.

Running-in in accordance with manufacturer's instructions.

Performance test, complete (full and part loads).

Endurance test.

Performance test, complete (full and part loads).

Disassembly, inspection and measurement.

Report.

NOTES : (1) Engine measurements may be carried out before running-in.

(2) The manufacturer is responsible for defining the running-in program and the engine should have been run-in before it is submitted for testing.

(3) In so far as possible, the manufacturer's drawing and technical data will be supplied with the engine, to assist inspection and measurement of components.

(4) It is normal practice for the engine to be given a preliminary performance test immediatly after receipt, to check acceptability.

(5) If an initial inspection is accomplished, the final one should be carried out by the same inspection team using the same gauges.

2.1.2. During performance and durability testing, the following variables will be monitored :

a - Main values
Speed (engine output shaft)
Torque (engine output shaft)

b - Ambient conditions
Temperature of ambient air
Atmospheric pressure
Humidity

c - Air and gases
Inlet air temperature
Inlet or cylinder inlet depression
Inlet air flow (performance test only)
Air temperature and pressure in the inlet manifold
Exhaust temperature
Exhaust back pressure

d - Lubrication and cooling
Oil temperatures and pressures
Temperatures into and out of external coolers
Flow rates of fluids to cooling devices external to the engine (for heat rejection calculations). Performance test only
Oil consumption (during endurance tests only)

e - Fuel
Fuel temperature
Fuel consumption

f - Miscellaneous
Blow-by
Smoke density

2.1.3. REGULATED PARAMETERS

Outlet temperature of cooling agent
a - water + antifreeze = 96°C ± 3°C
b - other cooling agents = to manufacturers specifications

Inlet Air Depression (*) at rated power : 25 ± 5 mbar
Exhaust Back Pressure (**) at rated power : 40 ± 5 mbar

Fuel temperature : at injection pump inlet : 30°C ± 3°C

Inlet air temperature : The inlet temperature will be maintained as close as possible to 25°C.

(*) Depression between static atmosphere and total pressure at the point of measurement.

(**) Exhaust back pressure between static atmospheric and static pressure at the point of measurement. For small engines, which are sensitive to exhaust back pressure manufacturers' recommended figures should be used

2.1.4. TEST CONDITIONS

Measuring is to be done in normal and stable operating conditions.

The temperature of the air entering the engine (ambient air) is to be measured at a maximum distance of 0,15 m from the air filter inlet or, if there is no filter, 0,15 m from the air inlet nozzle. The thermometer or thermocouple must be protected against heat radiation and be located directly in the air jet. Testing must be carried out in an adequate number of positions to give a representative inlet temperature.

Once an output speed has been selected for measurement purposes, its value must not vary by more than ± 1 % or ± 10 r.p.m. (whichever of these limits is the higher) during measurement.

The readings for brake load, fuel consumption and inlet air temperature are to be taken simultaneously, the value recorded being the average of two stabilized results, obtained in succession with brake load and fuel consumption differing by less than 2 %.

When a device fitted with an automatic starting system is used for measuring speed and fuel consumption, the duration of measurement must be at least 30 seconds ; if the measuring device is manually operated, the duration must be at least 60 seconds.

An instantaneous consumption measuring device may be utilised.

The exhaust gas outlet temperature must be measured at a point downstream and less than 100 mm from the flange(s) of the exhaust manifold(s).

Lubricant temperature is to be measured at the inlet and outlet of the heat exchanger if there is one. Otherwise it must be taken preferably in the lubrication system, or, failing this, in the crank case. The measuring point will be specified in the test report.

Fuel temperature must be read at the injection pump inlet, or carburattor inlet.

Auxiliary power take-offs may be loaded and then measured.

2.1.5. FUELS - LUBRICANTS AND ANTI FREEZES

Engines are to be tested on fuels, lubricants and anti-freezes as specified by the relevant NATO Authorities.

2.1.6. MEASUREMENT ACCURACY

- TORQUE

The torque must be accurate within ± 0,5 % of the highest value to be measured.

- OUTPUT SPEED

Measurement must be accurate to within ± 0,5 %.

- FUEL CONSUMPTION

± 1 % for all apparutus used.

- TEMPERATURES

Intake air ± 1°C.

- PRESSURE

Atmospheric pressure ± 0,7 mbar
Air and gas pressure ± 50 mbar
Induction and exhaust pressure and depression ± 0,250 mbar
Pressure of other fluids ± 250 mbar.

SECTION 2-2 - DEFINITION OF ENGINE

Engines will be equipped only with such auxiliary equipment as is strictly essential to their operation (see table of auxiliary equipment at section 2.6).

SECTION 2-3 - PERFORMANCE TEST

The performance test maximum load curve will be plotted from measurements taken at a minimum of five speed settings, one of these settings being the rated speed.

For each setting, the engine should be run for a sufficient time to allow the operating parameters to stabilize.

Part-load data is to recorded at the same pre-selected speeds as was used for the full-load test. The part loads for each speed point are to be calculated at least for 85 %, 70 %, 50 % and 25 % of the full load at the given speed.

During this test, the smoke emission as measured on the Robert BOSCH Scale (or equivalent) shall not exceed 4.5. (Diesel engines only).

No correction factor will be applied and the test results must include air temperature and atmospheric pressure.

SECTION 2-4 - ENDURANCE TEST

2.4.1. The endurance test duration is 400 hours, divided into four periods of 100 hours each. At the completion of each period, the engine shall be submitted to a full load performance check.

2.4.2. Normal maintenance and adjustment will be permissible after each 100 hour test period.

2.4.3. Engine oil and filters may be changed after each 100 hour period.

2.4.4. The engine oil temperature is to be measured in the lubrication system. The temperature measurement location shall be specified.

2.4.5. The four 100 hour periods which make up the endurance test are to be carried out with the fuel defined in 2.1.5.

2.4.6. Each 100 hour period is to comprise ten 10 hour cycles. Each 10 hour cycle will be carried out in accordance with the programme (2.5).

The change from one running condition to another should be accomplished within 15 seconds. If not, it must be reported in the test report.

2.4.7. Data will be recorded during the last five minutes of the sub-cycles included in the basic 10 hours cycle, with the exception of sub-cycle 5.

2.4.8. No interruptions are permitted during any of the sub-cycles, but the engine may be switched off on completion of any sub-cycle.

At least 5 times during each 100 hour period, the engine will be shut down for a minimum of 8 hours.

The engine must be warmed up prior to resumption of test.

SECTION 2-5 - PROGRAM OF 10 HOUR CYCLE

Sub-cycle	% Rated Speed	% Load	Duration in hours
1	IDLE (1)	0	½
2	100	100	2
3	governed speed (2)	0	½
4	75	100	1
5	IDLE (1) ——— 100 (3)	0 ——— 100 (4 min / 6 min)	2
6	60	100	½
7	IDLE (1)	0	½
8	governed speed (4)	70 (4)	½
9	Max torque speed	100	2
10	60	50 (5)	½
		Total	10

NOTES :

(1) Deviation from the regulated outlet coolant temperature (96°C ± 3°C) is permitted

(2) The speed shall be that attained with the engine at full throttle and with minimum load (residual brake load)

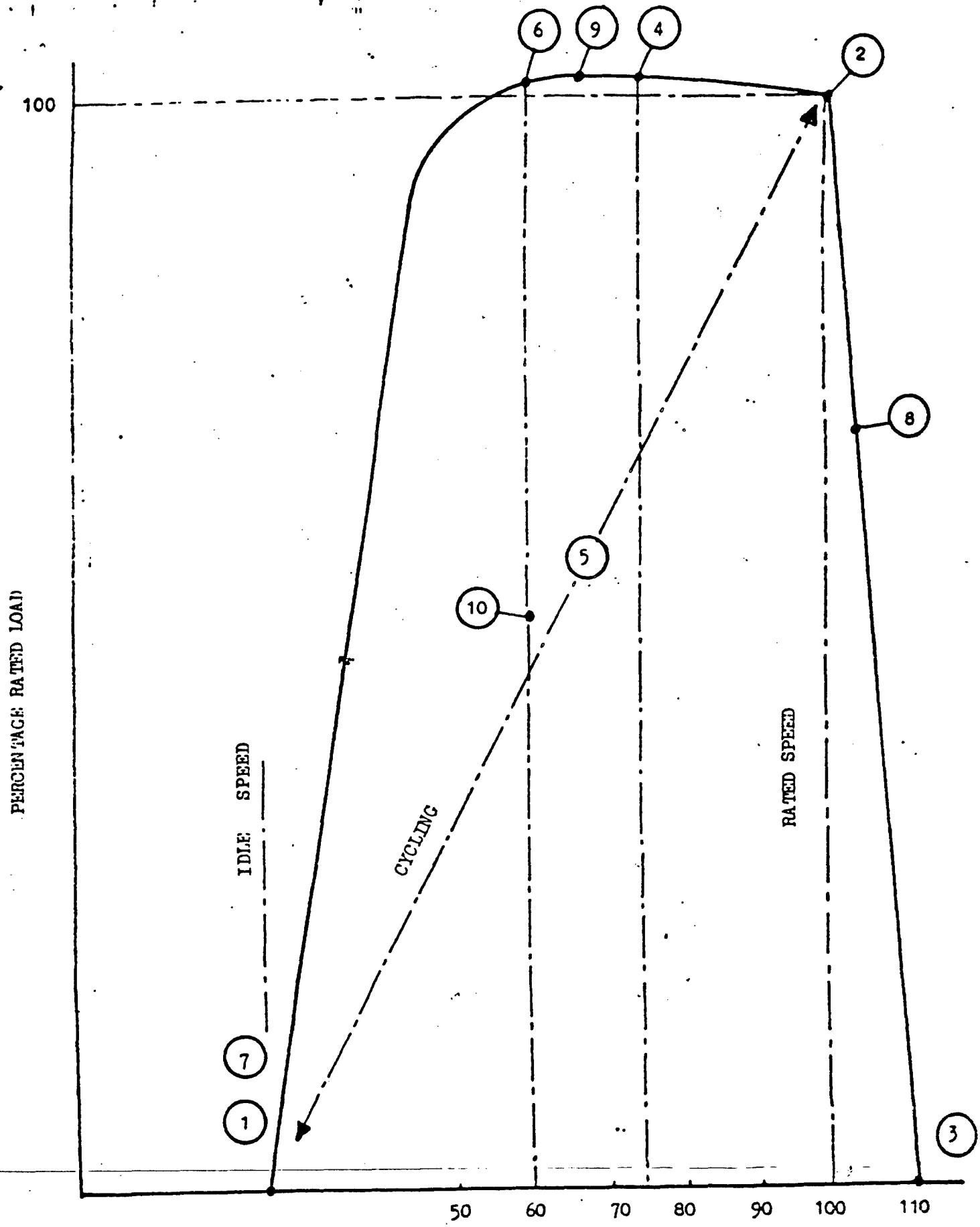
When the engine is not fitted with a governor, the throttle will be adjusted to attain 110 % of the rated speed

(3) The moving of the command is shorter than 3 seconds

(4) The speed shall be the steady speed of the engine at full throttle and 70 % load.

When the engine is not fitted with a governor the speed will be 103 % of the rated speed

(5) Part loads (70 and 50 %) shall be taken from the initial performance test.



GRAPHICAL PRESENTATION OF 10 HOUR CYCLE

SECTION 2-6 - DETAILS OF REQUIRED PRODUCTION AUXILIARY EQUIPMENT

Inlet system	
Inlet manifold.....	Yes
Air filter..... }	Optional
Inlet silencer..... }	
Blowby gas recirculation }	
intake..... }	
Exhaust system	
Manifold.....	Yes
Piping..... }	Test bench equipment
Silencer..... }	
Exhaust pipes..... }	
Fuel feed pump.....	Yes
Carburettor.....	Yes (details of adjustment will be specified)
Ignition system	
Distributor.....	Yes
Spark-plugs.....	Yes
Coils.....	Yes
Suppressor.....	Yes
Fuel injection equipment	
Prefilter..... }	Yes or test bench equipment
Filter..... }	
Pump.....	Yes
High-pressure pipes.....	Yes
Injector.....	Yes
Regulator.....	Yes

Liquid cooling equipment	
Radiator..... }	No
Fan..... }	
Water pump.....	Yes
Thermostat.....	Yes
Air cooling equipment	
Streamlining.....	Yes
Blower.....	Yes
Temperature regulating device.....	Yes
Electrical equipment.....	If necessary
Supercharging equipment	
Compressor driven directly or indirectly by the engine and/or exhaust gas.....	Yes
Charge cooler.....	Yes
Cooling pump or fan..... (engine driven)	Yes
Device for regulating flow of cooling fluid.....	Yes

SECTION 2-7 - INFORMATION TO BE INCLUDED IN TEST REPORT

A complete report covering all the tests, servicing, maintenance, rectification of faults and the condition of the engine at the strip examination including the measurements of the principal wearing arts will be compiled.

The report will also include the following.

1. A statement of the build standard of the engine, with drawings and a parts list

2. Photographs of the engine from four different views

3. Photographs of the test installation at least four different views

4. A list of equipment fitted to the engine

5. Sample test sheets and a summary with a list of faults and the remedial action taken.
Full load performance data will be shown in the format indicated.
A list of failures and corrective actions to overcome them.

6. An engine condition report at end of test with photographs of the condition of major parts such as pistons, bearings, valves, camshafts, crankshafts, cylinder bores together with any other components of interest.

7. A trend chart of oil consumption and blow-by during the endurance tests.

8. Analysis of new and used lubricating oil, the latter to be taken at approximately 100 hours intervals.

9. Fuel analysis

10. Any other relevant data.

MOTEUR / ENGINE type _____ n° _____

LIEU - PLACE _____

DATE _____

PERFORMANCES A PLEINE CHARGE / FULL - LOAD PERFORMANCES — init. / fin.

REFERENCE _____

COMBUSTIBLE / FUEL _____

MASSE VOLUMIQUE (15°C) / VOLUME MASS _____ kg/dm³

HUILE / OIL _____

GRADE _____

FREIN / BRAKE type _____

AMBIANCE AMBIENT	t0	°C								
	p0	m bar								
PERFORMANCE	n	tr/min r.p.m								
	M	mdan								
	P	kw								
	p.m.e m.e.p	bar								
COMBUSTIBLE FUEL	Cs/bsfc	g/kwh								
	Qc	mm/c								
	qm	kg/h								
	tf	°C								
HUILE OIL	th	°C								
	ph	bar								
EAU WATER	te	°C								
	ts	°C								
ADMISSION INLET	t1	°C								
	p0-p1	m bar								
	t2	°C								
	p2	bar								
	t2'	°C								
	p2-p2'	m bar								
	qa	kg/s								
ECHAPPEMENT EXHAUST	t3	°C								
	p3	bar								
	t4	°C								
	p4-p0	m bar								
	fumée smoke	Bosch								
soufflage carter Blow by		l/min								

SYMBOL DEFINITIONS

ti : température
pi : pressure
of

air or gas	i = 0	ambient
	= 1	after air filter
	= 2	after compressor
	= 2'	after charge cooler
	= 3	turbine inlet
	= 4	after turbine
fuel	i = f	
oil	i = h	
water	i = e	inlet engine
	= s	outlet engine

q : mass flow — i = m fuel per hour
= a air per second

qc : volumetric flow injected per cycle and per cylinder

bsfc : brake specific fuel consomption

bmep : brake mean effective pressure

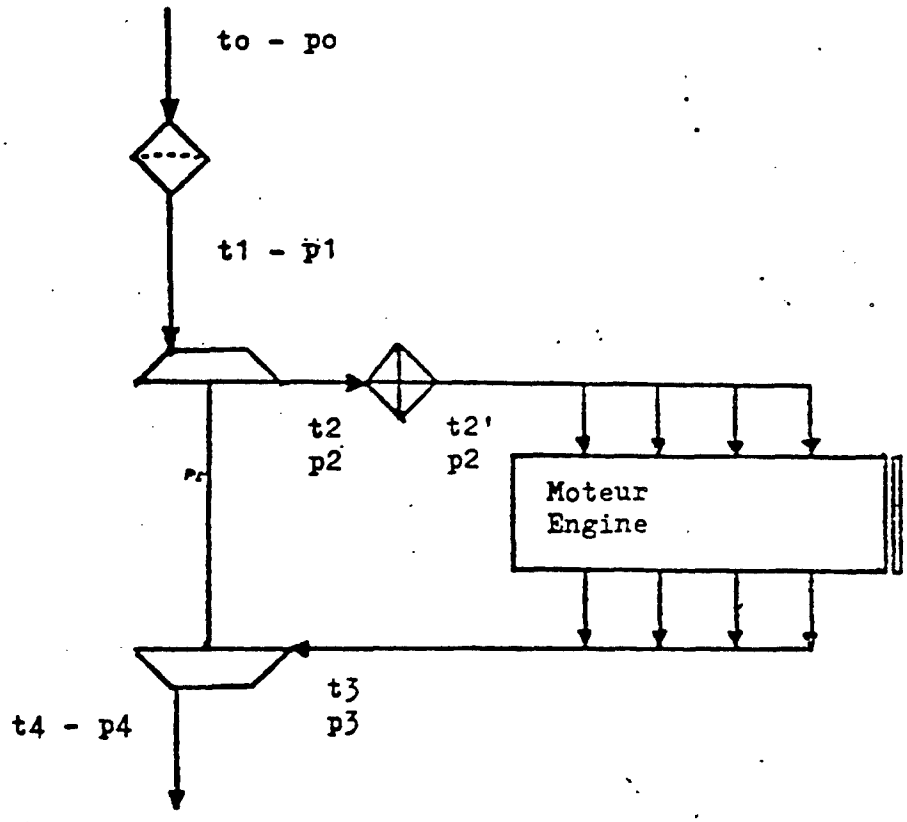
n : rotation speed (engine output shaft)

M : torque — idem

p : power — idem

- SCHEMA DE PRINCIPE DE MOTEUR DIESEL ET A ALLUMAGE COMMANDE

- SCHEMATIC DIAGRAM DIESEL AND SPARK IGNITION ENGINE



APPENDIX C

SAMPLE TEST SHEETS

57, 57, 73 FRF

U.S. ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA — SERIAL NUMBER: 176482 — 09/04/86 — 06:27

NEW ENGINE
SERIAL NUMBER 176482
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME
SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

PERFORMANCE TEST
100% LOAD.
FRDF
7 Sched
(11)

VOID ZEROPOINT / 100% PERFORMANCE TEST / VOID

				1	2	3	4	5	6	7	8	9	10		
131	DATE	MM:DD	8/29	9/03	9/03	9/03	9/03	9/03	9/03	9/03	9/03	9/03	MM/DD	131
130	TIME	HH:MM	8:05	6:34	8:10	8:22	8:37	9:05	9:22	9:53	10:19	13:18	HH:MM	130
113	RPM	RPM	0	0	1400	1602	1796	2000	2200	2400	2599	1401	RPM	113
120	TORQUE	LB/HR	-6	-2	383	407	431	429	410	399	371	373	LB-FT	120
143	BRAKE HORSE POWER	BHP	0	0	102	124	147	163	171	182	183	99	BHP	143
142	FUEL CONSUMPTION	LB/HR	0.0	1.5	43.3	52.5	60.5	69.1	76.9	82.1	88.9	40.4	LB/HR	142
145	BSFC	LB/HP-HR	0.000	0.000	0.424	0.422	0.410	0.422	0.447	0.450	0.484	0.406	BSFC	145
144	BMEP	BMEP	0.0	0.0	123.9	131.7	139.4	138.8	132.6	129.1	120.0	120.7	BMEP	144
	CRITICAL POINTS													
003	AIR AFT.CLEAN.	DEG F	61	76	75	76	76	78	79	82	83	92	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	0.14	1.06	-2.08	-2.74	-3.63	-4.57	-5.68	-6.99	-8.25	-2.28	H2O	082
090	AIR AFT.TURBO	HG.	-0.07	-0.02	9.24	12.39	16.56	20.45	24.19	27.31	29.99	8.21	Hs	090
085	BLOW BY,CRANKCASE	H2O	-1.91	-1.99	-0.44	-0.18	0.33	0.53	1.17	1.13	1.15	-0.56	H2O	085
103	OIL,ENGINE GALLERY	PSI	-1.1	-1.1	34.3	38.4	41.1	44.3	46.0	46.5	47.0	34.2	PSI	103
007	OIL,ENGINE GALLERY	DEG F	63	76	217	221	224	225	227	229	231	215	DEG F	007
006	OIL,SUMP	DEG F	62	76	228	231	234	237	239	242	245	224	DEG F	006
008	OIL,TURBO OUT	DEG F	62	74	226	231	235	238	240	244	247	223	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	89	102	111	113	115	117	117	121	118	119	DEG F	011
108	FUEL,AFT.FILTERS	PSI	-2.9	-1.1	29.6	21.4	8.6	7.7	9.2	15.6	18.8	18.5	PSI	108
015	COOLANT,ENG.OUT	DEG F	64	77	194	196	197	195	195	195	195	195	DEG F	015
069	EXH.AFT.TURBO	DEG F	60	78	938	965	976	968	968	977	985	941	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	-0.18	0.32	1.43	2.35	3.72	5.39	7.64	10.01	12.58	2.04	H2O	086
001	AIR,AMBIENT	DEG F	65	76	76	76	76	79	81	84	85	91	DEG F	001
002	AIR,B4 CLEANER	DEG F	64	74	76	75	76	79	80	84	84	91	DEG F	002
003	AIR,AFT.CLEANER	DEG F	61	76	75	76	76	78	79	82	83	92	DEG F	003
004	AIR,AFT.TURBO	DEG F	62	78	144	164	188	211	232	256	275	158	DEG F	004
006	OIL,ENG.SUMP	DEG F	62	76	228	231	234	237	239	242	245	224	DEG F	006
007	OIL,ENG.GALLERY	DEG F	63	76	217	221	224	225	227	229	231	215	DEG F	007
008	OIL,TURBO OUT	DEG F	62	74	226	231	235	238	240	244	247	223	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	61	75	82	82	81	80	82	88	85	86	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	89	102	111	113	115	117	117	121	118	119	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	86	76	96	101	124	130	144	145	144	106	DEG F	012

U.S. ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA — SERIAL NUMBER: 176482 — 09/04/86 — 0612?

			1	2	3	4	5	6	7	8	9	10	11	
015	COOLANT.ENG.INLET	DEG F	64	77	194	196	197	195	195	195	195	195	DEG F	015
016	COOLANT.ENG.OUTLET	DEG F	64	79	203	205	204	204	204	204	204	203	DEG F	016
018	WATER.TOWER INLET	DEG F	67	72	75	74	74	74	74	74	75	77	DEG F	018
019	WATER.TOWER OUTLET	DEG F	54	67	198	197	198	197	198	197	197	195	DEG F	019
020	DYNO.WATER OUTLET	DEG F	70	76	90	94	103	108	112	114	113	97	DEG F	020
017	REF.BATH	DEG F	193	200	199	199	199	199	199	199	200	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	199	200	199	199	199	199	199	199	199	199	ENTRY 3	141
061	EXH.PORT #1	DEG F	65	80	898	926	952	958	974	995	1005	898	DEG F	061
062	EXH.PORT #2	DEG F	65	80	979	1010	1044	1049	1064	1087	1102	978	DEG F	062
063	EXH.PORT #3	DEG F	65	80	923	959	991	1009	1020	1045	1065	923	DEG F	063
064	EXH.PORT #4	DEG F	65	80	920	956	978	992	1014	1039	1072	919	DEG F	064
065	EXH.PORT #5	DEG F	65	81	914	965	988	996	1011	1037	1062	921	DEG F	065
066	EXH.PORT #6	DEG F	64	80	822	869	888	895	907	931	952	835	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	64	80	1010	1042	1076	1086	1098	1122	1138	1009	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	84	100	930	985	1021	1038	1059	1084	1115	934	DEG F	068
069	EXH.AFTER TURBO	DEG F	60	78	938	965	976	968	968	977	985	941	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.64	30.98	29.93	29.93	29.93	29.93	29.93	29.93	29.93	29.93	Hg	136
081	AIR.CELL DEPRESSION	H20	-0.02	-0.01	-1.24	-1.24	-1.24	-1.24	-1.23	-1.24	-1.23	-1.22	H20	081
082	AIR.B4 TURBO TOTAL	H20	0.14	1.06	-2.08	-2.74	-3.63	-4.57	-5.68	-6.99	-8.25	-2.28	H20	082
083	AIR.B4 TURBO STATIC	H20	0.04	0.00	-4.73	-6.39	-8.67	-11.78	-15.50	-19.19	-23.31	-4.31	H20	083
090	AIR.AFT.TURBO	HG.	-0.07	-0.02	9.24	12.39	16.56	20.45	24.19	27.31	29.99	8.21	Hg	090
085	BLOW BY.CRANKCASE	H20	-1.91	-1.99	-0.44	-0.18	0.33	0.53	1.17	1.13	1.15	-0.56	H20	085
084	BLOW BY.CAL.ORIFICE	H20	-0.29	-0.06	0.67	0.90	1.37	1.60	2.13	2.10	2.11	0.81	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	-0.25	-0.23	6.58	9.03	12.29	15.65	19.57	23.57	27.64	6.12	Hg	091
086	EXH.AFT.TURBO STATIC	H20	-0.18	0.32	1.43	2.35	3.72	5.39	7.64	10.01	12.58	2.04	H20	086
108	FUEL.AFT.FILTERS	PSI	-2.9	-1.1	29.6	21.4	8.6	7.7	9.2	15.6	18.8	18.5	PSI	108
101	FUELSPILL INJ & PUMP	PSI	0.95	1.06	2.02	1.89	1.55	2.21	1.65	1.75	1.84	1.90	PSI	101
104	COOLANT.ENG.INLET	PSI	12.0	11.5	11.2	11.1	10.9	10.6	10.4	10.1	9.8	11.0	PSI	104
105	COOLANT.ENG.OUTLET	PSI	14.8	14.8	16.2	16.6	17.0	17.4	17.9	18.5	19.1	16.4	PSI	105
106	WATER.TOWER INLET	PSI	67.2	61.8	66.9	66.8	66.8	66.9	66.8	66.7	66.9	67.1	PSI	106
107	WATER.DYNO INLET	PSI	13.8	14.0	15.3	15.4	15.2	15.5	15.3	15.5	15.1	15.8	PSI	107
103	OIL.ENG.GALLERY	PSI	-1.1	-1.1	34.3	38.4	41.1	44.3	46.0	46.5	47.0	34.2	PSI	103

U.S. ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 09/04/86 06:32

NEW ENGINE
SERIAL NUMBER 176482
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME
SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

PERFORMANCE TEST
IN % OF LOAD
1400 & 1600 RPM.'S
FRF

			1400	85%	70%	50%	25%	1600 100%	85%	70%	50%	25%	1400		
				11	12	13	14	15	16	17	18	19	20		
131	DATE	MM:DD		9/03	9/03	9/03	9/03	9/03	9/03	9/03	9/03	9/03	9/03	MM/DD	131
130	TIME	HH:MM		13:35	13:43	13:59	14:24	14:38	15:08	15:21	15:37	15:46	16:11	HH:MM	130
113	RPM	RPM		1399	1399	1399	1402	1595	1598	1597	1600	1597	1599	RPM	113
120	TORQUE	LB/HR		321	266	188	96	395	348	287	200	101	413	LB-FT	120
143	BRAKE HORSE POWER	BHP		85	70	50	25	119	105	87	60	30	141	BHP	143
142	FUEL CONSUMPTION	LB/HR		33.6	29.3	23.1	13.5	50.3	44.1	35.4	27.5	15.8	58.9	LB/HR	142
145	BSFC	LB/HP-HR		0.392	0.413	0.461	0.526	0.422	0.416	0.427	0.451	0.514	0.415	BSFC	145
144	BMEP	BMEP		103.8	86.0	60.8	31.0	126.8	112.6	92.8	64.7	32.6	133.6	BMEP	144
	CRITICAL POINTS														
003	AIR AFT.CLEAN.	DEG F		93	92	93	94	94	93	93	93	93	93	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O		-2.19	-2.10	-2.06	-1.99	-2.77	-2.57	-2.50	-2.32	-2.17	-3.46	H2O	082
090	AIR AFT.TURBO	HG.		6.42	4.71	2.46	0.81	11.09	8.84	6.49	3.45	1.13	14.80	Hg	090
085	BLOW BY,CRANKCASE	H2O		-0.87	-1.58	-1.98	-2.30	-0.20	-0.62	-0.86	-1.32	-2.02	0.09	H2O	085
103	OIL,ENGINE GALLERY	PSI		34.2	34.7	36.0	36.8	36.9	37.4	37.9	39.1	41.1	40.0	PSI	103
007	OIL,ENGINE GALLERY	DEG F		215	214	211	210	219	218	217	215	211	221	DEG F	007
006	OIL,SUMP	DEG F		224	223	219	215	230	229	227	223	217	233	DEG F	006
008	OIL,TURBO OUT	DEG F		221	218	213	210	229	227	223	218	211	233	DEG F	008
011	FUEL,AFT.FILTERS	DEG F		120	120	121	121	118	117	117	116	117	120	DEG F	011
108	FUEL,AFT.FILTERS	PSI		14.3	16.2	26.0	19.0	20.0	22.5	19.1	24.7	27.5	11.3	PSI	108
015	COOLANT,ENG.OUT	DEG F		194	194	197	201	196	193	193	197	196	191	DEG F	015
069	EXH.AFT.TURBO	DEG F		856	759	614	440	973	900	806	652	474	990	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O		1.65	1.33	0.86	0.45	3.30	2.83	2.05	1.39	0.91	5.13	H2O	086
001	AIR,AMBIENT	DEG F		92	92	92	93	93	93	93	91	92	92	DEG F	001
002	AIR,B4 CLEANER	DEG F		92	92	93	94	94	93	94	92	94	93	DEG F	002
003	AIR,AFT.CLEANER	DEG F		93	92	93	94	94	93	93	93	93	93	DEG F	003
004	AIR,AFT.TURBO	DEG F		148	135	122	112	178	163	149	130	117	199	DEG F	004
006	OIL,ENG.SUMP	DEG F		224	223	219	215	230	229	227	223	217	233	DEG F	006
007	OIL,ENG.GALLERY	DEG F		215	214	211	210	219	218	217	215	211	221	DEG F	007
008	OIL,TURBO OUT	DEG F		221	218	213	210	229	227	223	218	211	233	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F		87	88	88	88	85	83	84	84	84	84	DEG F	010
011	FUEL,AFT.FILTERS	DEG F		120	120	121	121	118	117	117	116	117	120	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF		108	108	106	106	111	108	106	105	105	130	DEG F	012

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA — SERIAL NUMBER: 176482 — 09/04/86 — 06:34

			11	12	13	14	15	16	17	18	19	20		
015	COOLANT,ENG.INLET	DEG F	194	194	197	201	196	193	193	197	196	191	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	203	201	201	204	203	202	201	202	200	200	DEG F	016
018	WATER,TOWER INLET	DEG F	77	77	78	80	77	78	76	78	79	78	DEG F	018
019	WATER,TOWER OUTLET	DEG F	197	195	197	199	198	197	196	197	196	193	DEG F	019
020	DYNO,WATER OUTLET	DEG F	95	91	89	85	97	99	96	94	89	106	DEG F	020
017	REF.BATH	DEG F	200	200	199	199	199	200	199	199	199	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	199	199	199	199	199	199	199	199	199	199	ENTRY 3	141
061	EXH.PORT #1	DEG F	820	733	607	460	936	866	783	648	489	962	DEG F	061
062	EXH.PORT #2	DEG F	886	790	644	470	1018	945	847	685	497	1055	DEG F	062
063	EXH.PORT #3	DEG F	836	743	611	445	968	892	805	652	476	1003	DEG F	063
064	EXH.PORT #4	DEG F	835	742	606	437	960	889	797	651	470	992	DEG F	064
065	EXH.PORT #5	DEG F	841	741	600	423	972	889	793	649	468	1004	DEG F	065
066	EXH.PORT #6	DEG F	768	685	558	403	874	793	717	596	431	900	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	918	814	658	474	1053	974	875	703	506	1088	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	849	754	610	433	987	908	813	662	483	1034	DEG F	068
069	EXH.AFTER TURBO	DEG F	856	759	614	440	973	900	806	652	474	990	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.93	29.93	29.93	29.93	29.93	29.93	29.93	29.93	29.93	29.93	Hg	136
081	AIR,CELL DEPRESSION	H20	-1.23	-1.24	-1.23	-1.23	-1.23	-1.22	-1.25	-1.24	-1.23	-1.24	H20	081
082	AIR,B4 TURBO TOTAL	H20	-2.19	-2.10	-2.06	-1.99	-2.77	-2.57	-2.50	-2.32	-2.17	-3.46	H20	082
083	AIR,B4 TURBO STATIC	H20	-4.42	-4.24	-3.94	-3.74	-6.13	-5.82	-5.44	-4.92	-4.52	-8.30	H20	083
090	AIR,AFT.TURBO	HG.	6.42	4.71	2.46	0.81	11.09	8.84	6.49	3.45	1.13	14.80	Hg	090
085	BLOW BY,CRANKCASE	H20	-0.87	-1.58	-1.98	-2.30	-0.20	-0.62	-0.86	-1.32	-2.02	0.09	H20	085
084	BLOW BY,CAL.ORIFICE	H20	0.52	0.22	-0.09	-0.35	1.09	0.77	0.51	0.10	-0.14	1.34	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	5.26	4.53	3.38	2.47	8.34	7.19	6.07	4.55	3.27	11.26	Hg	091
086	EXH.AFT.TURBO STATIC	H20	1.65	1.33	0.86	0.45	3.30	2.83	2.05	1.39	0.91	5.13	H20	086
108	FUEL,AFT.FILTERS	PSI	14.3	16.2	26.0	19.0	20.0	22.5	19.1	24.7	27.5	11.3	PSI	108
101	FUELSPILL INJ & PUMP	PSI	1.90	1.87	2.10	2.05	2.02	2.27	2.13	2.03	2.29	1.80	PSI	101
104	COOLANT,ENG.INLET	PSI	10.9	10.8	10.9	10.9	10.8	10.7	10.8	10.7	10.8	10.5	PSI	104
105	COOLANT,ENG.OUTLET	PSI	16.4	16.3	16.4	16.4	16.7	16.7	16.8	16.8	16.8	17.1	PSI	105
106	WATER,TOWER INLET	PSI	67.0	67.1	67.0	67.1	67.0	67.1	67.0	67.0	67.1	66.9	PSI	106
107	WATER,DYNO INLET	PSI	15.9	15.8	15.7	15.8	15.8	15.8	15.8	15.7	15.7	15.7	PSI	107
103	OIL,ENG.GALLERY	PSI	34.2	34.7	36.0	36.8	36.9	37.4	37.9	39.1	41.1	40.0	PSI	103

U.S. ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA — SERIAL NUMBER: 176482 — 09/04/86 — 06:35

FRF
PERFORMANCE TEST
IN % OF LOAD

1800 R.P.M.

Y. Schick

(13)

1800 R.P.M

			85%	70%	50%	25%		
			21	22	23	24		
131	DATE	MM:DD	9/03	9/03	9/03	9/03	MM/DD	131
130	TIME	HH:MM	16:31	16:46	17:00	17:15	HH:MM	130
113	RPM	RPM	1798	1798	1800	1799	RPM	113
120	TORQUE	LB/HR	363	302	215	106	LB-FT	120
143	BRAKE HORSE POWER	BHP	124	103	73	36	BHP	143
142	FUEL CONSUMPTION	LB/HR	52.2	43.9	33.7	19.5	LB/HR	142
145	BSFC	LB/HP-HR	0.420	0.424	0.457	0.537	BSFC	145
144	BMEP	BMEP	117.4	97.7	69.5	34.3	BMEP	144
	CRITICAL POINTS							
003	AIR AFT.CLEAN.	DEG F	92	91	91	91	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	-3.23	-2.99	-2.70	-2.53	H2O	082
090	AIR AFT.TURBO	HG.	11.87	8.82	4.86	1.68	Hg	090
085	BLOW BY,CRANKCASE	H2O	-0.16	-0.61	-0.86	-1.54	H2O	085
103	OIL,ENGINE GALLERY	PSI	40.6	41.3	42.8	44.4	PSI	103
007	OIL,ENGINE GALLERY	DEG F	220	219	216	213	DEG F	007
006	OIL,SUMP	DEG F	231	229	225	219	DEG F	006
008	OIL,TURBO OUT	DEG F	230	227	221	214	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	122	122	122	122	DEG F	011
108	FUEL,AFT.FILTERS	PSI	10.7	12.7	12.5	12.2	PSI	108
015	COOLANT,ENG.OUT	DEG F	193	196	196	198	DEG F	015
069	EXH.AFT.TURBO	DEG F	922	835	693	509	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	4.34	3.39	2.40	1.45	H2O	086
001	AIR,AMBIENT	DEG F	92	91	91	90	DEG F	001
002	AIR,B4 CLEANER	DEG F	92	91	91	91	DEG F	002
003	AIR,AFT.CLEANER	DEG F	92	91	91	91	DEG F	003
004	AIR,AFT.TURBO	DEG F	181	163	139	120	DEG F	004
006	OIL,ENG.SUMP	DEG F	231	229	225	219	DEG F	006
007	OIL,ENG.GALLERY	DEG F	220	219	216	213	DEG F	007
008	OIL,TURBO OUT	DEG F	230	227	221	214	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	84	83	84	84	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	122	122	122	122	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	138	133	131	130	DEG F	012

U.S. ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA — SERIAL NUMBER: 176482 — 09/04/86 — 06:35

21 22 23 24

(13)

015	COOLANT.ENG.INLET	DEG F	193	196	196	198	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	202	202	201	201	DEG F	016
018	WATER.TOWER INLET	DEG F	78	78	79	79	DEG F	018
019	WATER.TOWER OUTLET	DEG F	197	196	197	197	DEG F	019
020	DYNO.WATER OUTLET	DEG F	105	102	97	92	DEG F	020
017	REF.BATH	DEG F	198	199	198	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	199	199	199	199	ENTRY 3	141
061	EXH.PORT #1	DEG F	893	823	687	514	DEG F	061
062	EXH.PORT #2	DEG F	978	886	733	533	DEG F	062
063	EXH.PORT #3	DEG F	936	846	699	513	DEG F	063
064	EXH.PORT #4	DEG F	926	821	693	516	DEG F	064
065	EXH.PORT #5	DEG F	922	841	697	504	DEG F	065
066	EXH.PORT #6	DEG F	821	757	641	470	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	1012	918	753	542	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	955	856	710	519	DEG F	068
069	EXH.AFTER TURBO	DEG F	922	835	693	509	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.93	29.93	29.93	29.93	Hg	136
081	AIR.CELL DEPRESSION	H2O	-1.24	-1.24	-1.24	-1.25	H2O	081
082	AIR.B4 TURBO TOTAL	H2O	-3.23	-2.99	-2.70	-2.53	H2O	082
083	AIR.B4 TURBO STATIC	H2O	-7.56	-6.87	-6.12	-5.44	H2O	083
090	AIR.AFT.TURBO	HG.	11.87	8.82	4.86	1.68	Hg	090
085	BLOW BY.CRANKCASE	H2O	-0.16	-0.61	-0.86	-1.54	H2O	085
084	BLOW BY.CAL.ORIFICE	H2O	1.11	0.80	0.46	-0.02	H2O	084
091	EXH.B4 TURBO(COMBINED)	HG.	9.83	8.34	6.15	4.26	Hg	091
086	EXH.AFT.TURBO STATIC	H2O	4.34	3.39	2.40	1.45	H2O	086
108	FUEL.AFT.FILTERS	PSI	10.7	12.7	12.5	12.2	PSI	108
101	FUELSPILL INJ & PUMP	PSI	2.04	2.25	2.18	2.01	PSI	101
104	COOLANT.ENG.INLET	PSI	10.5	10.6	10.6	10.6	PSI	104
105	COOLANT.ENG.OUTLET	PSI	17.1	17.2	17.0	17.1	PSI	105
106	WATER.TOWER INLET	PSI	66.8	66.9	66.9	67.1	PSI	106
107	WATER.DYNO INLET	PSI	15.8	15.7	15.6	15.5	PSI	107
103	OIL.ENG.GALLERY	PSI	40.6	41.3	42.8	44.4	PSI	103

DF2 57 H_2O 50 surfactant 74.3 50% LOAD PERFORMANCE

S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482____ 11/18/86 12:48

NEW ENGINE
SERIAL NUMBER 176482____
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME

SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

50% TEST IN CELL

FRF LOW H_2O

TEST HR = 400

ENG HR = 500

ALL TESTS COMPLETE 11/18/86

1986

			188	189	190	191	192	193	194		
131	DATE	MM:DD	11/18	11/18	11/18	11/18	11/18	11/18	11/18	MM/DD	131
130	TIME	HH:MM	10:10	10:48	11:05	11:42	11:54	12:11	12:22	HH:MM	130
113	RPM	RPM	1401	1600	1801	2000	2200	2399	2600	RPM	113
120	TORQUE	LB/HR	191	204	215	215	205	200	185	LB-FT	120
143	BRAKE HORSE POWER	BHP	50	62	73	81	85	91	91	BHP	143
142	FUEL CONSUMPTION	LB/HR	23.2	28.1	33.2	7.8	41.5	46.4	50.6	LB/HR	142
145	BSFC	LB/HP-HR	0.455	0.452	0.450	0.095	0.483	0.507	0.552	BSFC	145
144	BMEP	BMEP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	BMEP	144
	CRITICAL POINTS										
003	AIR AFT.CLEAN.	DEG F	70	72	71	71	70	71	70	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	-2.43	-2.43	-2.76	-3.11	-3.51	-4.45	-5.08	H2O	082
090	AIR AFT.TURBO	HG.	1.30	2.47	4.04	5.96	7.68	10.19	12.43	Hg	090
085	BLOW BY,CRANKCASE	H2O	-1.77	-1.82	-1.46	-1.36	-1.03	-0.78	-0.86	H2O	085
103	OIL,ENGINE GALLERY	PSI	39.4	43.5	45.4	47.1	48.3	48.9	49.1	PSI	103
007	OIL,ENGINE GALLERY	DEG F	212	214	217	218	220	222	223	DEG F	007
006	OIL,SUMP	DEG F	219	222	224	227	229	231	233	DEG F	006
008	OIL,TURBO OUT	DEG F	212	215	219	223	225	228	231	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	117	118	121	122	121	121	121	DEG F	011
108	FUEL,AFT.FILTERS	PSI	30.8	30.5	15.2	13.2	12.7	16.7	16.9	PSI	108
015	COOLANT,ENG.OUT	DEG F	199	199	199	199	199	199	197	DEG F	015
069	EXH.AFT.TURBO	DEG F	594	628	666	698	710	733	751	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	0.69	1.29	2.21	3.33	4.74	6.08	7.50	H2O	086
001	AIR,AMBIENT	DEG F	71	74	72	74	72	73	75	DEG F	001
002	AIR,B4 CLEANER	DEG F	70	72	71	72	71	72	71	DEG F	002
003	AIR,AFT.CLEANER	DEG F	70	72	71	71	70	71	70	DEG F	003
004	AIR,AFT.TURBO	DEG F	101	111	122	136	148	166	182	DEG F	004
006	OIL,ENG.SUMP	DEG F	219	222	224	227	229	231	233	DEG F	006
007	OIL,ENG.GALLERY	DEG F	212	214	217	218	220	222	223	DEG F	007
008	OIL,TURBO OUT	DEG F	212	215	219	223	225	228	231	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	85	87	85	85	84	85	87	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	117	118	121	122	121	121	121	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	100	104	123	136	142	140	138	DEG F	012

FRF 50%

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482____ 11/18/86 12:56

50% FRP (Low H2O)

015	COOLANT,ENG.INLET	DEG F	199	199	199	199	199	199	197	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	204	203	204	204	204	204	203	DEG F	016
018	WATER,TOWER INLET	DEG F	51	51	50	49	49	49	49	DEG F	018
019	WATER,TOWER OUTLET	DEG F	7289	7288	7289	7289	7289	7287	7289	DEG F	019
020	DYNO,WATER OUTLET	DEG F	53	56	57	59	60	60	61	DEG F	020
017	REF.BATH	DEG F	194	194	197	196	195	196	189	DEG F	017
141	REF.BATH (KEY IN)	DEG F	0	0	0	0	0	0	0	ENTRY 3	141
061	EXH.PORT #1	DEG F	588	620	655	699	706	744	775	DEG F	061
062	EXH.PORT #2	DEG F	623	663	708	749	764	795	825	DEG F	062
063	EXH.PORT #3	DEG F	598	633	672	706	726	765	795	DEG F	063
064	EXH.PORT #4	DEG F	597	640	675	714	740	781	814	DEG F	064
065	EXH.PORT #5	DEG F	576	618	671	705	727	766	800	DEG F	065
066	EXH.PORT #6	DEG F	543	579	622	633	656	681	712	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	656	698	744	784	802	835	867	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	589	640	688	730	760	799	835	DEG F	068
069	EXH.AFTER TURBO	DEG F	594	628	666	698	710	733	751	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.98	29.98	29.98	29.98	29.98	29.98	29.98	Hg	136
081	AIR,CELL DEPRESSION	H20	-1.13	-1.14	-1.11	-1.14	-1.14	-1.12	-1.14	H20	081
082	AIR,B4 TURBO TOTAL	H20	-2.43	-2.43	-2.76	-3.11	-3.51	-4.45	-5.08	H20	082
083	AIR,B4 TURBO STATIC	H20	-3.93	-4.96	-6.28	-7.97	-9.99	-12.50	-15.32	H20	083
090	AIR,AFT.TURBO	HG.	1.30	2.47	4.04	5.96	7.68	10.19	12.43	Hg	090
085	BLOW BY,CRANKCASE	H20	-1.77	-1.82	-1.46	-1.36	-1.03	-0.78	-0.86	H20	085
084	BLOW BY,CAL.ORIFICE	H20	0.00	0.01	0.22	0.26	0.55	0.71	0.56	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	3.61	4.84	6.51	8.69	10.94	13.81	16.62	Hg	091
086	EXH.AFT.TURBO STATIC	H20	0.69	1.29	2.21	3.33	4.74	6.08	7.50	H20	086
108	FUEL,AFT.FILTERS	PSI	30.8	30.5	15.2	13.2	12.7	16.7	18.9	PSI	108
101	FUELSPILL INJ & PUMP	PSI	1.66	1.65	0.97	1.09	1.11	0.99	1.09	PSI	101
104	COOLANT,ENG.INLET	PSI	10.3	10.1	9.8	9.7	9.5	9.3	9.0	PSI	104
105	COOLANT,ENG.OUTLET	PSI	14.8	15.1	15.5	15.9	16.3	16.7	17.1	PSI	105
106	WATER,TOWER INLET	PSI	68.8	68.8	68.7	68.8	68.8	68.8	68.8	PSI	106
107	WATER,DYNO INLET	PSI	15.1	15.1	14.9	14.8	14.7	14.4	14.6	PSI	107
103	OIL,ENG.GALLERY	PSI	39.4	43.5	45.4	47.1	48.3	48.9	49.1	PSI	103

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA : SERIAL NUMBER: 176482 09/04/86 16:02

(14)

NEW ENGINE
SERIAL NUMBER 176482
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME
SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

PERFORMANCE TEST
PERCENT LOADS
2000, 2200, 2400 R.P.M.'S
ON FRF FUEL

T. Schuh

			ZERO PRINT	2000 85%	70%	50%	25%	2200 85%	70%	50%	25%	2400 85%		
			25	26	27	28	29	30	31	32	33	34		
131	DATE	MM:DD	9/04	9/04	9/04	9/04	9/04	9/04	9/04	9/04	9/04	9/04	MM/DD	131
130	TIME	HH:MM	6:51	8:17	8:36	8:55	9:18	9:45	10:14	10:32	10:52	11:42	HH:MM	130
113	RPM	RPM	0	1998	1999	1998	1999	2200	2200	2199	2200	2399	RPM	113
120	TORQUE	LB/HR	2	365	299	214	107	351	287	205	103	339	LB-FT	120
143	BRAKE HORSE POWER	BHP	0	138	113	81	40	147	120	85	43	154	BHP	143
142	FUEL CONSUMPTION	LB/HR	4.1	59.9	50.3	38.7	23.6	65.4	54.8	41.4	26.4	76.0	LB/HR	142
145	BSFC	LB/HP-HR	0.000	0.434	0.441	0.475	0.579	0.444	0.455	0.481	0.611	0.490	BSFC	145
144	BMEP	BMEP	0.0	118.1	96.7	69.2	34.6	113.5	92.8	66.3	33.3	109.6	BMEP	144
	CRITICAL POINTS													
003	AIR AFT.CLEAN.	DEG F	86	83	83	83	84	84	85	86	87	88	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H20	0.18	-3.97	-3.59	-3.19	-2.83	-4.90	-4.32	-3.73	-3.21	-5.87	H20	082
090	AIR AFT.TURBO	HG.	-0.07	15.47	11.26	6.86	2.57	18.13	13.54	8.09	3.33	20.89	Hg	090
085	BLOW BY,CRANKCASE	H20	-2.00	0.29	0.12	-0.47	-1.23	0.72	0.13	-0.33	-1.13	0.65	H20	085
103	OIL,ENGINE GALLERY	PSI	-0.7	44.5	45.0	45.7	46.9	45.6	46.1	47.0	47.9	46.3	PSI	103
007	OIL,ENGINE GALLERY	DEG F	102	222	222	220	216	225	223	221	217	227	DEG F	007
006	OIL,SUMP	DEG F	95	233	231	228	222	236	233	229	224	238	DEG F	006
008	OIL,TURBO OUT	DEG F	87	232	229	225	217	236	232	227	220	239	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	121	122	124	124	129	124	124	126	127	121	DEG F	011
108	FUEL,AFT.FILTERS	PSI	-0.4	7.7	9.4	7.4	8.3	10.2	9.9	10.7	11.3	15.4	PSI	108
015	COOLANT,ENG.OUT	DEG F	98	194	197	199	200	195	197	197	199	195	DEG F	015
069	EXH.AFT.TURBO	DEG F	94	915	838	723	538	919	850	733	563	930	DEG F	069
086	EXH.AFT.TURBO STAT.	H20	-0.21	6.49	4.97	3.49	2.21	8.71	6.71	4.62	2.85	11.26	H20	086
001	AIR,AMBIENT	DEG F	84	83	84	83	84	85	86	86	86	88	DEG F	001
002	AIR,B4 CLEANER	DEG F	86	82	83	84	84	84	86	86	87	88	DEG F	002
003	AIR,AFT.CLEANER	DEG F	86	83	83	83	84	84	85	86	87	88	DEG F	003
004	AIR,AFT.TURBO	DEG F	85	192	170	144	121	210	189	159	132	233	DEG F	004
006	OIL,ENG.SUMP	DEG F	95	233	231	228	222	236	233	229	224	238	DEG F	006
007	OIL,ENG.GALLERY	DEG F	102	222	222	220	216	225	223	221	217	227	DEG F	007
008	OIL,TURBO OUT	DEG F	87	232	229	225	217	236	232	227	220	239	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	88	85	85	85	85	88	86	87	90	87	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	121	122	124	124	129	124	124	126	127	121	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	91	136	140	138	145	147	150	150	147	146	DEG F	012

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 09/04/86 16:04

			25	26	27	28	29	30	31	32	33	34		
015	COOLANT,ENG.INLET	DEG F	98	194	197	199	200	195	197	197	199	195	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	103	202	204	204	204	203	204	203	203	203	DEG F	016
018	WATER,TOWER INLET	DEG F	72	74	76	75	76	75	75	76	75	76	DEG F	018
019	WATER,TOWER OUTLET	DEG F	72	196	197	198	200	196	198	199	199	197	DEG F	019
020	DYNO,WATER OUTLET	DEG F	76	102	99	96	89	106	100	95	88	107	DEG F	020
017	REF.BATH	DEG F	199	198	198	198	198	198	199	199	198	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	199	200	200	200	200	200	200	200	200	200	ENTRY 3	141
061	EXH.PORT #1	DEG F	105	904	826	711	531	916	838	716	555	936	DEG F	061
062	EXH.PORT #2	DEG F	105	988	898	763	565	997	911	773	586	1018	DEG F	062
063	EXH.PORT #3	DEG F	105	947	854	732	547	952	874	747	582	985	DEG F	063
064	EXH.PORT #4	DEG F	105	936	847	729	543	960	877	751	576	981	DEG F	064
065	EXH.PORT #5	DEG F	105	939	846	733	543	951	874	746	571	978	DEG F	065
066	EXH.PORT #6	DEG F	105	847	764	669	511	859	787	679	517	882	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	102	1021	924	786	576	1026	941	798	607	1056	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	122	969	880	750	552	995	910	773	588	1021	DEG F	068
069	EXH.AFTER TURBO	DEG F	94	915	838	723	538	919	850	733	563	930	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.93	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	Hg	136
081	AIR,CELL DEPRESSION	H20	-0.01	-1.21	-1.22	-1.21	-1.21	-1.21	-1.22	-1.20	-1.21	-1.20	H20	081
082	AIR,B4 TURBO TOTAL	H20	0.18	-3.97	-3.59	-3.19	-2.83	-4.90	-4.32	-3.73	-3.21	-5.87	H20	082
083	AIR,B4 TURBO STATIC	H20	-0.15	-10.19	-9.01	-7.68	-6.50	-12.95	-11.44	-9.28	-7.85	-16.37	H20	083
090	AIR,AFT.TURBO	HG.	-0.07	15.47	11.26	6.86	2.57	18.13	13.54	8.09	3.33	20.89	Hg	090
085	BLOW BY,CRANKCASE	H20	-2.00	0.29	0.12	-0.47	-1.23	0.72	0.13	-0.33	-1.13	0.65	H20	085
084	BLOW BY,CAL.ORIFICE	H20	0.21	1.42	1.26	0.66	0.02	1.77	1.24	0.77	0.16	1.65	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	-0.24	13.18	10.92	8.09	5.53	16.06	13.34	10.01	6.80	19.55	Hg	091
086	EXH.AFT.TURBO STATIC	H20	-0.21	6.49	4.97	3.49	2.21	8.71	6.71	4.62	2.85	11.26	H20	086
108	FUEL,AFT.FILTERS	PSI	-0.4	7.7	9.4	7.4	8.3	10.2	9.9	10.7	11.3	15.4	PSI	108
101	FUELSPILL INJ & PUMP	PSI	1.50	2.26	2.28	2.45	2.64	1.72	2.47	2.74	2.09	1.85	PSI	101
104	COOLANT,ENG.INLET	PSI	11.1	10.2	10.3	10.3	10.3	10.1	10.1	10.1	10.1	9.9	PSI	104
105	COOLANT,ENG.OUTLET	PSI	14.8	17.1	17.2	17.2	17.2	17.8	17.8	17.8	17.8	18.3	PSI	105
106	WATER,TOWER INLET	PSI	61.6	66.9	66.8	66.9	66.9	66.9	66.9	66.8	66.9	66.9	PSI	106
107	WATER,DYNO INLET	PSI	14.1	15.3	15.3	15.2	15.3	15.3	15.4	15.5	15.3	15.4	PSI	107
103	OIL,ENG.GALLERY	PSI	-0.7	44.5	45.0	45.7	46.9	45.6	46.1	47.0	47.9	46.3	PSI	103

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 09/04/86 16:05

PERFORMANCE TEST
PERCENT LOADS
2400, 2600
ALSO. GOVN. SPEED CHECK
ON F.R.F. FUEL

(15)
T. Schmidt

C=43

			2400	70%	50%	25%	2600 85%	70%	50%	25%	GOVN. SPEED CHCK.		
			35	36	37	38	39	40	41	42			
131	DATE	MM:DD	9/04	9/04	9/04	9/04	9/04	9/04	9/04	9/04	MM/DD	131
130	TIME	HH:MM	12:18	12:52	13:24	14:00	14:23	14:45	15:30	15:33	HH:MM	130
113	RPM	RPM	2400	2399	2400	2598	2600	2597	2598	2895	RPM	113
120	TORQUE	LB/HR	279	200	100	317	260	186	95	40	LB-FT	120
143	BRAKE HORSE POWER	BHP	127	91	45	156	128	91	46	22	BHP	143
142	FUEL CONSUMPTION	LB/HR	60.4	46.9	30.4	77.2	65.7	51.2	33.2	28.2	LB/HR	142
145	BSFC	LB/HP-HR	0.473	0.513	0.665	0.492	0.510	0.556	0.706	1.011	BSFC	145
144	BMEP	BMEP	90.2	64.7	32.3	102.5	84.1	60.1	30.7	12.9	BMEP	144
	CRITICAL POINTS											
003	AIR AFT.CLEAN.	DEG F	87	89	90	90	91	92	92	92	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	-5.28	-4.39	-3.68	-7.11	-6.22	-5.27	-4.21	-4.63	H2O	082
090	AIR AFT.TURBO	HG.	15.89	10.15	4.44	23.26	18.00	11.89	5.83	5.54	Hg	090
085	BLOW BY,CRANKCASE	H2O	0.08	-0.41	-1.27	0.48	0.02	-0.42	-1.10	-1.23	H2O	085
103	OIL,ENGINE GALLERY	PSI	46.8	47.4	48.3	46.9	47.4	47.9	48.5	49.3	PSI	103
007	OIL,ENGINE GALLERY	DEG F	225	224	220	229	227	224	222	225	DEG F	007
006	OIL,SUMP	DEG F	236	233	228	242	240	235	231	233	DEG F	006
008	OIL,TURBO OUT	DEG F	235	231	224	243	238	233	227	230	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	120	119	120	117	117	117	119	119	DEG F	011
108	FUEL,AFT.FILTERS	PSI	14.8	18.3	18.8	20.3	21.6	22.9	22.9	24.3	PSI	108
015	COOLANT,ENG.OUT	DEG F	195	198	199	195	195	197	199	200	DEG F	015
069	EXH.AFT.TURBO	DEG F	861	760	595	942	876	778	633	602	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	8.88	6.53	3.92	13.91	11.09	8.08	4.96	5.16	H2O	086
001	AIR,AMBIENT	DEG F	88	90	91	91	92	92	94	91	DEG F	001
002	AIR,B4 CLEANER	DEG F	88	90	91	91	92	92	93	92	DEG F	002
003	AIR,AFT.CLEANER	DEG F	87	89	90	90	91	92	92	92	DEG F	003
004	AIR,AFT.TURBO	DEG F	207	179	146	254	227	195	161	163	DEG F	004
006	OIL,ENG.SUMP	DEG F	236	233	228	242	240	235	231	233	DEG F	006
007	OIL,ENG.GALLERY	DEG F	225	224	220	229	227	224	222	225	DEG F	007
008	OIL,TURBO OUT	DEG F	235	231	224	243	238	233	227	230	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	85	84	84	83	83	83	85	86	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	120	119	120	117	117	117	119	119	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	142	139	137	140	138	134	134	135	DEG F	012

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 09/04/86 16:06

			35	36	37	38	39	40	41	42		
015	COOLANT,ENG.INLET	DEG F	195	198	199	195	195	197	199	200	DEG F	015
016	COOLANT;ENG.OUTLET	DEG F	203	204	204	203	203	203	203	205	DEG F	016
018	WATER,TOWER INLET	DEG F	77	77	78	78	78	79	79	80	DEG F	018
019	WATER,TOWER OUTLET	DEG F	197	198	199	195	197	223	1590	117	DEG F	019
020	DYNO;WATER OUTLET	DEG F	102	99	91	106	103	100	92	89	DEG F	020
017	REF.BATH	DEG F	198	198	198	198	199	199	199	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	200	200	200	200	200	200	200	200	ENTRY 3	141
061	EXH.PORT #1	DEG F	857	753	595	962	888	785	643	632	DEG F	061
062	EXH.PORT #2	DEG F	929	809	630	1046	960	843	678	650	DEG F	062
063	EXH.PORT #3	DEG F	902	791	620	1007	928	813	660	632	DEG F	063
064	EXH.PORT #4	DEG F	902	791	620	1022	938	826	661	637	DEG F	064
065	EXH.PORT #5	DEG F	900	786	605	1007	927	812	650	616	DEG F	065
066	EXH.PORT #6	DEG F	810	712	554	902	831	736	594	577	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	964	841	651	1078	992	869	697	663	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	937	814	631	1055	968	847	677	659	DEG F	068
069	EXH.AFTER TURBO	DEG F	861	760	595	942	876	778	633	602	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.72	29.72	29.72	29.72	29.72	29.72	29.72	29.72	Hg	136
081	AIR.CELL DEPRESSION	H20	-1.21	-1.21	-1.19	-1.21	-1.20	-1.21	-1.20	-1.20	H20	081
082	AIR,B4 TURBO TOTAL	H20	-5.28	-4.39	-3.68	-7.11	-6.22	-5.27	-4.21	-4.63	H20	082
083	AIR,B4 TURBO STATIC	H20	-13.87	-11.57	-9.36	-19.59	-16.97	-13.85	-11.16	-12.14	H20	083
090	AIR,AFT.TURBO.	HG.	15.89	10.15	4.44	23.26	18.00	11.89	5.83	5.54	Hg	090
085	BLOW BY,CRANKCASE	H20	0.08	-0.41	-1.27	0.48	0.02	-0.42	-1.10	-1.23	H20	085
084	BLOW BY,CAL.ORIFICE	H20	1.19	0.75	0.05	1.56	1.17	0.71	0.19	-0.02	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	16.45	12.33	8.44	22.93	19.09	14.83	10.26	11.00	Hg	091
086	EXH.AFT.TURBO STATIC	H20	8.88	6.53	3.92	13.91	11.09	8.08	4.96	5.16	H20	086
108	FUEL,AFT.FILTERS	PSI	14.8	18.3	18.8	20.3	21.6	22.9	22.9	24.3	PSI	108
101	FUELSPILL INJ & PUMP	PSI	1.85	1.89	1.90	1.98	1.99	2.03	2.05	2.20	PSI	101
104	COOLANT,ENG.INLET	PSI	9.7	9.8	9.8	9.8	9.4	9.5	9.5	9.1	PSI	104
105	COOLANT;ENG.OUTLET	PSI	18.2	18.3	18.2	19.0	18.9	18.9	18.9	19.9	PSI	105
106	WATER,TOWER INLET	PSI	66.8	67.0	66.9	66.9	66.8	66.7	66.9	66.9	PSI	106
107	WATER,DYNO INLET	PSI	15.2	15.0	15.2	14.8	14.6	14.9	15.4	15.5	PSI	107
103	OIL,ENG.GALLERY	PSI	46.8	47.4	48.3	46.9	47.4	47.9	48.5	49.3	PSI	103

57 62 74 5

U.S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 11/04/86 15:27

NEW ENGINE
SERIAL NUMBER 176482
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME

SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

PERCENT LOAD PERFORMANCE TEST, 100% RUNS.
2600 - 1400% FR ON F.R. FUEL
TEST HOUR = 400

100%

			105	106	107	108	109	110	111				
131	DATE	MM:DD	11/03	11/03	11/03	11/03	11/03	11/03	11/03	11/04	11/04	MM/DD	131
130	TIME	HH:MM	14:00	14:17	14:32	14:50	15:04	15:20	15:36	7:10	9:15	HH:MM	130
113	RPM	RPM	2600	2400	2201	2001	1800	1601	1403	0	2598	RPM	113
120	TORQUE	LB/HR	358	388	409	425	423	403	376	-5	316	LB-FT	120
143	BRAKE HORSE POWER	BHP	177	177	171	161	144	122	100	0	156	BHP	143
142	FUEL CONSUMPTION	LB/HR	89.9	83.6	77.6	71.0	62.8	53.2	44.0	3.4	80.6	LB/HR	142
145	BSFC	LB/HP-HR	0.507	0.471	0.452	0.438	0.433	0.433	0.438	0.000	0.515	BSFC	145
144	BMEP	BMEP	115.8	125.5	132.3	137.5	136.8	130.4	121.6	0.0	102.2	BMEP	144
	CRITICAL POINTS												
003	AIR AFT.CLEAN.	DEG F	80	79	77	79	80	80	79	79	67	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	-11.35	-9.47	-7.62	-5.97	-4.49	-3.42	-2.68	0.09	-10.58	H2O	082
090	AIR AFT.TURBO	HG.	27.83	25.64	22.58	19.35	15.08	10.96	7.52	-1.48	24.50	Hg	090
085	BLOW BY,CRANKCASE	H2O	0.44	0.36	0.03	-0.24	-0.54	-0.94	-1.07	-2.32	0.00	H2O	085
103	OIL,ENGINE GALLERY	PSI	49.2	48.3	47.5	45.8	43.8	40.5	36.2	-1.1	49.3	PSI	103
007	OIL,ENGINE GALLERY	DEG F	227	227	225	224	222	221	217	86	225	DEG F	007
006	OIL,SUMP	DEG F	240	240	237	236	234	233	229	83	238	DEG F	006
008	OIL,TURBO OUT	DEG F	243	242	238	236	233	231	225	79	239	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	119	119	124	124	121	120	118	109	122	DEG F	011
108	FUEL,AFT.FILTERS	PSI	18.8	16.6	12.4	12.9	16.6	29.3	29.3	-5.9	17.9	PSI	108
015	COOLANT,ENG.OUT	DEG F	194	194	195	194	195	195	195	82	196	DEG F	015
069	EXH.AFT.TURBO	DEG F	985	973	962	966	967	953	922	80	907	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	16.13	13.00	9.96	7.24	5.20	3.54	2.42	0.41	14.41	H2O	086
001	AIR,AMBIENT	DEG F	83	82	79	81	81	81	82	77	70	DEG F	001
002	AIR,B4 CLEANER	DEG F	81	80	76	79	78	79	79	77	67	DEG F	002
003	AIR,AFT.CLEANER	DEG F	80	79	77	79	80	80	79	79	67	DEG F	003
004	AIR,AFT.TURBO	DEG F	270	253	231	213	193	170	149	80	236	DEG F	004
006	OIL,ENG.SUMP	DEG F	240	240	237	236	234	233	229	83	238	DEG F	006
007	OIL,ENG.GALLERY	DEG F	227	227	225	224	222	221	217	86	225	DEG F	007
008	OIL,TURBO OUT	DEG F	243	242	238	236	233	231	225	79	239	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	85	86	87	87	85	87	85	80	87	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	119	119	124	124	121	120	118	109	122	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	139	142	147	138	123	106	103	81	139	DEG F	012

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482____ 11/04/86 15:31

015	COOLANT,ENG.INLET	DEG F	194	194	195	194	195	195	195	82	196	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	205	203	204	205	206	205	203	87	204	DEG F	016
018	WATER,TOWER INLET	DEG F	57	55	55	56	58	57	59	79	59	DEG F	018
019	WATER,TOWER OUTLET	DEG F	2884	77	****	180	8306	8427	139	-175	9519	DEG F	019
020	DYNO,WATER OUTLET	DEG F	84	84	83	80	79	76	72	82	82	DEG F	020
017	REF.BATH	DEG F	197	197	197	197	199	199	199	197	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	200	200	200	200	200	200	200	200	200	ENTRY 3	141
061	EXH.PORT #1	DEG F	1037	1017	991	972	958	926	892	88	961	DEG F	061
062	EXH.PORT #2	DEG F	1117	1097	1066	1053	1034	1001	964	89	1022	DEG F	062
063	EXH.PORT #3	DEG F	1078	1057	1030	1017	1002	956	918	88	987	DEG F	063
064	EXH.PORT #4	DEG F	1088	1045	1022	1008	989	957	907	88	1005	DEG F	064
065	EXH.PORT #5	DEG F	1080	1043	1024	1014	986	964	903	88	996	DEG F	065
066	EXH.PORT #6	DEG F	966	942	917	900	875	854	815	87	883	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	1162	1142	1113	1100	1086	1047	1011	106	1067	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	1126	1090	1068	1054	1024	986	919	106	1037	DEG F	068
069	EXH.AFTER TURBO	DEG F	985	973	962	966	967	953	922	80	907	DEG F	069
136	BAROMETRIC PRESS.	HG.	29.98	29.98	29.98	29.98	29.98	29.98	29.98	29.98	29.98	Hg	136
081	AIR,CELL DEPRESSION	H20	-1.13	-1.16	-1.15	-1.15	-1.14	-1.16	-1.15	-0.01	-1.15	H20	081
082	AIR,B4 TURBO TOTAL	H20	-11.35	-9.47	-7.62	-5.97	-4.49	-3.42	-2.68	0.09	-10.58	H20	082
083	AIR,B4 TURBO STATIC	H20	-25.36	-20.96	-16.79	-12.76	-9.33	-6.75	-4.95	-0.05	-23.40	H20	083
090	AIR,AFT.TURBO	HG.	27.83	25.64	22.58	19.35	15.08	10.96	7.52	-1.48	24.50	Hg	090
085	BLOW BY,CRANKCASE	H20	0.44	0.36	0.03	-0.24	-0.54	-0.94	-1.07	-2.32	0.00	H20	085
084	BLOW BY,CAL.ORIFICE	H20	1.74	1.68	1.47	1.25	0.97	0.63	0.51	-0.12	1.24	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	27.97	24.61	20.43	16.57	12.49	9.03	6.64	-0.39	25.27	Hg	091
086	EXH.AFT.TURBO STATIC	H20	16.13	13.00	9.96	7.24	5.20	3.54	2.42	0.41	14.41	H20	086
108	FUEL,AFT.FILTERS	PSI	18.8	16.6	12.4	12.9	16.6	29.3	29.3	-5.9	17.9	PSI	108
101	FUELSPILL INJ & PUMP	PSI	1.15	1.00	0.90	0.87	0.98	1.71	1.66	0.71	1.11	PSI	101
104	COOLANT,ENG.INLET	PSI	8.6	8.9	9.0	9.3	9.5	9.7	9.9	10.6	9.0	PSI	104
105	COOLANT,ENG.OUTLET	PSI	17.0	16.6	16.1	15.7	15.4	15.0	14.7	13.7	17.1	PSI	105
106	WATER,TOWER INLET	PSI	68.5	68.5	68.5	68.4	68.5	68.6	68.6	-3.0	68.5	PSI	106
107	WATER,DYNO INLET	PSI	14.4	14.5	15.0	15.0	15.0	15.1	14.9	0.1	14.2	PSI	107
103	OIL,ENG.GALLERY	PSI	49.2	48.3	47.5	45.8	43.8	40.5	36.2	-1.1	49.3	PSI	103

"S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482 11/04/86 15:34

NEW ENGINE
SERIAL NUMBER 176482
MODEL DT-466
SPECIAL PROGRAM CODE
I.H./FIRE RETARDANT FUEL
INITIAL CELL ASSIGNMENT 1
COMPRESSION RATIO 16.3 TO 1
ORDER NUMBER
CUSTOMER NAME

SPECIAL INSTRUCTIONS

THIS TEST IS TO BE USED TO DETERMINE HOW FIRE RETARDANT FUEL WILL EFFECT THE PERFORMANCE OF A MILITARY-ADAPTED ENGINE DURING A NATO ENDURANCE TEST. THE ENGINE IS TO BE RUN IN THE MANUAL MODE, WITH THE ELWOOD SYSTEM RECORDING DATA. THE OPERATOR WILL HAVE TO CHANGE THE SPEED AND LOAD FOR EACH OPERATING CONDITION.

POC FOR THIS PROGRAM IS
LARRY NIEMCHAK
574-5711 / HOME 772-0268
OR
KEN RATCLIFF
574-5711 / HOME 779-5398
POC FOR TECHNICAL INFO. IS
MILAD MEKARI
574-6652

PERCENT LOAD PERFOMANCE TEST. 2600 85% - 2200 70% ON F.R. FUEL.

			2600 85%	70%	50%	25%	2400 85%	70%	50%	25%	2200 85%	70%		
			113	114	115	116	117	118	119	120	121	122		
131	DATE	MM:DD	11/04	11/04	11/04	11/04	11/04	11/04	11/04	11/04	11/04	11/04	MM/DD	131
130	TIME	HH:MM	8:15	8:27	8:38	8:51	9:06	9:19	9:31	9:48	10:06	10:25	HH:MM	130
113	RPM	RPM	2598	2599	2601	2599	2400	2400	2400	2400	2200	2199	RPM	113
120	TORQUE	LB/HR	316	260	185	93	339	279	200	99	349	287	LB-FT	120
143	BRAKE HORSE POWER	BHP	156	128	91	46	154	127	91	45	146	120	BHP	143
142	FUEL CONSUMPTION	LB/HR	80.6	68.8	53.7	36.0	74.4	63.0	49.3	31.7	66.7	56.8	LB/HR	142
145	BSFC	LB/HP-HR	0.515	0.068	0.586	0.782	0.480	0.494	0.539	0.700	0.456	0.472	BSFC	145
144	BMEP	BMEP	102.2	84.1	59.8	30.0	109.6	90.2	64.7	32.0	112.9	92.8	BMEP	144
	CRITICAL POINTS													
003	AIR AFT.CLEAN.	DEG F	67	69	68	69	69	70	70	70	71	71	DEG F	003
082	AIR AFT.CLEAN.TOTAL	H2O	-10.58	-9.11	-7.54	-5.90	-8.70	-7.45	-6.27	-5.06	-6.81	-5.98	H2O	082
090	AIR AFT.TURBO	HG.	24.50	19.06	12.89	6.03	21.58	16.53	10.68	4.44	18.20	13.36	Hg	090
085	BLOW BY,CRANKCASE	H2O	0.00	-0.07	-0.44	-0.97	-0.18	-0.35	-0.86	-1.34	-0.40	-0.43	H2O	085
103	OIL,ENGINE GALLERY	PSI	49.3	49.0	49.3	49.9	48.8	49.0	49.3	49.6	48.0	48.3	PSI	103
007	OIL,ENGINE GALLERY	DEG F	225	226	224	221	225	224	222	220	223	221	DEG F	007
006	OIL,SUMP	DEG F	238	236	235	231	236	235	231	227	234	231	DEG F	006
008	OIL,TURBO OUT	DEG F	239	237	232	226	237	233	229	223	234	229	DEG F	008
011	FUEL,AFT.FILTERS	DEG F	122	121	121	121	119	120	120	121	120	119	DEG F	011
108	FUEL,AFT.FILTERS	PSI	17.9	18.1	18.6	19.3	16.0	15.6	16.2	17.0	12.9	13.7	PSI	108
015	COOLANT,ENG.OUT	DEG F	196	197	197	199	194	197	199	200	196	198	DEG F	015
069	EXH.AFT.TURBO	DEG F	907	844	751	616	895	828	734	585	882	812	DEG F	069
086	EXH.AFT.TURBO STAT.	H2O	14.41	11.33	8.19	5.39	11.39	9.23	6.87	4.34	8.40	6.69	H2O	086
001	AIR,AMBIENT	DEG F	70	74	72	71	72	73	72	72	73	75	DEG F	001
002	AIR,B4 CLEANER	DEG F	67	70	69	70	70	72	72	69	73	74	DEG F	002
003	AIR,AFT.CLEANER	DEG F	67	69	68	69	69	70	70	70	71	71	DEG F	003
004	AIR,AFT.TURBO	DEG F	236	212	180	144	220	196	166	132	200	177	DEG F	004
006	OIL,ENG.SUMP	DEG F	238	236	235	231	236	235	231	227	234	231	DEG F	006
007	OIL,ENG.GALLERY	DEG F	225	226	224	221	225	224	222	220	223	221	DEG F	007
008	OIL,TURBO OUT	DEG F	239	237	232	226	237	233	229	223	234	229	DEG F	008
010	FUEL,B4 ENG.FILTERS	DEG F	87	88	87	88	85	84	85	86	84	82	DEG F	010
011	FUEL,AFT.FILTERS	DEG F	122	121	121	121	119	120	120	121	120	119	DEG F	011
012	FUELSPILL INJ & PUMP	DEGF	139	138	135	131	138	139	136	133	140	137	DEG F	012

PARTIAL LOAD · 2400 @ 50% TORQ GOVN. SPD.

U S ARMY TANK-AUTOMOTIVE COMMAND RESEARCH AND DEVELOPMENT CENTER TEST CELL DATA SERIAL NUMBER: 176482____ 11/07/86 15:06

DF2

015	COOLANT,ENG.INLET	DEG F	199	199	196	196	196	200	201	DEG F	015
016	COOLANT,ENG.OUTLET	DEG F	205	204	204	204	203	205	204	DEG F	016
018	WATER,TOWER INLET	DEG F	58	58	56	57	57	58	58	DEG F	018
019	WATER,TOWER OUTLET	DEG F	201	200	2761	197	199	200	201	DEG F	019
020	DYNO,WATER OUTLET	DEG F	72	62	85	79	72	64	58	DEG F	020
017	REF.BATH	DEG F	199	199	199	199	199	199	199	DEG F	017
141	REF.BATH (KEY IN)	DEG F	199	199	199	199	199	199	199	ENTRY 3	141
061	EXH.PORT #1	DEG F	795	628	1039	945	822	666	623	DEG F	061
062	EXH.PORT #2	DEG F	859	670	1126	1028	887	718	660	DEG F	062
063	EXH.PORT #3	DEG F	825	654	1079	985	852	690	638	DEG F	063
064	EXH.PORT #4	DEG F	834	663	1093	996	871	698	641	DEG F	064
065	EXH.PORT #5	DEG F	828	649	1082	989	860	683	621	DEG F	065
066	EXH.PORT #6	DEG F	727	563	948	868	754	600	572	DEG F	066
067	EXH.B4 TURBO FRONT	DEG F	910	715	1175	1078	936	758	688	DEG F	067
068	EXH.B4 TURBO REAR	DEG F	864	680	1139	1039	901	714	653	DEG F	068
069	EXH.AFTER TURBO	DEG F	797	637	993	918	811	663	599	DEG F	069
136	BAROMETRIC PRESS.	HG.	30.19	30.19	30.19	30.19	30.19	30.19	30.19	Hg	136
081	AIR,CELL DEPRESSION	H20	-1.16	-1.17	-1.17	-1.16	-1.18	-1.17	-1.18	H20	081
082	AIR,B4 TURBO TOTAL	H20	-4.86	-3.91	-8.26	-7.20	-5.89	-4.59	-4.79	H20	082
083	AIR,B4 TURBO STATIC	H20	-13.52	-10.49	-24.62	-21.14	-16.69	-12.69	-13.32	H20	083
090	AIR,AFT.TURBO	HG.	12.14	5.15	29.00	22.97	15.11	7.15	5.36	Hg	090
085	BLOW BY,CRANKCASE	H20	-0.44	-1.20	0.50	0.09	-0.41	-1.01	-1.33	H20	085
084	BLOW BY,CAL.ORIFICE	H20	1.00	0.37	1.78	1.38	0.89	0.38	0.12	H20	084
091	EXH.B4 TURBO(COMBINED)	HG.	15.07	10.75	28.99	24.68	18.44	13.25	13.23	Hg	091
086	EXH.AFT.TURBO STATIC	H20	6.35	3.77	14.08	11.27	7.96	5.08	4.97	H20	086
108	FUEL,AFT.FILTERS	PSI	15.5	15.9	17.7	18.0	18.2	18.8	21.6	PSI	108
101	FUELSPILL INJ & PUMP	PSI	0.87	0.90	0.86	0.88	0.84	0.89	0.97	PSI	101
104	COOLANT,ENG.INLET	PSI	9.0	9.0	8.7	8.9	8.9	8.7	8.4	PSI	104
105	COOLANT,ENG.OUTLET	PSI	16.4	16.5	17.0	17.1	17.0	17.1	17.7	PSI	105
106	WATER,TOWER INLET	PSI	68.5	68.5	68.6	68.6	68.6	68.6	68.5	PSI	106
107	WATER,DYNO INLET	PSI	14.3	14.6	14.2	14.2	14.5	14.5	15.1	PSI	107
103	OIL,ENG.GALLERY	PSI	48.7	49.2	48.3	48.5	48.9	49.3	49.8	PSI	103

APPENDIX D

PHOTOGRAPHS

LIST OF PHOTOGRAPHS

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23.	_____	Engine Block	D-27
24.	_____	Intake and exhaust valves in cylinder Head	D-28
25.	_____	In-line, 6 plungers and barrels fuel injection pump and governor housing	D-29
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29.	_____	Barrel, gasket, delivery valve body, spring, washer and holder	D-33
30.	_____	Intake and Exhaust valves	D-34
31.	_____	Intake and Exhaust valves	D-35
32.	_____	Exhaust Manifold	D-36
33.	_____	Turbocharger, turbine outlet	D-37

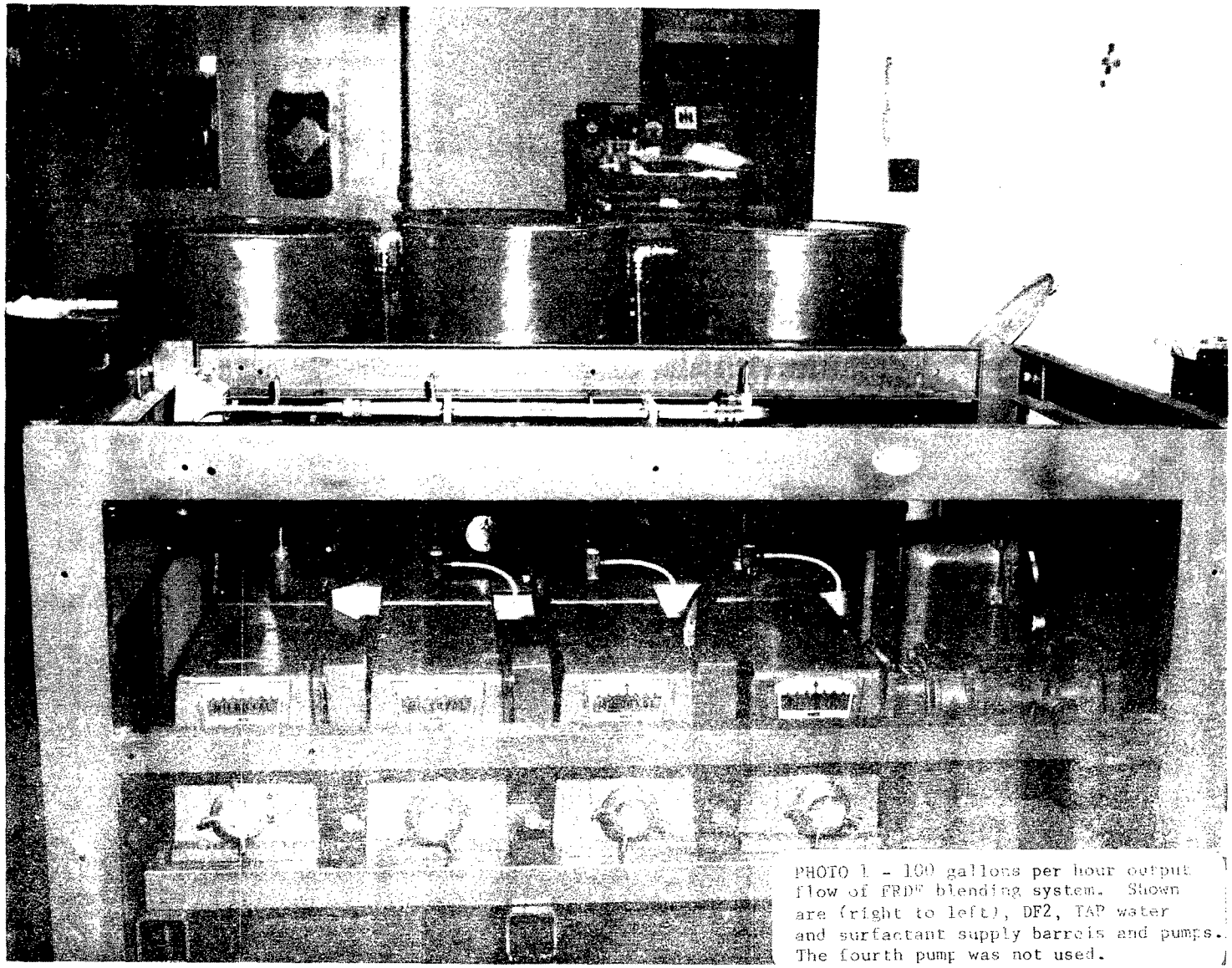


PHOTO 1 - 100 gallons per hour output flow of FRD™ blending system. Shown are (right to left), DF2, TAP water and surfactant supply barrels and pumps. The fourth pump was not used.

PHOTO 2 - positive displace
to right) DF2, TAP water, su
pumps of the blending syste



PHOTO 3 - DF2, TAP water, and surfactant barrels

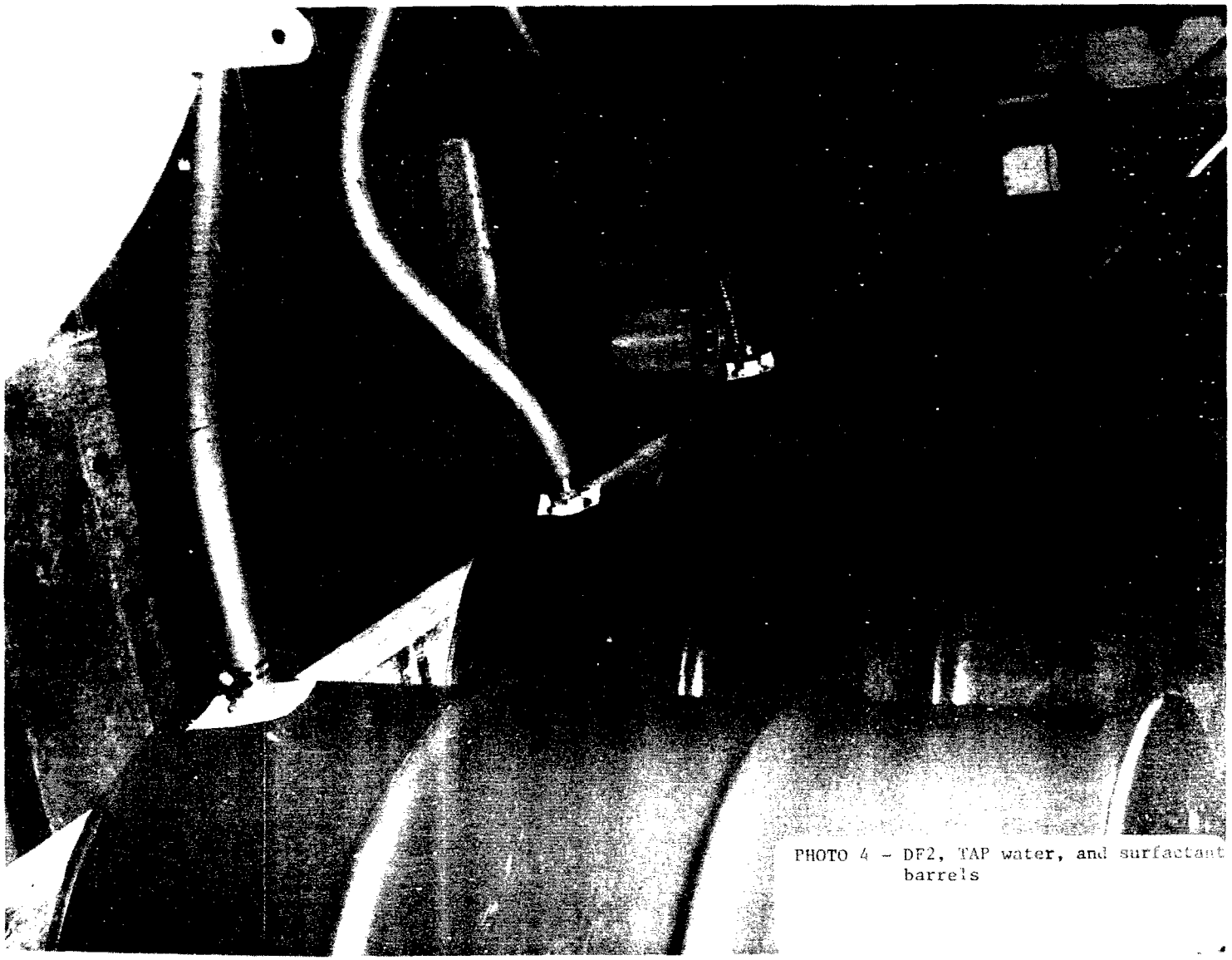


PHOTO 4 - DF2, TAP water, and surfactant barrels

PHOTO [illegible] The [illegible] into
300 gallons storage tank

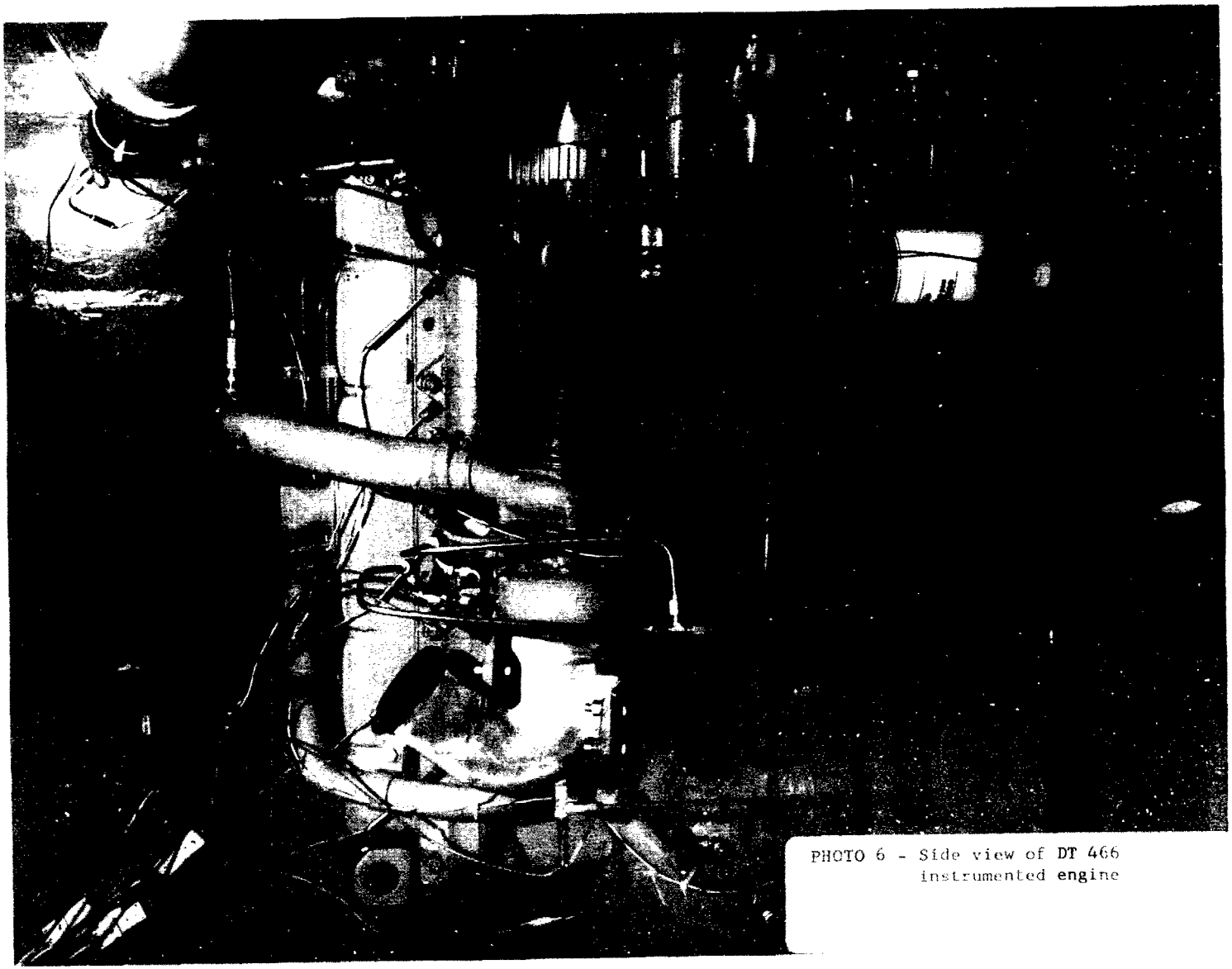


PHOTO 6 - Side view of DT 466 instrumented engine

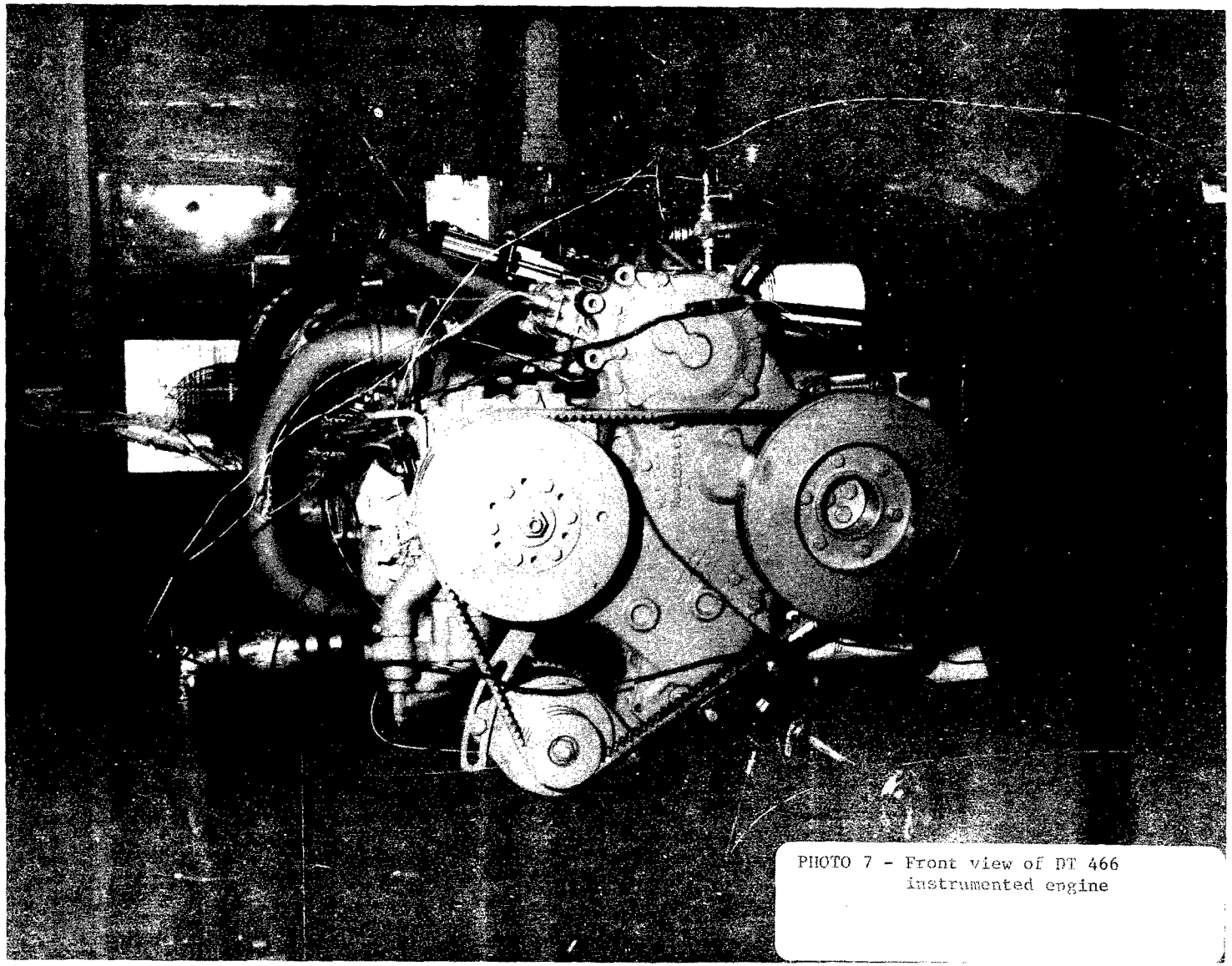
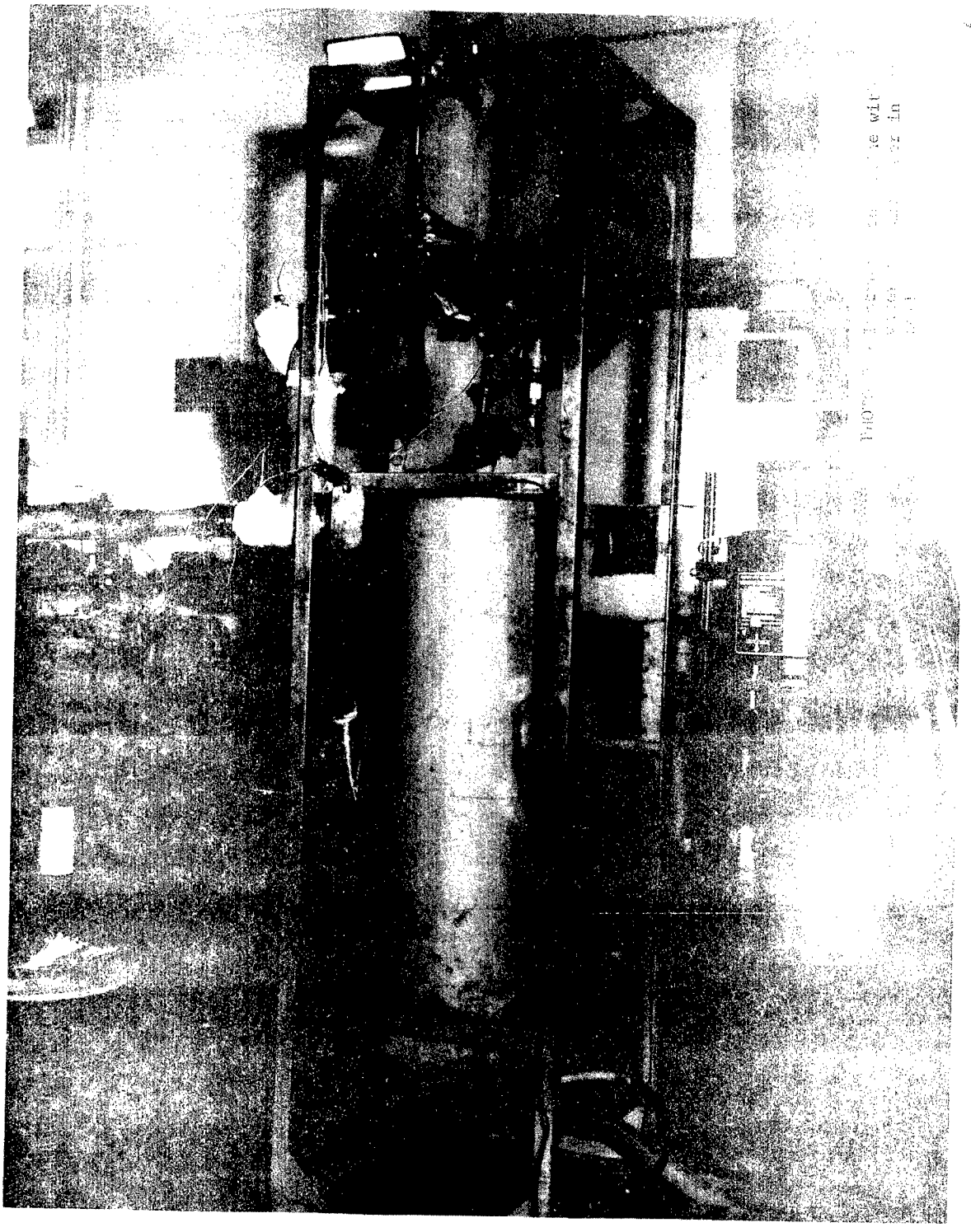


PHOTO 7 - Front view of DT 466 instrumented engine

PHOTO 8 - Rear view of PT 466 instrumented engine



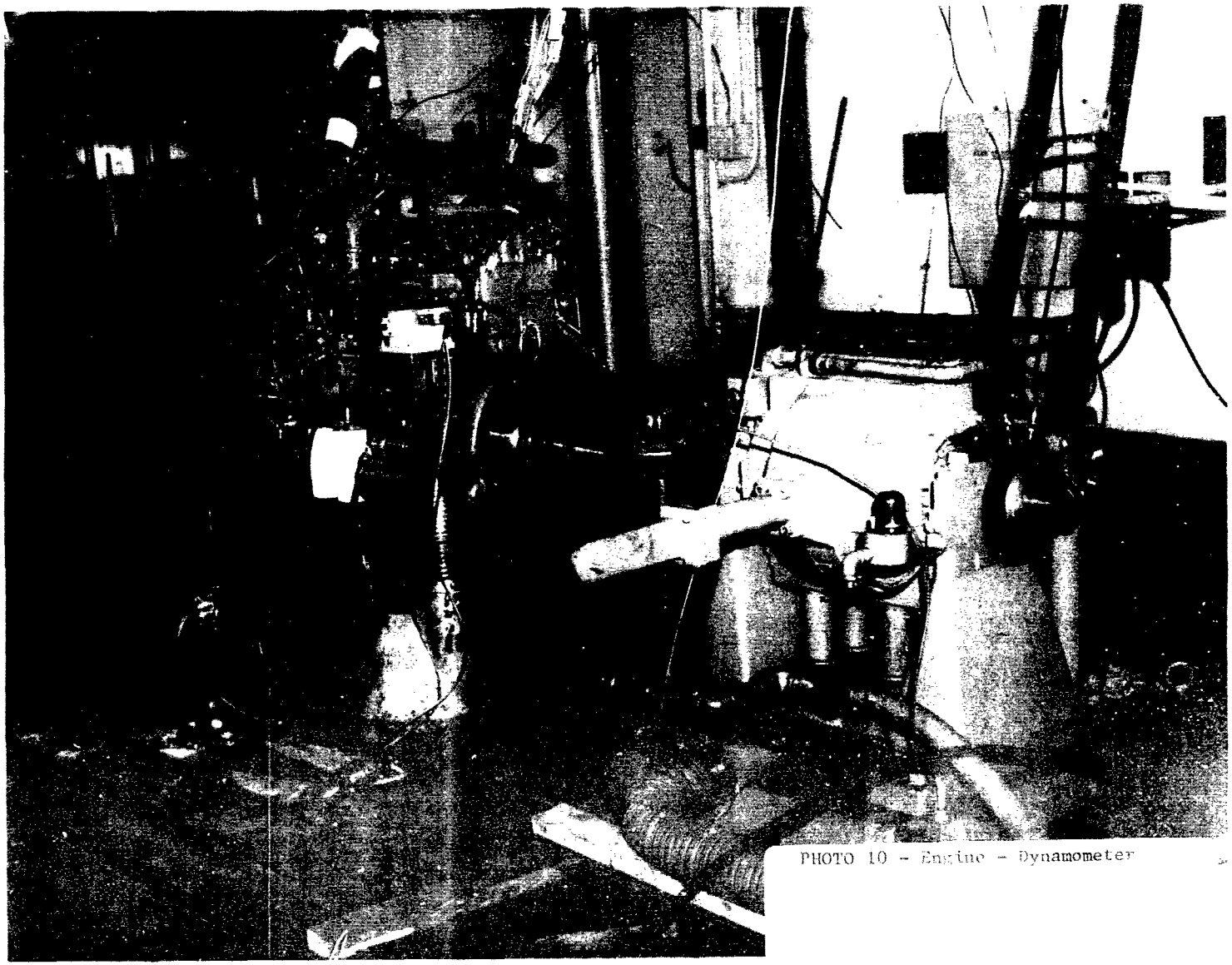


PHOTO 10 - Engine - Dynamometer

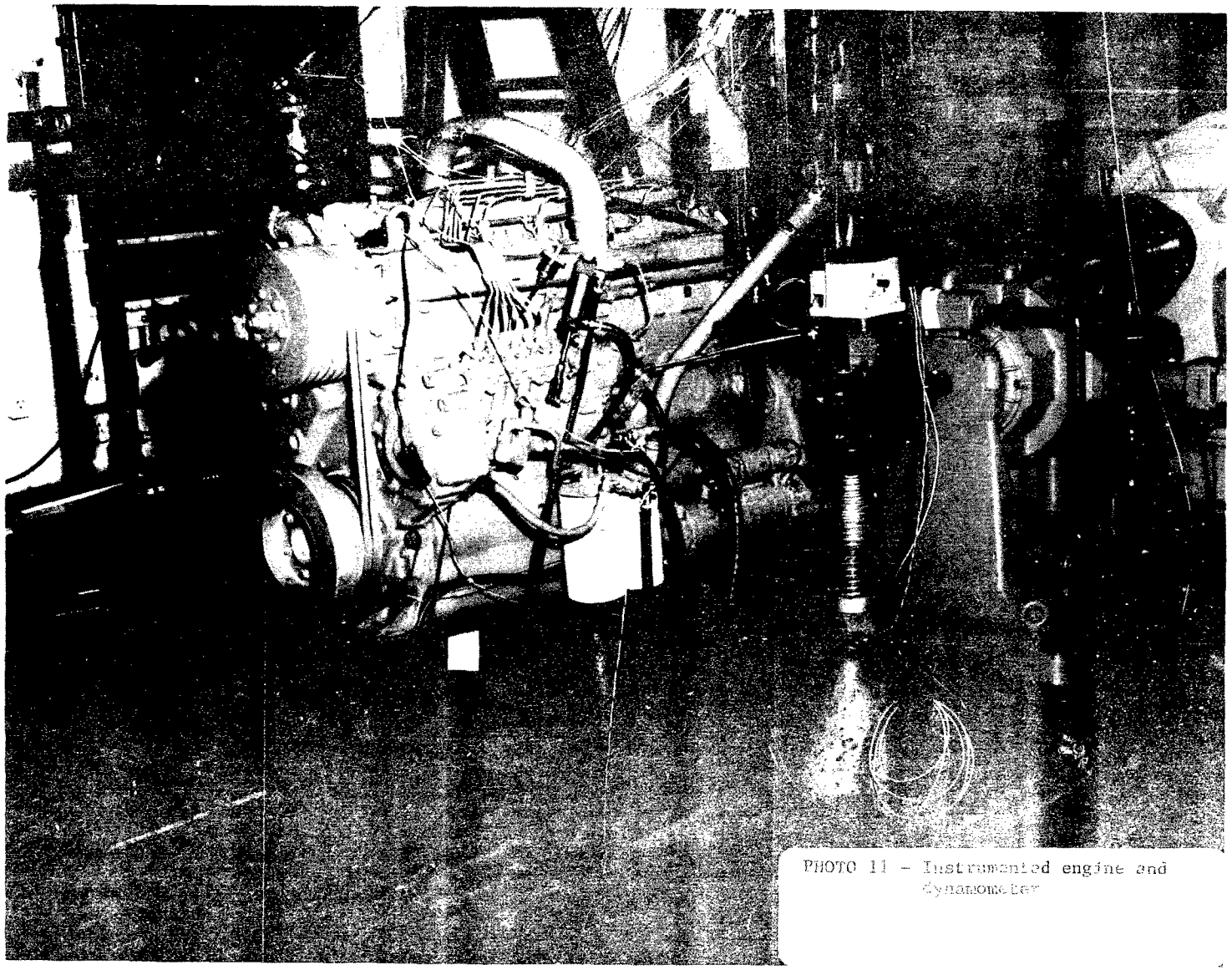


PHOTO 11 - Instrumented engine and dynamometer

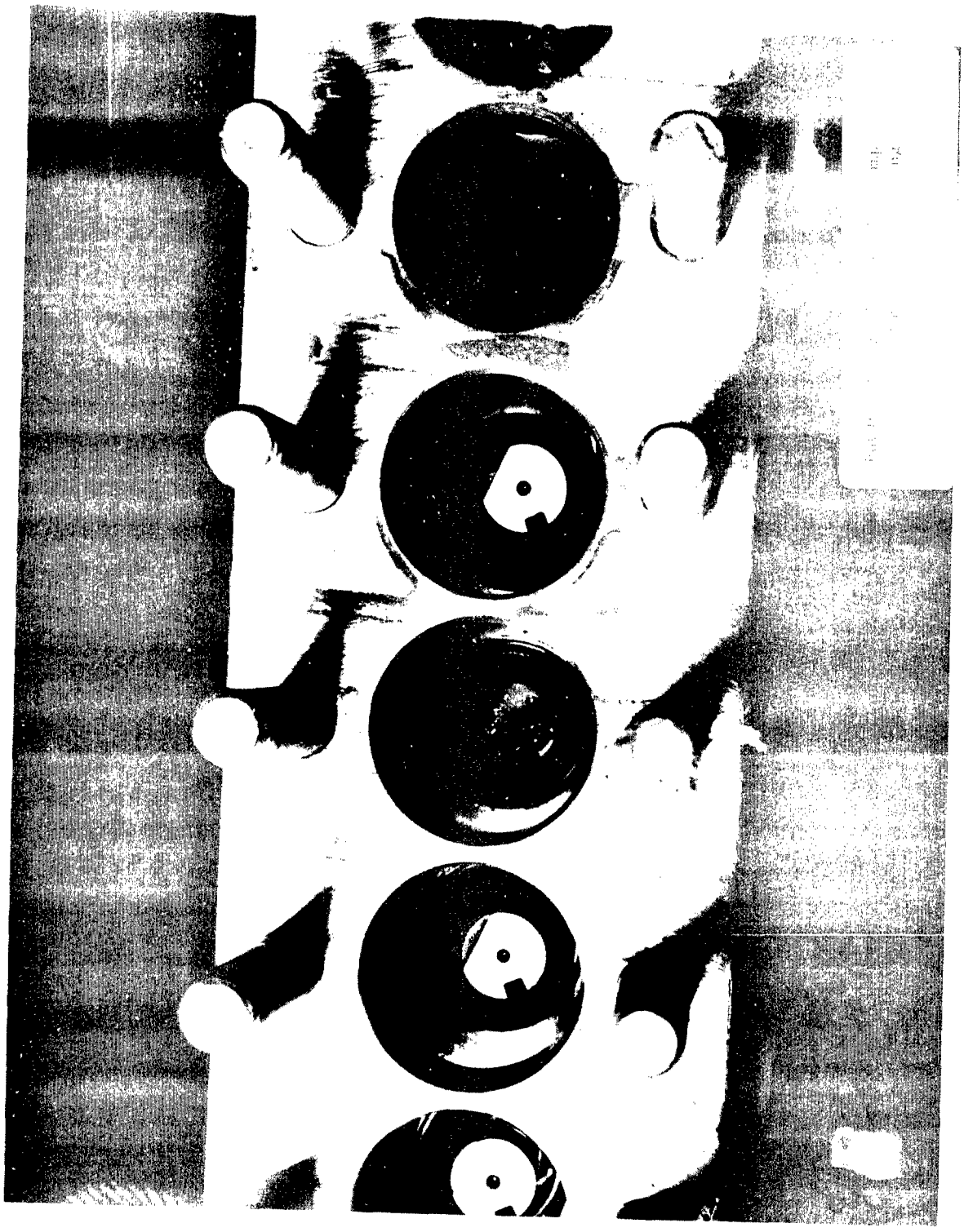


PHOTO 13 - Fuel injection pump's barrels, delivery valves holders, delivery valves bodies, delivery valves gaskets, and springs.

PHOTO 14 - Delivery valve bodies and delivery valve gaskets

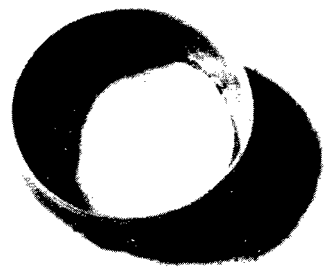


PHOTO 15 - Failed delivery valve gasket (copper material). The gasket failed after 388 hours of 3400 endurance test with #2DF.

PHOTO 16 - Nozzle bodies



PHOTO 17 - Nozzle body and nozzle cap nut, third front, typical

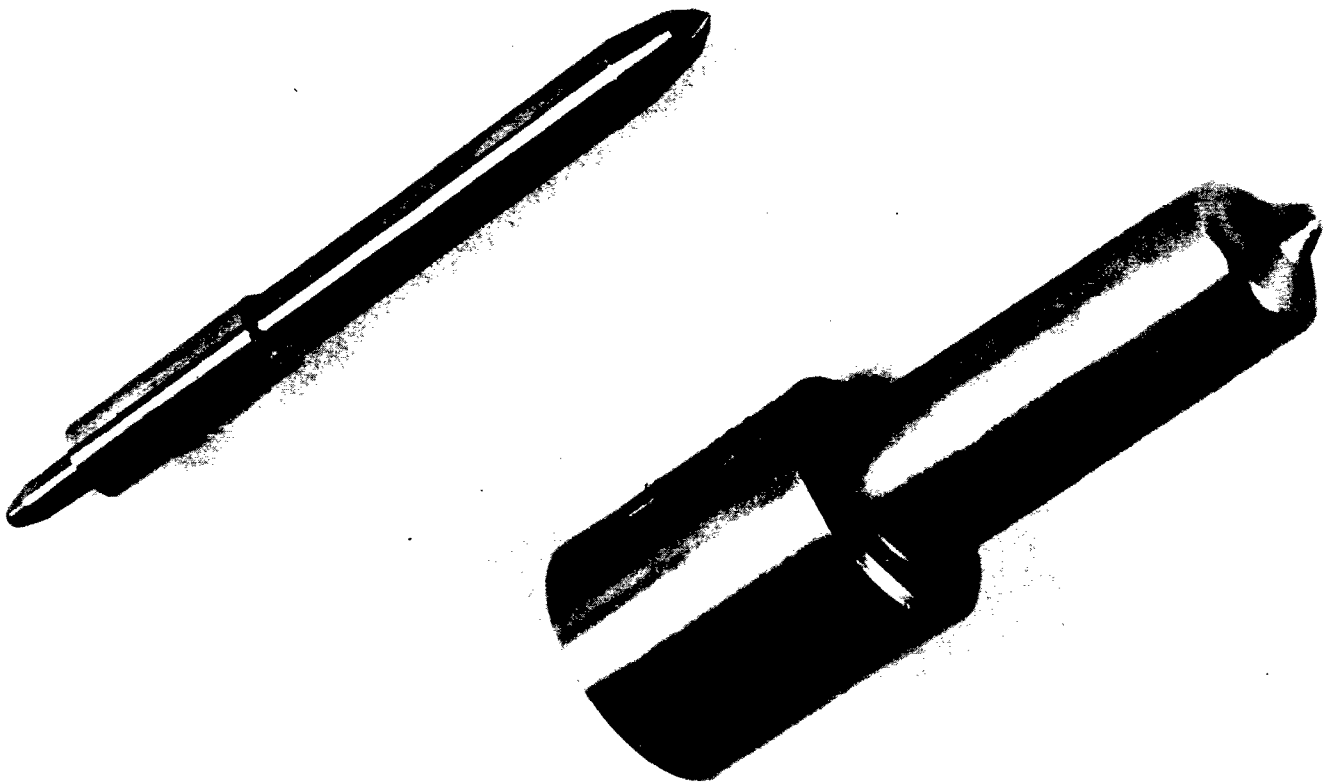


PHOTO 18 - Glass beads blasted nozzle body and needle valve, third front typical

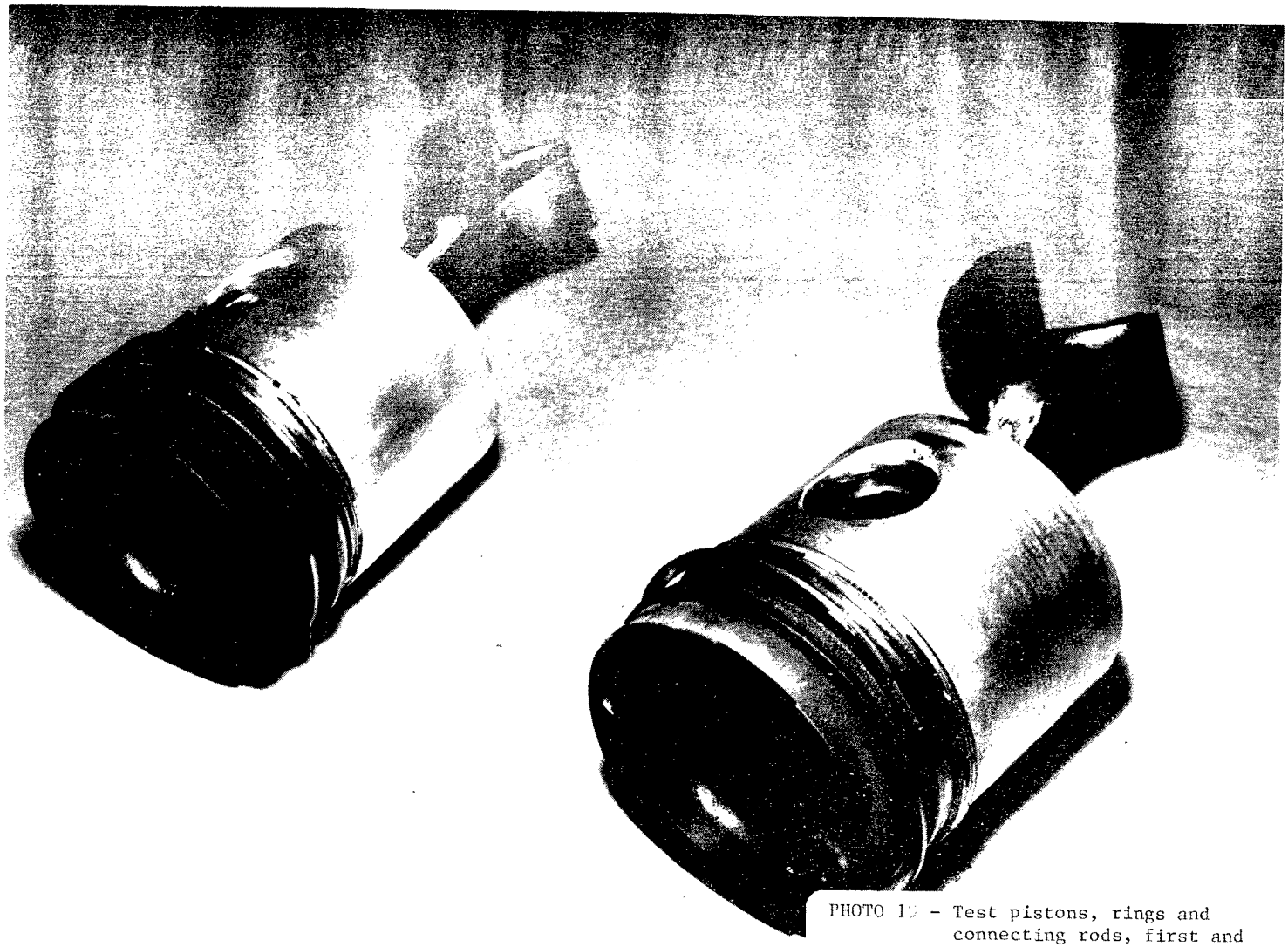


PHOTO 1[illegible] - Test pistons, rings and connecting rods, first and third, front.



PHOTO 20 - Test piston, third, front typical (carbon deposit is shown on the top of the piston).



PHOTO 21 - Glass beads, balsted piston, third, front, typical

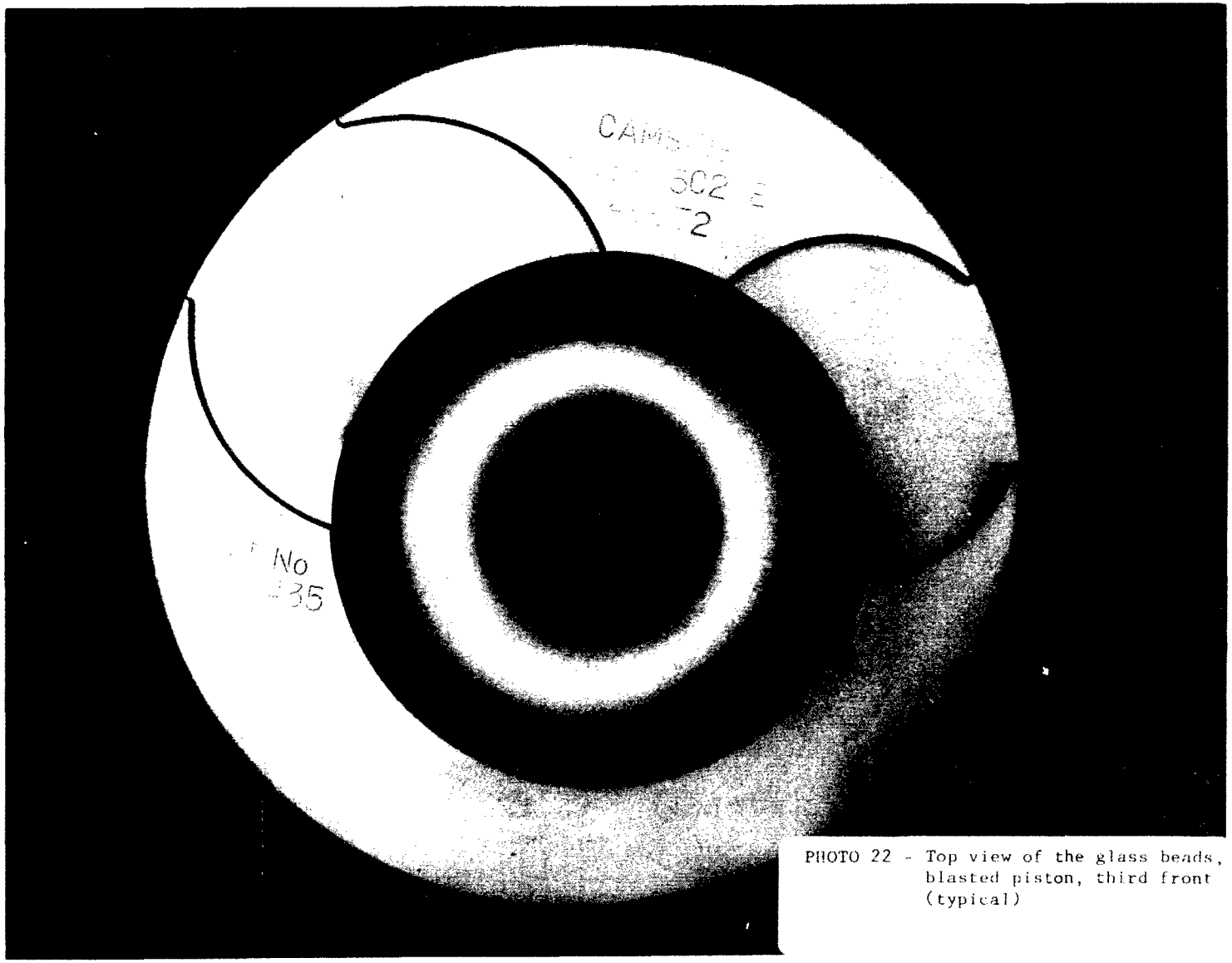


PHOTO 22 - Top view of the glass beads, blasted piston, third front (typical)

PHOTO 23 - Engine block, cylinders sleeves and pistons

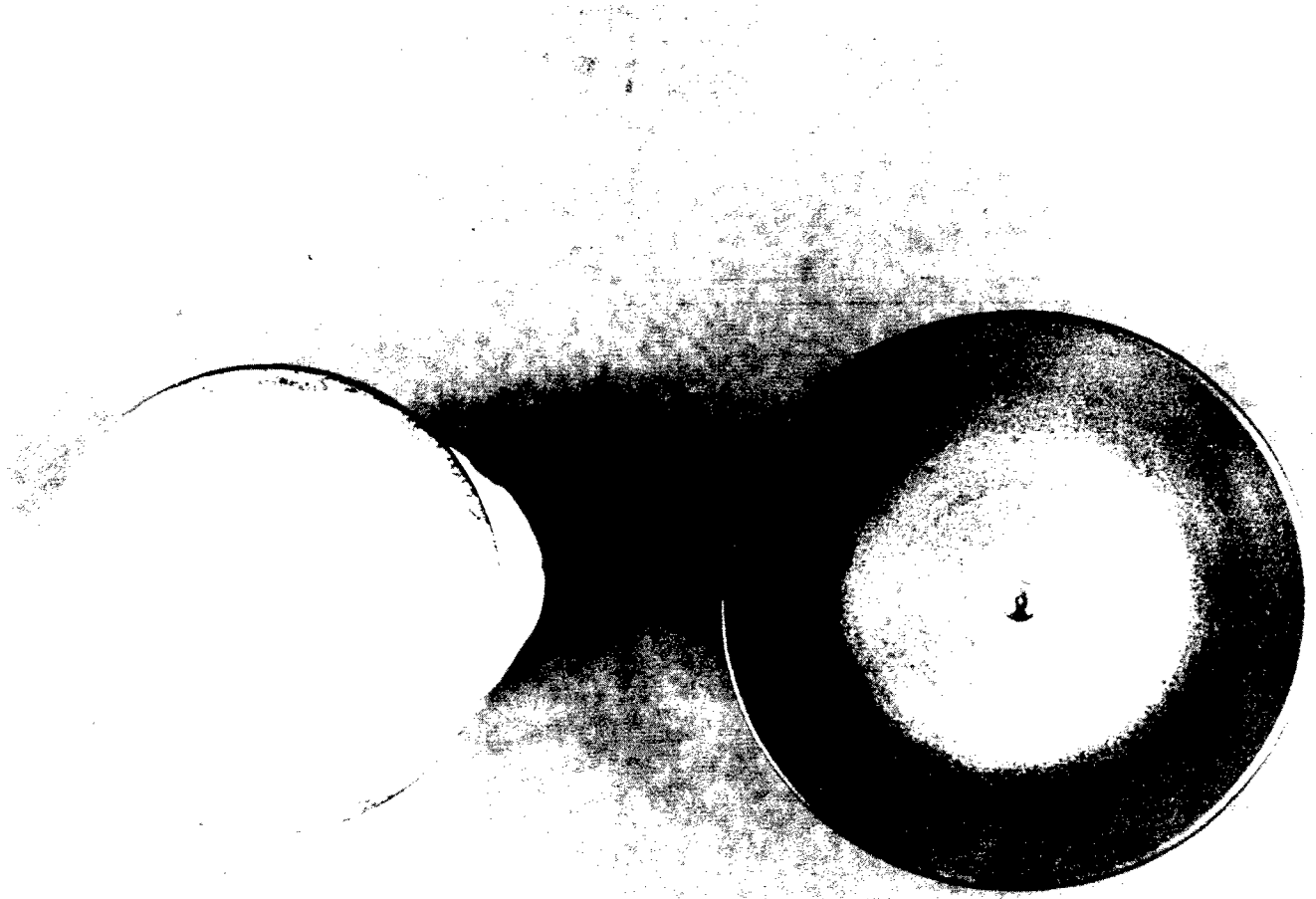


PHOTO 24 - Intake and exhaust valves in cylinder head, bottom view

PHOTO 29 - In-line, 6 plunger fuel injection pump and governor housing.

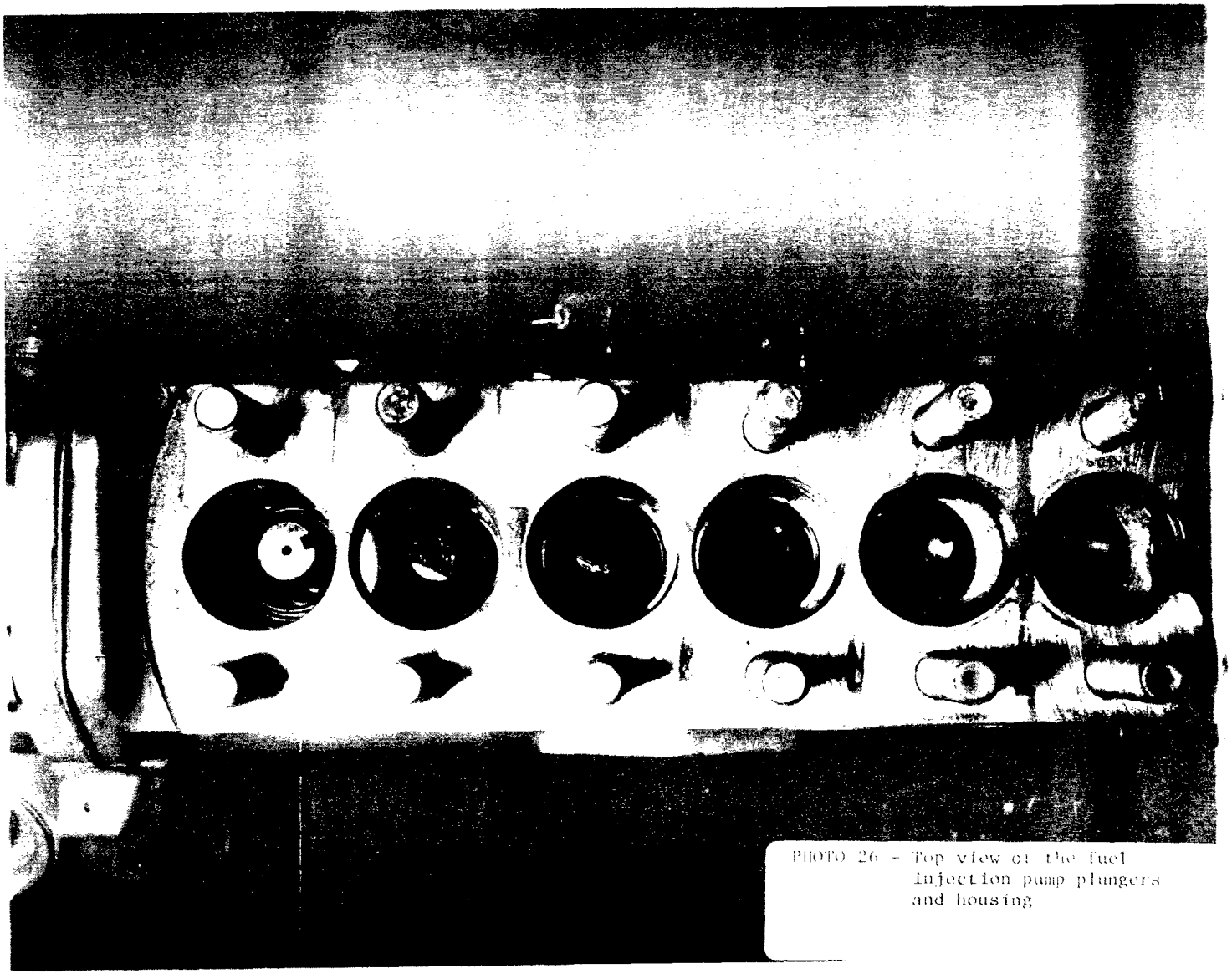


PHOTO 26 - Top view of the fuel injection pump plungers and housing

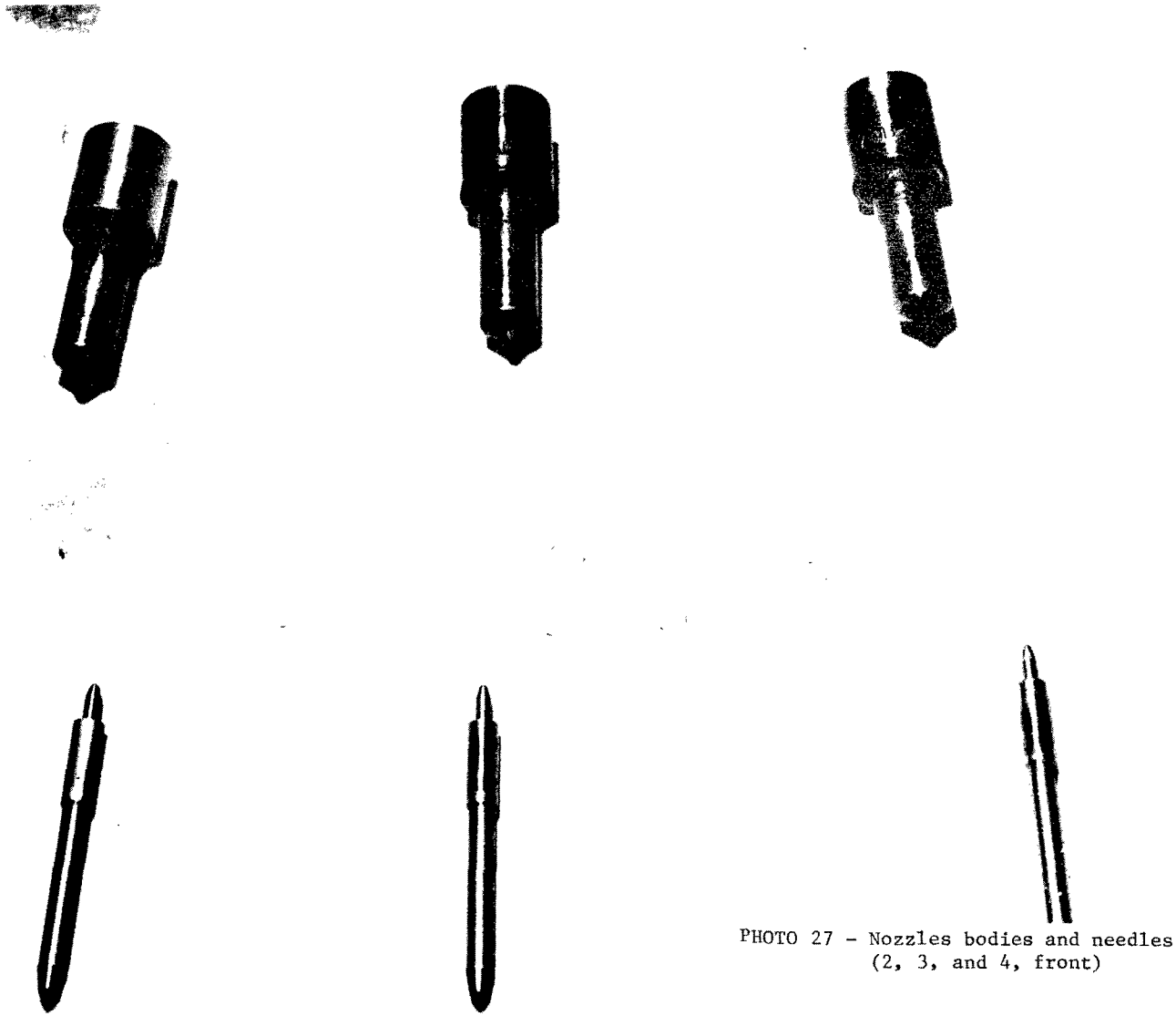


PHOTO 27 - Nozzles bodies and needles
(2, 3, and 4, front)

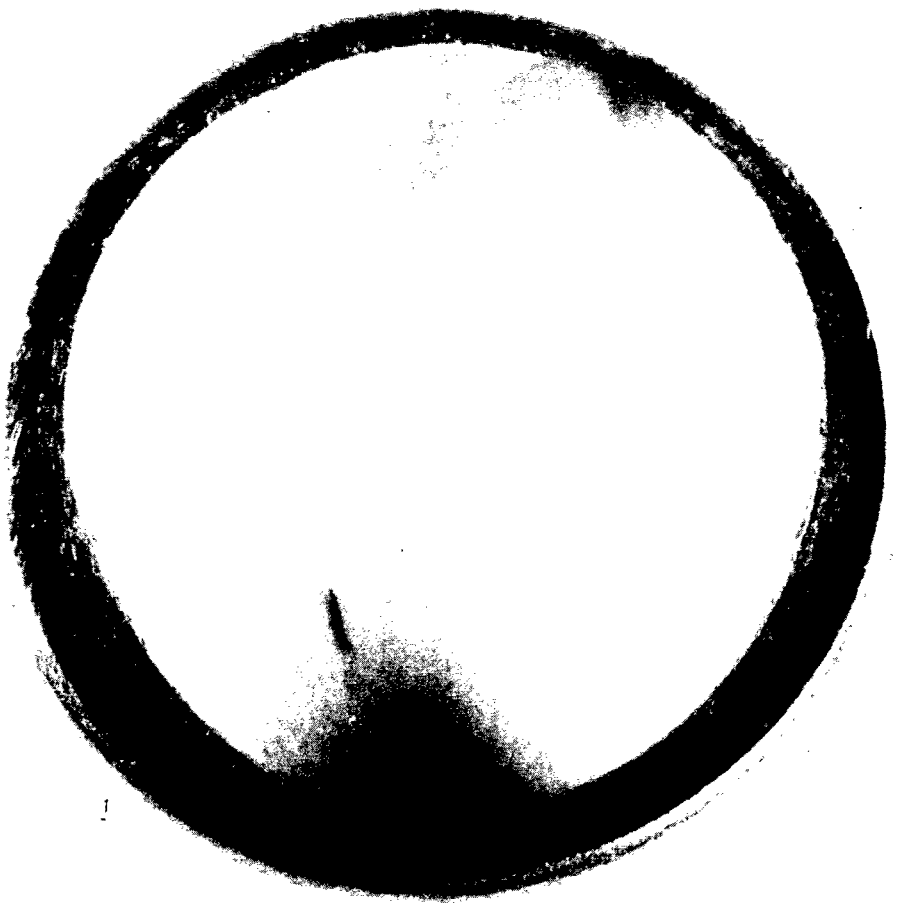


PHOTO 28 - Delivery valve's copper gasket, failed after 388 hour endurance testing.

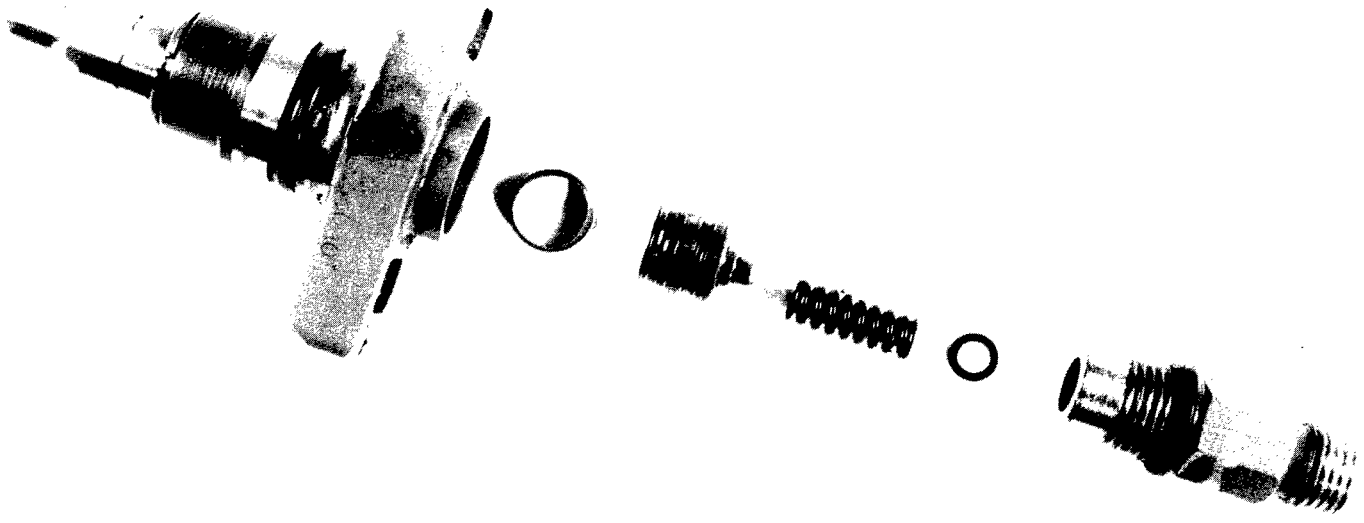


PHOTO 29 - Barrel, gasket, delivery valve body, spring, washer, and holder

PHOTO 30 - Intake and exhaust valves

PHOTO 31 - Intake and exhaust valves

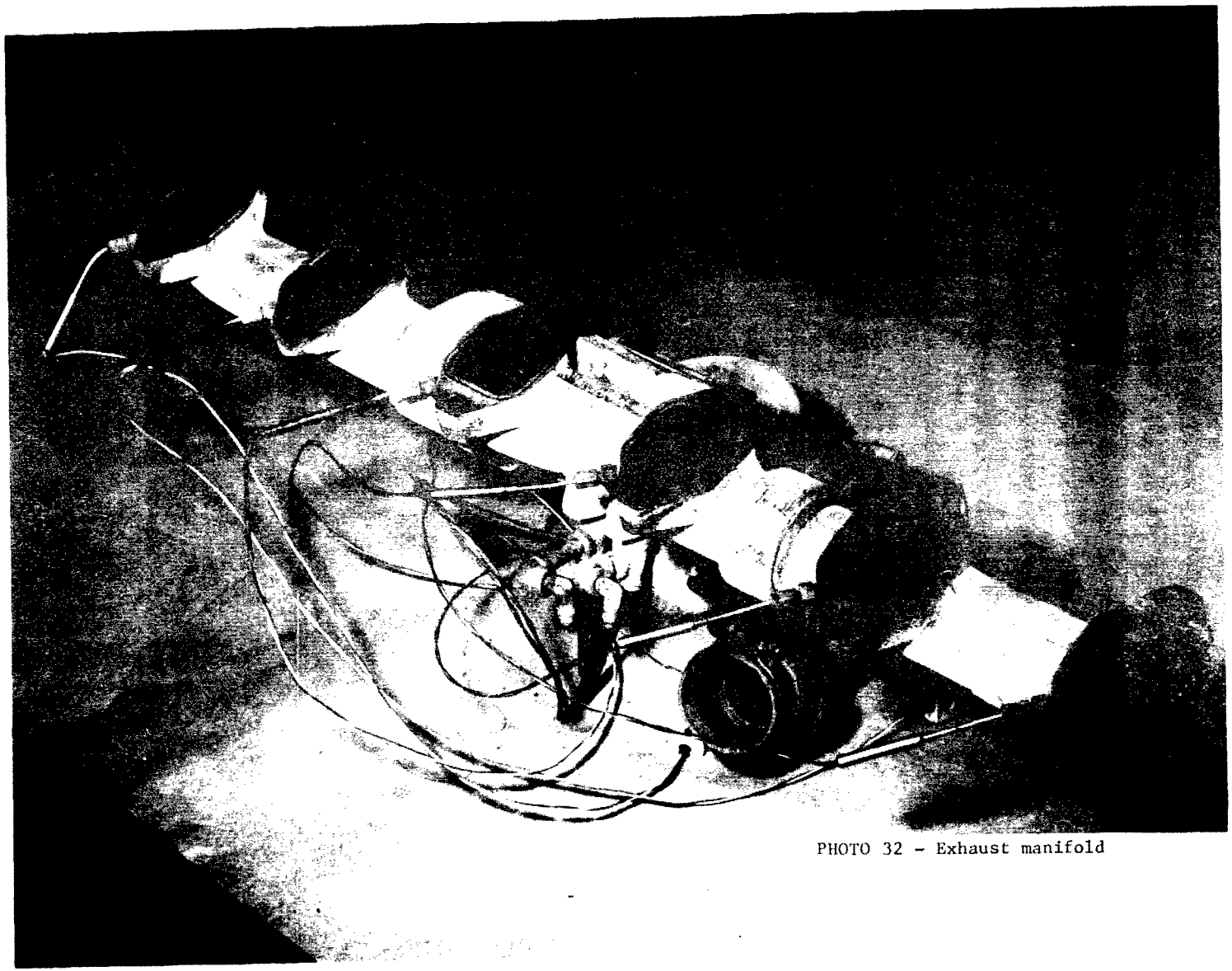


PHOTO 32 - Exhaust manifold

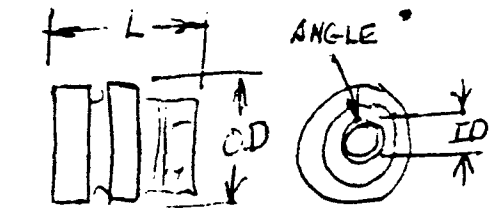
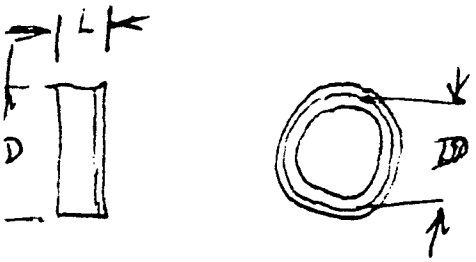
PHOTO 33 - Turbocharger, turbine outlet

APPENDIX E

DIMENSIONAL ANALYSIS

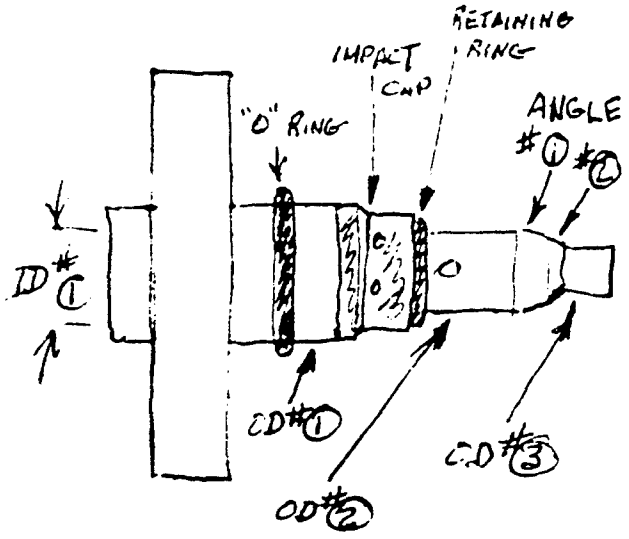
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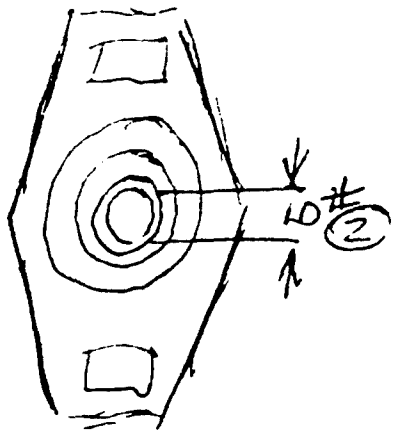
#6

			VISUAL SURFACE FINISH
Delivery Valve Body 			
*	L	.4724 mm / in	16 ✓
	OD	.5444 mm / in Ø	32 ✓
	ID	.2368 mm / in Ø	8 ✓
	ANGLE	45°	8 ✓
Delivery Valve Gasket 			
	L	3.984 mm / .157 in	
	OD	14.010 mm / .552 in Ø	
	ID	13.654 mm / .538 in Ø	
	Material Thickness	0.177 mm / .007 in	

Barrel

6





OD #1	23.959 mm / .944 in	∅	32 ✓
OD #2	16.670 mm / .6568 in	∅	32 ✓
OD #3	12.182 mm / .480 in	∅	32 ✓
ANGLE #1	15°		
# 2	30°		
ID #1	14.979 mm / .5902 in	∅	16 ✓
* ID #2	10.010 mm / .3944 in	∅	8 ✓

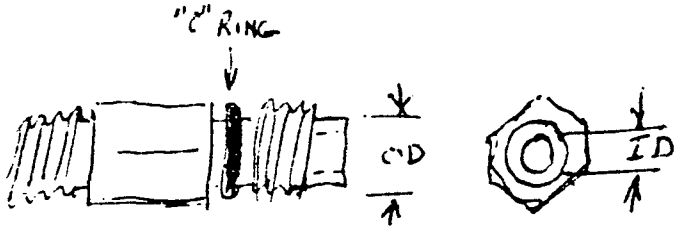
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#6

VISUAL

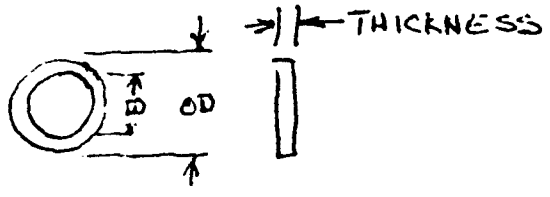
SURFACE FINISH ✓

Delivery Valve Holder



OD	13.578 mm / .535 in	⌀	63 ✓
ID	9.355 mm / .3686 in	⌀	32 ✓

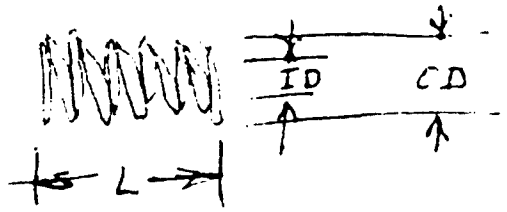
Washer



OD	7.804 mm / .3075 in	⌀	
ID	4.923 mm / .194 in	⌀	
THICKNESS	0.720 mm / .0284 in		32 ✓

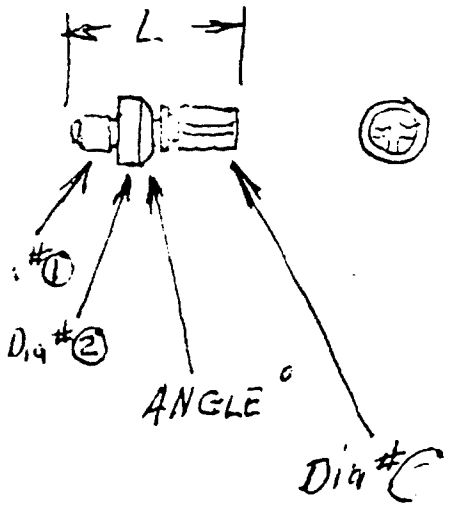
#6

Delivery Valve Spring



L	19.923 mm / .785 in	
OD	7.449 mm / .2935 in	⌀
ID	7.461 mm / .294 in	⌀
Wire Dia.	1.192 mm / .047 in	

Delivery Valve



L	17.360 mm / .684 in		
Dia #①	4.703 mm / .1853 in	⌀	32 ✓
Dia #②	7.487 mm / .295 in	⌀	32 ✓
ANGLE	45°		16 ✓
* Dia #③	6.000 mm / .2364 in	⌀	8 ✓

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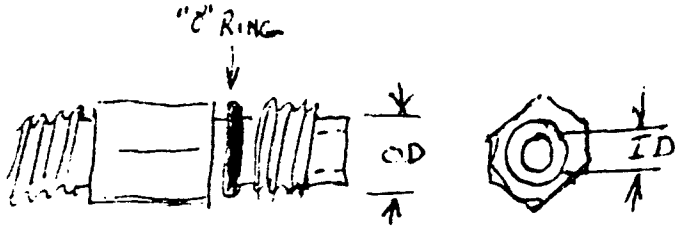
#5



VISUAL

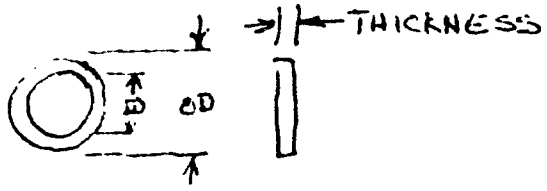
SURFACE FINISH ✓

Delivery Valve Holder



OD	13.616 mm ∅ / .5365 in ∅	63 ✓
ID	9.352 mm ∅ / .3685 in ∅	32 ✓

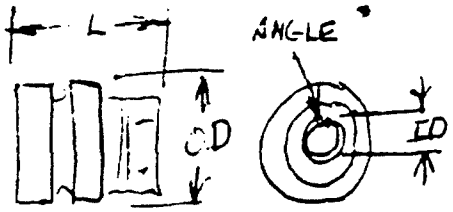
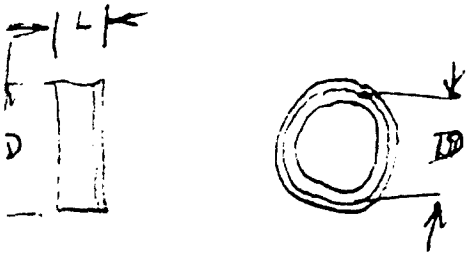
Washer



OD	7.791 mm ∅ / .307 in ∅	
ID	4.923 mm ∅ / .194 in ∅	
THICKNESS	0.718 mm / .0283 in	32 ✓

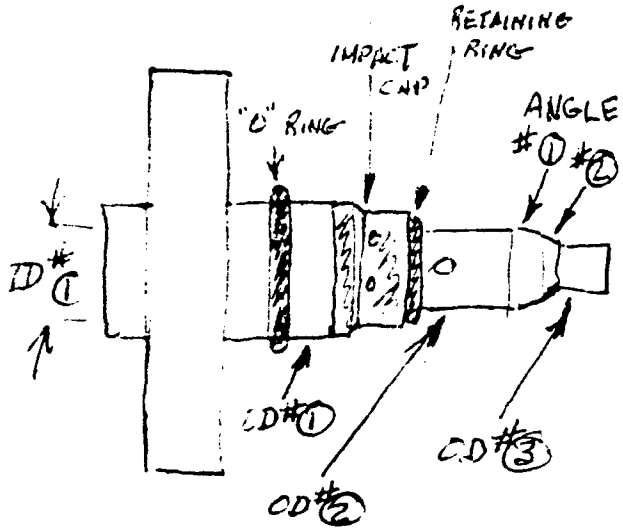
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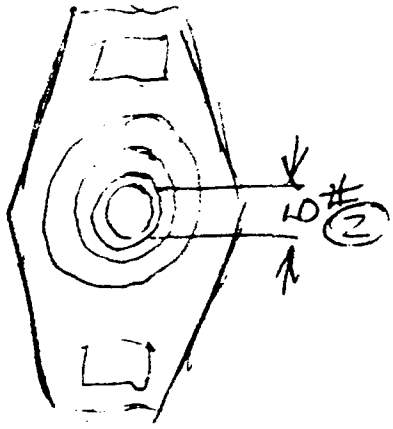
#5

				VISUAL SURFACE FINISH
Delivery Valve Body				
	*	L	11.987 mm ,4723 in	16
		OD	13.807 mm Ø ,544 in	32
		ID	6.002 mm Ø ,2365 in	8
		ANGLE	45°	16
Delivery Valve Gasket				
		L	3.807 mm ,150 in	
		OD	13.832 mm Ø ,545 in	
		ID	13.553 mm Ø ,534 in	
		Material Thickness	0.177 mm ,007 in	

Barrel

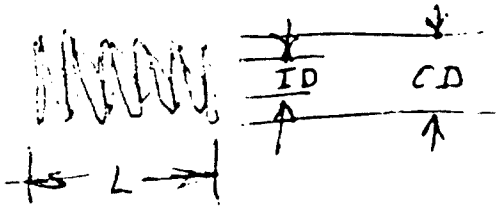
#5





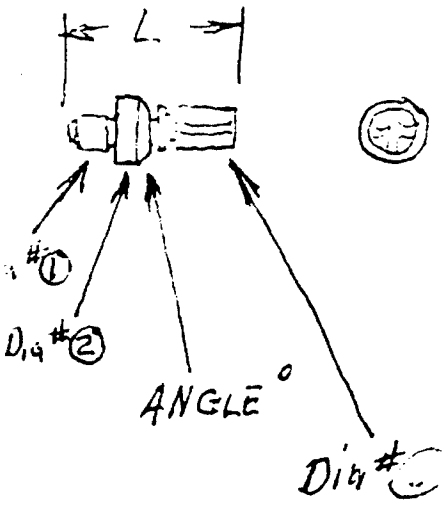
OD #1	23.959 mm ,944 in	⌀	32
OD #2	16.667 mm ,6567 in	⌀	32
OD #3	12.187 mm ,4802 in	⌀	32
ANGLE #1	15°		
# 2	30°		
ID #1	14.979 mm ,5902 in	⌀	16
* ID #2	10.005 mm ,3942 in	⌀	8

Delivery Valve Spring



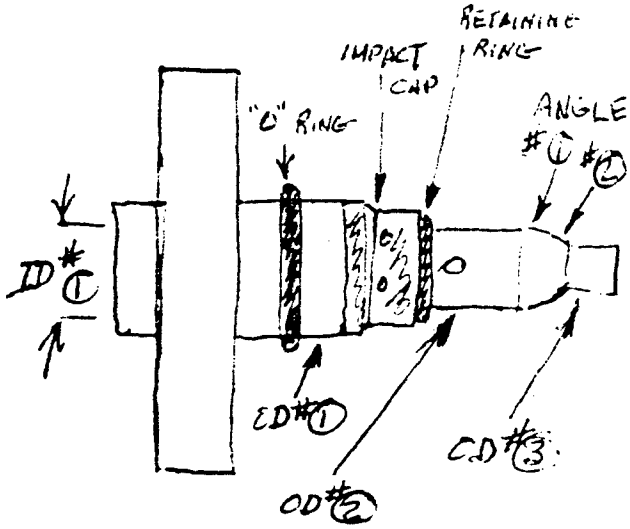
L	19.898 mm ,784 in	# 5
OD	7.461 mm Ø ,294 in Ø	
ID	4.818 mm Ø ,193 in Ø	
Wire Dia.	1.192 mm ,047 in	

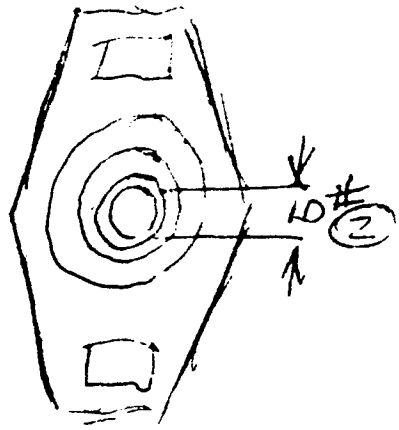
Delivery Valve



L	17.411 mm ,686 in	63 ✓
Dia #1	4.682 mm Ø ,1845 in Ø	✓
Dia #2	7.454 mm Ø ,2937 in Ø	32 ✓
ANGLE	45°	16 ✓
* Dia #3	5.992 mm Ø ,2361 in Ø	16 ✓

Barrel





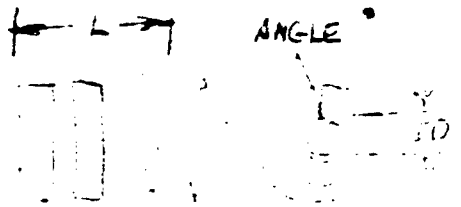
#2

CD #1	23.967 mm / .9443 in	⌀	32
CD #2	16.675 mm / .1657 in	⌀	32
CD #3	12.190 mm / .4803 in	⌀	32
ANGLE #1	15°		
# 2	30°		
ID #1	14.974 mm / .5902 in	⌀	10
* ID #2	10.007 mm / .3943 in	⌀	8

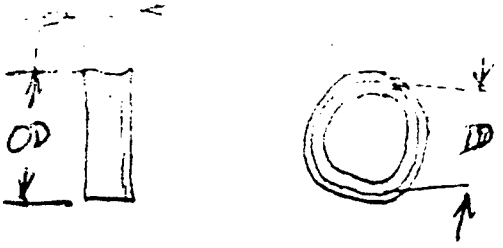
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#2

Delivery Tube Rig



L	12.030 in ,474 in
OD	13.792 mm Ø ,5437 in Ø
	6.007 .2367
ANGLE	45°



L	3.807 ,150 in
OD	13.883 mm Ø ,547 in Ø
ID	13.527 mm Ø ,533 in Ø
Material Thickness	0,177 mm ,007 in

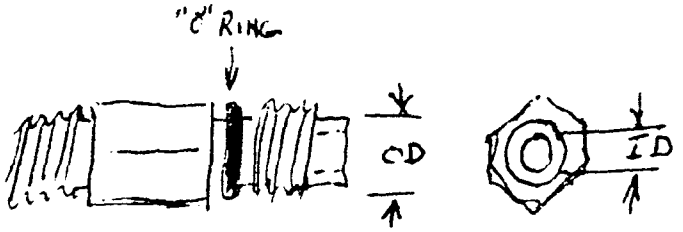
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#1

VISUAL

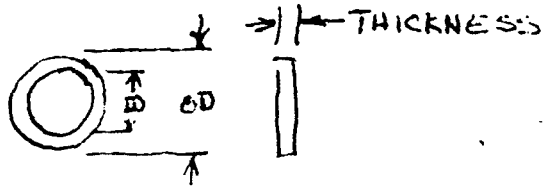
SURFACE FINISH

Delivery Valve Holder



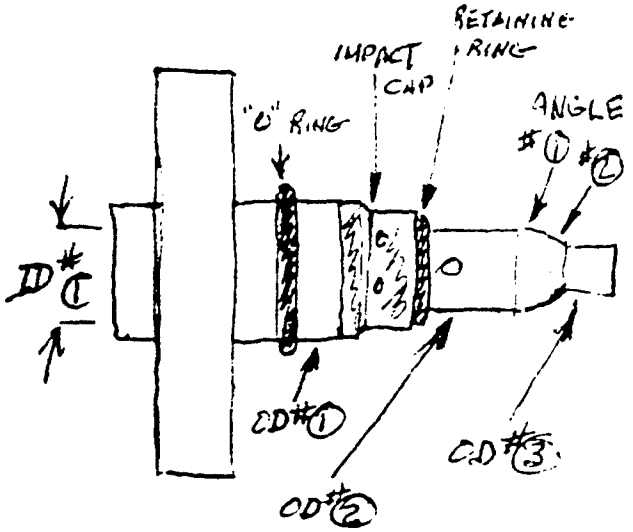
OD	13.758 mm / .535 in ⌀	63 ✓
ID	9.350 mm / .3684 in ⌀	63 ✓

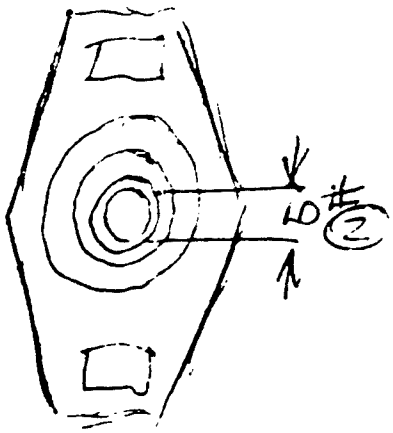
Washer



OD	7.817 mm / .308 in ⌀	
ID	7.461 mm / .294 in ⌀	
THICKNESS	0.685 mm / .027 in	32 ✓

Barrel



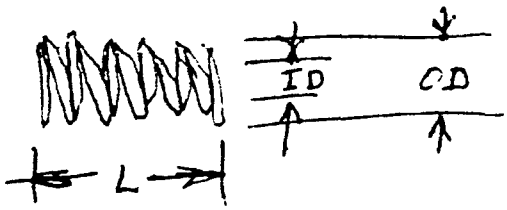


#1

OD #1	23.967 mm / .9443 in	⌀	32 ✓
OD #2	16.667 mm / .6567 in	⌀	32 ✓
OD #3	12.187 mm / .4802 in	⌀	32
ANGLE #1	15°		
# 2	30°		
LD #1	14.974 mm / .5902 in	⌀	16 ✓
* ID #2	10.007 mm / .3943 in	⌀	8 ✓

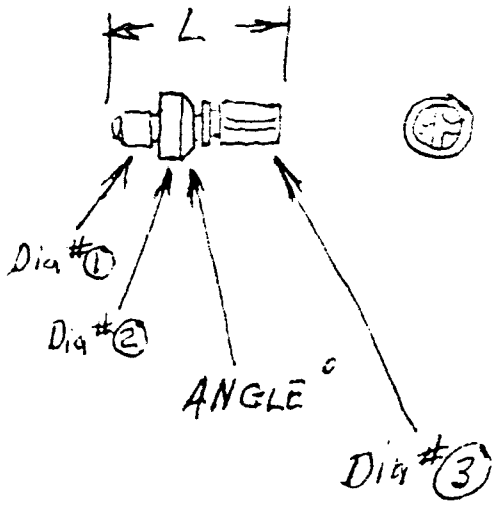
Delivery Valve Spring

#1



L	19.796 mm / .780 in	
OD	7.436 mm / .293 in Ø	
ID	4.873 mm / .192 in Ø	
Wire Dia.	1.167 mm / .046 in Ø	

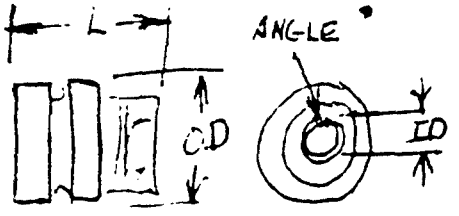
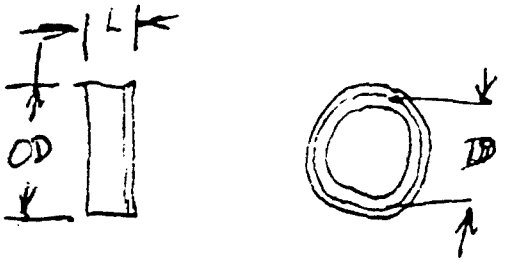
Dilivery Valve



L	17.352 mm / .6837 in	63 ✓
Dia #1	4.695 mm / .185 in Ø	32 ✓
Dia #2	7.444 mm / .2933 in Ø	16 ✓
ANGLE	45 °	16 ✓
Dia #3	6.000 mm / .2364 in Ø	

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#1

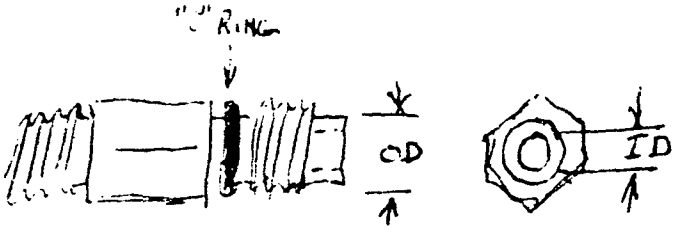
				LYSCH SURFACE FINISH
Delivery Valve Body 	*	L	12.626 mm / .4975 in	16
		OD	13.812 mm / .5442 in Ø	32
		ID	6.007 mm / .2367 in Ø	8
		ANGLE	45 °	8
Delivery Valve Gasket 		L	3.807 mm / .150 in	
		OD	13.908 mm / .548 in Ø	
		ID	13.553 mm / .534 in Ø	
		Material Thickness	0.177 mm / .007 in	

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#4

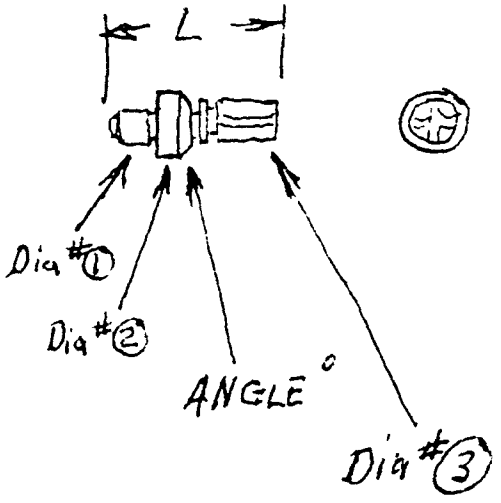
VISUAL

Delivery Valve Holder



OD	13.758 mm / .535 in	∅	63 ✓
ID	9.352 mm / .3685 in	∅	63 ✓

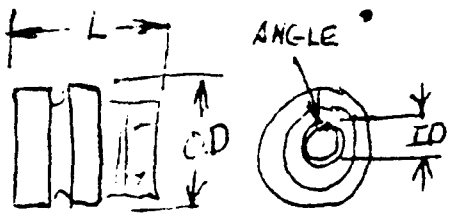
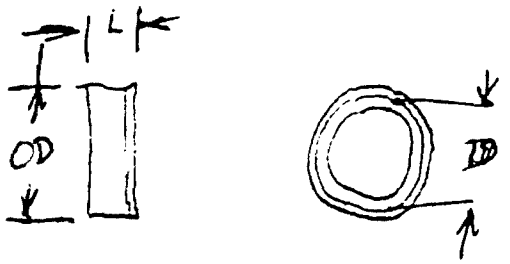
Dilivery Valve



L	.681 mm / in		
Dia #1	.1843 mm / in	∅	63 ✓
Dia #2	.2923 mm / in	∅	32 ✓
ANGLE	45°		16 ✓
* Dia #3	.2362 mm / in	∅	16 ✓

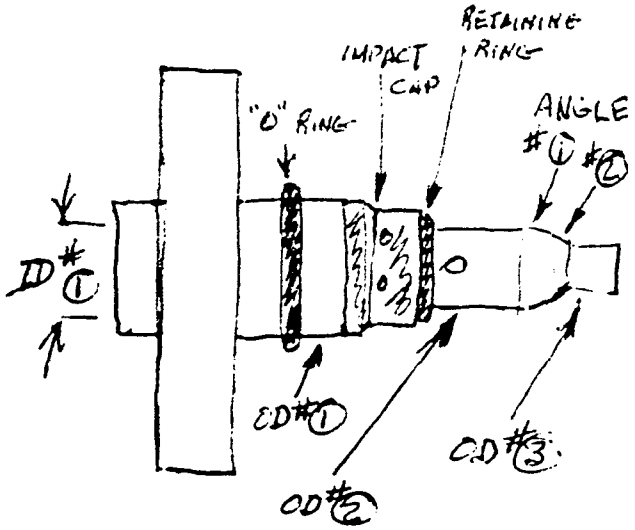
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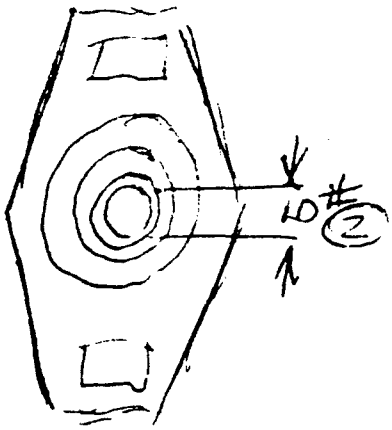
#3

Delivery Valve Body 	*	L	12.000 mm .4728 in	16
		OD	13.814 mm Ø .5443 in	32
		ID	6.010 mm Ø .2368 in	8
		ANGLE	45°	8
Delivery Valve Gasket 		L	3.807 mm .150 in	
		OD	13.908 mm Ø .548 in	
		ID	13.553 mm Ø .534 in	
		Material Thickness	0.177 mm .007 in	

Barrel

#3

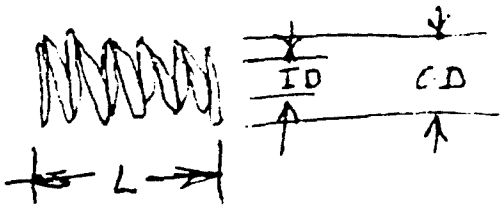




OD #1	23.959 mm / .944 in	∅	32 ✓
OD #2	16.667 mm / .6567 in	∅	32 ✓
OD #3	12.190 mm / .4803 in	∅	32 ✓
ANGLE #1	15°		
# 2	30°		
ID #1	14.979 mm / .5902 in	∅	16 ✓
* ID #2	10.015 mm / .3946 in	∅	8 ✓

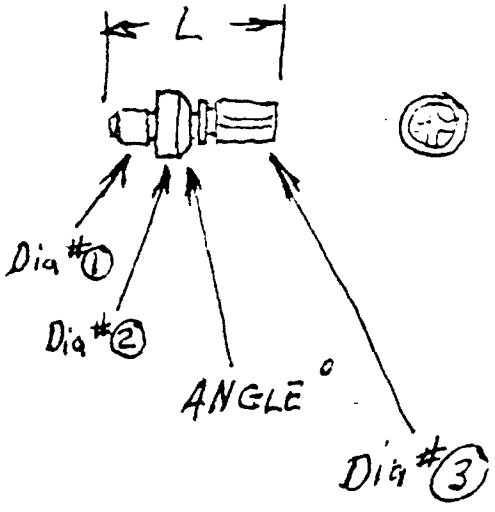
#3

Delivery Valve Spring



L	20.00 mm / .788 in	
OD	7.436 mm / .293 in	∅
ID	4.873 mm / .192 in	∅
Wire Dia.	1.218 mm / .048 in	

Dilivery Valve



L	17.335 mm / .683 in		
Dia #1	4.680 mm / .1844 in	∅	63 ✓
Dia #2	7.454 mm / .2937 in	∅	32 ✓
ANGLE	45 °		16 ✓
* Dia #3	5.997 mm / .2363 in	∅	16 ✓

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #6
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED

PART #6

PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
.0137 Ø 4PLCS.	(1) .0137		NO CARBON
	(2) .0137		APPEARING ON
	(3) .0137		THESE 4 holes
	(4) .0137		
NOZZLE PARTS			
FOR #6			
PART #ADB-1[illegible]-20[illegible]-7			
LARGE Ø	.575		
SMALL Ø	.355/.359		
HOLE Ø	.1774		

INSPECTOR	PAGE NO.	NO. OF PGS.
RICHARD MELANSHEK 21 FEB 1987	1	1

STA Form 23
1 Dec 82

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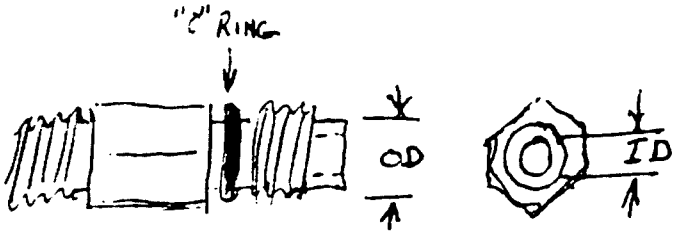
#3



VISUAL

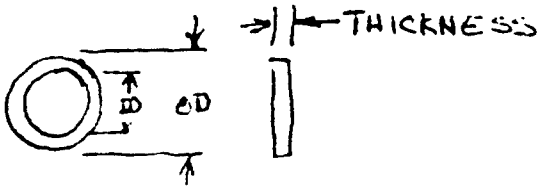
SURFACE FINISH

Delivery Valve Holder



OD	13.604 mm / .536 in ⌀	63
ID	9.355 mm / .3686 in ⌀	32

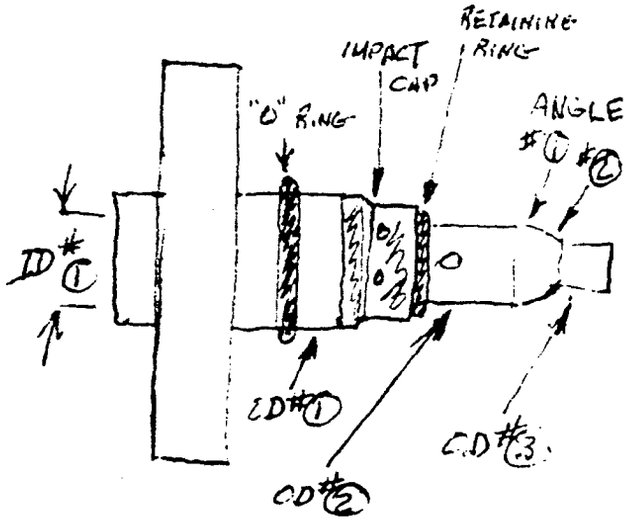
Washer

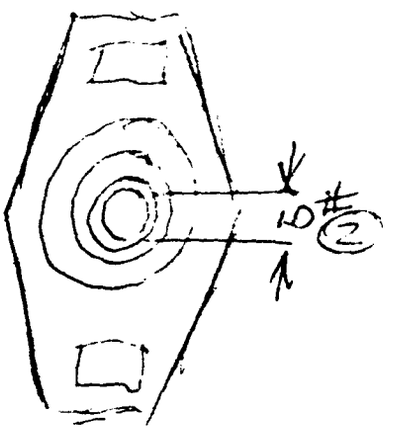


OD	7.802 mm / .3074 in ⌀	
ID	4.923 mm / .194 in ⌀	
THICKNESS	0.710 mm / .028 in	32

Barrel

#4



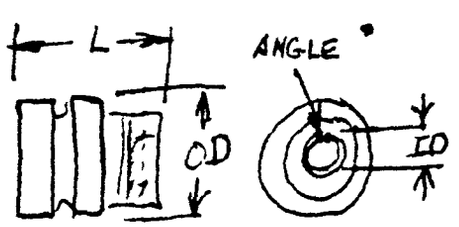


OD #1	23.959 mm / .944 in	⌀	32 ✓
OD #2	16.664 mm / .6566 in	⌀	32 ✓
OD #3	12.190 mm / .4803 in	⌀	32 ✓
ANGLE #1	°		
# 2	°		
ID #1	14.979 mm / .5902 in	⌀	16 ✓
* ID #2	10.012 mm / .3945 in	⌀	8 ✓

#4

VISUAL SURFACE FINISH

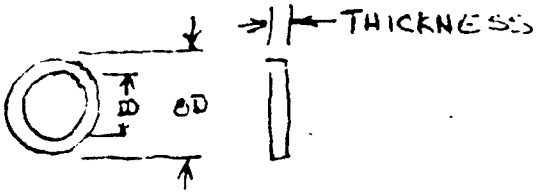
Delivery Valve Body



L	11.959 mm / .4712 in		16 ✓
OD	13.819 mm / .5445 in	⌀	32 ✓
* ID	6.002 mm / .2365 in	⌀	8 ✓
ANGLE	45 °		8 ✓

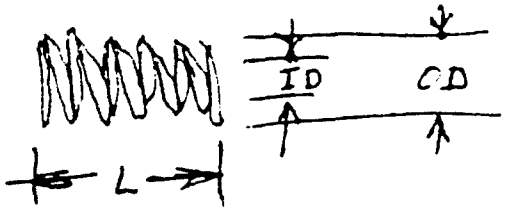
#2

Washer



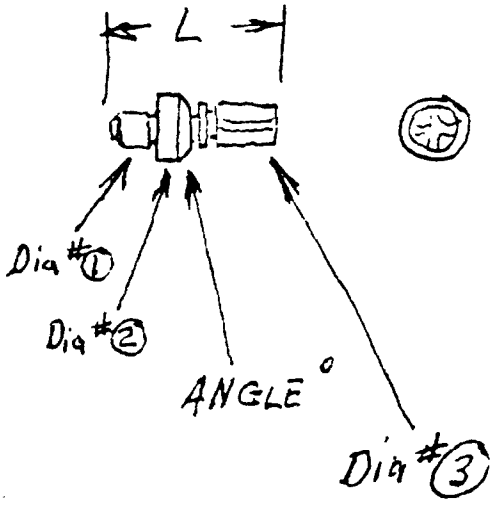
OD	7,817 mm ϕ ,308 in ϕ	
ID	4,923 mm ϕ ,194 in ϕ	
THICKNESS	0,710 mm ,028 in	32

Delivery Valve Spring



L	19,847 mm ,782 in
OD	7,449 mm ϕ ,2935 in ϕ
ID	4,898 mm ϕ ,193 in ϕ
Wire Dia.	1,167 mm ,046 in

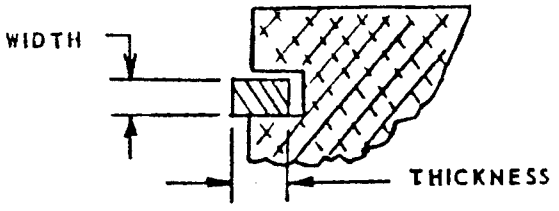
Dilivery Valve



	L	17,335 mm ,683 in	
	Dia #1	4,677 mm ϕ ,1843 in ϕ	✓
	Dia #2	7,487 mm ϕ ,295 in ϕ	✓
	ANGLE	45°	
*	Dia #3	5,997 mm ϕ ,2363 in ϕ	✓ ▲

PISTON RING THICKNESS AND WIDTH
(LAB. SOP.)

DATE	SHEET OF
2 1 [illegible] 7	1 of 1
ENGINE NO. 466T2	WORK ORDER
RECORDED BY MLEANSHEK	CHECKED BY MELANSHEK

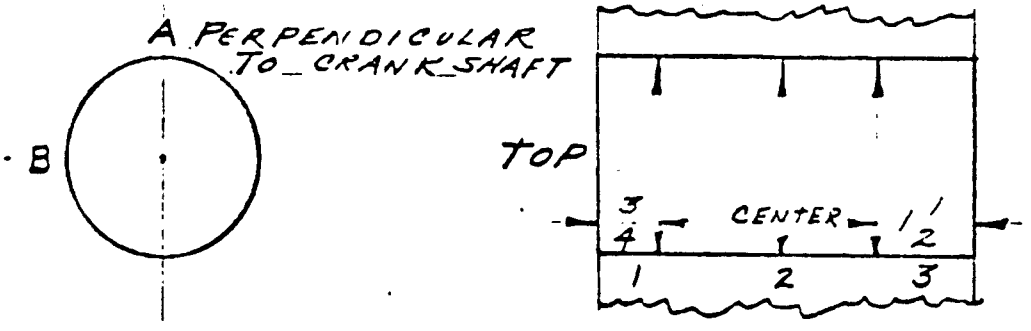


CYL. NO.		THICKNESS RING NO.						WIDTH RING NO.					
		TOP	2	3	4	5	6	TOP	2	3	4	5	6
#1	MAX.	.176	.175	.180	.174	.180	.182	.117	.115	.114	.115	.115	.117
	MIN.												
#2	MAX.	.176	.177	.177	.178	.178	.179	.116	.116	.116	.116	.116	.117
	MIN.												
	MAX.												
	MIN.												
	MAX.												
	MIN.												
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	MAX.												
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	MAX.												
	MIN.												

TAC FORM 4534 F
22 JUL 60

CYLINDER LINER BORES

DATE	SHEET OF
1-25-87	1 1
ENGINE NO 466T2	SERIAL NO.
RECORDED BY M. MESSINA	CHECKED BY R. MELANSHEK

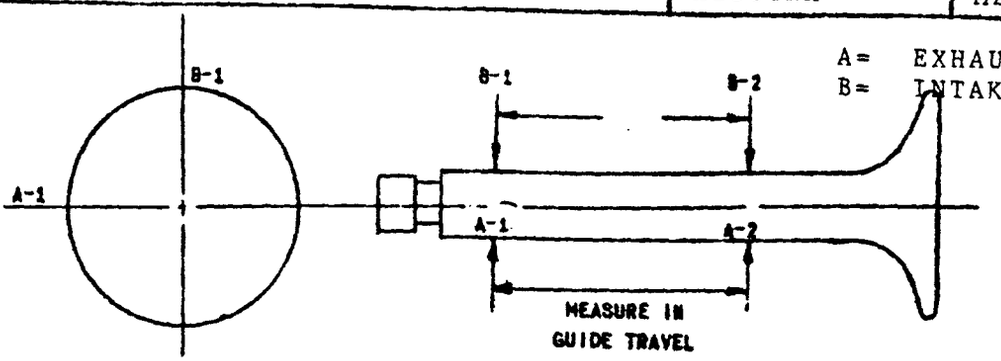


CYL NO.	LOC.	POSITION 1	2	3	TAPER	REMARKS
1	A	4.3004	4.3006	4.3004		
RAC	B					
	OR					
	A	4.3005	4.3005	4.3009		
	B					
	OR					
	A	4.3005	4.3007	4.3005		
	B					
	OR					
	A	4.3007	4.3008	4.3011		
	B					
	OR					
	A	4.3004	4.3008	4.3010		
	B					
	OR					
	A	4.3006	4.3008	4.3011		
	B					
	OR					

25 FEB 1987

EXHAUST AND INTAKE VALVE STEM DIMENSIONS
(LAB SOP)

DATE	SHEET
2-21-97	1 OF 1
ENGIUE NO.	WORK ORDER
RECORDED BY: MESSINA	CHECKED BY: MESSINA



A= EXHAUST
B= INTAKE

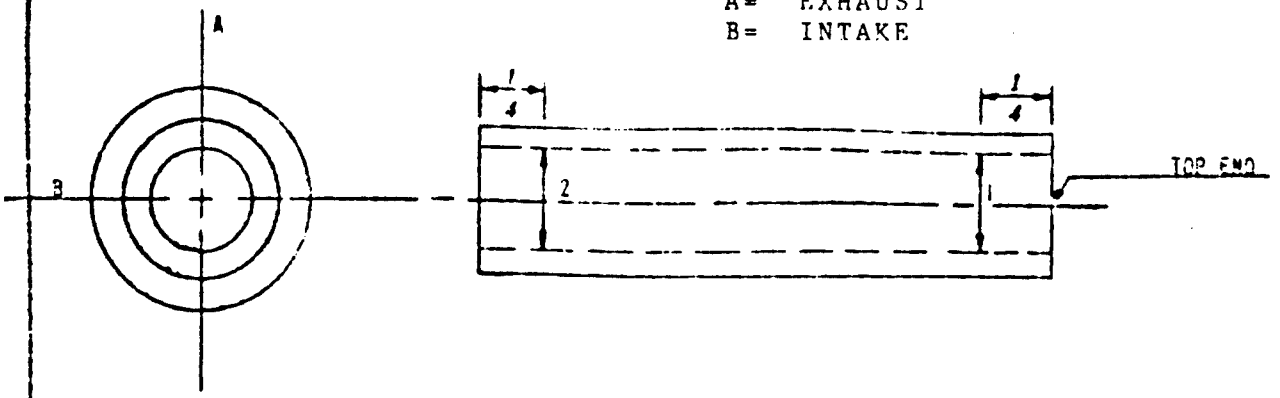
CYL. NO.	LOC.	POSITION 1	POSITION 2	TAPER
EXH. # 1	A	.3720	3717	
	B			
	OR			
INT. # 1	A	.3720	.3720	
	B			
	OR			
EXH. # 2	A	.3720	.3719	
	B			
	OR			
INT. # 2	A	.3720	.3720	
	B			
	OR			
EXH. # 3	A	.3720	.3718	
	B			
	OR			
INT. # 3	A	.3718	.3719	
	B			
	OR			
EXH. # 4	A	.3720	.3715	
	B			
	OR			
INT. # 4	A	.3720	.3720	
	B			
	OR			
EXH. # 5	A	.3721	.3715	
	B			
	OR			
INT. # 5	A	.3719	.3718	
	B			
	OR			
EXH. # 6	A	3720	3718	
	B			
	OR			
INT. # 6	A	.3717	.3717	
	B			
	OR			

CYL. NO.	LOC.	POSITION 1	POSITION 2	TAPER
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			
EXH. #	A			
	B			
	OR			
INT. #	A			
	B			
	OR			

INTAKE VALVE GUIDE BORE DIMENSIONS
(LAB. SOP.)

DATE	SHEET 1 OF 1
2-21-87	
ENGINE NO.	WORK ORDER
RECORDED BY	CHECKED BY
MESSINA	MESSINA

A= EXHAUST
B= INTAKE



INTAKE

CYL. NO.	LOC.	POSITION TOP 1	POSITION BOTTOM 2	TAPER	CYL. NO.	LOC.	POSITION TOP 1	POSITION BOTTOM 2	TAPER
1	A	.3738			4	A	.3738		
	B	.3755				B	.3738		
	A					OR			
2	A	.3752			5	A	.3756		
	B	.3748				B	.3785		
	OR					OR			
3	A	.3747			6	A	.3758		
	B	.3758				B	.3749		
	OR					OR			
	A					A			
	B					B			
	OR					OR			
	A					A			
	B					B			
	OR					OR			
	A					A			
	B					B			
	OR								

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #1
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED 21 FEB 1987

PART #1

PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
.0137 Ø 4 PLCS	1. .0312		
	2. .0312		
	3. .0312		
	4. .0312		
PART ADB-150M-208-7			
LARGE Ø	.575		
SMALL Ø	.356/.357		
HOLE Ø	.1775		
NEEDLE PIN Ø	.1773		

INSPECTOR
RICHARD MELANSHEK

21 FEB 1987

PAGE NO. 1 | NO. OF PGS. 1



ETA Form 23
1 Dec 82

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #5
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED

PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
PART #5			
.0137 Ø 4 PLCS	(1) .0132		
	(2) .0132		
	(3) .0132		
	(4) .0132		
PART #ADB-150M-208-7			
LARGE Ø	.575		
SMALL Ø	355/358		
HOLE Ø	.1775		
NEEDLE PIN Ø	.1773		

INSPECTOR RICHARD MELANSHEK 81 ... 1987

PAGE NO. 1 | NO. OF PGS 1

STA Form 23
1 Dec 82

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #3
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED

PART #3

PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
.0137 ~~0~~ 4/PLCS	(1) .0132		
	(2) .0132		
	(3) .0132		
	(4) .0132		
NOZZLE PARTS			
FOR PART #3	SHIMS ARE MISSING		
PART #ADB-150-208-7			
LARGE ~~0~~	.575		
SMALL ~~0~~	.355/.357		
HOLE ~~0~~	.1774		
NEEDLE PIN ~~0~~	.1773		

INSPECTOR	PAGE NO.	NO. OF PGS.
RICHARD MELANSHEK 81 FEB 1987	1	1

DTA Form 23
1 Dec 82

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #4
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED

PART #4

PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
.0137 ,0 4 PLCS	1 .0132 Ø		
	2 .0132 Ø		
	3 .0132 Ø		
	4 .0132 Ø		
NOZZLE PARTS			
FOR #4	SHIMS ARE MISSING		
PART #ADB-150M-208-7			
LARGE Ø	.575		
SMALL Ø	.355/.358		
HOLE Ø	.1774		
NEEDLE PIN Ø	.1773		

INSPECTOR	PAGE NO.	NO. OF PGS.
RICHARD MELANSHEK 21 FEB 87	1	1

COMPONENT NAME FUEL INJECTION NOZZLE	INSPECTION REPORT	REPORT NUMBER PART #2
MANUFACTURER		SERIAL NUMBER
PART NUMBER	DRAWING NUMBER	REVISION DATEER

REVISION NUMBER	EX. ORDER NUMBER	JOB ORDER NUMBER	DATE COMPLETED

PART #2

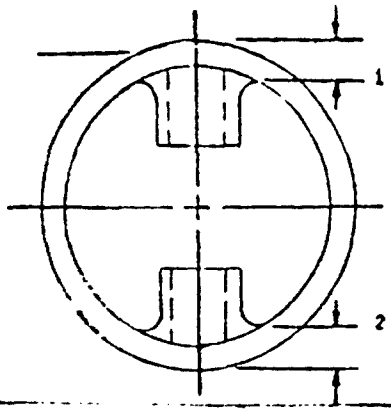
PRESCRIBED DIMENSION	ACTUAL DIMENSION	OUT OF TOLERANCE	REMARKS
.037 Ø 4/PLCS.	(1) .0132		
	(2) .0132		
	(3) .0132		
	(4) .0132		
NOZZLE PARTS			
FOR #2			
SHIMS ARE MISSING			
PART #ADB-150M-208-7			
LARGE Ø	.575		
SMALL Ø	.356/.357		
HOLE Ø	.1774		
NEEDLE PIN Ø	.1773		

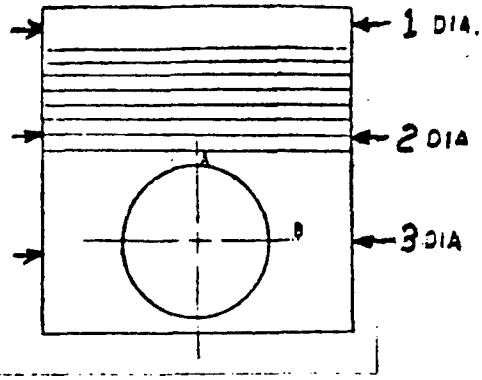
INSPECTOR	PAGE NO.	NO. OF PGS.
RICHARD MELANSHEK 21 FEB 1987	1	1

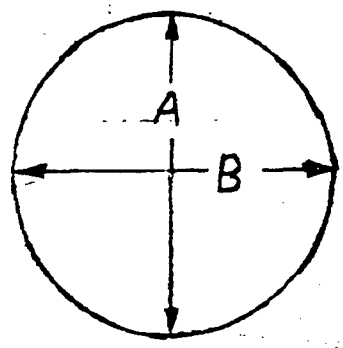
STA Form 23
1 Dec 82

PISTON PIN BORE & PISTON OD.

DATE: 21 Feb 87	SHEET 1 OF 1
ENGINE NO.: 466T2	WORK ORDER:
RECORDED BY: R. MELANSHEK	CHECKED BY: R. MELANSHEK







#	PISTON PIN BORE	TAPER	AVG. DIA	PISTON OD.	1 DIA	2 DIA	3 DIA
1 with carbon on	A1 A2			A	4.2342	4.2478	4.2933
	B1 B2			B	4.2460	4.2480	4.2873
	OR OR			OR	.0118	.0002	.0040
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
# 2 CLEAN	A1 A2			A	4.2308	4.2478	4.2860
	B1 B2			B	4.2318	4.2477	4.2950
	OR OR			OR	.0010	.0001	.0090
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			
	A1 A2			A			
	B1 B2			B			
	OR OR			OR			



25 FEB 1987

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