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Technical Report

No. 13461

NATO FOREIGN DIESEL COMPARATIVE TEST PROGRAM
GM-MVO/MT883 ENGINE EVALUATION

MARCH 1991

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1991	Final Dec 88 to May 89

4. TITLE AND SUBTITLE
NATO Foreign Diesel Comparative Test Program
GM-MVO/MT883 Engine Evaluation

5. FUNDING NUMBERS
Contract
DAAE07-88-C-R052

6. AUTHOR(S)
Ellsworth C. Adams and Satyanarayana Kodali

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Tank-Automotive Command
ATTN: AMSTA-RGD
Warren, MI 48397-5000

8. PERFORMING ORGANIZATION REPORT NUMBER
13461

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
International Materiel Evaluation Division (AMCIP-IM)
Aberdeen Proving Ground, MD 21005

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Test and Evaluation Document distribution, limited to US Governement agencies only. Other requests for this document must be referred to USATACOM, ATTN: ASQNC-TAC-DIT

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A nominal 1100kW V12 diesel engine Model MT883, produced by Motoren-und Turbinen Union of West Germany, was tested at TACOM under the NATO Comparative Test Program (Nunn Amendment) for performance, fuel economy, acceleration, high fuel and air temperatures, high inlet and exhaust restrictions, and hi-sulphur DF-2/ Jet A fuel operation. The engine generated a peak power of 1093 kW (1465 bhp) at 3,000 rpm and a peak torque of 4456 Nm (3287 ft-lb) under NATO Standard Test conditions. General Motors Military Vehicles Operation (GM-MVO) is the American licensee for this engine and was the contractor providing the engine and support for the test.

14. SUBJECT TERMS Turbocharged Aftercooled Diesel Engine Dry Sump Lubrication System, Engine Performance, Fuel Consumption, Heat Rejection, Air Consumption

15. NUMBER OF PAGES 99

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLAS	UNCLAS	UNCLAS	SAR

PREFACE

Motoren und Turbinen Union Friedrichshafen (MTU-West Germany) is a subsidiary of Mercedes Benz. The MT880 series diesel engines are descended from the MB837 series of the mid-fifties and the MB870 series designed in the mid-sixties. The MB873 V12 diesel engine, at 1500 metric horsepower, powers the Leopard 2 West German main battle tank, and a V8 version is used in the the Korean Type 88 tank.

Each new series of engine has been designed for higher power density, and the 880 series uses short connecting rods and pistons to make a very compact basic engine power train, crankcase, and structure. Conventional materials and manufacturing methods are used, with mechanical and thermal loads at proven levels. Manifolds and accessories are located between and under the cylinder banks for a small, rectangular cross section. Accessories are gear driven and fluid lines use short piping runs with O-ring sealing for reliability and ease of maintenance.

The MT883 V12 engine first ran in 1979 with a precombustion chamber design, and this newer version has an open combustion chamber for lower fuel consumption and heat rejection. The result is a compact diesel engine at the 1100 kW level that will fit into the M1 tank powerpack space as proposed by General Motors Military Vehicles Operation.

This test was supervised and conducted by the U. S. Army Tank-Automotive Command (TACOM), RDE Center, Propulsion Systems Division, in Test Cell 3 of Building 212. The test started on 7 March 1989 and was completed on 5 May 1989. Thanks are expressed for the fine cooperation of Messrs. Horst Bernhardt and Meinrad Reisch of MTU and Larry Belna and Brian Braglia of GM MVO. Their excellent support in providing engine parts and supplies was also appreciated.

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1.0. INTRODUCTION

The Motoren-und Turbinen Union (MTU) engine evaluation was a part of the North Atlantic Treaty Organization (NATO) Comparative Test Program of heavy armored vehicle engines. General Motors Military Vehicles Operation (GM-MVO) was the American licensee for MTU (West Germany) and supplied this engine and support under contract with TACOM. Photographs of the bare engine are shown in Figures 1-1 and 1-2.

2.0. OBJECTIVE

The objective was evaluation of the MT883 diesel engine for comparison with other NATO source engines. This included lab performance testing under a variety of conditions and check of physical size, weight, etc.

3.0. CONCLUSIONS

3.1. Engine Power Output

As provided with the 1100 kW rating, the MTU diesel engine output under NATO test conditions on MIL-F-46162C (DF-2) fuel was:

1465 bhp (1093 kW) at 3000 r/min
3287 ft-lb (4456 Nm) torque at 2000 r/min

All of the testing was run on DF-2 fuel except one run, which was conducted on Jet A to simulate JP-8 fuel. At the request of GM-MVO, the fuel flow was set up to run one 3000 r/min point, and the output was:

1506 bhp (1123 kW), with no increase in exhaust smoke.

3.2. Engine Fuel Comsumption

The brake specific fuel consumption was:

0.371 lb/bhp-hr (226 g/kWh) at 3000 r/min power peak
0.347 lb/bhp-hr (211 g/kWh) at 2000 r/min torque peak

3.3. Heat Rejection

Heat rejection to the cooling system was 26 Btu/bhp-min up to 2600 rpm and increasing to 29 Btu/bhp-min at 3000 rpm.

3.4. New Engine Feature

The MTU engine had another feature to increase power output; coolant for the aftercoolers was run through a secondary radiator to further reduce intake air temperature and enhance specific output.

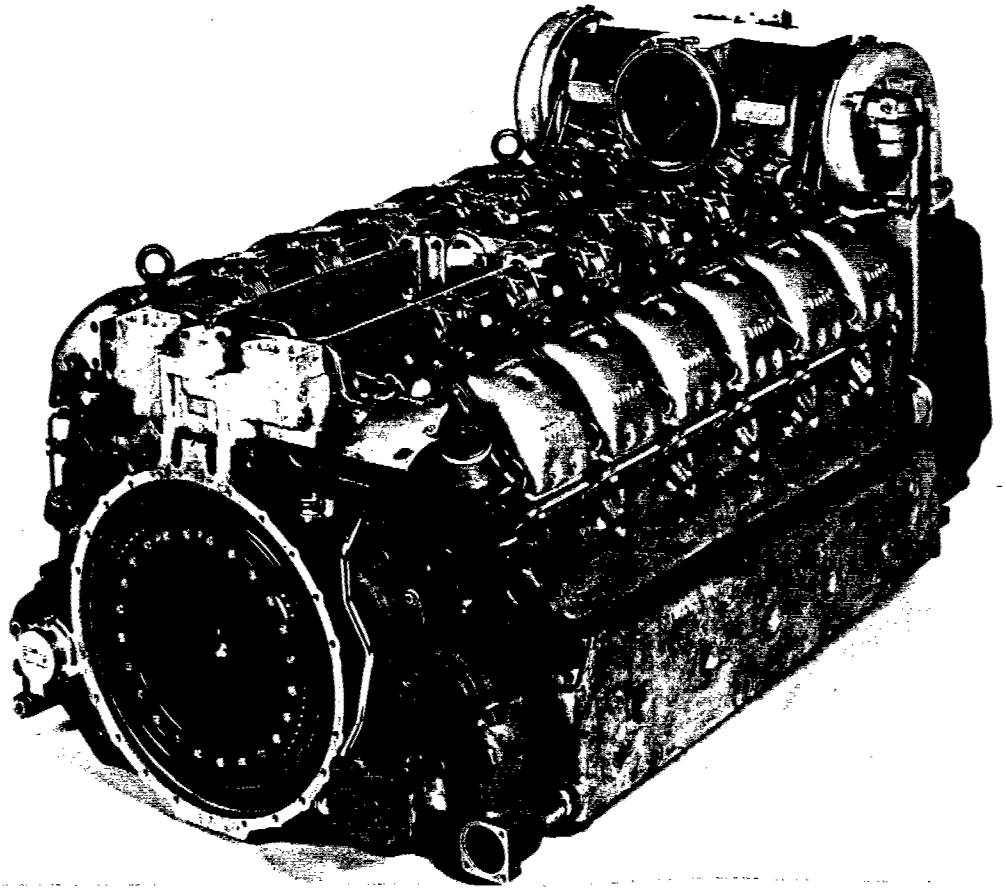


Figure 1-1. MTU MT883 V12 Diesel Engine - Flywheel (Rear) End

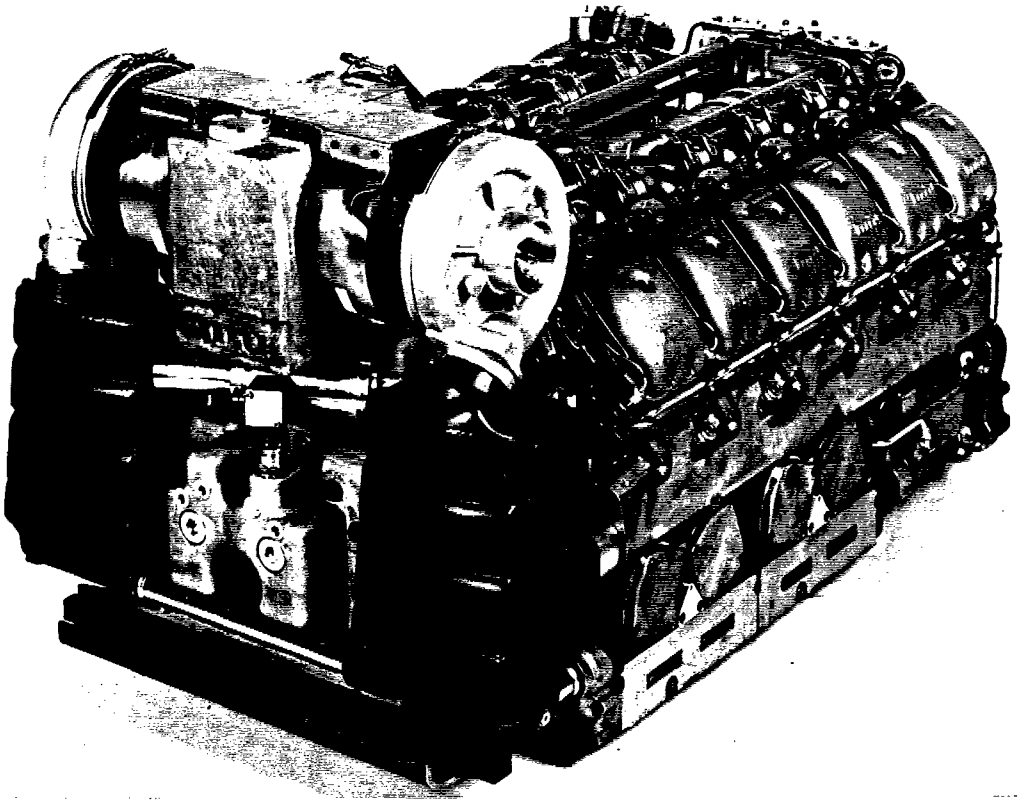


Figure 1-2. MTU MT883 V12 Diesel Engine - Damper (Front) End

3.5. Other Performance Run Conditions

Other performance runs were made with higher ambient temperatures, fuel temperatures, inlet air restriction, and exhaust restriction, as well as a part load matrix down to 25% load.

3.6. Power Runs with Typical Vehicle Temperatures

A set of power runs were made, using vehicle engine installation operating temperature parameters as provided by MTU.

3.7. Engine Performance on JP8 Fuel

On Jet A fuel (JP8), the power output at NATO standard conditions was:

1321 bhp (985 kW) at 3000 r/min and
2909 ft-lb (3944 Nm) torque at 2000 r/min.

3.8. Acceleration Tests on the Dynamometer

Acceleration tests were run with the Test Cell 3 dynamometer for comparison with other NATO engines to be run on the same dynamometer.

3.9. Engine Dimensions

Length	67.9 in.	1725 mm
Width	38.0 in.	965 mm
Height	29.7 in.(flywheel end)	754 mm
	35.0 in.(turboch. end)	889 mm
Volume	46.1 cu ft	1.31 cu-m

3.10. Engine Weight

The dry weight of the engine was 4200 lb (1909 kg) including starter, generator, front mount, coolant expansion tanks, fuel filter, and torque converter drive plate with starter ring gear.

4.0. RECOMMENDATIONS

The MT883 engine is a new generation, 12 cylinder diesel at the 1500 bhp level. An MTU 883 propulsion system will fit into the M1 tank powerplant space as proposed by GM-MVO, its American licensee. It features a very compact engine packaging configuration, electronic fuel control, turbocharging and aftercooling, and uses conventional materials and construction. Its fuel economy is very competitive with other modern high output diesels in the same power class. It is currently in development, with prototype engines running in Israeli Defense Force Merkava Mk 4 test vehicles, and on a NATO endurance test.

It is recommended that a complete MT883 propulsion system be evaluated as a candidate system, along with other powerpacks in the same power class, in any future powerpack studies.

5.0. DISCUSSION

5.1. Engine Description and Specifications

The MT883 is an 1100 kW, 12 cylinder, 90 degree vee, liquid cooled diesel engine. It features a direct injection combustion system, twin parallel flow turbochargers, and charge air cooling.

Basic engine specifications as furnished by MTU:

Engine model	MT883 Ka-500	
Displacement	27.36 liters	1670 cu in
Bore	144 mm	5.67 in
Stroke	140 mm	5.51 in
Engine rated speed	3000 r/min	
Power	1100 kW	1475 bhp
Mean effective pressure/power peak	16.1 bar	233 psi
Mean effective pressure/torque peak	18.5 bar	268 psi
Mean piston speed	14.0 m/s	2755 ft/mn
Compression ratio	14 to 1	
Low idle speed	1000 r/min	
Tactical idle	1400 r/min	
Max governed speed-no load	3300 r/min	
Cooling system capacity	189 litrs(aprx)	200 qt
Oil system capacity	70 liters	74 qt

5.2. Full-Load Performance, Heat Rejection, And Air Consumption

The last full performance run on 5 May 89 (Test 97) gave the best output:
1465 bhp (1093 kW) at 3000 r/min and
3287 ft-lb (4456 Nm) at 2000 r/min

Figures 5-1, 5-2, and 5-3 are the curve sheets for this run, and Figure 5-4 shows the heat rejection. The heat rejection to the cooling system was a typical 26 Btu/bhp-min up to 2600 rpm and then increased in a linear fashion to 29 Btu/bhp-min at 3000 rpm.

The first two full-load runs gave slightly less output. The increase in output with running time may reflect reduction of friction in the engine, which accumulated about 58 test hours. The earlier runs showed:

1452 bhp (1083 kW) 10 Mar 89 (test 25) with Merriam air consumption measurement.
1454 bhp (1085 kW) 24 Apr 89 (test 81) with MTU nozzles used for engine air consumption measurement.

The engine air consumption is shown in Figure 5-5. These curves were drawn using new calibration data for the Merriam laminar flow elements and the MTU furnished nozzles. These results are given with a standard air condition of 70F and 29.92 Hg pressure (21C and 760mm Hg). Figure 5-6 shows full and part-load air consumption.

Between run 25 (Merriam airflow measurement) and run 81 (MTU nozzle airflow measurement) the engine was rebuilt by MTU after the cylinder liner failure. In run 25, the bank-to-bank intake manifold pressure was quite even. In run 81 and run 97 (full-load heat rejection runs), the right bank manifold pressure was about 12% lower than the left bank (see Appendix B for the data), and the right bank airflow was down, as measured with the MTU nozzles. The left bank air consumption in this run showed reasonable aggreement with the Merriam results. Therefore, it appears that some bank-to-bank unbalance anomaly caused a reduction in the right bank air consumption. This was not serious, showing no significant effect on performance or exhaust smoke.

Thus it appears that the run 25 Merriam air consumption results are valid.

All the performance runs were made under NATO standard conditions, unless otherwise stated as follows:

Fuel MIL-F-46162C containing 1% sulphur	
Lubricant MIL-L-2104D 15W-40	
Coolant out temperature 96 C (205 F)	
Fuel Temperature 25 C (86 F)	
Inlet air depression (at rated power)	25 mbar (10" H2O)
Exhaust back pressure (at rated power)	40 mbar (16" H2O)
Inlet air temperature	25 C (77 F)
Coolant to aftercoolers (from MTU)	63 C (145 F)

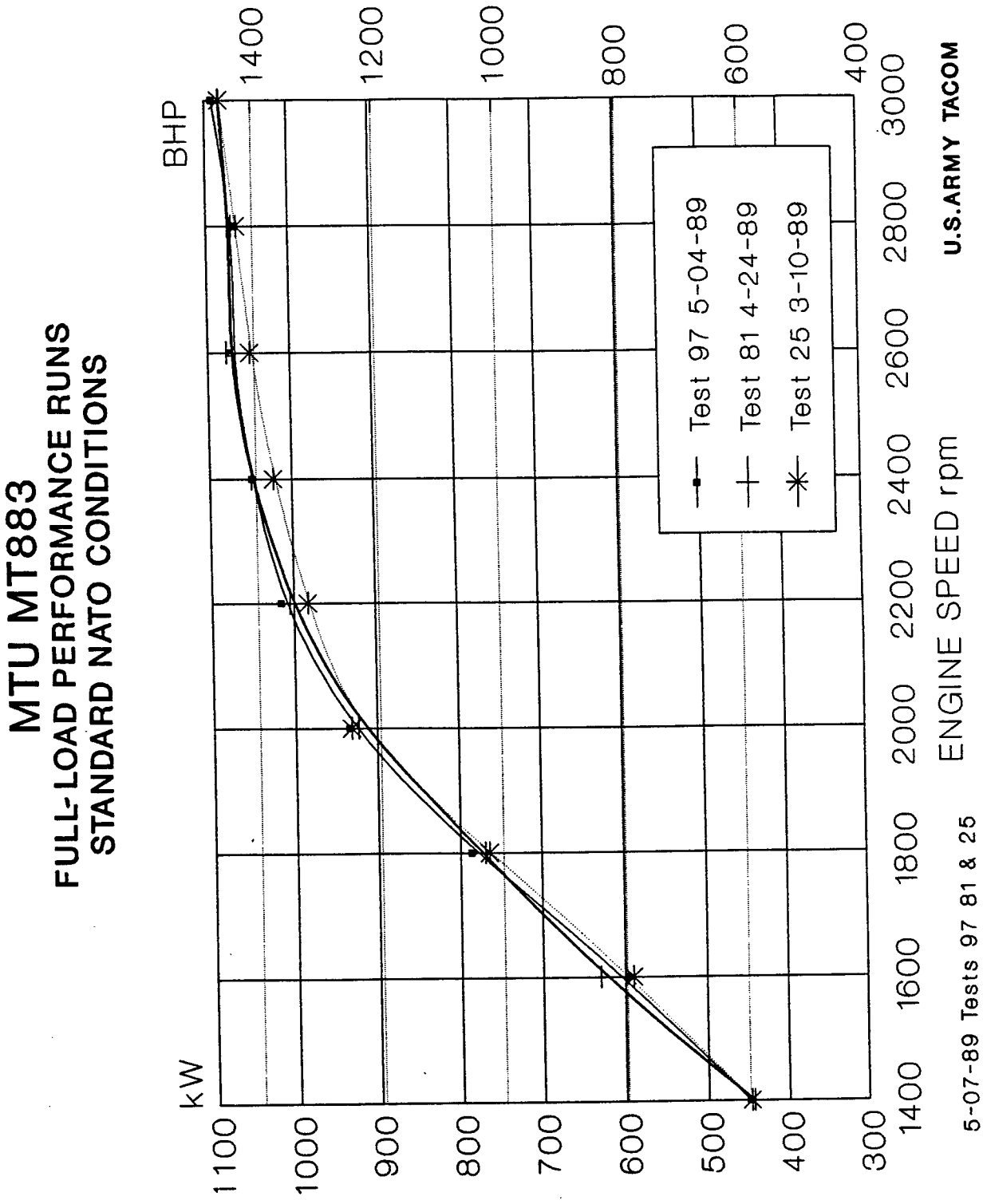


Figure 5-1. MTU MT883 Full-Load Performance, Brake Horsepower

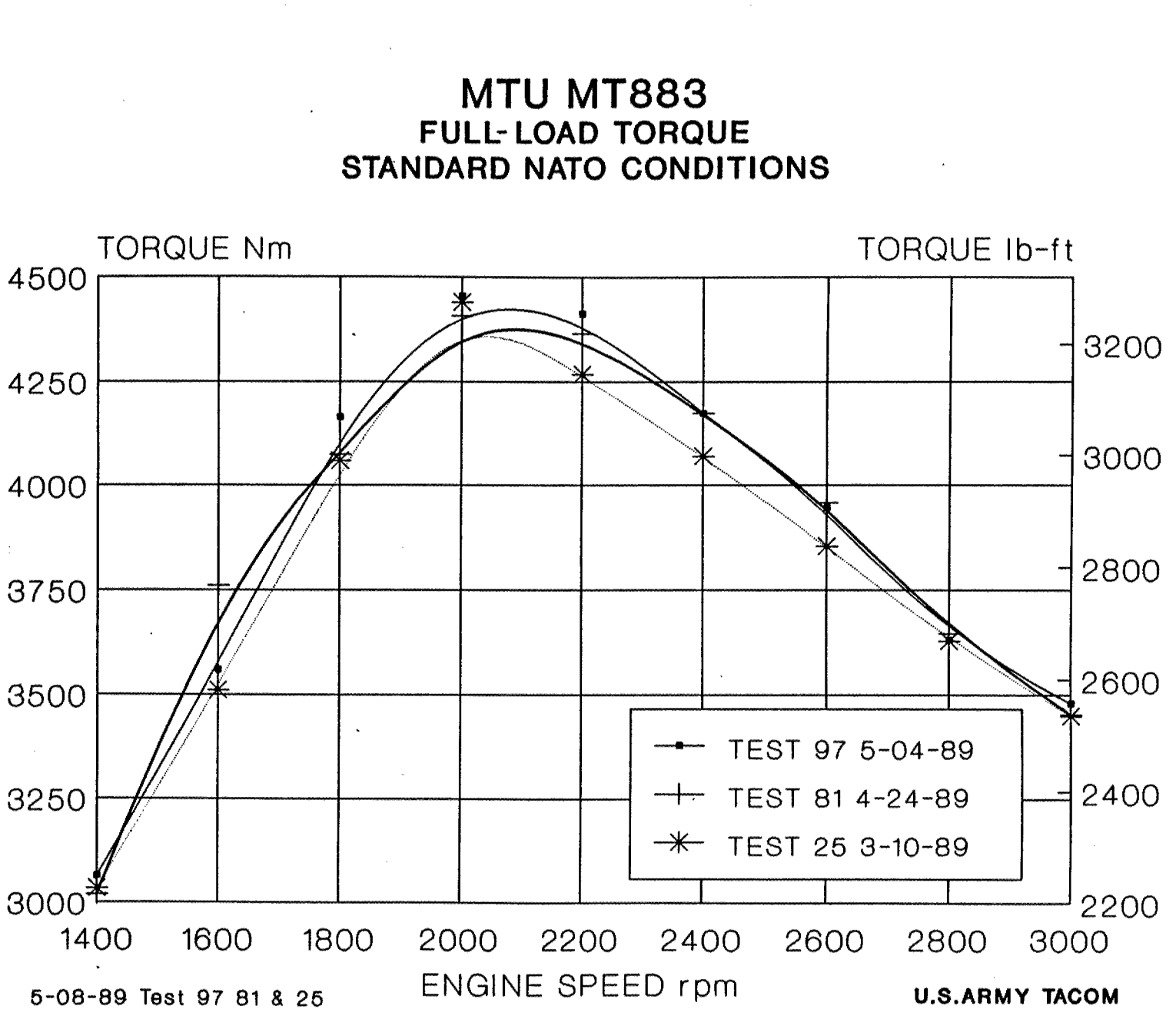


Figure 5-2. MTU MT883 Full-Load Performance, Torque

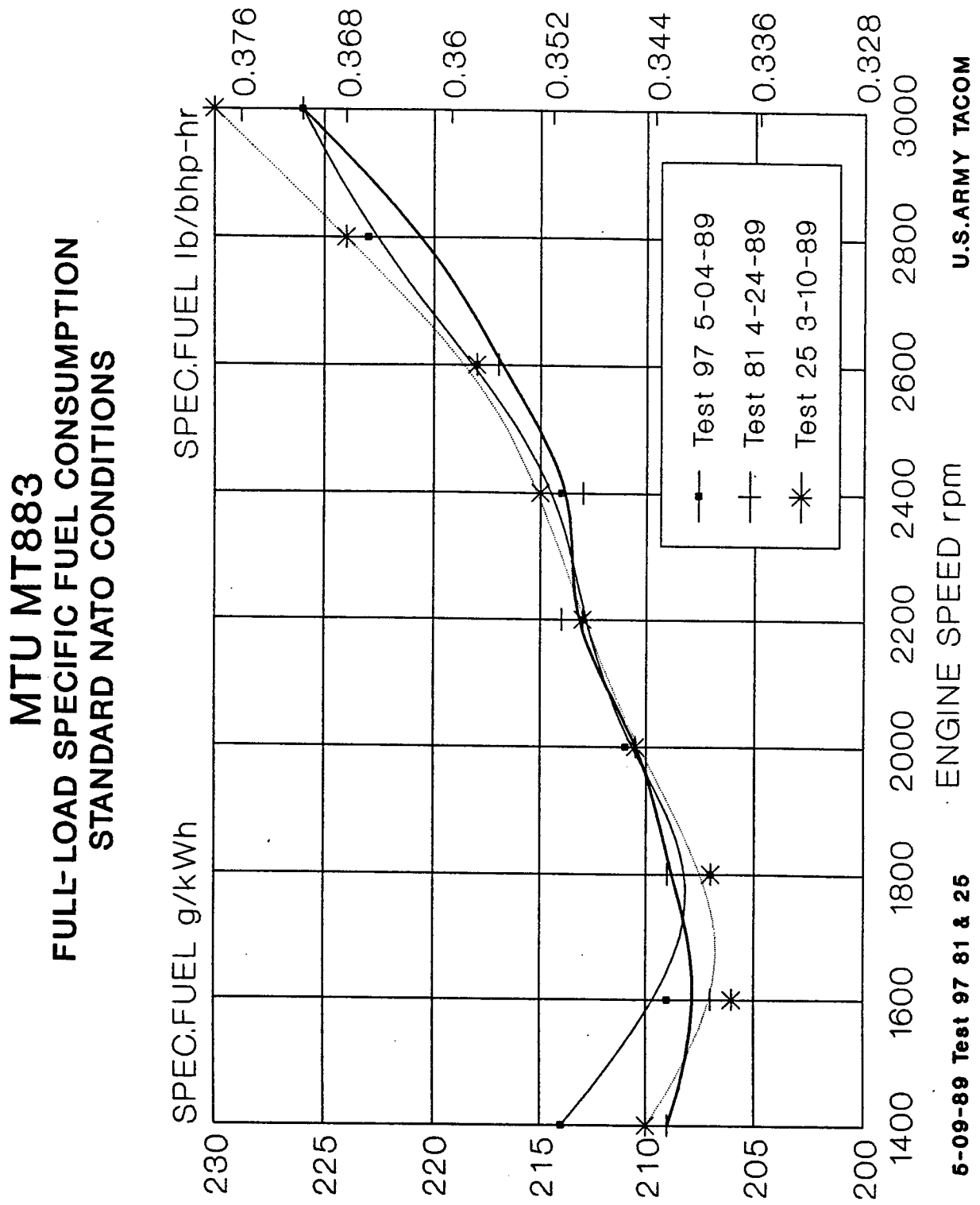


Figure 5-3. MTU MT883 Full-Load Brake Specifice Fuel Consumption

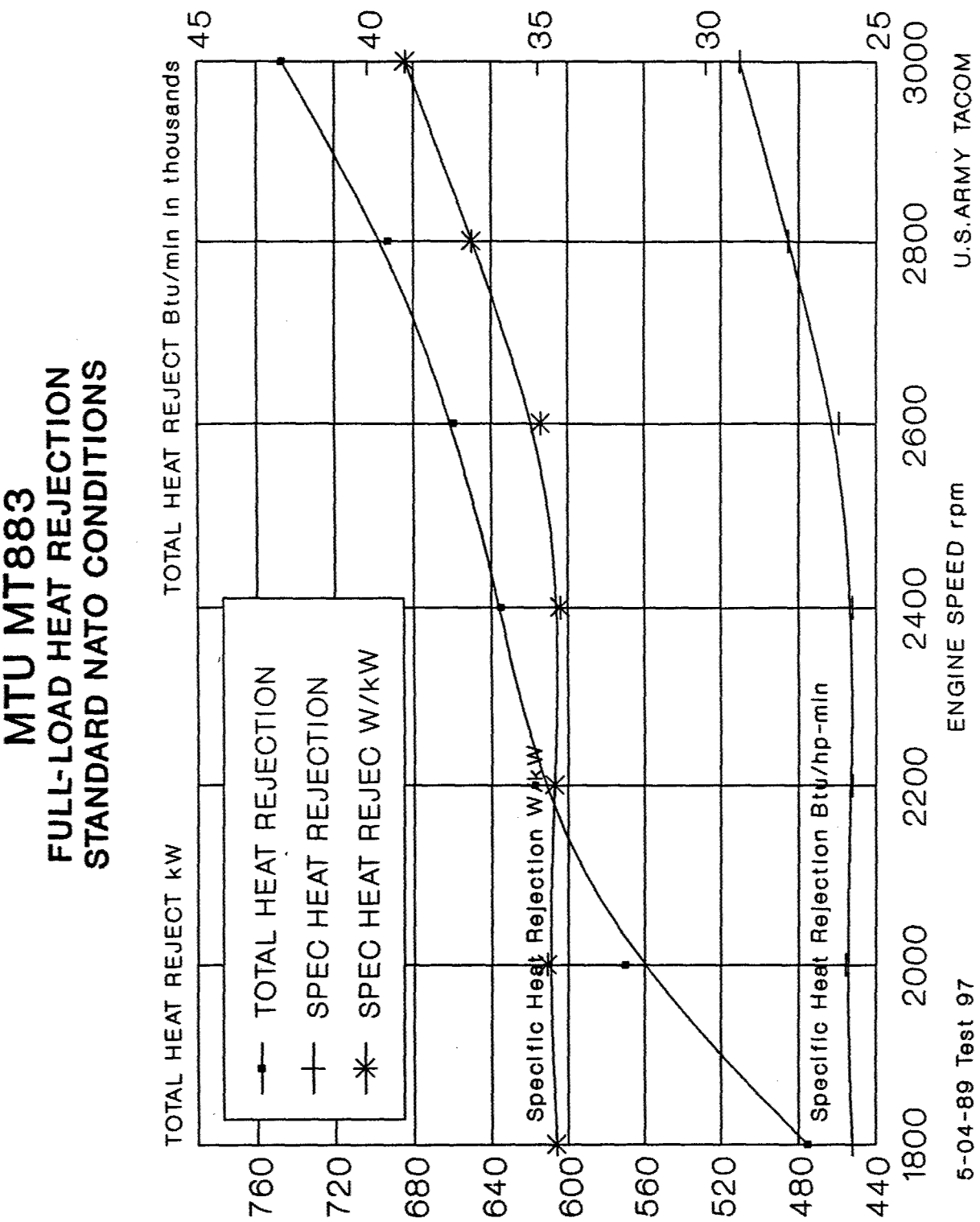


Figure 5-4. MTU MT883 Full-Load Heat Rejection to Coolant

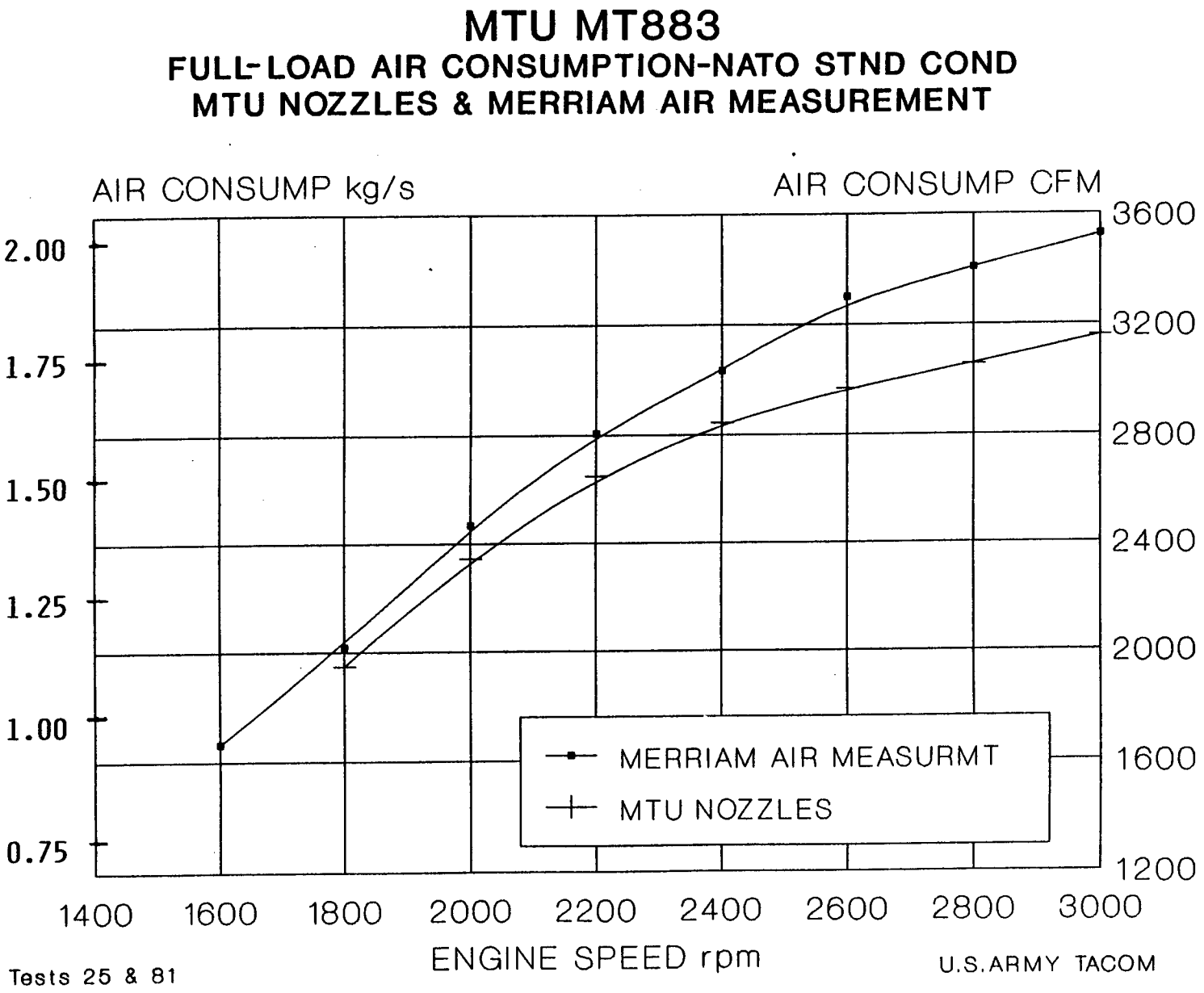


Figure 5-5. MTU MT883 Full-Load Air Consumption

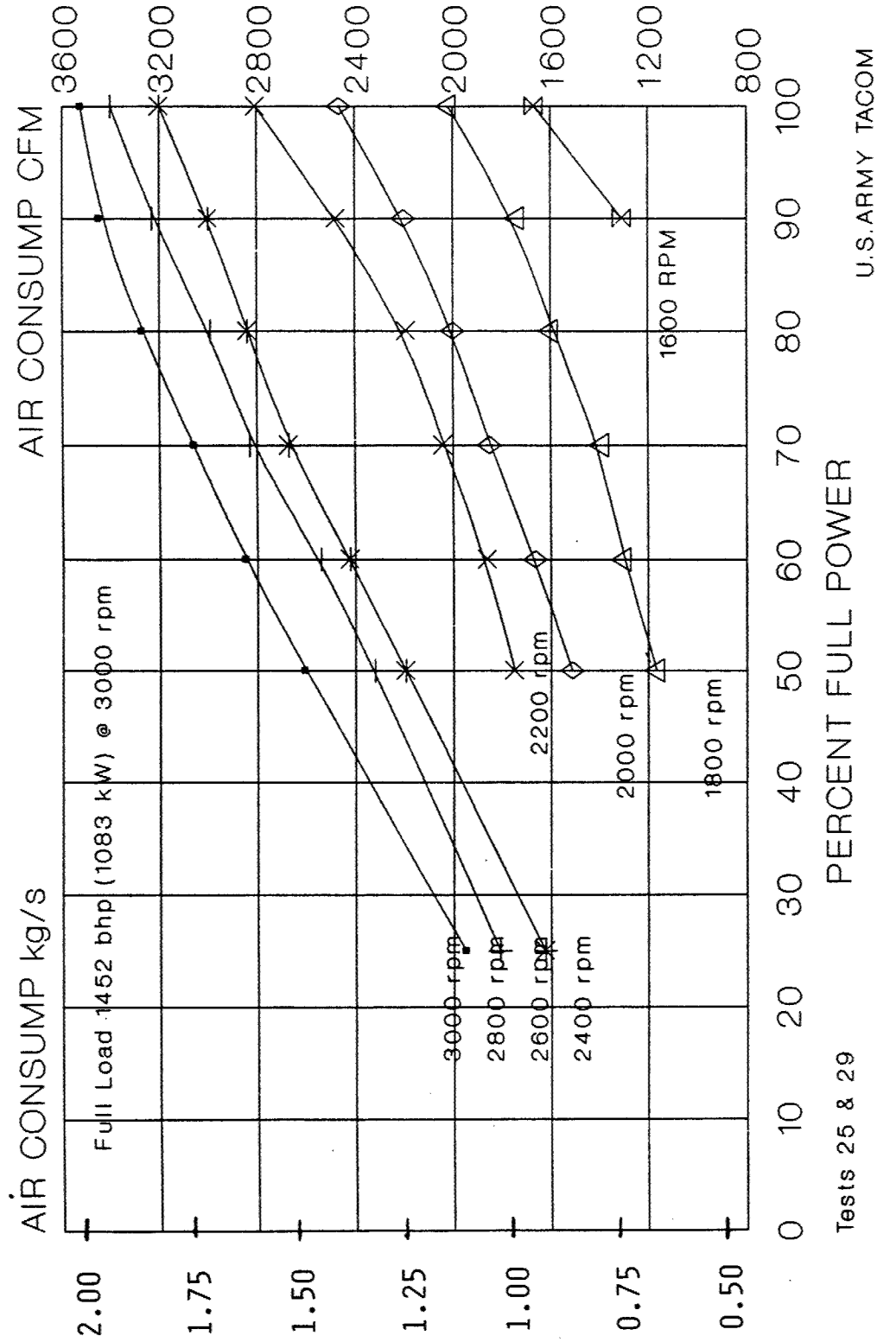


Figure 5-6. MTU MT883 Full-& Part-Load Air Consumption

5.3. Engine Part-Load Performance - Fuel Map

The fuel map for the MT883 engine is shown in Figure 5-7. This is quite competitive with comparable diesel engines recently evaluated.

5.4. Engine Performance With Higher Inlet Air Restriction

Performance runs with higher inlet air restriction are shown in Figure 5-8. The higher restriction had little effect on output. Exhaust smoke showed very little change in opacity, all runs showing 16% to 17% opacity (3 Bosch units) at 1400 rpm.

5.5. Engine Performance with Higher Fuel Temperatures

Engine performance with higher fuel temperatures is shown in Figure 5-9 at 25 C (77 F) air temperature and Figure 5-10 at 49 C (120 F) air temperature. The MTU electronic fuel control was programmed to reduce fuel flow with increasing fuel temperatures. Smoke readings increased slightly with 79 C (175 F) fuel, with 11% opacity (approx. 2.7 Bosch units) at 1800 rpm at 25 C (77 F) ambient air, and 16% opacity (approx 3.3 Bosch units) at 49 C (120 F) ambient air.

5.6. Engine Performance with Increased Exhaust Restriction

Figure 5-11 shows engine performance with standard exhaust restriction of 40 mbar (16"H2O) and 60 mbar (24" H2O). The increased restriction had very little effect on performance. The smoke readings increased slightly with 11% opacity maximum (approx 2.7 Bosch units) at 1800 rpm.

5.7. Engine Performance With Typical Vehicle Installation Temperatures

The MTU engine uses a second radiator in a vehicle installation to further cool the aftercoolers. In the laboratory test set up, it would be easy to overcool the aftercoolers, so data from MTU was used to establish realistic aftercooler temperatures. Since this data also showed some temperatures (such as coolant outlet and fuel) varying from NATO conditions, these temperatures were used to run a set of engine performance curves to the conditions shown in Table 5-1. The curves are shown in Figures 5-12 and 5-13.

Table 5-1. Typical Vehicle Temperatures

	C/F	C/F	C/F	C/F	C/F
Ambient Air Temperature	25/77	38/100	43/110	49/120	54/130
Engine Coolant Outlet	85/185	93/200	98/209	104/219	106/223
Coolant into Aftercoolers	57/135	63/145	66/151	72/162	73/163
Fuel Temperature Inlet	41/105	53/127	58/136	64/147	69/156

MTU MT 883
SPECIFIC FUEL CONSUMPTION - FUEL MAP
STANDARD NATO CONDITIONS

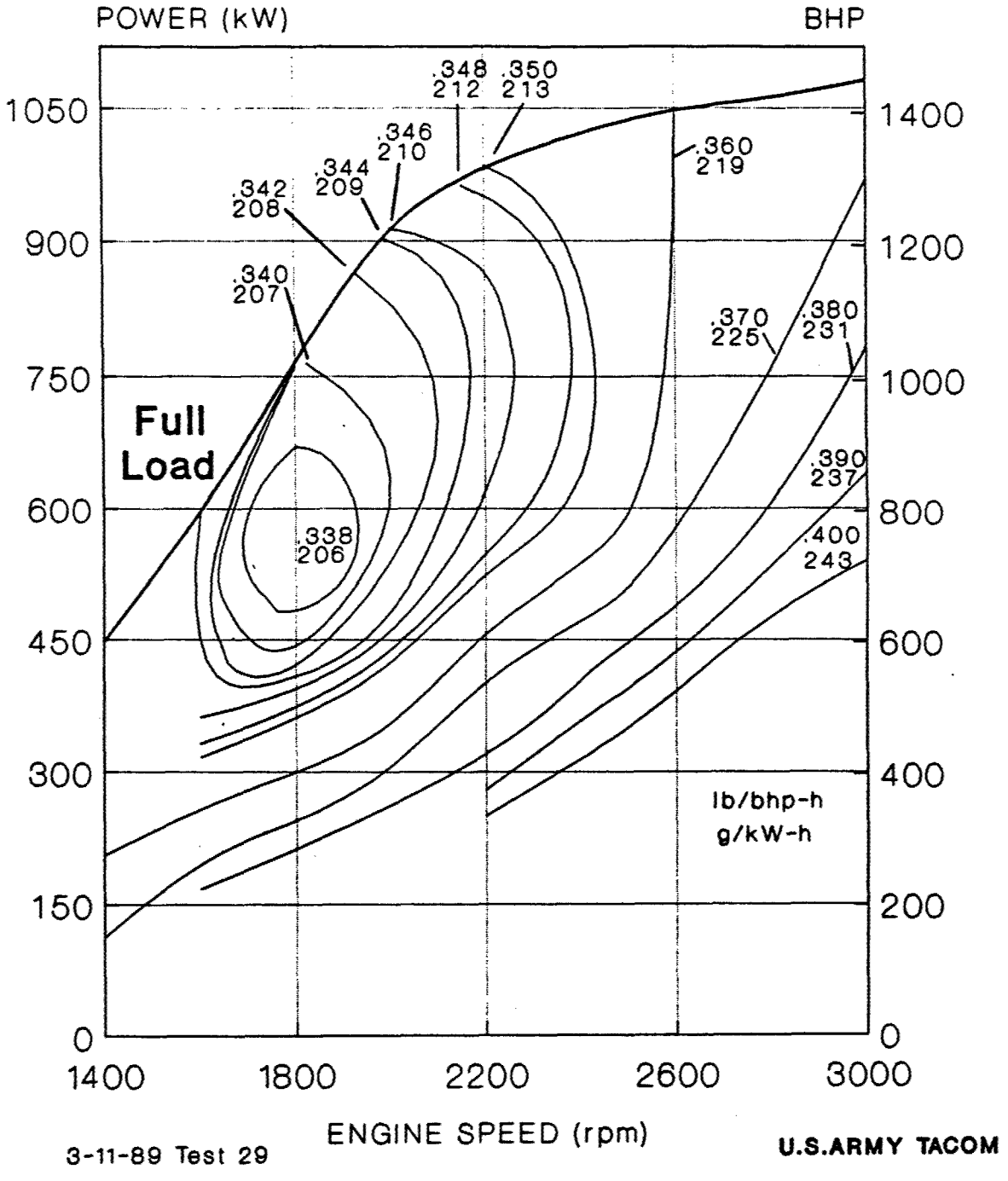


Figure 5-7. MTU MT883 Engine Specific Fuel Consumption

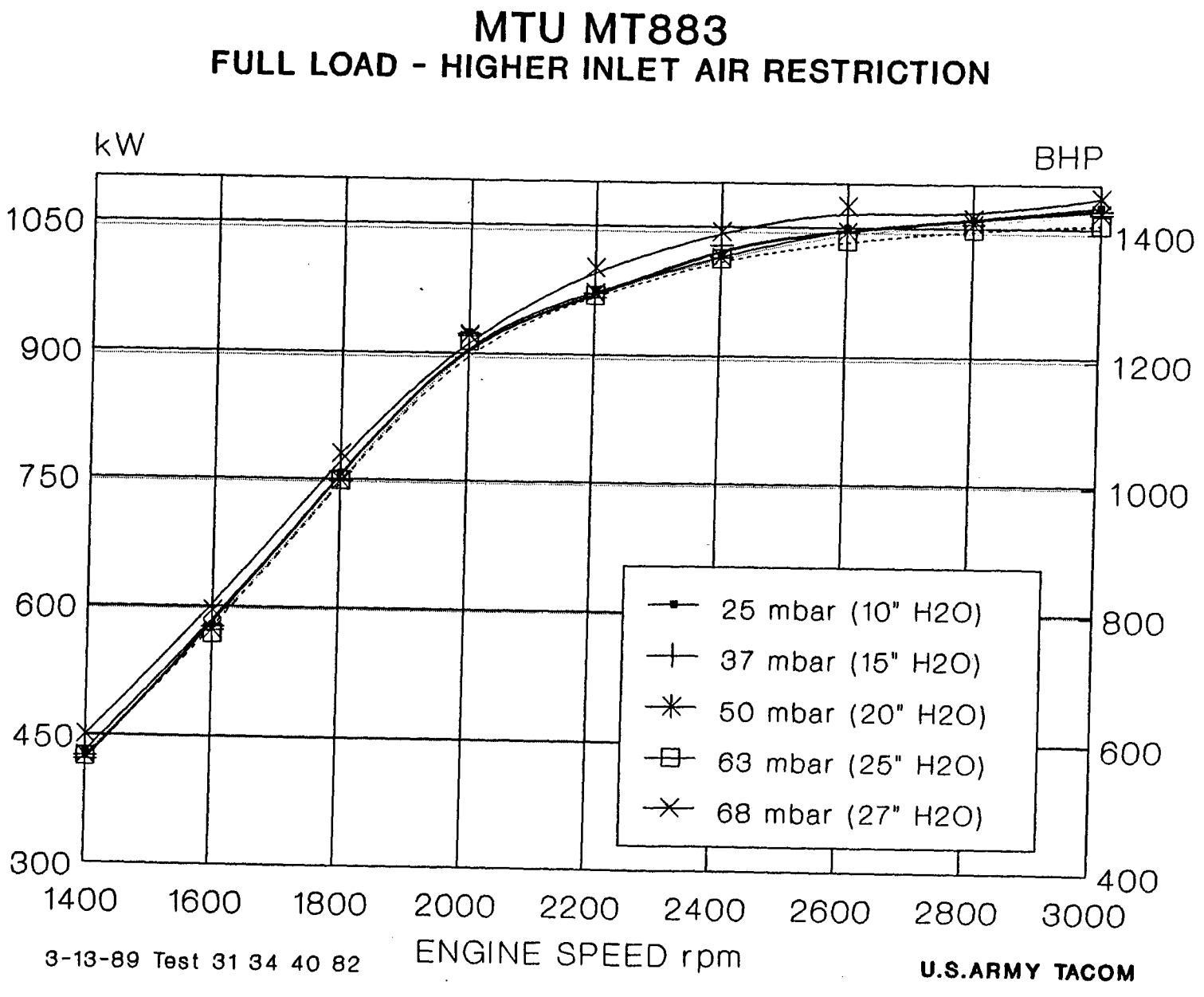


Figure 5-8. MTU MT883 Full-Load Power - Higher Inlet Air Restriction

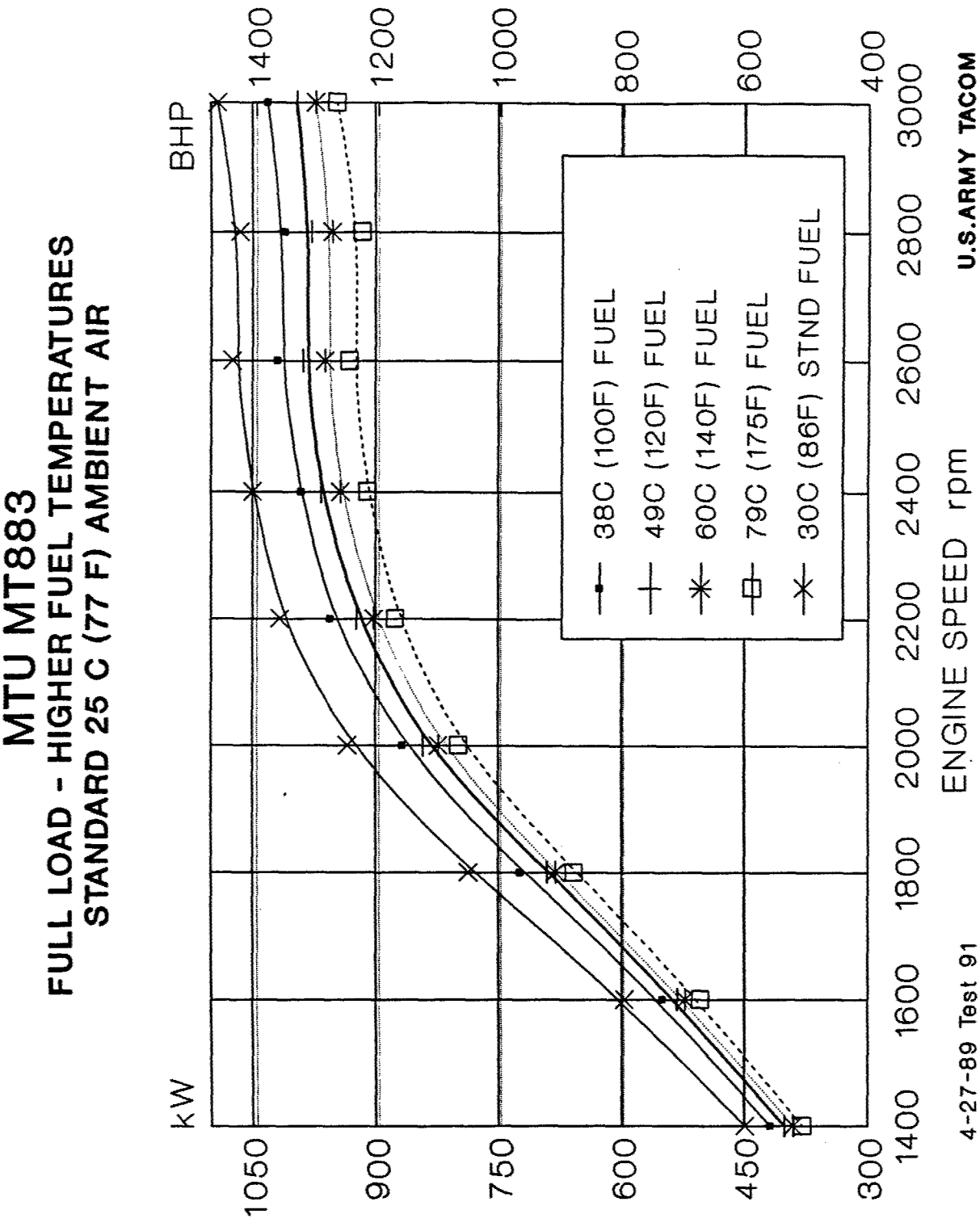


Figure 5-9. MTU MT883 Full-Load Power - Higher Fuel Temperatures
25 C (77 F) Air Temperature

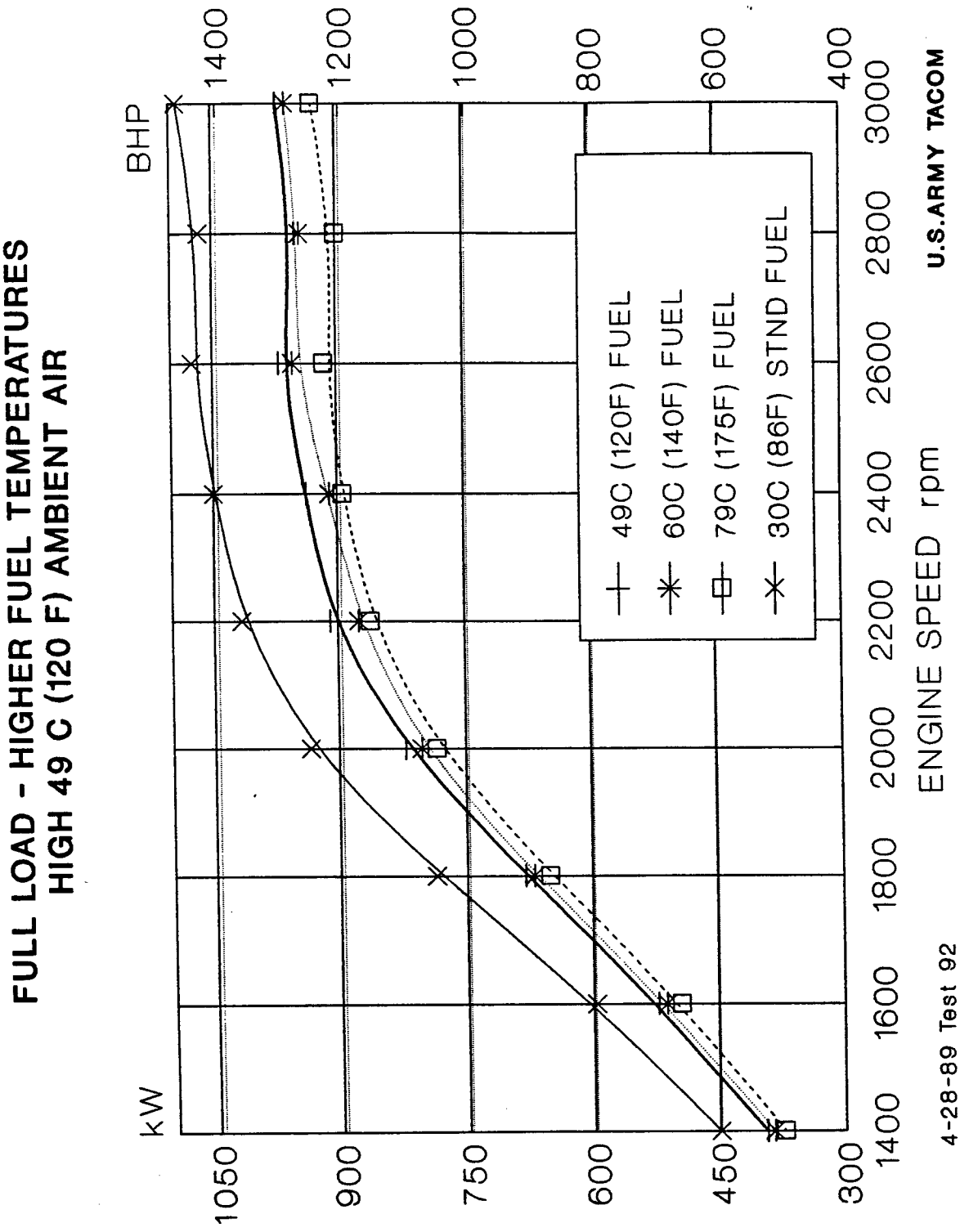


Figure 5-10. MTU MT883 Full-Load Power - Higher Fuel Temperatures
49 C (120 F) Air Temperature

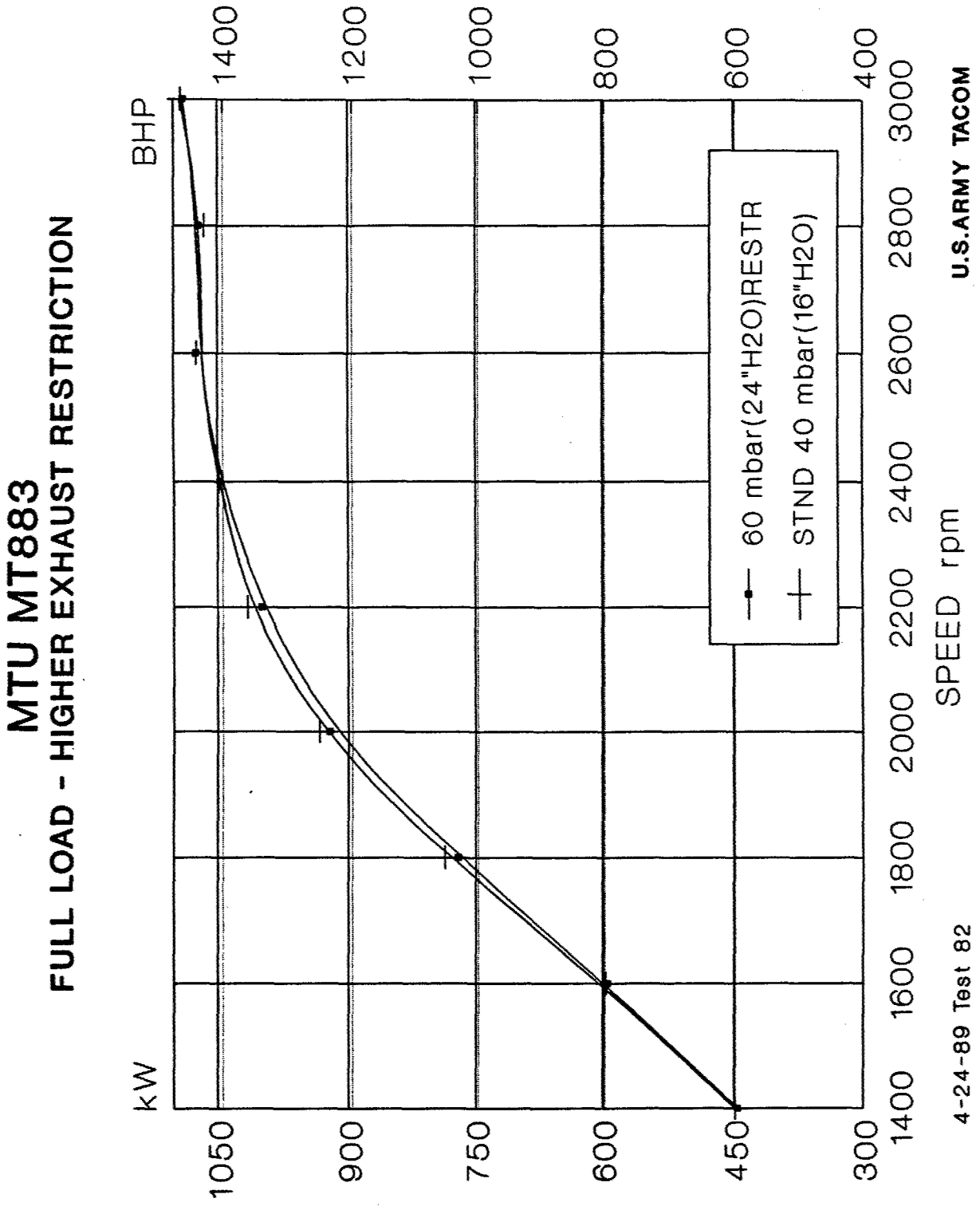


Figure 5-11. MTU MT883 Full-Load Power with Higher Exhaust Restriction

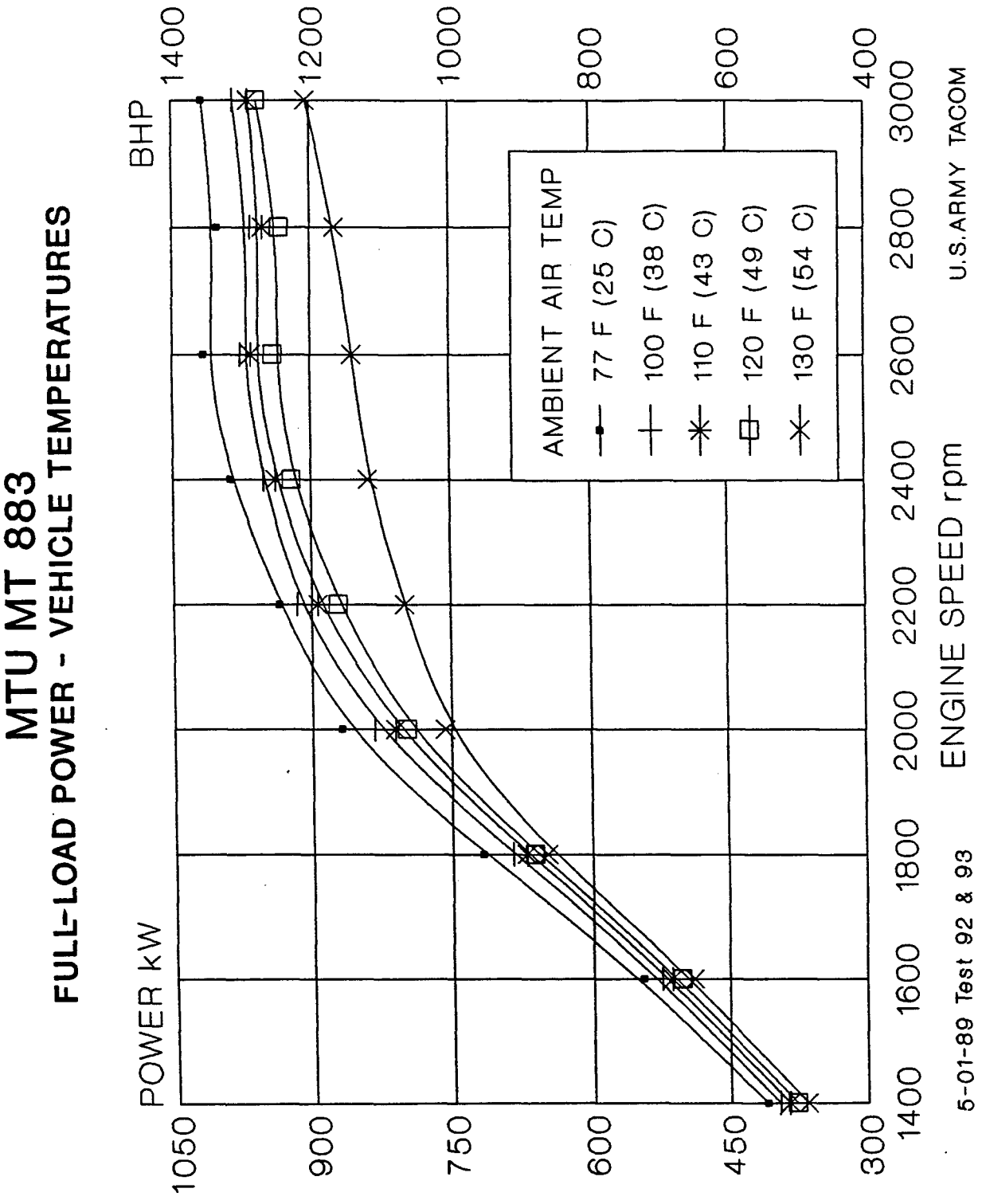


Figure 5-12. MTU MT883 Full-Load Power - Vehicle Temperatures

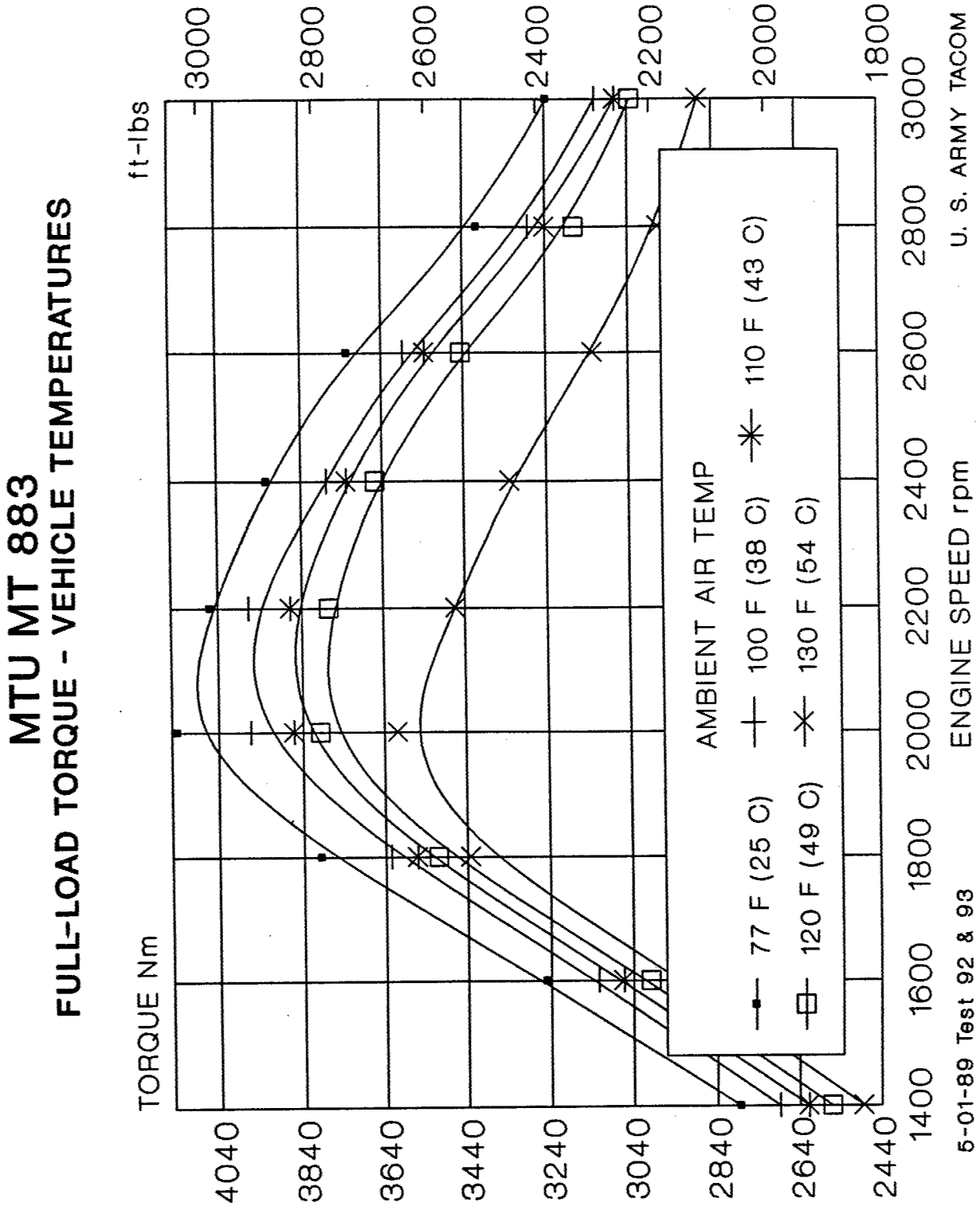


Figure 5-13. MTU MT883 Full-Load Torque - Vehicle Temperatures

5.8. Engine Performance with Jet A (JP8) Fuel - NATO Standard Conditions

Figure 5-14 shows the performance with Jet A fuel, simulating JP8 fuel:

1321 bhp (985 kW) at 3000 r/min
2909 ft-lb (3944 Nm) torque at 2000 r/min, for about 10% loss from the ouput with DF-2 fuel.

5.9. Acceleration Runs On Cell 3 Dynamometer

Acceleration runs were made on the Cell 3 dynamometer for comparison with runs to be made with the other NATO source engines on the same setup.

5.9.1. Constant-Speed Picking Up Load

At constant speed, the MTU electronic fuel control would not provide a no-load condition, so these runs were made from 700 ft-lb (950 Nm) to 2500 ft-lb (3390 Nm) torque. Table 5-2 shows the results, and the curves are shown in Figures 5-15, 5-16, and 5-17.

Table 5-2. Constant-Speed Picking Up Load

1600 r/min	from 700 ft-lb to 2500 ft-lb torque (950 Nm to 3390 Nm torque)	4.2 seconds
2100 r/min	same	3.0 seconds
2600 rpm	same	2.9 seconds

5.9.2. Acceleration-1400 rpm Idle to 2500 ft-lb(3390 Nm) Torque-3 Speeds

In the second set of runs from idle to various speeds with load, it was necessary to start the acceleration from 1400 r/min tactical idle, due to the MTU electronic control program. Table 5-3 shows the results, and the curves are shown in Figures 5-18, 5-19, and 5-20.

Table 5-3. ACCELERATION FROM 1400 r/min TACTICAL IDLE TO 2500 ft-lb (3390 Nm) TORQUE - 3 SPEEDS - see Figures 5-18, 5-19, and 5-20.

1400 r/min to 1600 r/min	4.7 seconds
1400 r/min to 2100 r/min	6.5 seconds
1400 r/min to 2600 r/min	8.0 seconds

Figure 5-21 shows an acceleration test plot from MTU with a Renk transmission. The inertia behind the transmission was higher, but with the first-gear transmission ratio, the equivalent inertia at the engine was roughly half that of the Cell 3 dynamometer. This plot shows the engine and transmission system accelerating from 1100 r/min to 2600 engine r/min in approximately 3.4 seconds.

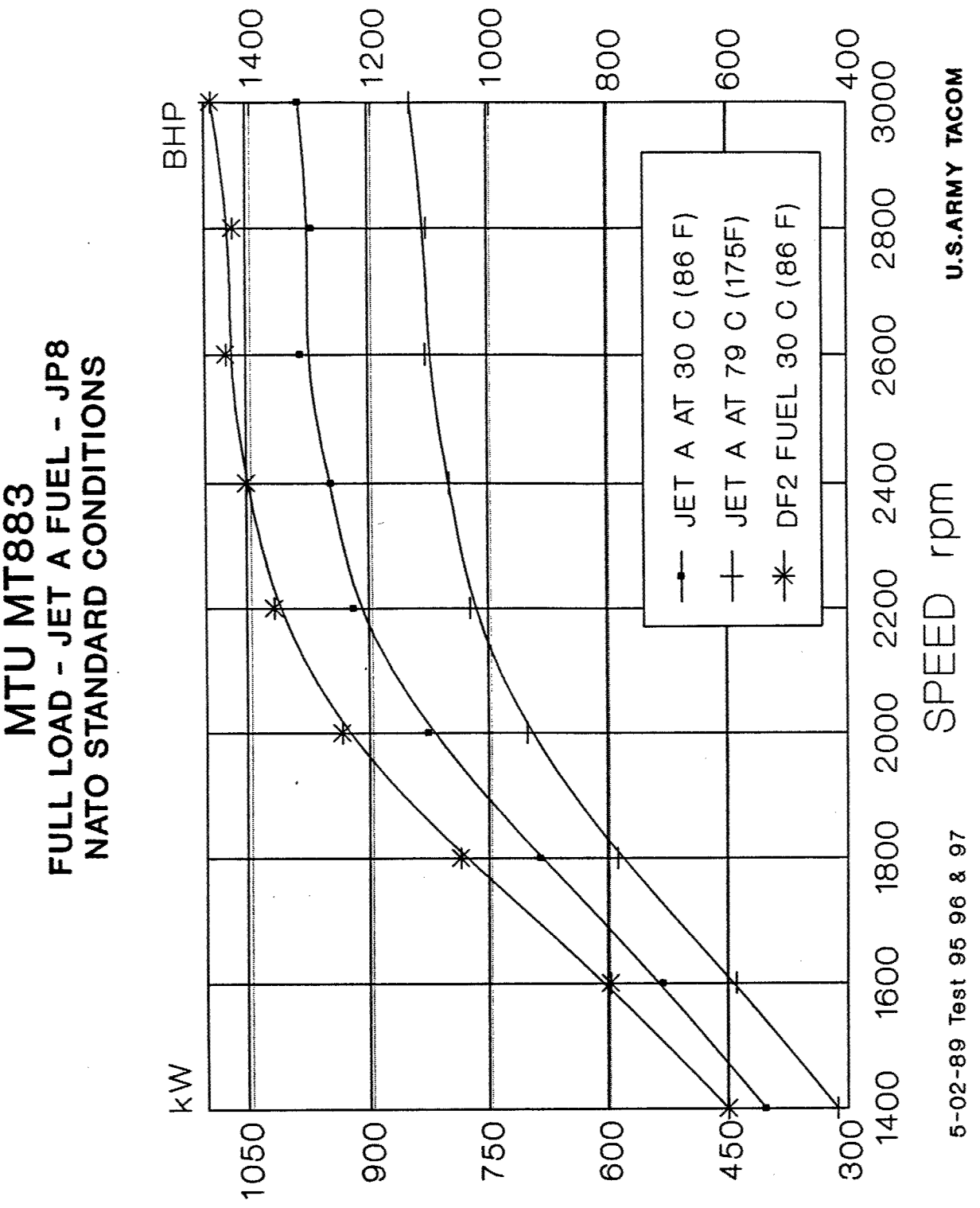


Figure 5-14. MTU MT883 Full-Load Power - JP8 (Jet A) Fuel

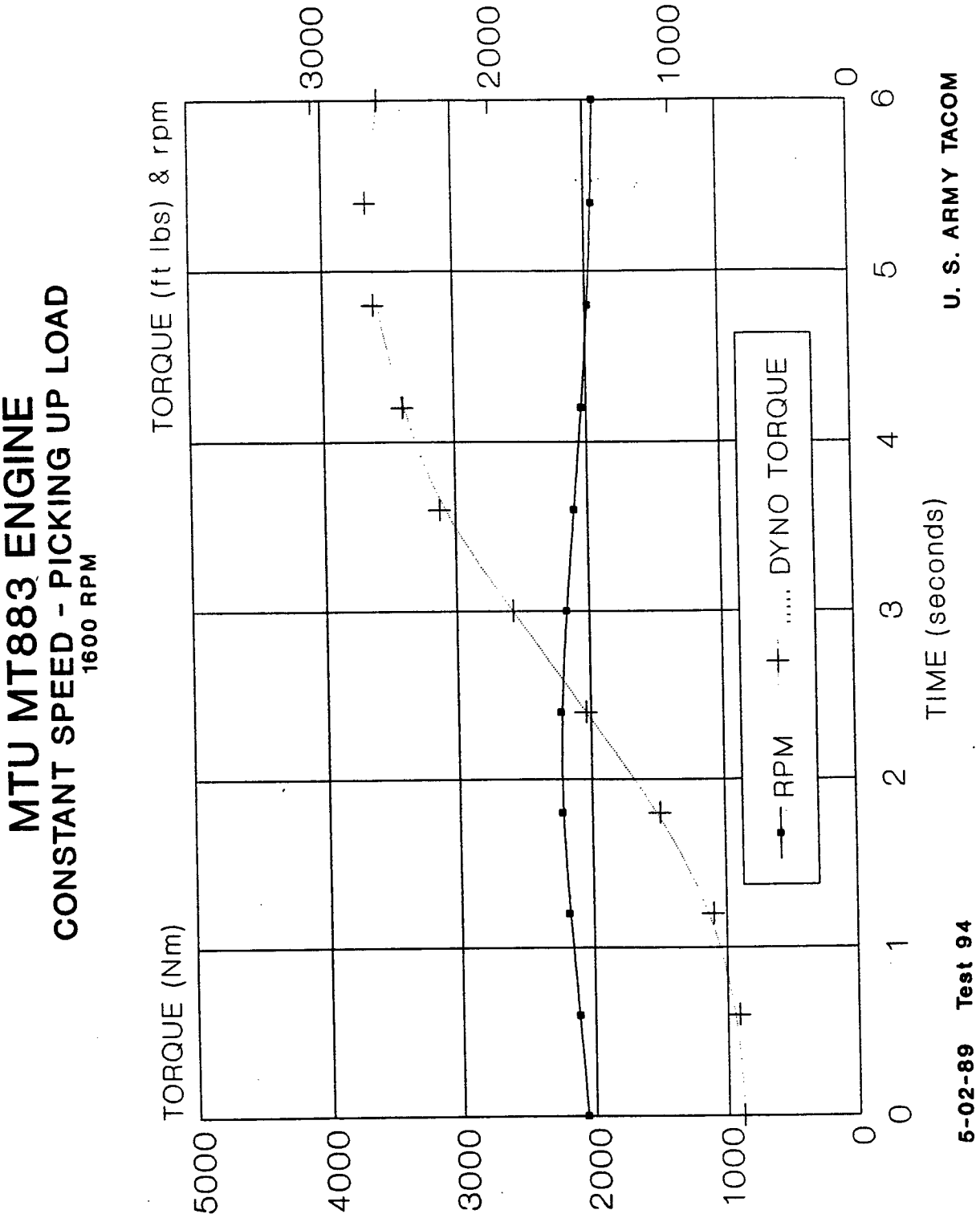


Figure 5-15. MTU MT883 Engine Acceleration - Picking Up Load - 1600 rpm

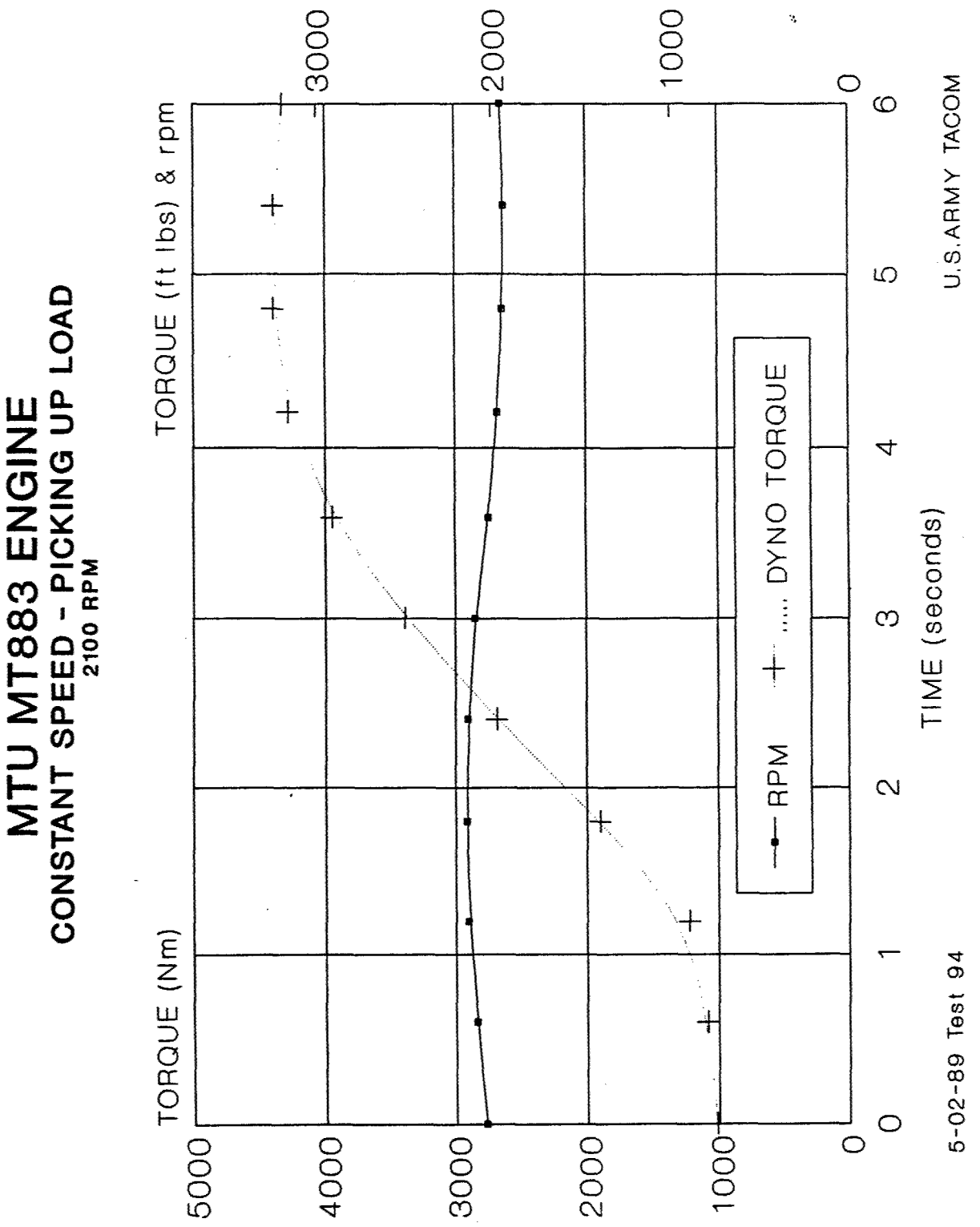


Figure 5-16. MTU MT883 Engine Acceleration - Picking Up Load - 2100 rpm

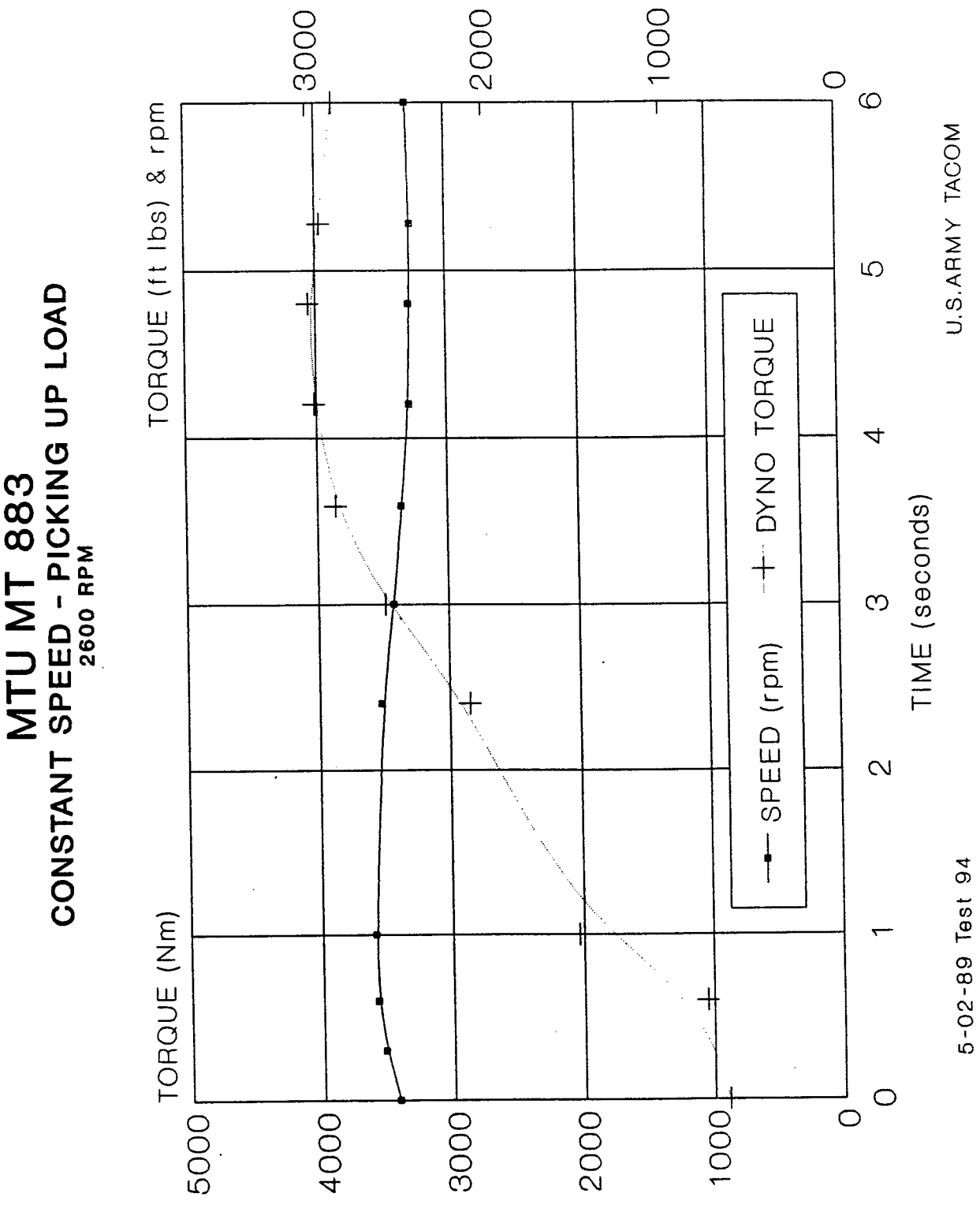


Figure 5-17. MTU MT883 Engine Acceleration - Picking Up Load - 2600 rpm

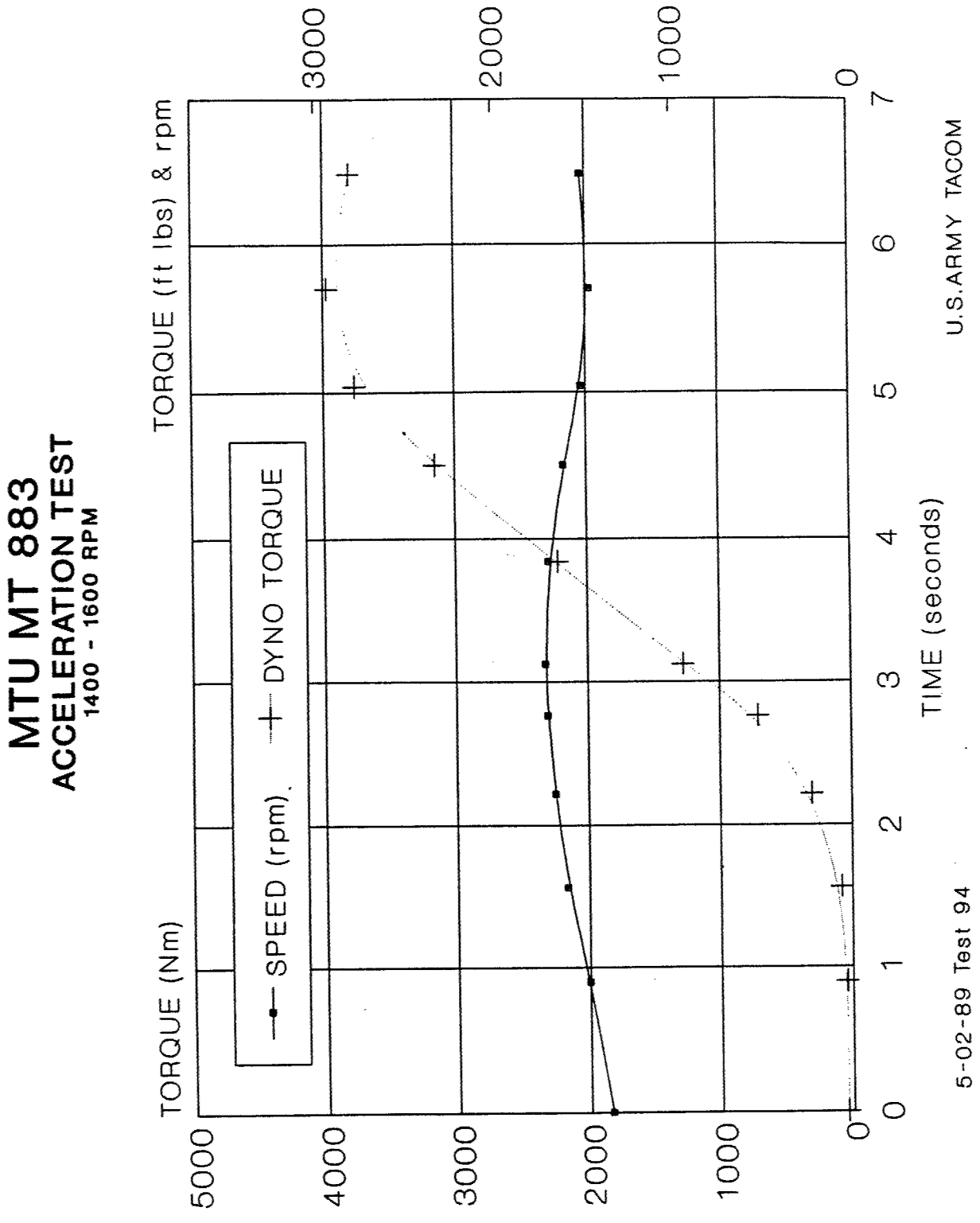


Figure 5-18. MTU MT883 Engine Acceleration - 1400 to 1600 rpm

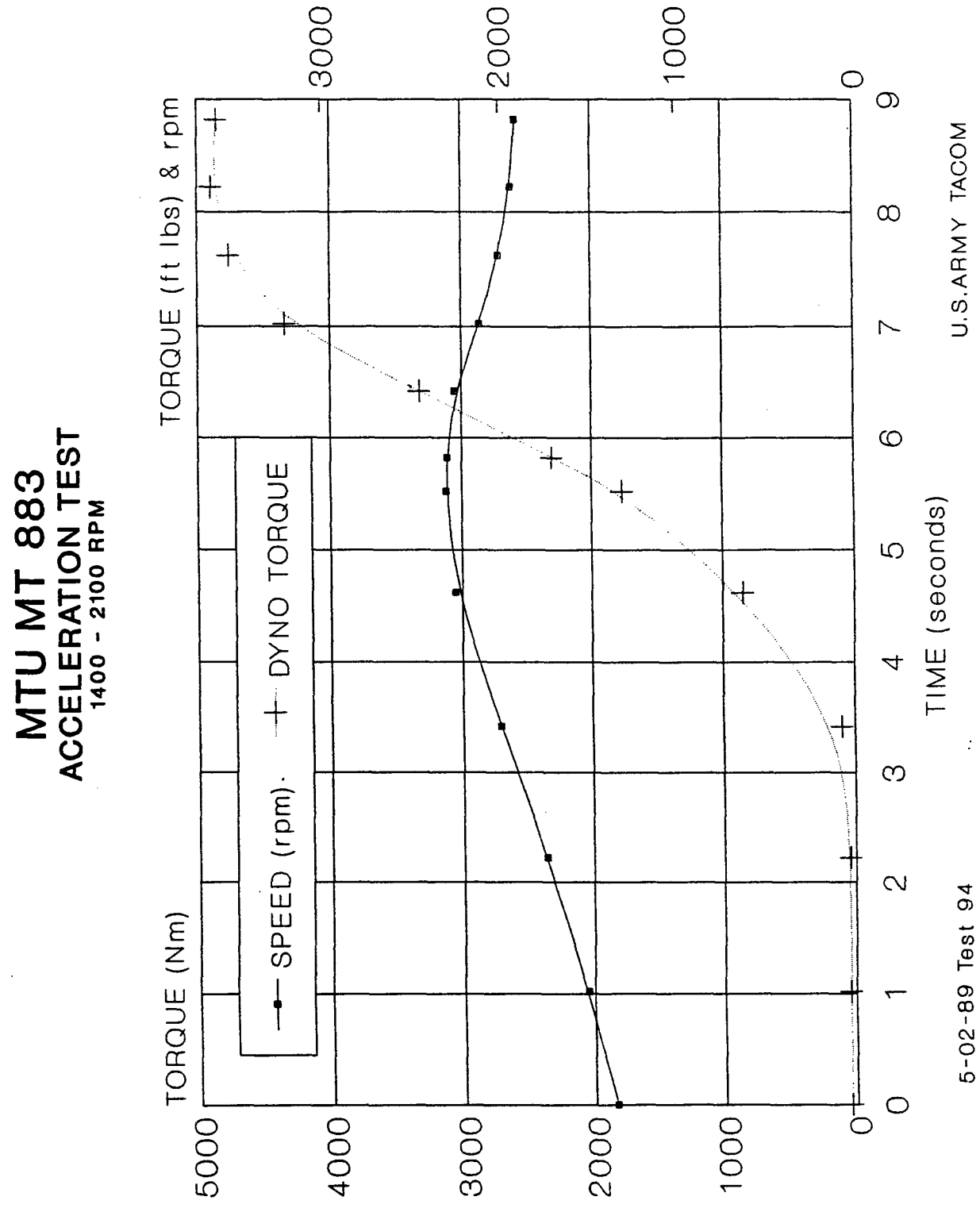


Figure 5-19. MTU MT883 Engine Acceleration - 1400 to 2100 rpm

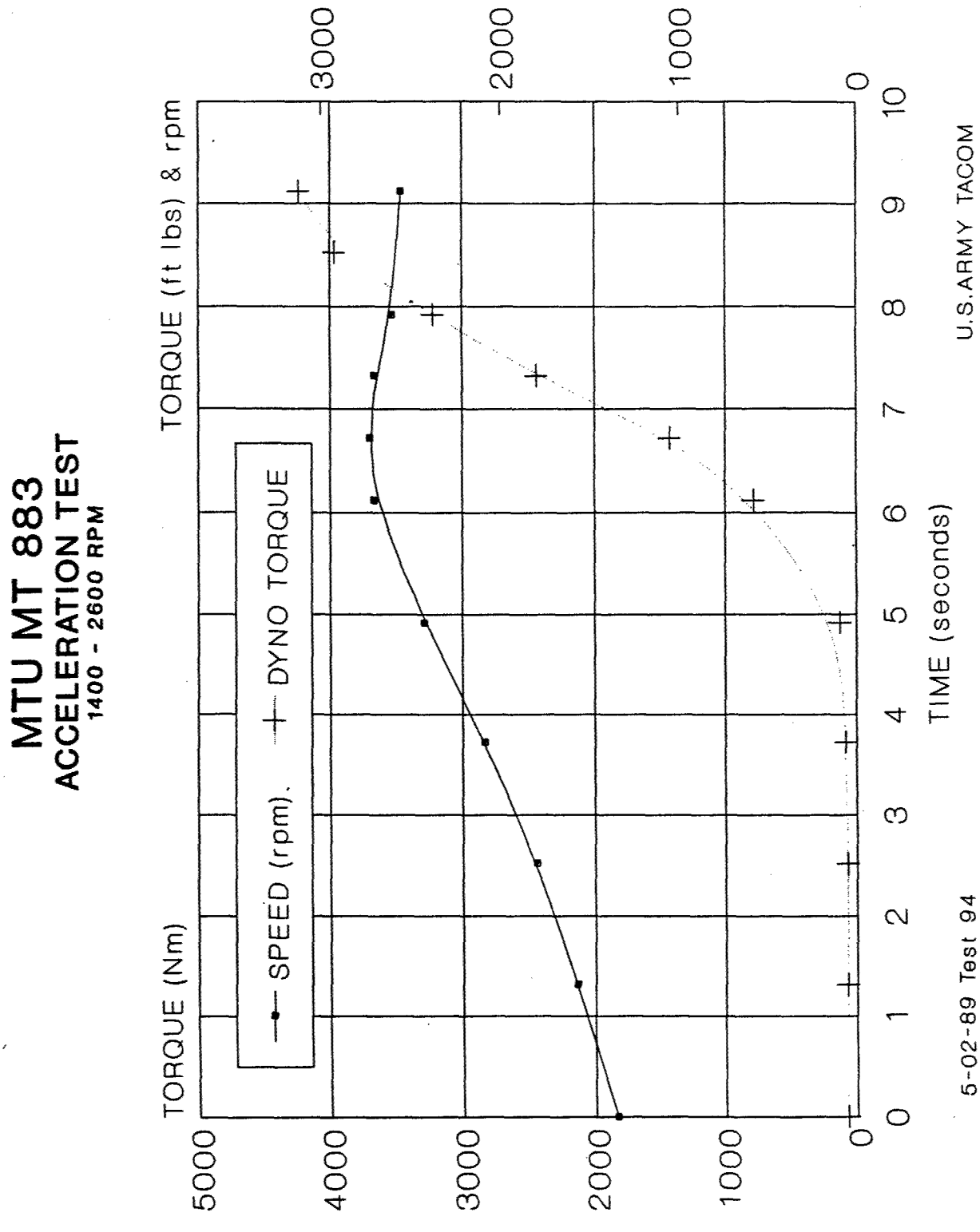


Figure 5-20. MTU MT883 Engine Acceleration - 1400 to 2600 rpm

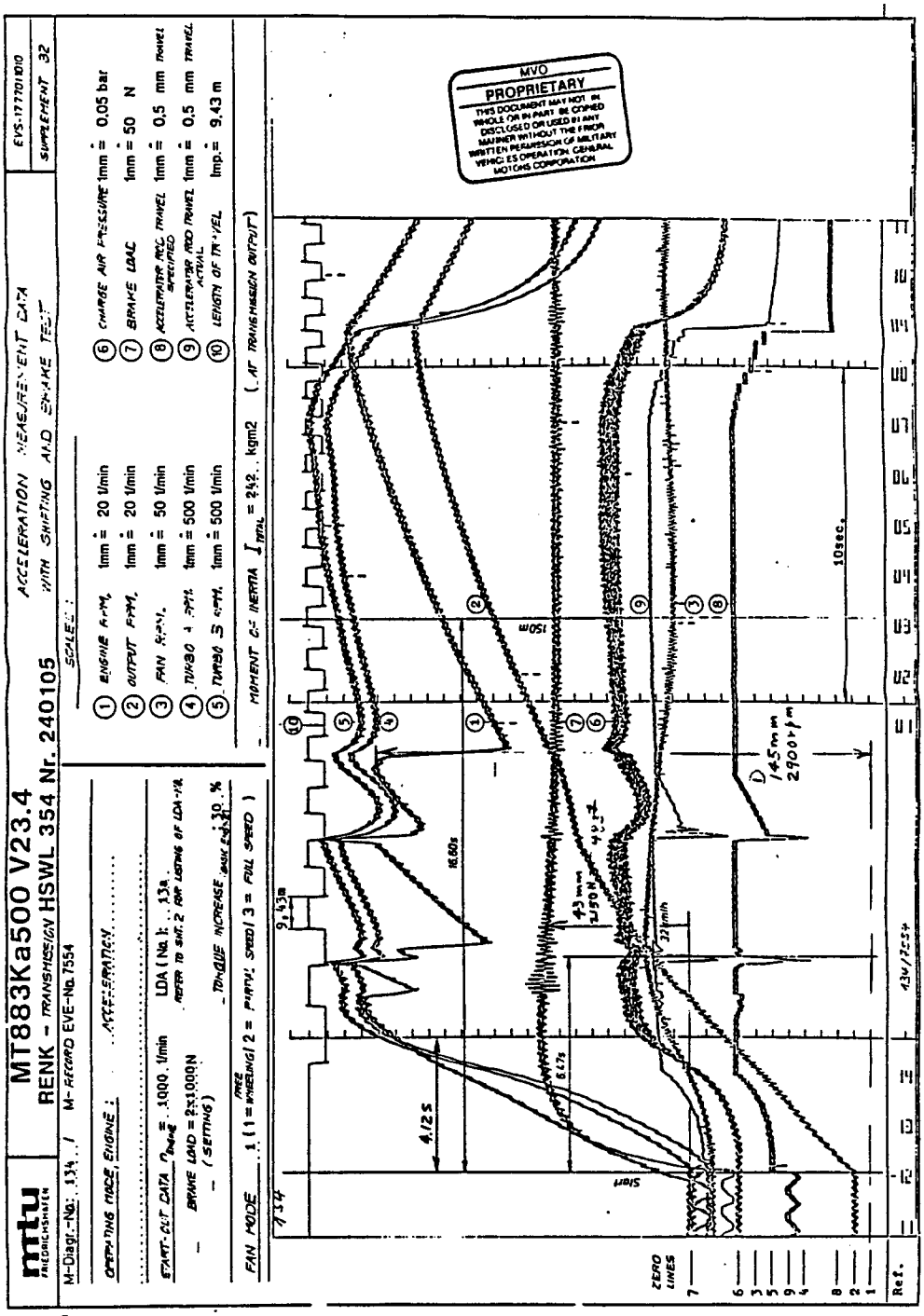


Figure 5–21. MTU MT883 Engine Acceleration with Renk Transmission

5.10. MTU MT883 Engine Test Program, Analysis of Failed Cylinder Liner

The MTU test engine was received from General Motors Military Vehicles Operation on 7 December 1988. Design and fabrication of the propshaft adaptor, front mount crossmember, etc., took place during December and January 1989. The engine was moved into Cell 3 on 6 February and installation began.

At this time, meetings were held with GM-MVO and MTU personnel to finalize the test plan, which is shown in Appendix A.

Hook up and instrumentation was completed the first week of March, and the engine first ran on 6 March 1989, with MTU personnel supervising. MTU personnel also hooked up the electronic engine controls. The engine had previously been run in at MTU.

The first TACOM data was taken on 8 March, with GM-MVO and MTU personnel in attendance, and they remained for the rest of the test program. Table 5-4 shows the sequence of the test runs.

On 14 March, with the engine running at 2400 r/min on an inlet restriction run, the left bank coolant outlet hose failed adjacent to the insulated laboratory exhaust pipe. The engine was shut down immediately, with a loss of about 5 gallons of coolant. The coolant hoses were replaced, and a steel heat shield was added at the exhaust pipe.

On 15 March, after two hours of additional running, a large increase of crankcase blowby occurred at 2600 r/min, with a sudden increase in coolant and crankcase pressures. Coolant was found in the oil pan, and a borescope inspection indicated a cylinder liner crack in the 4B cylinder. The engine had run 26.5 test hours at TACOM. After consultation with MTU personnel, the engine was removed from the stand and crated for shipment back to MTU on 17 March.

On 18 April, the engine was received from MTU along with the 4B cylinder failed parts. The liner had cracked on the major and minor thrust sides in a "J" shaped vertical crack, down to the upper O-ring groove at the bottom end, and the piston skirt had scuffed in these areas. The connecting rod and bearing were OK. Photographs of these parts are shown in Appendix D. All of the other cylinders had been found to be in good condition, and the engine was rebuilt by MTU, with new liner, piston, rings, connecting rod, etc, in the 4B cylinder. Test work resumed on 21 April. On 25 April, during a hot fuel performance run, the coolant outlet line parted at the sight glass joint with a loss of about 10 gallons of coolant. A compression check indicated no damage to the engine. Two 8 mm (5/16 in.) rods were installed across the sight glass joints. Tests resumed and were completed on 4 May 1989.

A report from MTU on its analysis of the 4B cylinder liner failure stated that overheating caused the piston skirt to scuff, which then resulted in the liner cracking. A variation in the cylinder head water jacket coring at the glow plug, which is close to the exhaust valve seats, restricted cooling flow in this area. The resulting distortion of the seats caused loss of combustion air and excessive temperature during combustion. An engineering change was made on the cylinder head to insure sufficient cooling flow.

Table 5-4. MTU MT883 Engine Test Runs and Data Sheet Numbers
TACOM - Building 212 - Test Cell 3

TEST NO.	DATE	TEST
16	3-8-89	Initial engine check out
23	3-10	Dynamometer and control system check out
25	3-10	Full-load performance with Merriam air flow measurement
29	3-11	Part-load matrix 90-80-70-60-50-25% load
31	3-13	Inlet air restriction 10in. & 15in. H2O
34	3-14	Inlet air restrict 20in. coolant hose failed
40	3-15	Inlet air restrict 25in, large blowby increase, #4B cylinder liner cracked
	3-17	Engine shipped to MTU for inspection
	4-18	Engine received from MTU
76	4-21	Engine checkout
81	4-24	Full-load performance with MTU nozzle air measurement
82	4-24	Inlet air restriction 27in. limited by exhaust temperature - 24in. exhaust restriction run
85	4-25	Hot fuel performance, water outlet parted
91	4-27	Hot fuel performance 100F 120F 140F 175F fuel
92	4-28	Hot fuel performance at 120F ambient air, 120F 140F 175F fuel
93	5-1	MTU vehicle temperature performance at 77F 100F 110F 120F & 130F ambient air
94	5-2	Acceleration tests
95	5-2	Jet A fuel performance NATO conditions
96	5-3	Jet A fuel performance at 175F fuel temp
97	5-4	1500 bhp point and heat rejection on a standard full-load performance
98	5-4	Idle run - no dynamometer shaft
		Total TACOM engine run time - 57.7 hours

APPENDIX A

TEST PLAN

Propulsion Systems Division
MT-883 Test Program
Test Plan

PURPOSE:

To determine the military adaptability and performance characteristics of the MTU MT883 V12 turbocharged diesel engine.

Outline of Tests

1. Install engine in cell 3 and prepare for tests
2. Install and calibrate instrumentation
3. Maintenance of equipment
4. Engine operating limits
5. Engine and instrumentation operational checkout
6. Performance tests
7. Heat rejection tests
8. Acceleration tests

Test Material

a. MT883 Ka-500 turbo charged diesel engine

1500 HP @ 3000 rpm
2840 lb ft torque @ 2000 rpm
Bore 144mm ----------5.67"
Stroke 140 mm ----------5.51"
Displacement 27.36 liters 1670 cu. in.
90 V 12
Compression ratio - - approx 13 to 1
Engine dry weight 1840 kg 4048 lbs

b. Lubricating oil MIL Spec MIL-L-2104D 15W-40

c. Fuel

1. MIL-F-46162B (high sulphur .95 to 1.05% by weight)DF-2
2. Jet A-1

Test Equipment

Test cell 3, dynamometer, controls associated instrumentation and equipment Building 212

Test Procedure - Outline of tests

1. Prepare engine for performance tests.

a. Obtain and record dry weight and dimensions of engine. Install engine in test cell and connect to dynamometer Install connections to two (2) cooling towers per MTU sheet 2, with smaller heat exchanger for charge air cooling circuit. Make necessary fuel, exhaust and intake air connections. The 12" Berkley opacity meter will be used for smoke readings.

b. Install all required thermocuples, pressure lines, speed and load cell connections. Install warning lights, shut-down system for critical temperature, pressure and RPM limits on engine and dynamometer equipment.

c. Prepare orifices and calibrate for 10 and 20 CFM max blowby flow (Not to exceed 15" H_2O crankcase pressure.)

d. Please provide:

(1) Sight glasses in Engine water outlet and charge air coolant circuits

(2) Vent lines in coolant system as instructed.

(3) Exhaust back pressure control.

2. Instrumentation - Install and calibrate instrumentation to obtain and record data at each specified condition.

Parameters From Contract	Expected Values
1. RPM	0-3000 RPM full load to 3300 RPM no load for brief governor check only
2. Torque	3850 Nm+5%/2000 RPM 2840 # ft
3. Fuel Flow	263 kg/hr max 579 #/hr max
4. Fuel Temp at Inj Pump Inlet	Up to 46 C 115 F
5. Fuel Press at Inj Pump Inlet	4.5 bar 65psi
6. Air Flow (Total)	1.9 Kg/s 3275 CFM
7. Air Ambient Temp	Typical
8. Air Ambient Pressure	Typical
9. Air Temp After Air Cleaner*(same as 11)	---
10. Air Pressure After Air Cleaner L&R *(same as 12)	---
11. Air Temp Before Turbo L&R	Typical
12. Air Pressure Before Turbo L&R	Typical
13. Air Temp after turbo L&R ---	
14. Air Press after turbo L&R ---	
15. Air Temp Intake Manifold L&R	210 C 195 F 410 F Max
16. Air Pressure Intake Manifold L&R	2.1 bar 62" hg

17.	Oil Pressure in Gallery	7 bar 102 psi
18.	Oil Temperature OIl Gallery	125 C 257 F
19.	Oil Temp Sump (Tank)	125 C
20.	Oil Temp Cooler In *(Same as 19)	---
21.	Engine Coolant Pressure pump discharge	4.3 bar 62 psi
22.	Engine Coolant Temp Out	97 C 207F
23.	Engine Coolant Temp in (coolant into charge air heat exchanger is same)	typical
24.	Coolant Temp from charge air heat exchanger	Up to 80C 176F
25.	Engine Coolant/Water Heat Exchanger	---
	a. Water Flow	
	b. Water Temp In	
	c. Water Temp Out	
26.	Aftercooler coolant/water heat exchanger:	
	a. Water Flow	
	b. Water Temp In	
	c. Water Temp Out	
27.	Temp In Stack Turbocharger discharge	600 C max 1112F
28.	Pressure In Stack	0 - 40 mbar 0-18"$H_2$0
29.	Smoke opacity Readings	0-38% max (0-4.5 Bosch)
30.	Blowby (Flow-CFM)	0-20 CFM
31.	Pressure - crankcase	0 - 15"$H_2$0
32.	Cellmate Acquisition Sys, Record data on diskettes	
33.	In Line Shaft Torque Sensor to be used for Acceleration Tests	
34.	Exhaust Port Temperatures	

3. Maintenance of Equipment

a. Change oil every 100 hours

(1) 8 oz oil sample every 100 hours

(2) 2 oz oil sample every 10 hours.

b. Record oil used

c. Replace fuel & oil filters and air cleaner elements every 100 hours.

4. Engine Operating Limits and Adjustments

a. Oil temperature: 240 F warning
255 F max manual return to idle

b. Oil pressure-idle 25 psi warning
20 psi shutdown

Oil pressure - normal operation
normal pressure 80-90 psi
30 psi warning
25 psi shutdown

c. Cell air temp - specified for each test

d. Coolant outlet temp

normal	205 F
warning	215 F
return to idle above	220 F
coolant inlet to pump	psi

e. Fuel temp into engine 86 $\pm$ 5 F except as otherwise specified

f. Exhaust back pressure at rated conditions 16 $\pm$ 2" $H_2\emptyset$

g. Crankcase pressure maximum 15" $H_2\emptyset$

h. Maximum fuel flow 580 #/HR

i. Inlet air depression into turbochargers 10 $\pm$ 2" $H_2\emptyset$ at rated conditions

j. Exhaust outlet temperature after turbocharger 1200 F max

5. Engine instrumentation and operational checkout

a. Engine will be run to check for leaks, proper operation of all instrumentation channels, recording and printout systems and any other problems. The engine has already been run-in. Do not run engine at 1200 rpm - manufacturer's specification.

b. Operational checkout will be conducted according to the following schedule. Monitor blow-by in CFM and/or pressure during checkout. Do not continue test if blow-by exceeds allowed maximum. For each checkout period take complete data and record on log sheet.

TIME IN HOURS	ENGINE SPEED RPM	TORQUE LB. - FT.
1/4	1,100	idle*
1/4	1,400	idle
1/4	1,600	100
1/4	1,800	200
1/4	2,000	600
1/4	2,200	1,000
1/4	2,400	1,500
1/4	2,600	2,000
1/4	2,800	2,400
1/4	3,000	Full Rack

*If rough running or prop shaft noise occurs, run 1400 rpm. Higher loads at the low speeds can be used if necessary to maintain stable operation.

c. Check governor and adjust if necessary at full load and no load to limit the maximum engine speed as follows:

Full load 3,000 RPM
No load 3,300 RPM max

6. Performance Tests

a. Run full and part-load performance tests as specified below, the full load runs to be at increasing and decreasing speeds. Take all the data previously specified so that heat rejection can be evaluated for any run.

Fuel: MIL-F-46162B, containing 1% sulphur
Fuel pressure to engine 65 ± 3 psi

Lubricant: MIL-L-2104D, 15W-40 AMOCO 300 oil
NATO standard conditions:

Coolant out temp	205 ± 5 F
Coolant to aftercoolers	145 ± 5 F
Fuel temp to engine	86 ± 5 F
Inlet Air Depression @ rated power	10 ± 2" H_2O
Exhaust Back Pressure @ rated power	16 ± 2" H_2O

Test points to be run at 77 F ambient air in the matrix below:

LOAD	RPM								
100%	1400	1600	1800	2000	2200	2400	2600	2800	3000
90%	x	x	x	x	x	x	x	x	x
80%	x	x	x	x	x	x	x	x	x
70%	x	x	x	x	x	x	x	x	x
60%	x	x	x	x	x	x	x	x	x
50%	x	x	x	x	x	x	x	x	x
25%	x	x	x	x	x	x	x	x	x
0%	x	x	x	x	x	x	x	x	x

b. Run full load performance with NATO standard conditions, except inlet air restriction at 10, 15, 20, 25, 30, and 35" H_2O.

c. Run full load performance, NATO conditions, except fuel inlet temperatures of 100 F, 120 F, 140 F and 175 F. Repeat with 120 F ambient air temperature and fuel inlet temperatures of 120 F, 140 F and 175 F.

d. Run full-load performance at NATO standard conditions except exhaust restriction at 24" H_2O.

e. Run full-load performance with temperatures as shown for a typical vehicle installation as furnished by MTU:(Not NATO conditions)

Cell Ambient Air Temp	Engine Coolant Out	Aftercooler Coolant In	Fuel Temp Into Injectors
77 F	185 F	135 F	105 F
100	200	145	127
110	209	151	136
120	219	162	147
130	223	163	156

f. Run full load performance with Jet A-1 fuel at NATO standard conditions.

7. Acceleration Tests - Using the in-line shaft torque sensor, run full-load acceleration tests, with the dynamometer set at constant speed. Record time for engine to go from minimum light load to full load at:

1600 rpm
2100 rpm
2600 rpm

E. C. Adams
24 FEB 89

APPENDIX B

SAMPLE DATA SHEETS

TYPICAL DATA - PERFORMANCE RUN - MTU MT883 ENGINE
RUN 97 - STANDARD NATO CONDITIONS

SPEED						
rpm	2998	2599	2199	2000	1803	1597
POWER						
bhp	1465	1440	1362	1251	1054	799
kW	1093	1074	1016	933	786	596
TORQUE						
ft-lb	2567	2911	3255	8287	3072	2630
Nm	3480	3947	4413	4456	4165	3566
BSFC						
lb/bhph	.371	.359	.351	.347	.341	.344
gm/kWh	226	218	213.5	211	207	209
INTAKE AIR TEMP						
Deg F	72 F	75	72	76	74	74
Deg C	22 C	24	22	24	23	23
COOLANT OUT TEMP						
Deg F	200 F	201	200	201	201	201
Deg C	93 C	94	93	94	94	94
OIL SUMP TEMP						
Deg F	237 F	229	225	224	215	210
DEG C	114 C	109	107	107	102	99
EXH TEMP						
Deg F	1113 F	1112	1175	1211	1231	1231
Deg C	601 C	600	635	655	666	666
EXH BACK PRES						
In H20	14.7	11.7	8.5	6.9	4.2	2.2
mbar	37	29	21	17	10.5	5.5

MTU, DOCUMENTATION

Test Objective: TUNE CHECKUP FULL LOAD PERFORMANCE
Todays Fuel Temp-Deg f: 85 oF
Test Start point: INITIAL DYNO TUNEUP AND AUTO
Operator Name: Schiele,Ratcliff
Test Engineer: E.C.Adams, Reisch
Engine: MTU-DIESEL V12X1500 HP
Meriam Flows Corrected YES or NO: no 0
Observed Barometer: NONE
Observed Humidity: OUT
Oil Added: NONE
Oil Sample Taken #: 1/2 gal. for MTU

MTU-V12X1500HP

Wall Time		14:31	14:40	14:58	14:59	15:06	15:19	15:26	15:26	15:35	15:35
Elapsed Time		001:54:37	002:03:50	002:16:30	002:22:32	002:29:20	002:42:21	002:50:09	002:50:11	002:58:18	002:58:20
Engine Speed	RPM	2998	2802	2601	2400	2199	2003	1799	1799	1605	1604
Engine Load	FT-LBS	2549	2676	2848	3002	3148	3276	2994	3994	2596	2595
Brake Horsepower	BHP	1451	1427	1407	1371	1318	1249	1025	1025	798	798
Fuel Consumption,Engine	LBS/HR	547.9	525.2	504.4	484.9	460.9	491.8	349.4	349.4	272.2	272.2
BSFC	LBS/HP-HR	3.776 .378	3.680	3.585	3.586	3.497	3.457	3.408 .341	3.408	3.432	3.433
BMEP	PSI	229.5	241.5	256.6	271.0	284.8	295.8	270.4	270.4	234.4	234.4
Smokemeter Opacity	%	7.7	7.3	7.6	8.9	8.7	11.1	10.1	10.4	10.6	10.2
Water Tower,Out-(Flow)	Hz	191	166	183	170	140	123	122	111	87	106
Water Exch-Out	Hz	0	0	0	0	0	0	0	0	0	0
Barometric Pressure	Hg	29.71	29.71	29.70	29.70	29.70	29.69	29.69	29.69	29.69	29.69
Air,Cell Ambient,Left	DEG F	84.1	81.0	81.3	82.7	80.3	85.8	81.7	82.0	78.5	78.5
Air,Cell Ambient,Right	DEG F	70.4	68.2	69.3	69.3	68.9	71.4	67.2	67.5	66.8	67.2
Air,Cell Depression	H2O	-0.3	-0.3	-0.2	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3
Air,Cleaner Out Left	DEG F	85.4	72.5	76.8	78.2	74.6	89.2	75.7	75.8	82.7	82.0
Air,Cleaner Out Right	DEG F	75.7	66.8	72.1	70.4	69.3	76.0	68.6	68.2	70.0	69.6
Air,Meriam Before Left	H2O	-5.2	-4.8	-4.4	-3.8	-3.1	-2.4	-1.5	-1.5	-0.9	-0.9
Air,Meriam After Left	H2O	-12.1	-11.4	-10.6	-9.8	-8.9	-7.2	-5.3	-5.3	-3.9	-3.9
Air,Meriam Before Right	H2O	-5.2	-4.8	-4.3	-3.8	-3.2	-2.5	-1.7	-1.7	-1.3	-1.3
Air,Meriam After Right	H2O	-11.7	-11.1	-10.1	-9.3	-8.0	-6.8	-4.9	-4.9	-3.3	-3.3
Air,Before Turbo Left	H2O	-11.2	-10.5	-9.7	-9.0	-7.4	-6.3	-4.5	-4.5	-3.1	-3.1
Air,Before Turbo Right	H2O	-11.2	-10.5	-9.8	-9.0	-7.4	-6.3	-4.4	-4.8	-3.0	-3.0
Air,After Turbo Left	DEG F	418.1	391.6	384.8	380.9	363.1	361.8	297.7	297.7	248.7	241.4
Air,After Turbo Right	DEG F	401.8	382.2	379.9	369.9	358.2	351.7	295.4	295.4	234.0	233.7
Air,After Turbo-Left	Hg	63.7	62.8	61.5	59.8	57.5	53.4	40.5	40.8	27.1	27.2
Air,After Turbo-Right	Hg	60.2	60.0	78.0	77.8	75.2	72.8	59.6	59.7	45.7	45.7
Air,Aftercooler Out-L	DEG F	203.4	199.1	194.8	192.1	187.5	184.5	169.9	169.5	159.5	159.5
Air,Aftercooler Out-R	DEG F	191.5	188.5	184.5	180.2	174.2	170.2	159.5	159.5	152.2	152.2
Air,Intake Manifold-L	Hg	59.8	59.6	59.4	58.8	56.4	52.8	39.5	39.8	27.1	27.2
Air,Intake Manifold-R	Hg	59.0	59.3	58.2	57.9	56.8	53.6	41.8	41.6	28.0	28.2
Crankcase Pressure	H2O	2.9	2.3	1.6	0.9	0.6	0.8	0.0	0.0	0.0	0.0
Blowby Cal-Orifice	H2O	2.1	2.0	2.1	1.8	1.8	1.9	1.7	1.8	1.7	1.8
Exhaust,Port #1-Right	DEG F	1336.5	1302.8	1293.7	1298.5	1315.8	1341.7	1298.9	1298.5	1279.0	1277.8
Exhaust,Port #2-Right	DEG F	1815.8	1815.8	1815.8	1815.8	1815.8	1815.8	1815.8	1815.8	1816.7	1816.7
Exhaust,Port #3-Right	DEG F	1348.8	1311.4	1301.1	1298.5	1311.9	1347.6	1292.4	1298.7	1260.7	1261.5
Exhaust,Port #4-Right	DEG F	1329.6	1291.1	1295.9	1290.7	1317.9	1372.6	1336.5	1334.8	1305.0	1304.1
Exhaust,Port #5-Right	DEG F	1346.8	1311.9	1326.1	1336.5	1366.9	1420.2	1367.8	1368.9	1323.1	1328.1
Exhaust,Port #6-Right	DEG F	1240.8	1197.4	1193.6	1193.6	1207.3	1249.7	1185.2	1184.3	1122.5	1122.9
Exhaust,Turbo Out-Right	DEG F	1143.2	1118.2	1120.0	1139.0	1172.9	1228.8	1240.8	1240.4	1267.0	1266.6
Wall Time		14:31	14:40	14:58	14:59	15:06	15:19	15:26	15:26	15:35	15:35

Wall Time		14:31	14:40	14:59	14:59	15:06	15:19	15:26	15:26	15:35	15:35
Exhaust,Port #1-Left	DEG F	1399.6	1362.1	1347.6	1377.8	1381.8	1416.7	1370.0	1370.4	1326.6	1325.7
Exhaust,Port #2-Left	DEG F	1448.9	1403.6	1408.4	1422.8	1437.6	1479.5	1420.6	1421.0	1370.9	1370.0
Exhaust,Port #3-Left	DEG F	1311.4	1278.4	1264.0	1267.8	1277.7	1308.0	1239.5	1287.4	1155.5	1154.6
Exhaust,Port #4-Left	DEG F	1229.2	1177.1	1163.6	1154.2	1159.2	1202.1	1155.1	1154.2	1126.7	1126.2
Exhaust,Port #5-Left	DEG F	1359.5	1307.1	1295.0	1289.0	1308.7	1370.0	1316.2	1316.2	1278.6	1279.9
Exhaust,Port #6-Left	DEG F	1224.0	1175.9	1166.5	1161.0	1161.0	1190.7	1130.9	1131.8	1070.0	1069.5
Exhaust,Turbo Out-Left	DEG F	1098.6	1062.9	1067.4	1084.9	1121.6	1194.5	1202.5	1201.7	1220.2	1219.7
Exhaust Stack	DEG F	1099.1	1071.2	1078.0	1091.9	1131.4	1192.8	1206.0	1205.5	1225.8	1225.9
Exhaust Stack	H2O	17.9	16.4	14.1	12.8	10.9	8.6	5.2	5.8	2.7	2.7
Fuel,Engine Supply	DEG F	88.9	90.6	92.8	93.0	87.1	84.1	85.4	85.4	89.5	89.5
Fuel,Engine Supply	PSI	49.7	49.6	50.0	50.0	50.2	50.5	51.1	51.2	51.5	51.5
Fuel,Engine Spillback	DEG F	118.0	120.0	116.9	116.6	108.7	105.8	104.8	108.9	105.0	105.8
Fuel,Engine Spillback	PSI	9.7	9.7	9.7	9.7	9.7	9.8	9.8	9.8	9.9	9.9
Fuel,After Engine-Filter	DEG F	83.2	85.4	85.9	86.8	80.9	78.7	80.0	80.0	84.1	83.6
Fuel,After Engine-Filter	PSI	45.9	46.0	46.4	46.5	46.8	47.1	47.9	47.9	48.4	48.8
Oil Sump-Temp.	DEG F	235.7	232.4	231.4	227.7	222.1	222.1	215.4	216.7	208.8	208.8
Oil Into Cooler Temp.	DEG F	241.0	239.4	236.7	235.0	232.4	230.7	227.1	227.4	222.4	222.7
Oil Into Cooler Press.	PSI	85.8	81.7	76.1	72.7	67.8	61.2	54.6	54.8	49.8	49.8
Coolant,Engine Inlet	DEG F	179.8	179.8	180.5	179.5	180.8	179.8	177.5	177.2	191.5	191.8
Coolant,Engine Inlet Pres.	PSI	17.6	18.3	19.2	18.8	19.8	18.9	18.9	18.4	20.1	19.8
Coolant,Aftercooler In	DEG F	136.9	134.6	142.8	142.6	142.9	141.9	140.8	140.6	148.9	148.9
Coolant,Aftercooler Out	DEG F	184.8	184.2	184.2	183.2	184.2	182.5	180.5	179.5	187.8	188.8
Coolant,After Water,Pump	PSI	62.8	58.7	55.7	50.9	48.8	41.9	36.8	36.8	34.8	34.5
Coolant,Engine Out-Left	DEG F	195.8	195.3	196.5	195.5	195.8	195.8	194.3	194.1	198.8	199.5
Coolant,Engine Out-Right	DEG F	195.5	195.8	196.8	195.8	196.8	196.5	195.1	194.1	198.8	200.1
Coolant,Engine Out-Comb.	DEG F	196.5	196.1	197.5	196.5	197.5	196.8	195.8	195.1	198.8	200.1
Coolant,Engine Out-Left	PSI	28.7	28.0	27.3	26.0	24.9	24.5	23.2	23.2	28.9	28.4
Coolant,Engine Out-Right	PSI	32.2	32.5	32.8	30.8	29.2	29.0	27.0	26.9	28.1	27.7
Coolant,Intercooler In	PSI	45.8	45.8	42.5	39.0	34.7	32.6	28.9	28.9	28.1	27.9
Coolant,Intercooler Out	PSI	49.7	47.6	44.9	41.5	37.4	34.6	30.9	30.9	30.1	29.7
Water,Tower In-Left	DEG F	39.8	39.4	40.5	40.5	40.5	40.9	40.9	40.9	41.2	41.8
Water,Tower In-Right	DEG F	38.4	39.1	39.4	39.4	39.8	40.2	40.5	40.2	51.9	41.9
Water,Tower In-Left	PSI	68.0	68.0	67.9	67.8	68.2	68.2	68.4	68.2	68.3	68.1
Water,Tower In-Right	PSI	67.9	68.0	67.6	67.8	68.0	68.0	68.1	68.1	68.2	68.1
Water Tower-Out	DEG F	179.5	180.8	180.8	181.8	183.2	181.8	182.2	181.8	185.2	189.1
After Cooler-Exch,In	DEG F	87.0	87.0	88.0	98.0	98.0	88.4	88.4	88.4	88.4	88.7
After Cooler-Exch,Out	DEG F	77.1	76.8	97.8	101.5	105.0	105.0	104.6	104.8	109.7	108.7
Water Exchanger-Inlet	PSI	70.7	70.2	68.4	68.8	69.8	69.5	69.6	69.7	69.8	69.7
Dyno,Water In	DEG F	46.9	47.6	49.7	54.0	56.9	59.3	58.6	58.6	60.8	61.5
Dyno,Water Out	PSI	22.0	21.8	21.9	21.7	21.7	22.2	22.9	23.1	25.1	24.9
Dyno,Water Out	DEG F	130.3	130.0	131.9	133.9	133.9	132.9	121.0	121.7	113.2	112.8
Dyno,Water Delta-T	DEG F	84.1	82.4	81.6	79.9	77.0	73.6	62.4	63.1	52.4	51.8

U. S. ARMY TACOM TEST# 25 started 3/10/89 at 14:31 Page 4.0

Meriam Airflow,Left	CFM	1958.4	1900.8	1814.4	1728.0	1526.4	1411.2	1094.4	1128.2	864.0	864.0
Meriam Airflow,Right	CFM	1872.0	1785.6	1670.4	1584.0	1382.4	1298.4	921.6	921.6	576.0	576.0

U. S. ARMY TACOM TEST# 25 started 9/10/89 at 14:31 Page 2.1

Wall Time		15:42	15:58	16:01	16:05	16:08	16:13	16:17	16:21	16:25	16:32
Elapsed Time		003:06:14	003:21:20	003:24:58	003:28:59	003:31:24	003:36:39	003:40:45	003:44:39	003:48:47	003:55:32
Engine Speed	RPM	1409	1409	1606	1805	1805	2002	2200	2399	2606	2804
Engine Load	FT-LBS	2230	2200	2590	2988	2996	3268	3143	3018	2868	2685
Brake Horsepower	BHP	600	590	791	1025	1029	1249	1316	1378	1420	1485
Fuel Consumption,Engine	LBS/HR	208.4	207.7	267.8	348.7	355.7	431.8	457.5	485.8	507.1	527.6
BSFC	LBS/HP-HR	3.474	3.521	3.386	3.402	3.457	3.469	3.476	3.522	3.571	3.676
BMEP	PSI	202.2	198.5	239.7	269.2	270.5	294.6	288.7	272.4	258.5	242.8
Smokemeter Opacity	%	15.6	15.7	10.0	11.2	10.4	10.9	8.7	8.7	7.7	8.0
Water Tower,Out-(Flow)	Hz	50	92	88	89	154	171	131	171	157	167
Water Exch-Out	Hz	0	0	0	0	0	0	0	0	0	0
Barometric Pressure	Hg	29.69	29.68	29.67	29.68	29.68	29.67	29.67	29.67	29.67	29.67
Air,Cell Ambient,Left	DEG F	83.7	81.3	84.7	85.4	83.7	79.2	82.8	81.7	79.6	82.7
Air,Cell Ambient,Right	DEG F	69.9	68.6	70.4	70.0	68.6	68.6	69.6	68.6	69.8	69.6
Air,Cell Depression	H2O	-0.8	-0.8	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8	-0.2	-0.8
Air,Cleaner Out Left	DEG F	85.4	79.6	88.5	87.1	76.4	79.8	76.0	77.8	75.7	79.6
Air,Cleaner Out Right	DEG F	71.1	71.4	73.9	72.1	69.8	71.4	71.1	69.6	70.0	71.4
Air,Meriam Before Left	H2O	-0.6	-0.6	-0.9	-1.5	-1.5	-2.4	-3.1	-3.9	-4.5	-4.9
Air,Meriam After Left	H2O	-3.0	-3.0	-3.9	-5.4	-5.4	-7.1	-8.5	-9.8	-10.8	-11.6
Air,Meriam Before Right	H2O	-0.1	-0.1	-0.2	-1.4	-1.4	-2.5	-3.3	-4.0	-4.4	-5.2
Air,Meriam After Right	H2O	-2.5	-2.4	-3.3	-4.9	-4.9	-6.7	-8.0	-9.2	-10.3	-11.2
Air,Before Turbo Left	H2O	-2.3	-2.2	-3.2	-4.5	-4.6	-6.2	-7.6	-8.7	-9.9	-10.8
Air,Before Turbo Right	H2O	-2.2	-2.1	-2.8	-4.5	-4.5	-6.3	-7.4	-8.7	-9.8	-10.7
Air,After Turbo Left	DEG F	196.8	196.8	250.3	307.2	300.0	353.0	364.3	379.3	386.4	397.8
Air,After Turbo Right	DEG F	190.5	190.1	235.0	297.0	296.4	345.2	357.5	370.2	378.9	390.3
Air,After Turbo-Left	Hg	17.0	16.9	27.9	39.8	40.5	52.7	57.8	61.5	68.1	64.1
Air,After Turbo-Right	Hg	35.7	35.8	45.4	59.2	59.8	71.1	74.7	78.1	79.7	81.0
Air,Aftercooler Out-L	DEG F	149.6	152.9	159.2	170.2	169.9	188.5	186.5	192.1	194.8	199.5
Air,Aftercooler Out-R	DEG F	144.9	148.2	151.9	159.5	160.5	170.2	178.2	180.2	184.8	188.8
Air,Intake Manifold-L	Hg	17.1	17.1	27.2	39.8	39.9	51.6	56.1	59.8	60.9	61.4
Air,Intake Manifold-R	Hg	18.4	18.0	27.8	41.0	41.8	52.8	55.9	59.0	59.9	60.4
Crankcase Pressure	H2O	-1.2	0.1	0.2	0.1	0.2	0.5	0.6	1.2	1.8	2.8
Blowby Cal-Orifice	H2O	1.8	1.8	2.0	2.0	2.0	2.8	2.2	2.4	2.4	2.5
Exhaust,Port #1-Right	DEG F	1248.8	1248.8	1276.4	1306.2	1306.2	1384.8	1317.5	1302.8	1298.0	1308.4
Exhaust,Port #2-Right	DEG F	1816.2	1816.7	1816.7	1817.2	1817.2	1817.2	1817.2	1817.6	1817.6	1817.6
Exhaust,Port #3-Right	DEG F	1224.5	1214.1	1250.9	1281.6	1279.5	1324.8	1303.7	1291.6	1294.1	1315.8
Exhaust,Port #4-Right	DEG F	1298.0	1298.9	1296.3	1328.7	1330.9	1362.6	1310.1	1290.7	1290.8	1298.0
Exhaust,Port #5-Right	DEG F	1313.2	1314.0	1321.4	1360.4	1365.2	1413.6	1362.1	1338.5	1329.1	1318.8
Exhaust,Port #6-Right	DEG F	1094.9	1103.4	1120.0	1180.9	1185.6	1239.5	1205.5	1190.7	1202.1	1206.4
Exhaust,Turbo Out-Right	DEG F	1282.0	1279.0	1264.0	1238.7	1238.7	1224.9	1171.6	1141.5	1127.6	1128.0
Wall Time		15:42	15:58	16:01	16:05	16:08	16:13	16:17	16:21	16:25	16:32

U. S. ARMY TACOM TEST# 25 started 8/10/89 at 14:31 Page 3.1

Wall Time		15:42	15:58	16:01	16:05	16:08	16:13	16:17	16:21	16:25	16:32
Exhaust,Port #1-Left	DEG F	1322.7	1321.8	1334.3	1385.7	1376.5	1411.0	1384.4	1376.5	1353.7	1365.6
Exhaust,Port #2-Left	DEG F	1350.6	1348.5	1378.3	1436.3	1428.0	1466.8	1430.6	1410.6	1404.0	1408.4
Exhaust,Port #3-Left	DEG F	1094.0	1105.1	1152.5	1242.9	1237.8	1301.5	1276.9	1269.1	1260.7	1282.0
Exhaust,Port #4-Left	DEG F	1061.4	1051.2	1127.6	1159.3	1150.8	1187.7	1154.2	1154.2	1164.4	1179.7
Exhaust,Port #5-Left	DEG F	1256.9	1264.9	1287.2	1320.1	1315.6	1348.9	1304.5	1289.4	1301.9	1322.2
Exhaust,Port #6-Left	DEG F	1025.2	1049.1	1077.1	1138.5	1140.2	1180.1	1154.2	1164.8	1171.6	1185.2
Exhaust,Turbo Out-Left	DEG F	1236.9	1237.8	1224.5	1210.8	1203.0	1186.9	1120.4	1083.9	1068.2	1069.5
Exhaust Stack	DEG F	1245.9	1243.8	1225.3	1207.3	1207.3	1198.2	1136.0	1100.0	1083.9	1084.7
Exhaust Stack	H20	1.4	1.4	2.6	5.2	5.2	8.7	11.1	13.5	14.8	16.8
Fuel,Engine Supply	DEG F	81.8	85.4	86.1	91.6	82.7	88.9	85.1	86.8	89.5	88.5
Fuel,Engine Supply	PSI	51.9	52.0	51.8	50.9	50.9	50.5	50.8	49.9	49.7	49.4
Fuel,Engine Spillback	DEG F	96.4	101.9	101.9	108.0	107.0	108.6	106.7	110.4	115.2	114.9
Fuel,Engine Spillback	PSI	9.8	9.9	9.8	9.8	9.8	9.7	9.7	9.6	9.6	9.6
Fuel,After Engine-Filter	DEG F	76.0	79.1	80.0	86.3	80.0	83.2	79.1	80.9	83.2	82.7
Fuel,After Engine-Filter	PSI	48.7	48.8	48.1	47.7	47.7	47.1	46.8	46.4	46.1	45.8
Oil Sump-Temp.	DEG F	204.4	204.4	207.8	213.1	214.7	219.7	221.7	225.7	231.0	232.4
Oil Into Cooler Temp.	DEG F	218.4	219.7	221.7	226.1	226.1	229.7	232.0	234.4	236.4	239.7
Oil Into Cooler Press.	PSI	45.6	45.4	49.7	55.1	54.9	60.8	68.4	72.4	76.2	81.8
Coolant,Engine Inlet	DEG F	182.5	186.1	189.8	176.2	187.5	180.5	177.8	179.5	180.8	181.5
Coolant,Engine Inlet Pres.	PSI	19.9	20.0	19.5	17.8	18.8	17.8	17.8	17.9	18.2	18.9
Coolant,Aftercooler In	DEG F	143.8	144.9	144.2	139.6	144.2	143.8	140.6	142.6	142.6	143.8
Coolant,Aftercooler Out	DEG F	179.2	182.2	185.5	178.8	186.1	183.8	181.5	184.2	184.2	184.8
Coolant,After Water,Pump	PSI	81.4	81.4	84.9	85.9	86.8	40.5	44.0	49.1	55.5	60.1
Coolant,Engine Out-Left	DEG F	191.1	193.8	197.1	194.5	198.1	196.8	194.1	196.5	195.5	196.8
Coolant,Engine Out-Right	DEG F	191.5	194.1	197.5	194.8	198.5	197.8	194.5	196.8	196.1	196.5
Coolant,Engine Out-Comb.	DEG F	192.1	194.5	197.1	195.1	198.5	197.8	195.1	197.1	196.1	196.8
Coolant,Engine Out-Left	PSI	22.9	22.8	23.6	22.1	23.4	23.8	24.1	25.9	26.9	28.9
Coolant,Engine Out-Right	PSI	27.2	27.5	27.7	26.8	27.5	27.8	28.1	30.0	31.4	33.8
Coolant,Intercooler In	PSI	25.7	26.0	27.8	28.8	29.2	31.7	34.2	37.9	41.9	45.6
Coolant,Intercooler Out	PSI	27.6	27.2	29.5	30.1	31.8	33.8	36.6	40.8	44.8	48.8
Water,Tower In-Left	DEG F	43.0	43.4	44.4	40.9	40.9	41.2	40.9	41.2	40.9	40.9
Water,Tower In-Right	DEG F	62.2	66.4	68.2	39.8	40.5	40.5	40.2	40.5	40.2	40.2
Water,Tower In-Left	PSI	68.8	68.6	68.6	68.4	68.0	67.9	68.1	67.9	67.9	67.8
Water,Tower In-Right	PSI	68.6	68.5	68.4	68.9	68.0	67.9	68.0	67.8	67.9	67.7
Water Tower-Out	DEG F	180.5	181.5	181.5	181.5	186.5	185.2	181.2	184.5	183.5	184.2
After Cooler-Exch,In	DEG F	98.7	99.1	98.7	98.4	98.4	98.7	98.4	98.4	98.4	98.4
After Cooler-Exch,Out	DEG F	120.0	122.8	113.2	102.2	111.1	106.0	100.8	99.8	98.1	97.4
Water Exchanger-Inlet	PSI	70.4	70.3	69.9	69.7	69.5	69.4	69.2	68.8	68.5	68.8
Dyno,Water In	DEG F	61.5	57.9	55.8	55.4	56.5	56.1	55.8	56.1	56.5	58.8
Dyno,Water Out	PSI	27.6	28.4	26.2	23.8	23.4	22.2	21.6	21.8	21.8	21.5
Dyno,Water Out	DEG F	105.0	102.2	109.7	119.7	120.4	130.0	132.9	135.6	137.6	138.9
Dyno,Water Delta-T	DEG F	43.5	44.3	53.9	64.8	63.9	78.9	77.1	79.5	81.1	80.6

U. S. ARMY TACOM TEST# 25 started 9/10/89 at 14:31 Page 4.1

Meriam Airflow,Left	CFM	691.2	691.2	864.0	1129.2	1129.2	1353.6	1555.2	1699.2	1814.4	1929.6
Meriam Airflow,Right	CFM	691.2	662.4	892.8	1008.0	1008.0	1209.6	1353.6	1526.4	1670.4	1756.8

Wall Time		16:36	16:42
Elapsed Time		003:59:45	004:05:48
Engine Speed	RPM	3003	-1
Engine Load	FT-LBS	2549	17
Brake Horsepower	BHP	1454	-1
Fuel Consumption,Engine	LBS/HR	548.6	58.2
BSFC	LBS/HP-HR	3.773	0.056
BMEP	PSI	229.6	54.6
Smokemeter Opacity	%	7.8	-0.8
Water Tower,Out-(Flow)	Hz	189	45
Water Exch-Out	Hz	0	0
Barometric Pressure	Hg	29.67	29.67
Air,Cell Ambient,Left	DEG F	78.5	84.4
Air,Cell Ambient,Right	DEG F	68.2	68.2
Air,Cell Depression	H2O	-0.2	-0.8
Air,Cleaner Out Left	DEG F	75.0	87.1
Air,Cleaner Out Right	DEG F	70.7	76.4
Air,Meriam Before Left	H2O	-5.4	0.1
Air,Meriam After Left	H2O	-12.8	0.0
Air,Meriam Before Right	H2O	-5.7	0.0
Air,Meriam After Right	H2O	-11.9	0.0
Air,Before Turbo Left	H2O	-11.2	0.0
Air,Before Turbo Right	H2O	-11.4	0.8
Air,After Turbo Left	DEG F	403.7	111.8
Air,After Turbo Right	DEG F	399.1	109.6
Air,After Turbo-Left	Hg	65.0	-2.9
Air,After Turbo-Right	Hg	81.7	17.4
Air,Aftercooler Out-L	DEG F	202.8	145.2
Air,Aftercooler Out-R	DEG F	192.1	141.6
Air,Intake Manifold-L	Hg	61.4	-2.8
Air,Intake Manifold-R	Hg	60.5	-1.6
Crankcase Pressure	H2O	3.0	-1.2
Blowby Cal-Orifice	H2O	2.7	2.0
Exhaust,Port #1-Right	DEG F	1338.9	419.5
Exhaust,Port #2-Right	DEG F	1817.6	1817.2
Exhaust,Port #3-Right	DEG F	1326.6	390.5
Exhaust,Port #4-Right	DEG F	1329.1	956.1
Exhaust,Port #5-Right	DEG F	1341.7	978.3
Exhaust,Port #6-Right	DEG F	1236.9	490.7
Exhaust,Turbo Out-Right	DEG F	1142.8	542.0
Wall Time		16:36	16:42

Wall Time		16:36	16:42
Exhaust,Port #1-Left	DEG F	1881.8	874.6
Exhaust,Port #2-Left	DEG F	1485.9	972.4
Exhaust,Port #3-Left	DEG F	1300.2	423.5
Exhaust,Port #4-Left	DEG F	1198.6	295.0
Exhaust,Port #5-Left	DEG F	1845.1	970.1
Exhaust,Port #6-Left	DEG F	1217.2	402.6
Exhaust,Turbo Out-Left	DEG F	1078.8	497.7
Exhaust Stack	DEG F	1094.9	481.7
Exhaust Stack	H20	18.4	-0.9
Fuel,Engine Supply	DEG F	87.1	97.4
Fuel,Engine Supply	PSI	49.2	52.7
Fuel,Engine Spillback	DEG F	118.6	100.8
Fuel,Engine Spillback	PSI	9.6	9.9
Fuel,After Engine-Filter	DEG F	81.4	90.4
Fuel,After Engine-Filter	PSI	45.6	50.5
Oil Sump-Temp.	DEG F	235.0	191.8
Oil Into Cooler Temp.	DEG F	242.8	81.0
Oil Into Cooler Press.	PSI	85.5	1.9
Coolant,Engine Inlet	DEG F	179.5	172.5
Coolant,Engine Inlet Pres.	PSI	18.1	18.1
Coolant,Aftercooler In	DEG F	143.6	128.6
Coolant,Aftercooler Out	DEG F	184.2	167.9
Coolant,After Water,Pump	PSI	62.8	18.5
Coolant,Engine Out-Left	DEG F	196.1	179.2
Coolant,Engine Out-Right	DEG F	196.1	179.8
Coolant,Engine Out-Comb.	DEG F	196.5	179.8
Coolant,Engine Out-Left	PSI	28.8	18.8
Coolant,Engine Out-Right	PSI	32.9	22.7
Coolant,Intercooler In	PSI	47.8	16.8
Coolant,Intercooler Out	PSI	50.2	17.5
Water,Tower In-Left	DEG F	40.9	45.1
Water,Tower In-Right	DEG F	39.8	85.8
Water,Tower In-Left	PSI	67.6	68.7
Water,Tower In-Right	PSI	67.6	68.7
Water,Tower-Out	DEG F	182.8	172.5
After Cooler-Exch,In	DEG F	96.4	89.1
After Cooler-Exch,Out	DEG F	97.1	98.1
Water Exchanger-Inlet	PSI	68.0	70.7
Dyno,Water In	DEG F	58.6	58.6
Dyno,Water Out	PSI	21.1	92.0
Dyno,Water Out	DEG F	139.6	62.9
Dyno,Water Delta-T	DEG F	81.0	4.8

Meriam Airflow,Left	CFM	2016.0	57.6
Meriam Airflow,Right	CFM	1785.6	0.0

MTU,DOCUMENTATION

Test Objective: 100% CURVE MTU-AIR SYS
~~Todays Fuel Temp Deg f: 85 oF~~
Test Start point: AT START 100% PERF. CURVE
Operator Name: Schiele,Ratcliff
~~Test Engineer: E.C.Adams, Reisch~~
Engine: MTU-DIESEL, MT-883 Ka 500 V 101
Meriam Flows Corrected YES or NO: *NO 0*
~~Observed Barometer: OUT~~
Observed Humidity: OUT
Oil Added: NONE
~~Oil Sample Taken #: NONE~~

MTU-V12X1500HP

Wall Time		09:34	09:43	09:52	10:09	10:11	10:22	10:30	10:39	10:48	10:57
Elapsed Time		000:24:56	000:33:15	000:43:00	000:53:59	001:01:53	001:12:32	001:20:46	001:29:30	001:38:30	001:47:57
Engine Speed	RPM	2999	2802	2602	2403	2199	2200	2000	1809	1600	1405
Engine Load	FT-LBS	2548	2690	2920	3079	3221	3205	3251	3006	2774	2227
Brake Horsepower	BHP	1454	1485	1446	1408	1348	1342	1238	1031	845	595
Fuel Consumption,Engine	LBS/HR	539.8	520.3	517.6	494.4	475.3	474.8	427.2	354.6	288.1	204.3
BSFC	LBS/HP-HR	0.371	0.362	0.357	0.351	0.352	0.353	0.345	0.343	0.340	0.343
BMEP	PSI	229.9	242.9	268.7	277.8	290.8	289.4	298.5	271.4	250.7	200.9
Smokemeter Opacity	%	5.4	5.2	6.4	6.8	7.9	7.5	8.6	9.9	8.5	8.2
Water Tower,Out-(Flow)	Hz	202	188	167	174	191	115	118	150	85	21
Water Exch-Out	Hz	0	0	0	0	0	0	0	0	0	0
Barometric Pressure	Hg	29.49	29.49	29.48	29.48	29.48	29.47	29.47	29.47	29.47	29.47
Air,Cell Ambient,Left	DEG F	67.2	66.8	68.9	62.9	61.1	63.2	62.5	62.2	62.2	61.1
Air,Cell Ambient,Right	DEG F	68.9	70.4	71.8	66.4	66.4	67.2	66.1	64.7	64.7	64.7
Air,Cell Depression	H2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Air,Cleaner Out Left	DEG F	76.0	77.8	78.5	69.6	69.9	70.7	69.6	69.8	68.9	68.6
Air,Cleaner Out Right	DEG F	94.0	97.4	97.4	92.6	89.2	89.2	85.4	82.8	81.0	80.0
Air,Meriam Before Left	H2O	0.7	1.1	1.3	1.0	0.5	0.7	1.0	1.2	1.2	1.3
Air,Meriam After Left	H2O	-6.7	-6.8	-5.9	-5.8	-4.5	-4.5	-3.6	-2.5	-1.9	-1.3
Air,Meriam Before Right	H2O	2.3	3.0	3.7	3.8	3.5	2.8	1.7	1.4	1.1	0.7
Air,Meriam After Right	H2O	5.2	5.0	4.7	4.1	3.6	3.6	2.7	1.8	1.2	0.7
Air,Before Turbo Left	H2O	-11.4	-10.9	-10.0	-8.9	-7.4	-7.4	-5.7	-3.9	-2.5	-1.6
Air,Before Turbo Right	H2O	-11.8	-11.4	-10.5	-9.5	-8.2	-8.2	-6.1	-4.1	-2.4	-1.4
Air,After Turbo Left	DEG F	405.4	395.5	399.5	380.2	372.1	375.0	350.4	308.9	255.0	187.1
Air,After Turbo Right	DEG F	402.4	401.0	402.7	383.0	376.0	374.7	348.0	301.9	249.0	182.0
Air,After Turbo-Left	Hg	63.0	62.8	63.1	62.3	59.9	59.9	58.6	41.0	30.8	17.6
Air,After Turbo-Right	Hg	74.0	74.3	75.1	73.6	73.0	72.9	67.0	55.5	45.6	33.3
Air,Aftercooler Out-L	DEG F	201.0	201.1	200.0	196.0	193.0	192.1	185.0	173.0	161.2	153.2
Air,Aftercooler Out-R	DEG F	190.1	190.1	189.5	183.0	178.5	176.5	170.5	162.5	158.9	149.2
Air,Intake Manifold-L	Hg	59.6	59.9	60.0	60.4	58.5	58.5	52.9	40.0	30.2	17.4
Air,Intake Manifold-R	Hg	52.0	52.7	53.9	53.1	53.0	52.6	47.4	36.0	26.2	14.3
Crankcase Pressure	H2O	4.0	2.9	2.2	1.6	1.0	1.1	0.5	0.3	0.1	0.0
Blowby Cal Orifice	H2O	1.6	1.7	1.8	0.9	0.5	0.2	0.2	0.2	0.2	0.0
Exhaust,Port 1-Left	DEG F	1879.6	1876.5	1897.5	1887.4	1415.4	1415.4	1418.0	1380.9	1369.5	1308.4
Exhaust,Port 2-Left	DEG F	1819.6	1817.9	1844.6	1830.9	1357.8	1357.8	1361.8	1322.2	1312.7	1251.4
Exhaust,Port 3-Left	DEG F	1278.8	1279.0	1299.8	1295.4	1320.9	1325.7	1329.6	1291.6	1280.6	1166.1
Exhaust,Port 4-Left	DEG F	1352.7	1336.1	1385.2	1318.8	1347.2	1344.2	1367.4	1352.7	1327.4	1277.7
Exhaust,Port 5-Left	DEG F	1333.5	1317.5	1315.3	1300.6	1329.6	1329.6	1355.7	1341.7	1320.1	1265.8
Exhaust,Port 6-Left	DEG F	1268.9	1227.8	1220.6	1204.7	1230.1	1226.6	1237.4	1230.6	1197.4	1148.3
Exhaust,Port 1-Right	DEG F	1417.1	1421.0	1427.1	1415.4	1494.1	1428.4	1437.6	1421.0	1428.9	1354.0
Exhaust,Port 2-Right	DEG F	1349.3	1358.7	1369.4	1346.8	1368.2	1366.5	1366.9	1348.0	1354.4	1279.0

Exhaust,Port 3-Right	DEG F	1298.9	1309.7	1305.4	1279.0	1305.4	1295.0	1288.1	1267.4	1256.9	1192.8
Exhaust,Port 4-Right	DEG F	1378.3	1375.2	1383.3	1372.6	1402.8	1393.7	1411.4	1384.4	1375.2	1306.2
Exhaust,Port 5-Right	DEG F	1352.7	1349.7	1359.1	1351.4	1387.4	1378.7	1392.2	1359.5	1358.2	1293.7
Exhaust,Port 6-Right	DEG F	1272.1	1255.2	1256.4	1228.3	1236.1	1227.9	1245.4	1209.0	1212.9	1152.9
Exhaust,Turbo Out-Left	DEG F	1073.4	1073.4	1090.7	1091.1	1129.7	1138.0	1166.1	1184.3	1220.6	1228.2
Exhaust,Turbo Out-Right	DEG F	1156.8	1158.0	1169.1	1167.0	1198.6	1194.5	1224.5	1245.9	1280.8	1259.5
Exhaust Stack	DEG F	1124.2	1124.2	1141.5	1140.7	1178.0	1178.8	1210.3	1227.9	1258.5	1237.8
Exhaust Stack	H20	14.0	13.4	12.8	11.2	9.8	9.8	7.1	4.0	2.0	0.9
Fuel,Engine Supply	DEG F	84.7	82.8	82.8	81.7	82.7	83.0	81.0	82.0	81.0	80.0
Fuel,Engine Supply	PSI	49.2	49.4	49.4	49.7	50.0	49.8	50.6	50.8	51.1	51.8
Wall Time		09:04	09:48	09:52	10:08	10:11	10:22	10:30	10:39	10:48	10:57
Fuel,Engine Spillback	DEG F	119.8	118.5	111.5	108.0	107.0	107.0	105.0	102.9	100.2	97.4
Fuel,Engine Spillback	PSI	9.5	9.5	9.5	9.6	9.6	9.6	9.6	9.6	9.7	9.7
Fuel,After Engine-Filter	DEG F	80.5	78.2	77.8	76.4	78.2	77.8	77.3	77.0	77.3	76.0
Fuel,After Engine-Filter	PSI	45.6	45.8	46.0	46.3	46.6	46.4	47.2	47.7	48.0	48.8
Oil Sump-Temp.	DEG F	237.4	238.7	230.4	227.4	228.1	228.3	226.4	220.1	212.4	209.4
Oil Into Cooler Temp.	DEG F	249.8	247.8	245.8	241.7	239.8	236.8	237.4	233.7	229.7	224.4
Oil Into Cooler Press	PSI	87.8	82.1	75.8	72.3	67.6	68.6	60.0	58.2	47.8	42.8
Coolant,Engine Inlet	DEG F	183.8	185.2	184.8	183.8	183.8	186.8	184.8	191.5	197.8	200.8
Coolant,Engine Inlet Pres.	PSI	12.9	12.8	10.6	9.8	8.6	10.8	19.8	20.8	22.6	23.2
Coolant,Aftercooler In	DEG F	142.6	142.3	142.3	141.6	140.9	140.9	140.6	143.6	143.6	144.2
Coolant,Aftercooler Out	DEG F	187.5	188.1	188.1	187.1	186.5	187.8	185.5	189.8	192.1	193.1
Coolant,After Water,Pump	PSI	52.6	47.1	43.8	37.8	32.7	45.2	41.1	88.2	97.8	36.8
Coolant,Engine Out-Left	DEG F	200.4	201.4	201.4	201.1	200.4	201.4	200.4	204.4	204.8	205.4
Coolant,Engine Out-Right	DEG F	200.4	200.8	201.1	201.1	200.4	200.8	199.8	203.4	204.1	205.1
Coolant,Engine Out-Comb.	DEG F	200.4	201.4	201.4	201.4	200.4	200.4	200.4	204.4	204.8	205.8
Coolant,Engine Out-Left	PSI	22.1	19.8	18.1	16.8	14.8	26.1	25.0	24.6	26.6	26.7
Coolant,Engine Out-Right	PSI	26.4	24.0	23.1	20.7	18.5	30.0	29.2	29.5	31.2	31.8
Coolant,Intercooler In	PSI	38.8	35.3	31.0	26.3	22.7	35.2	33.8	30.6	30.5	29.3
Coolant,Intercooler Out	PSI	41.5	36.8	34.0	29.2	25.3	37.8	34.8	32.5	32.4	30.9
Water,Tower In-Left	DEG F	50.5	50.5	50.8	50.8	50.8	51.2	51.2	51.2	51.9	52.8
Water,Tower In-Right	DEG F	49.7	49.7	50.1	50.1	50.3	50.8	50.8	51.2	51.6	52.2
Water,Tower In-Left	PSI	65.5	65.7	65.9	65.9	66.0	65.7	65.3	65.1	65.1	65.3
Water,Tower In-Right	PSI	65.6	65.7	66.1	66.1	66.3	65.8	65.7	65.5	65.4	65.6
Water,Tower Out	DEG F	186.8	186.8	186.8	187.1	186.8	188.8	187.1	193.8	193.8	189.5
After Cooler-Exch,In	DEG F	48.3	48.7	48.8	49.4	49.8	49.7	49.7	49.4	49.7	50.1
After Cooler-Exch,Out	DEG F	78.5	79.2	81.0	82.0	83.7	81.8	85.1	89.2	94.0	96.0
Water Exchanger-Inlet	PSI	59.6	60.9	62.5	62.8	64.5	62.6	64.4	65.0	65.8	66.1
Dyno,Water In	DEG F	56.9	58.6	65.7	67.9	73.2	78.2	72.5	70.7	72.5	71.8
Dyno,Water Out	PSI	23.8	23.7	23.1	21.7	20.6	19.9	20.0	21.2	21.8	24.1
Dyno,Water Out	DEG F	135.6	136.9	143.6	145.9	149.6	160.8	144.2	132.9	124.1	112.8
Dyno,Water Delta-T	DEG F	78.7	78.3	77.9	78.0	76.4	77.0	71.7	62.2	51.6	40.7

MTU,DOCUMENTATION

Test Objective: JET-A PERFORMANCE TEST
Todays Fuel Temp-Deg f: 85 oF
Test Start point: AT NATO CONDITIONS
Operator Name: Schiele,Ratcliff
Test Engineer: E.C.Adams, Reisch
Engine: MTU-DIESEL, MT-883 Ka 500 V 101
Meriam Flows Corrected YES or NO: NO 0
Observed Barometer: OUT
Observed Humidity: OUT
Oil Added: NONE
Oil Sample Taken @: NONE

MTU-V12X1500HP

JET-A ACCELERATION

Wall Time		13:06	13:13	13:20	13:27	13:35	13:41	13:52	13:58	14:06	14:21
Elapsed Time		000:22:30	000:29:20	000:36:27	000:43:04	000:50:55	000:57:42	001:08:04	001:14:43	001:22:43	001:37:02
Engine Speed	RPM	2999	2808	2599	2399	2200	2000	1798	1601	1397	1428
Engine Load	FT-LBS	2814	2496	2664	2780	2943	2909	2684	2338	2034	21
Brake Horsepower	BHP	1321	1300	1318	1269	1232	1107	918	711	541	5
Fuel Consumption,Engine	LBS/HR	485.2	468.1	468.6	438.9	420.8	376.8	308.7	239.7	180.6	18.9
BSFC	LBS/HP-HR	0.367	0.356	0.351	0.345	0.341	0.340	0.330	0.337	0.333	3.780
BMEP	PSI	208.9	219.9	240.6	251.0	265.5	262.5	242.8	210.6	188.9	1.7
Smokemeter Opacity	%	3.4	3.3	3.4	3.4	4.5	5.9	8.1	7.3	6.9	1.6
Water Tower,Out-(Flow)	Hz	172	173	187	120	120	148	0	67	15	2
Water Exch-Out	Hz	856	858	855	718	558	499	404	332	2	1
Barometric Pressure	Hg	29.19	29.19	29.19	29.19	29.19	29.19	29.18	29.18	29.18	29.18
Air,Cell Ambient,Left	DEG F	71.1	74.6	78.6	79.2	78.1	74.6	78.6	74.6	76.0	74.6
Air,Cell Ambient,Right	DEG F	72.8	78.9	73.6	74.3	71.8	74.3	78.9	75.3	79.6	75.3
Air,Cell Depression	H2O	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Air,Cleaner Out Left	DEG F	78.2	80.3	80.3	77.5	78.2	79.2	77.1	75.7	77.5	78.2
Air,Cleaner Out Right	DEG F	71.4	77.8	78.9	74.6	71.4	74.8	75.0	75.7	82.3	77.5
Air,Meriam Before Left	H2O	1.6	2.6	3.6	4.1	4.4	4.5	4.2	3.8	3.3	2.0
Air,Meriam After Left	H2O	2.6	4.0	5.4	6.4	7.2	7.5	7.7	7.6	7.2	6.7
Air,Meriam Before Right	H2O	-0.4	1.1	2.8	4.0	5.3	6.2	7.2	7.5	7.6	7.2
Air,Meriam After Right	H2O	2.9	4.4	6.0	7.2	8.5	9.3	10.2	10.6	10.7	10.1
Air,Before Turbo Left	H2O	-9.4	-8.8	-8.1	-7.0	-5.9	-4.2	-2.6	-1.6	-1.0	-0.6
Air,Before Turbo Right	H2O	-11.5	-10.9	-10.2	-8.9	-7.9	-5.9	-4.0	-2.5	-1.6	-1.0
Air,After Turbo Left	DEG F	880.2	884.8	885.7	865.6	860.5	838.1	286.6	230.7	184.5	90.6
Air,After Turbo Right	DEG F	855.2	861.1	866.9	842.0	837.5	814.4	268.8	218.1	175.5	87.8
Air,After Turbo-Left	Hg	60.2	59.1	58.2	56.8	54.7	46.2	35.5	29.3	14.5	-0.7
Air,After Turbo-Right	Hg	72.2	71.2	71.0	68.4	67.8	60.4	49.8	38.0	30.1	16.4
Air,Aftercooler Out-L	DEG F	201.1	200.4	198.1	198.1	192.8	184.5	171.2	160.2	151.9	145.9
Air,Aftercooler Out-R	DEG F	189.5	188.8	185.8	180.2	176.8	169.9	160.2	153.6	147.6	148.3
Air,Intake Manifold-L	Hg	56.9	56.3	56.1	55.1	53.2	45.1	34.8	29.0	14.6	-0.6
Air,Intake Manifold-R	Hg	50.3	50.1	50.2	48.2	47.9	40.7	30.8	19.4	11.8	-1.7
Crankcase Pressure	H2O	4.5	2.6	1.6	1.2	1.2	0.4	0.0	0.0	-0.1	-0.4
Blowby Cal-Orifice	H2O	1.8	1.7	1.5	1.5	1.5	1.5	1.3	1.3	1.2	1.3
Exhaust,Port 1-Left	DEG F	1817.0	1845.5	1852.3	1849.8	1868.9	1867.4	1836.5	1294.6	1258.1	824.5
Exhaust,Port 2-Left	DEG F	1283.6	1268.3	1301.1	1289.8	1305.8	1308.0	1277.2	1280.9	1189.4	810.6
Exhaust,Port 3-Left	DEG F	1198.7	1217.6	1227.9	1230.9	1261.5	1261.1	1231.8	1178.8	1185.6	869.1
Exhaust,Port 4-Left	DEG F	1309.7	1297.6	1301.9	1288.1	1881.7	1888.7	1809.7	1266.1	1289.5	896.8
Exhaust,Port 5-Left	DEG F	1293.3	1276.0	1277.7	1278.8	1316.2	1322.7	1299.8	1259.0	1224.9	846.4
Exhaust,Port 6-Left	DEG F	1219.7	1192.8	1182.6	1169.1	1209.0	1202.1	1183.5	1145.7	1107.6	896.0
Exhaust,Port 1-Right	DEG F	1325.7	1336.9	1334.8	1893.0	1363.0	1370.9	1358.7	1332.6	1292.0	811.1
Exhaust,Port 2-Right	DEG F	561.5	595.8	1283.8	1279.9	1315.8	1316.2	1292.9	1266.6	1223.2	298.2

U. S. ARMY TACOM TEST# 95 started 5/02/89 at 18:06 Page 3.0

Wall Time		18:06	18:18	18:20	18:27	18:35	18:41	18:52	19:58	14:06	14:21
Exhaust,Port 3-Right	DEG F	1198.7	1225.8	1227.9	1217.6	1250.9	1246.8	1226.2	1186.9	1148.6	807.1
Exhaust,Port 4-Right	DEG F	1309.7	1309.7	1318.6	1307.1	1347.2	1347.6	1316.6	1281.2	1245.0	865.6
Exhaust,Port 5-Right	DEG F	1290.8	1298.7	1301.1	1295.4	1342.1	1345.1	1307.1	1273.8	1235.6	855.2
Exhaust,Port 6-Right	DEG F	1204.8	1194.0	1187.7	1169.5	1201.2	1207.8	1165.9	1138.5	1098.9	829.9
Exhaust,Turbo Out-Left	DEG F	1055.9	1060.6	1071.2	1088.1	1132.2	1166.5	1176.7	1182.6	1192.8	810.6
Exhaust,Turbo Out-Right	DEG F	1118.2	1125.4	1134.8	1141.1	1181.4	1210.8	1225.8	1232.6	1222.7	854.8
Exhaust Stack	DEG F	1086.4	1097.8	1109.8	1118.7	1161.4	1191.5	1207.8	1205.1	1196.1	888.1
Exhaust Stack	H20	17.6	16.7	14.1	12.1	9.7	6.8	4.4	2.7	1.2	0.1
Fuel,Engine Supply	DEG F	87.8	84.4	85.1	89.5	82.8	86.5	89.5	88.4	88.2	80.0
Fuel,Engine Supply	PSI	48.6	48.5	48.8	49.0	49.1	49.5	49.5	50.4	50.5	51.7
Fuel,Engine Spillback	DEG F	116.6	112.5	111.8	112.5	106.0	108.7	106.7	101.9	102.2	93.0
Fuel,Engine Spillback	PSI	9.5	9.5	9.5	9.5	9.5	9.6	9.6	9.6	9.6	9.7
Fuel,After Engine-Filter	DEG F	86.8	89.5	88.1	88.6	86.8	88.1	89.5	98.0	98.2	96.1
Fuel,After Engine-Filter	PSI	45.4	45.2	45.6	45.9	46.0	46.6	46.9	47.6	47.6	49.5
Oil Sump-Temp.	DEG F	292.4	231.0	229.0	224.4	223.7	219.4	217.1	209.8	206.4	171.9
Oil Into Cooler Temp.	DEG F	248.7	242.7	241.0	238.4	236.0	234.4	230.7	227.1	222.7	176.8
Oil Into Cooler Press	PSI	83.6	79.0	78.5	70.0	65.8	58.9	58.0	47.4	43.6	66.0
Coolant,Engine Inlet	DEG F	185.8	188.1	187.8	189.1	186.8	188.8	191.8	197.8	191.1	160.5
Coolant,Engine Inlet Pres	PSI	14.8	14.8	15.8	16.8	18.7	18.8	21.1	22.5	23.5	22.8
Coolant,Aftercooler In	DEG F	145.8	146.8	144.9	145.6	144.6	148.6	144.9	146.8	148.8	148.6
Coolant,Aftercooler Out	DEG F	188.1	190.5	189.8	190.1	188.1	185.5	189.5	192.5	185.5	158.9
Coolant,After Water,Pump	PSI	56.9	54.1	51.4	48.6	45.7	40.4	39.5	37.8	35.0	85.1
Coolant,Engine Out-Left	DEG F	411.9	476.8	689.1	1312.8	701.7	705.6	700.8	709.8	714.4	607.5
Coolant,Engine Out-Right	DEG F	199.8	201.8	201.4	201.8	201.1	200.1	201.4	204.1	197.8	161.5
Coolant,Engine Out-Comb.	DEG F	200.1	202.4	201.8	202.4	201.8	200.8	202.1	204.1	198.1	161.5
Coolant,Engine Out-Left	PSI	24.8	24.9	25.8	24.7	25.6	24.8	25.9	26.9	26.8	25.9
Coolant,Engine Out-Right	PSI	29.2	29.2	29.4	28.9	29.8	28.9	30.8	31.1	31.0	29.8
Coolant,Intercooler In	PSI	41.8	40.8	38.1	36.8	34.8	31.8	32.4	31.0	29.2	29.1
Coolant,Intercooler Out	PSI	45.6	41.6	40.1	39.6	36.1	33.6	34.8	32.9	31.9	30.0
Water,Tower In-Left	DEG F	58.8	58.7	58.7	54.4	54.4	54.7	55.4	56.1	60.8	71.1
Water,Tower In-Right	DEG F	52.6	52.9	53.8	58.7	58.7	54.4	58.7	62.0	90.9	116.6
Water,Tower In-Left	PSI	64.4	65.6	65.8	65.6	65.0	66.8	67.6	67.4	66.1	66.6
Water,Tower In-Right	PSI	66.8	66.6	65.8	66.7	67.1	67.4	68.8	69.1	67.4	67.8
Water Tower-Out	DEG F	184.2	187.5	186.1	186.5	184.8	184.5	188.1	193.5	183.5	157.9
After Cooler-Exch,In	DEG F	51.2	51.5	51.5	51.9	52.6	52.6	53.8	53.8	53.8	54.4
After Cooler-Exch,Out	DEG F	74.8	78.9	78.6	76.4	79.6	80.8	84.4	88.5	94.7	133.8
Water Exchanger-Inlet	PSI	57.4	56.9	57.8	61.8	62.8	65.2	66.9	68.8	69.2	70.0
Dyno,Water In	DEG F	56.1	59.7	65.0	67.9	70.0	71.1	72.5	72.8	71.4	67.5
Dyno,Water Out	PSI	22.6	24.1	23.4	22.7	22.6	23.5	24.6	25.9	27.8	33.6
Dyno,Water Out	DEG F	125.2	128.2	133.9	134.6	134.9	130.8	122.4	112.5	103.6	67.9
Dyno,Water Delta-T	DEG F	69.1	68.5	68.9	66.4	64.9	59.8	49.9	39.7	32.2	0.4

JET-A - ACCEL

Wall Time		14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21
Elapsed Time		001:37:04	001:37:06	001:37:08	001:37:10	001:37:13	001:37:15	001:37:18	001:37:20	001:37:22	001:37:25
Engine Speed	RPM	1688	2037	2542	2752	2476	2368	2686	2599	2587	2598
Engine Load	FT-LBS	21	25	40	1981	2802	2468	2469	2685	2709	2629
Brake Horsepower	BHP	6	9	19	988	1329	1206	1239	1328	1334	1300
Fuel Consumption,Engine	LBS/HR	19.5	19.5	46.8	46.8	107.8	107.8	153.9	153.8	153.8	188.4
BSFC	LBS/HP-HR	3.252	2.170	2.468	0.047	0.081	0.089	0.128	0.115	0.114	0.144
BMEP	PSI	1.7	2.1	3.6	178.7	252.9	222.7	229.0	242.3	244.7	237.4
Smokemeter Opacity	%	84.6	88.8	84.5	8.7	7.0	6.4	5.8	5.8	5.0	4.8
Water Tower,Out-(Flow)	Hz	P	P	P	P	P	P	P	P	P	P
Water Exch-Out	Hz	1	1	1	1	1	1	1	1	1	1
Barometric Pressure	Hg	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18
Air,Cell Ambient,Left	DEG F	74.6	78.9	78.6	78.2	78.6	78.9	74.8	75.0	75.0	75.7
Air,Cell Ambient,Right	DEG F	75.3	75.0	75.0	75.3	76.0	76.4	77.1	77.1	77.1	77.1
Air,Cell Depression	H2O	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Air,Cleaner Out Left	DEG F	78.2	77.8	77.1	75.7	75.7	75.7	75.7	76.4	78.2	79.6
Air,Cleaner Out Right	DEG F	77.1	76.8	76.8	76.8	78.5	80.0	80.6	80.6	80.6	80.0
Air,Meriam Before Left	H2O	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Air,Meriam After Left	H2O	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Air,Meriam Before Right	H2O	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Air,Meriam After Right	H2O	10.1	10.1	10.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Air,Before Turbo Left	H2O	-0.8	-1.6	-5.8	-8.0	-7.8	-7.8	-8.2	-8.1	-7.9	-8.1
Air,Before Turbo Right	H2O	-1.0	-2.4	-5.8	-10.8	-9.4	-9.4	-10.0	-10.1	-9.9	-10.8
Air,After Turbo Left	DEG F	90.6	96.0	111.1	211.1	258.7	286.6	305.2	313.1	322.9	326.4
Air,After Turbo Right	DEG F	87.5	95.7	118.5	219.1	251.0	282.8	289.5	301.9	307.5	308.9
Air,After Turbo-Left	Hg	-0.2	11.9	32.4	51.5	51.7	52.1	53.0	54.1	54.2	54.7
Air,After Turbo-Right	Hg	17.7	22.2	49.9	68.9	68.8	64.8	65.6	66.4	66.5	67.4
Air,Aftercooler Out-L	DEG F	145.9	146.2	146.2	131.2	155.9	162.9	166.2	171.5	173.5	176.8
Air,Aftercooler Out-R	DEG F	148.6	148.8	148.9	145.9	158.9	159.9	162.2	164.5	168.2	169.2
Air,Intake Manifold-L	Hg	1.8	6.4	29.6	46.7	49.7	50.1	51.0	51.7	52.1	52.2
Air,Intake Manifold-R	Hg	0.9	6.0	16.8	42.5	48.8	48.5	45.4	46.8	46.5	46.7
Crankcase Pressure	H2O	0.1	0.1	0.5	2.0	1.8	1.6	2.1	1.7	1.7	1.7
Blowby Cal-Orifice	H2O	1.8	1.8	1.4	1.6	1.5	1.5	1.5	1.5	1.5	1.5
Exhaust,Port 1-Left	DEG F	377.4	480.8	598.4	878.8	966.9	1094.9	1172.9	1199.5	1236.9	1250.1
Exhaust,Port 2-Left	DEG F	311.1	459.9	559.8	792.2	872.1	998.7	1087.8	1105.5	1149.5	1166.5
Exhaust,Port 3-Left	DEG F	276.7	386.7	510.8	700.4	769.8	877.5	919.5	955.5	1018.0	1035.1
Exhaust,Port 4-Left	DEG F	314.2	407.5	648.7	884.7	961.8	1064.8	1102.9	1138.0	1175.8	1189.0
Exhaust,Port 5-Left	DEG F	278.5	378.2	480.8	733.5	902.7	1008.4	1048.8	1081.8	1128.4	1144.9
Exhaust,Port 6-Left	DEG F	280.2	354.8	447.7	650.0	728.6	829.0	871.6	942.1	990.6	1009.6
Exhaust,Port 1-Right	DEG F	339.8	445.0	717.2	859.7	1042.4	1149.5	1185.6	1218.3	1249.7	1260.7
Exhaust,Port 2-Right	DEG F	325.4	400.4	596.2	706.0	876.7	940.8	1038.2	1075.0	1127.1	1145.8

U. S. ARMY TACOM TEST@ 95 started 5/02/89 at 13:06 Page 3.1

Wall Time		14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21	14:21
Exhaust,Port 3-Right	DEG F	307.1	412.4	598.0	688.0	761.9	874.6	918.7	988.9	1036.9	1055.5
Exhaust,Port 4-Right	DEG F	367.9	548.5	802.5	907.2	985.5	1091.9	1129.7	1181.8	1212.0	1223.2
Exhaust,Port 5-Right	DEG F	369.8	498.8	642.2	857.1	929.8	1034.0	1078.8	1105.5	1150.4	1179.7
Exhaust,Port 6-Right	DEG F	344.4	402.6	562.8	653.9	791.8	888.8	920.8	953.0	1001.6	1019.7
Exhaust,Turbo Out-Left	DEG F	314.6	354.8	475.5	597.5	641.8	714.6	744.6	771.2	814.7	849.0
Exhaust,Turbo Out-Right	DEG F	854.8	489.7	564.6	616.6	660.9	798.9	764.5	815.1	836.2	871.6
Exhaust Stack	DEG F	360.6	445.0	658.8	781.8	808.4	858.0	875.0	888.0	908.2	917.0
Exhaust Stack	H2O	0.6	1.4	8.2	9.8	8.9	8.7	9.8	10.0	10.2	10.8
Fuel,Engine Supply	DEG F	79.6	80.0	79.6	80.0	80.0	80.0	80.0	79.6	79.6	79.6
Fuel,Engine Supply	PSI	51.1	50.2	48.8	48.9	48.9	48.9	48.8	48.8	48.9	48.9
Fuel,Engine Spillback	DEG F	93.3	93.0	92.6	93.8	94.7	95.4	95.7	96.7	97.1	97.4
Fuel,Engine Spillback	PSI	9.6	9.6	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Fuel,After Engine-Filter	DEG F	96.1	95.6	96.1	96.1	96.5	96.5	96.9	96.9	96.9	96.9
Fuel,After Engine-Filter	PSI	48.1	47.8	46.1	45.7	46.0	45.8	45.8	45.8	45.8	45.8
Oil Sump-Temp.	DEG F	171.9	171.5	171.9	172.5	174.5	176.2	177.2	178.8	180.2	180.5
Oil Into Cooler Temp.	DEG F	176.5	176.8	176.8	177.2	177.5	177.8	179.5	181.2	181.8	182.8
Oil Into Cooler Press	PSI	69.2	97.7	103.7	105.5	103.2	103.1	104.0	103.7	103.0	103.0
Coolant,Engine Inlet	DEG F	160.5	160.9	160.5	160.5	160.5	161.5	161.9	163.5	164.5	166.2
Coolant,Engine Inlet Press	PSI	22.7	22.4	23.0	23.5	20.8	21.1	20.7	20.6	19.8	20.1
Coolant,Aftercooler In	DEG F	142.9	142.9	142.9	144.9	147.2	147.9	148.6	149.2	149.6	149.6
Coolant,Aftercooler Out	DEG F	158.9	158.9	158.9	159.5	160.5	161.9	162.9	164.5	165.2	166.9
Coolant,After Water,Pump	PSI	35.0	44.9	58.7	68.4	55.6	56.8	56.7	57.8	56.9	57.8
Coolant,Engine Out-Left	DEG F	589.9	621.6	618.7	617.0	607.8	602.9	605.9	576.8	567.5	566.6
Coolant,Engine Out-Right	DEG F	161.5	161.9	162.2	162.5	164.5	165.9	167.9	169.9	170.9	172.2
Coolant,Engine Out-Comb.	DEG F	161.5	161.5	162.2	162.9	164.5	165.5	166.9	168.9	171.2	171.9
Coolant,Engine Out-Left	PSI	87.1	80.8	82.8	84.8	89.5	90.4	80.9	89.8	89.7	89.9
Coolant,Engine Out-Right	PSI	29.8	82.5	86.9	87.9	88.5	84.0	84.4	82.9	88.5	88.4
Coolant,Intercooler In	PSI	80.0	87.5	48.9	48.2	42.4	48.7	44.1	43.6	48.2	44.1
Coolant,Intercooler Out	PSI	80.1	87.8	51.7	52.9	44.4	47.5	47.6	46.8	47.0	47.1
Water,Tower In-Left	DEG F	71.1	70.7	70.7	71.1	71.1	71.1	71.1	71.4	71.8	72.1
Water,Tower In-Right	DEG F	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6	116.6
Water,Tower In-Left	PSI	66.8	66.8	66.0	66.6	66.9	66.8	65.8	65.9	66.7	66.8
Water,Tower In-Right	PSI	68.0	67.5	67.9	67.9	67.5	67.6	68.6	67.5	67.8	67.4
Water Tower-Out	DEG F	157.9	157.9	157.6	157.6	157.6	157.6	157.6	157.2	157.2	157.2
After Cooler-Exch,In	DEG F	54.4	54.4	54.4	54.7	54.4	54.4	54.7	54.7	54.4	54.4
After Cooler-Exch,Out	DEG F	188.6	188.6	188.6	188.9	188.9	185.6	186.8	187.8	187.6	186.6
Water Exchanger-Inlet	PSI	70.6	69.8	70.9	69.9	68.6	70.4	70.9	70.5	69.9	70.4
Dyno,Water In	DEG F	67.9	67.5	67.5	67.5	67.5	67.9	67.9	67.5	67.5	67.8
Dyno,Water Out	PSI	84.4	84.0	84.5	88.2	84.7	88.5	88.2	88.8	88.6	
Dyno,Water Out	DEG F	67.9	67.9	67.2	67.9	68.2	70.0	78.9	90.2	95.7	101.5
Dyno,Water Delta-T	DEG F	0.0	0.4	-0.8	0.4	0.7	2.1	11.0	22.7	28.2	84.0

MTU, DOCUMENTATION

Test Objective: 1500 HP AND HEAT REJT.
Todays Fuel Temp-Deg f: 85 oF ONLY
Test Start point: AT STANDARD NATO CONDITIONS
Operator Name: Schiele,Ratcliff
Test Engineer: E.C.Adams, Reisch
Engine: MTU-DIESEL MT-888 Ka 500 V 101
Meriam Flows Corrected YES or NO: NO 0
Observed Barometer: OUT
Observed Humidity: OUT
Oil added: NONE
Oil Sample Taken @: NONE

MTU-U12X1500HP

Wall Time		09:30	09:36	09:49	09:51	10:00	10:02	10:18	10:14	10:21	10:22
Elapsed Time		000:30:11	000:36:05	000:48:21	000:51:10	000:59:48	001:01:38	001:12:48	001:14:05	001:20:35	001:22:01
Engine Speed	RPM	2998	2998	2998	2998	2802	2801	2597	2599	2401	2401
Engine Load	FT-LBS	2540	2639	2567	2562	2675	2678	2912	2911	3078	3078
Brake Horsepower	BHP	1449	1506	1465	1462	1427	1428	1439	1440	1407	1407
Fuel Consumption,Engine	LBS/HR	538.6	560.8	544.0	544.0	523.0	523.0	518.6	517.8	496.1	497.8
BSFC	LBS/HP-HR	0.371	0.372	0.371	0.372	0.366	0.366	0.360	0.359	0.352	0.353
BMEP	PSI	229.3	238.2	231.7	231.2	241.5	241.8	262.8	262.7	278.0	277.9
Smokemeter Opacity	%	3.6	3.7	3.7	4.0	4.4	4.4	4.8	5.0	5.7	5.5
Water Tower,Out-(Flow)	Hz	225	189	215	222	199	186	177	172	169	165
Water Exch-Out	Hz	888	890	889	890	891	892	880	852	885	886
Barometric Pressure	Hg	29.40	29.39	29.39	29.39	29.38	29.38	29.38	29.38	29.37	29.37
Air,Cell Ambient,Left	DEG F	67.2	68.2	69.6	71.4	70.4	69.6	72.1	70.4	70.7	71.4
Air,Cell Ambient,Right	DEG F	71.1	71.4	72.8	75.0	77.5	77.5	76.8	80.6	75.7	76.0
Air,Cell Depression	H2O	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
Air,Cleaner Out Left	DEG F	68.2	72.5	78.6	76.0	72.5	74.8	78.5	76.0	75.8	75.8
Air,Cleaner Out Right	DEG F	68.9	70.4	70.7	74.8	72.8	72.1	75.0	78.2	72.8	74.8
Air,Meriam Before Left	H2O	-0.1	0.2	1.1	1.3	1.7	1.8	2.0	2.0	2.0	2.0
Air,Meriam After Left	H2O	-1.9	-1.8	0.0	0.2	1.0	1.0	1.6	1.7	1.9	1.9
Air,Meriam Before Right	H2O	2.0	2.6	3.7	4.0	4.9	5.0	5.7	5.8	6.1	6.2
Air,Meriam After Right	H2O	1.0	1.6	2.7	3.0	3.9	4.0	4.7	4.8	5.1	5.1
Air,Before Turbo Left	H2O	-10.2	-10.7	-10.4	-10.2	-9.6	-9.7	-8.8	-8.9	-7.8	-7.8
Air,Before Turbo Right	H2O	-12.9	-13.4	-13.1	-13.0	-12.5	-12.8	-11.6	-11.5	-10.2	-10.2
Air,After Turbo Left	DEG F	394.9	412.2	407.7	408.6	394.5	400.4	399.5	396.8	391.9	390.8
Air,After Turbo Right	DEG F	378.5	385.7	379.8	385.7	375.7	375.4	379.8	377.0	367.8	368.9
Air,After Turbo-Left	Hg	64.5	66.8	64.4	64.0	64.8	68.1	68.4	68.6	61.7	62.2
Air,After Turbo-Right	Hg	76.1	78.2	76.2	75.7	75.4	75.4	75.4	75.5	78.2	78.8
Air,Aftercooler Out-L	DEG F	208.4	207.4	206.1	206.4	208.8	204.1	202.1	202.1	197.8	198.1
Air,Aftercooler Out-R	DEG F	198.8	196.5	195.8	196.5	194.1	194.1	192.5	192.8	186.5	187.1
Air,Intake Manifold-L	Hg	61.4	63.4	61.2	60.6	61.4	60.8	60.9	61.5	60.0	60.5
Air,Intake Manifold-R	Hg	54.6	56.7	54.8	54.8	54.5	54.4	55.1	55.1	58.4	58.5
Crankcase Pressure	H2O	3.4	4.2	2.9	3.8	2.7	2.6	1.8	2.0	1.6	1.4
Blowby Cal-Orifice	H2O	1.1	1.2	1.2	1.3	1.2	1.2	1.1	1.1	1.1	1.1
Exhaust,Port 1-Left	DEG F	1363.0	1399.2	1376.5	1378.7	1351.4	1357.0	1377.4	1374.8	1378.8	1377.4
Exhaust,Port 2-Left	DEG F	1307.1	1348.8	1317.9	1324.4	1300.2	1309.7	1329.6	1329.6	1328.5	1326.1
Exhaust,Port 3-Left	DEG F	1258.5	1279.9	1260.2	1268.6	1257.7	1259.0	1274.7	1271.2	1282.9	1280.8
Exhaust,Port 4-Left	DEG F	1334.8	1365.2	1349.8	1348.9	1338.0	1334.8	1337.8	1331.8	1331.7	1333.6
Exhaust,Port 5-Left	DEG F	1321.4	1350.6	1334.8	1333.0	1311.4	1317.5	1323.5	1315.8	1311.9	1314.0
Exhaust,Port 6-Left	DEG F	1240.4	1274.8	1256.9	1261.5	1233.1	1236.9	1228.8	1225.8	1219.8	1214.1
Exhaust,Port 1-Right	DEG F	1369.5	1399.2	1380.5	1387.9	1383.1	1381.8	1394.4	1389.2	1388.7	1391.4
Exhaust,Port 2-Right	DEG F	1314.5	1344.2	1326.6	1331.7	1329.1	1325.7	1336.9	1334.8	1329.1	1332.6

Wall Time		09:30	09:36	09:49	09:51	10:00	10:02	10:18	10:14	10:21	10:22
Exhaust,Port 3-Right	DEG F	1256.9	1279.0	1259.0	1266.6	1268.6	1259.0	1274.3	1278.0	1257.7	1269.6
Exhaust,Port 4-Right	DEG F	1338.2	1368.0	1347.6	1354.8	1385.2	1338.5	1349.3	1346.8	1346.8	1350.2
Exhaust,Port 5-Right	DEG F	1315.8	1341.7	1327.9	1338.2	1319.2	1314.5	1340.0	1336.9	1338.2	1340.8
Exhaust,Port 6-Right	DEG F	1248.3	1259.4	1242.9	1248.0	1220.6	1219.7	1220.6	1220.2	1214.1	1215.4
Exhaust,Turbo Out-Left	DEG F	1065.7	1085.2	1070.4	1072.5	1064.8	1068.1	1091.5	1089.4	1102.1	1102.1
Exhaust,Turbo Out-Right	DEG F	1138.5	1152.1	1137.7	1145.8	1132.2	1131.8	1147.8	1145.3	1068.2	1155.9
Exhaust Stack	DEG F	1106.8	1126.7	1118.1	1117.8	1104.6	1104.2	1114.8	1112.8	1126.8	1128.4
Exhaust Stack	H2O	17.2	17.4	14.7	13.9	12.7	12.6	11.6	11.7	10.8	10.8
Fuel,Engine Supply	DEG F	85.8	84.7	84.7	85.1	85.1	85.4	84.4	84.7	89.0	88.0
Fuel,Engine Supply	PSI	49.1	48.9	48.8	48.8	49.1	49.1	49.2	49.3	49.2	49.3
Fuel,Engine Spillback	DEG F	117.3	116.6	117.3	117.6	115.6	115.6	111.8	111.8	108.4	108.4
Fuel,Engine Spillback	PSI	9.6	9.6	9.5	9.6	9.6	9.7	9.7	9.7	9.6	9.6
Fuel,After Engine-Filter	DEG F	81.4	81.4	80.5	83.2	84.5	83.6	81.8	80.9	79.6	82.3
Fuel,After Engine-Filter	PSI	45.8	45.4	45.4	45.4	45.8	45.8	46.0	46.0	46.1	46.1
Oil Sump-Temp.	DEG F	234.0	235.7	237.0	237.0	233.4	233.4	228.0	228.7	225.1	228.4
Oil Into Cooler Temp.	DEG F	245.3	247.3	248.7	248.7	246.0	245:7	241.0	242.3	241.0	241.4
Oil Into Cooler Press	PSI	83.2	81.5	81.3	81.5	78.0	78.0	73.9	72.9	69.1	68.7
Coolant,Engine Inlet	DEG F	180.2	182.5	181.8	181.8	183.2	184.8	182.8	183.5	182.8	183.5
Coolant,Engine Inlet Pres	PSI	13.4	13.9	13.1	13.8	14.1	14.5	15.5	15.6	16.7	16.7
Coolant,Aftercooler In	DEG F	142.3	143.6	144.2	144.6	143.9	144.9	143.6	143.6	143.8	143.8
Coolant,Aftercooler Out	DEG F	184.5	186.8	186.5	186.8	187.1	188.5	186.1	187.1	186.1	186.8
Coolant,After Water,Pump	PSI	55.7	56.0	56.3	55.8	54.1	54.0	51.2	50.9	47.6	48.4
Coolant,Engine Out-Left	DEG F	360.1	436.2	415.1	439.7	476.9	455.8	442.0	435.8	427.4	430.8
Coolant,Engine Out-Right	DEG F	197.1	199.5	199.5	199.5	199.8	200.8	199.8	199.8	199.8	200.1
Coolant,Engine Out-Comb	DEG F	197.1	199.8	200.4	200.4	200.8	201.8	200.8	201.1	200.4	200.8
Coolant,Engine Out-Left	PSI	28.9	24.4	24.6	28.7	24.8	24.5	24.5	24.8	24.6	24.7
Coolant,Engine Out-Right	PSI	27.9	29.1	28.1	27.9	28.4	28.8	28.8	28.2	28.9	28.9
Coolant,Intercooler In	PSI	40.9	40.4	40.8	40.7	39.8	39.0	37.5	38.1	36.6	36.6
Coolant,Intercooler Out	PSI	43.4	44.7	43.6	43.9	43.5	42.2	40.4	42.8	38.7	39.5
Water,Tower In-Left	DEG F	49.7	50.1	50.8	51.2	51.2	51.2	51.5	51.2	51.5	51.5
Water,Tower In-Right	DEG F	49.7	49.0	49.4	49.4	49.7	49.7	50.1	49.7	50.5	50.5
Water,Tower In-Left	PSI	63.2	64.1	63.4	65.8	64.8	64.8	66.9	67.0	66.8	65.0
Water,Tower In-Right	PSI	66.6	67.0	66.8	67.2	66.5	67.1	66.6	67.6	66.9	66.8
Water Tower-Out	DEG F	179.5	181.5	183.2	182.8	185.2	187.1	186.5	187.5	186.8	187.5
After Cooler-Exch,In	DEG F	48.0	48.0	48.3	48.8	49.0	49.0	49.0	49.0	49.4	49.4
After Cooler-Exch,Out	DEG F	70.8	70.4	70.4	70.7	70.4	70.7	71.1	70.4	69.8	69.6
Water Exchanger-Inlet	PSI	56.5	56.7	57.1	57.0	56.8	57.0	58.7	59.8	57.6	56.9
Dyno,Water In	DEG F	50.1	54.4	68.2	65.7	71.1	71.8	71.4	70.7	71.1	71.4
Dyno,Water Out	PSI	23.5	23.6	21.9	22.2	22.0	22.6	22.9	23.1	23.1	22.4
Dyno,Water Out	DEG F	126.5	132.9	138.6	140.9	143.9	144.9	145.9	145.9	144.2	144.2
Dyno,Water Delta-T	DEG F	76.4	78.5	75.4	75.2	72.8	73.1	74.5	75.2	73.1	72.8

U. S. ARMY TACOM TEST# 97 started 5/04/89 at 09:30 Page 2.1

Wall Time		10:28	10:38	10:39	10:40	10:41	10:52	10:58	10:59	11:00	11:06
Elapsed Time		001:27:29	001:30:09	001:38:22	001:39:36	001:40:49	001:51:20	001:52:42	001:58:20	001:59:38	002:06:07
Engine Speed	RPM	2200	2199	2000	2002	2000	1808	1808	1597	1599	1400
Engine Load	FT-LBS	3246	3255	3285	3286	3287	3072	3061	2630	2625	2260
Brake Horsepower	BHP	1359	1362	1250	1252	1251	1054	1050	799	799	602
Fuel Consumption,Engine	LBS/HR	475.8	478.5	485.5	494.5	485.8	360.2	361.4	275.1	274.9	212.3
BSFC	LBS/HP-HR	0.350	0.351	0.388	0.347	0.347	0.341	0.344	0.344	0.344	0.352
BMEP	PSI	292.9	293.7	296.4	296.5	296.8	277.4	276.2	237.8	236.9	204.1
Smokemeter Opacity	%	6.9	6.6	8.8	7.9	7.8	9.2	10.1	7.4	7.7	7.6
Water Tower Out-(Flow)	Hz	171	164	151	149	148	85	117	87	66	5
Water Exch-Out	Hz	887	892	706	644	601	660	612	358	198	90
Barometric Pressure	Hg	29.87	29.87	29.87	29.87	29.87	29.86	29.86	29.86	29.86	29.86
Air,Cell Ambient,Left	DEG F	71.4	70.4	70.0	72.5	73.6	70.0	70.4	71.4	70.4	73.2
Air,Cell Ambient,Right	DEG F	77.5	78.9	76.8	78.2	78.2	74.3	75.7	73.6	72.8	74.6
Air,Cell Depression	H2O	-0.2	-0.2	-0.2	-0.2	-0.2	-0:2	-0.2	-0.2	-0.2	-0.2
Air,Cleaner Out Left	DEG F	72.5	70.4	71.4	75.0	77.1	73.2	73.9	74.6	73.2	75.0
Air,Cleaner Out Right	DEG F	73.6	74.8	73.7	77.1	73.8	74.6	75.3	73.9	73.5	74.6
Air,Meriam Before Left	H2O	1.9	1.8	1.7	1.6	1.6	1.8	1.8	1.1	1.0	0.7
Air,Meriam After Left	H2O	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.7	1.7	1.4
Air,Meriam Before Right	H2O	6.4	6.5	6.6	6.6	6.6	6.7	6.8	6.7	6.7	6.5
Air,Meriam After Right	H2O	5.8	5.4	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.4
Air,Before Turbo Left	H2O	-6.5	-6.4	-4.8	-4.8	-4.8	-3.1	-3.2	-1.8	-1.8	-1.1
Air,Before Turbo Right	H2O	-9.0	-9.1	-7.8	-7.1	-7.1	-5.0	-5.0	-3.0	-2.9	-1.9
Air,After Turbo Left	DEG F	884.1	878.6	855.6	857.2	860.8	812.7	813.1	248.7	247.7	198.1
Air,After Turbo Right	DEG F	869.2	867.6	847.8	847.2	846.8	802.6	802.9	287.4	285.7	191.8
Air,After Turbo-Left	Hg	60.2	60.6	58.6	58.7	58.1	42.8	42.8	28.1	28.1	17.6
Air,After Turbo-Right	Hg	72.6	72.9	66.5	66.6	66.7	56.4	56.8	42.3	42.1	33.0
Air,Aftercooler Out-L	DEG F	196.8	196.8	189.5	189.8	189.8	175.5	175.5	161.9	162.2	160.5
Air,Aftercooler Out-R	DEG F	183.5	183.2	176.2	176.5	176.8	166.3	166.9	157.6	157.6	159.2
Air,Intake Manifold-L	Hg	58.7	58.7	52.3	52.5	52.0	42.3	41.7	27.8	27.8	17.6
Air,Intake Manifold-R	Hg	53.9	58.5	47.3	47.6	47.6	37.7	37.6	24.0	24.0	15.0
Crankcase Pressure	H2O	1.1	1.3	0.6	0.6	0.7	0.3	0.3	0.2	0.1	0.0
Blowby Cal-Orifice	H2O	1.2	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Exhaust,Port 1-Left	DEG F	1410.6	1409.6	1409.7	1411.9	1417.1	1377.0	1380.0	1350.2	1348.0	1325.7
Exhaust,Port 2-Left	DEG F	1356.3	1348.0	1352.8	1355.8	1358.2	1328.7	1324.4	1289.0	1288.1	1260.2
Exhaust,Port 3-Left	DEG F	1319.8	1314.5	1319.6	1320.9	1324.4	1294.6	1288.5	1252.2	1251.8	1189.4
Exhaust,Port 4-Left	DEG F	1365.6	1358.2	1378.7	1381.8	1387.4	1364.8	1368.4	1322.8	1323.1	1308.0
Exhaust,Port 5-Left	DEG F	1352.8	1348.9	1363.0	1366.1	1367.4	1358.1	1351.9	1306.2	1307.1	1286.8
Exhaust,Port 6-Left	DEG F	1247.1	1247.6	1250.1	1252.2	1257.7	1235.6	1230.5	1181.8	1184.8	1160.2
Exhaust,Port 1-Right	DEG F	1428.4	1427.6	1429.3	1431.5	1428.0	1426.7	1426.8	1387.4	1387.0	1358.7
Exhaust,Port 2-Right	DEG F	1370.4	1366.5	1368.2	1368.7	1363.4	1357.8	1355.7	1322.2	1321.4	1285.9

U. S. ARMY TACOM TEST# 97 started 5/04/89 at 09:30 Page 3.1

Wall Time		10:28	10:30	10:39	10:40	10:41	10:52	10:53	10:59	11:00	11:06
Exhaust,Port 3-Right	DEG F	1299.8	1298.6	1292.4	1288.1	1286.4	1269.1	1271.7	1282.6	1281.8	1198.7
Exhaust,Port 4-Right	DEG F	1397.5	1396.6	1409.7	1414.5	1411.8	1378.7	1378.7	1388.7	1387.8	1309.8
Exhaust,Port 5-Right	DEG F	1393.1	1389.2	1400.5	1405.8	1408.1	1366.9	1369.1	1380.9	1380.4	1304.5
Exhaust,Port 6-Right	DEG F	1245.4	1242.5	1258.1	1259.0	1259.4	1219.7	1227.0	1188.1	1187.8	1164.0
Exhaust,Turbo Out-Left	DEG F	1148.7	1146.1	1183.0	1186.4	1189.8	1205.1	1205.1	1280.5	1229.6	1255.6
Exhaust,Turbo Out-Right	DEG F	1196.6	1194.0	1229.2	1230.9	1227.5	1251.8	1251.8	1264.5	1268.6	1269.5
Exhaust Stack	DEG F	1177.6	1175.0	1209.4	1210.7	1211.1	1231.8	1230.5	1231.8	1230.5	1237.8
Exhaust Stack	NPO	8.8	8.5	6.5	6.9	6.9	4.8	3.9	2.8	2.1	0.9
Fuel,Engine Supply	DEG F	82.8	82.8	82.0	82.8	82.8	82.8	83.0	84.4	84.1	84.4
Fuel,Engine Supply	PSI	49.4	49.4	50.0	49.9	49.8	50.2	50.4	50.7	50.7	51.8
Fuel,Engine Spillback	DEG F	106.0	106.8	103.9	104.8	104.8	102.2	102.2	101.9	101.9	100.5
Fuel,Engine Spillback	PSI	9.6	9.6	9.7	9.7	9.6	9.7	9.7	9.8	9.8	9.8
Fuel,After Engine-Filter	DEG F	89.2	85.0	85.4	86.8	86.8	80.9	80.5	82.7	82.8	84.1
Fuel,After Engine-Filter	PSI	46.2	46.2	46.8	46.7	46.7	47.8	47.4	47.9	48.0	48.5
Oil Sump-Temp.	DEG F	224.7	225.1	220.7	224.1	223.7	215.1	216.1	209.4	210.1	206.8
Oil Into Cooler Temp.	DEG F	239.7	239.0	236.7	236.7	236.7	232.4	232.7	229.0	229.0	224.4
Oil Into Cooler Press	PSI	54.4	54.7	58.0	58.2	58.0	52.5	52.5	47.1	47.2	43.8
Coolant,Engine Inlet	DEG F	182.5	181.8	182.5	181.5	182.2	185.8	184.2	189.5	187.1	188.8
Coolant,Engine Inlet Pres.	PSI	18.1	18.0	19.5	19.2	19.8	20.6	20.5	22.1	21.8	23.1
Coolant,Aftercooler In	DEG F	140.9	140.8	140.8	140.8	141.8	139.8	139.8	142.6	142.9	151.9
Coolant,Aftercooler Out	DEG F	185.8	184.8	184.5	184.2	184.5	185.8	184.5	186.8	185.2	186.5
Coolant,After Water,Pump	PSI	45.0	44.9	41.7	42.2	42.4	39.0	39.4	36.8	36.4	35.0
Coolant,Engine Out-Left	DEG F	425.8	428.8	438.9	439.7	435.8	431.0	400.1	424.8	425.5	416.1
Coolant,Engine Out-Right	DEG F	200.4	199.5	200.1	199.1	199.5	200.1	199.5	200.8	200.1	200.4
Coolant,Engine Out-Comb.	DEG F	201.4	200.4	201.1	200.4	200.8	200.8	200.4	202.1	200.8	201.1
Coolant,Engine Out-Left	PSI	25.8	25.4	25.8	25.8	25.8	25.9	25.4	26.1	25.7	26.4
Coolant,Engine Out-Right	PSI	29.1	29.2	29.2	29.2	29.0	30.0	29.8	30.4	29.8	30.5
Coolant,Intercooler In	PSI	34.9	34.5	33.1	33.1	33.0	31.2	30.8	29.8	29.9	29.2
Coolant,Intercooler Out	PSI	37.7	37.9	36.1	35.1	35.4	33.7	32.8	31.7	30.8	28.5
Water,Tower In-Left	DEG F	51.9	51.9	52.2	52.2	52.2	52.2	52.6	52.6	52.9	52.9
Water,Tower In-Right	DEG F	50.8	50.8	51.2	51.2	51.2	51.5	51.5	51.5	51.5	51.9
Water,Tower In-Left	PSI	65.6	65.8	67.1	66.9	65.8	66.0	66.8	67.7	66.8	66.8
Water,Tower In-Right	PSI	67.8	67.8	68.1	68.2	68.2	67.8	67.8	68.4	66.8	68.6
Water Tower-Out	DEG F	186.8	185.5	187.5	185.8	186.8	189.8	189.1	192.8	191.5	191.5
After Cooler-Exch,In	DEG F	49.4	49.4	50.1	50.1	50.1	50.1	50.5	50.8	51.2	51.2
After Cooler-Exch,Out	DEG F	68.6	68.2	71.1	72.5	74.6	71.1	72.5	82.9	86.5	117.6
Water Exchanger-Inlet	PSI	58.5	58.8	61.9	63.5	64.5	61.8	62.4	67.7	67.9	70.8
Dyno,Water In	DEG F	71.8	71.8	71.8	71.8	71.8	71.4	71.4	71.1	71.1	69.6
Dyno,Water Out	PSI	22.9	24.2	22.6	23.4	23.9	23.2	23.7	24.9	24.1	25.7
Dyno,Water Out	DEG F	142.9	142.9	137.3	137.9	137.6	127.9	127.6	115.6	115.2	105.8
Dyno,Water Delta-T	DEG F	71.1	71.1	65.5	66.1	65.8	56.5	56.2	44.5	44.1	35.7

APPENDIX C

FUEL & OIL ANALYSIS

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

BFLRF

File: 02-1955-180
05 September 1989

Commander
U.S. Army Tank-Automotive Command (TACOM)
Attn: AMSTA-RGE (Mr. Lewakowski)
Warren, Michigan 48397-5000

Subject: **Inspection Tests on Fuel Samples**

Dear Sir:

Two fuel samples were received from TACOM, a sample of Jet A fuel, simulating JP-8 (AL-18934-F) and a sample of MIL-F-46162, high-sulfur referee fuel (AL-18935-F). These samples were analyzed to determine if they conformed to their respective specifications. The enclosed Table 1 shows the results for AL-18934-F and Table 2 shows the results for AL-18935-F.

The Jet A fuel met all JP-8 specification requirements with the exception of the smoke point and the fuel conductivity. The extremely low conductivity indicates that the fuel contains insufficient conductivity additive.

The high-sulfur fuel had a high accelerated stability result. This test was rerun and the high result was confirmed. The cetane number also tested slightly high. Since the precision of the cetane number test is ± two numbers, this is probably not of great concern. The fuel tested negative for nitrate-type cetane improver additive.

Should you have any questions on this matter, please call Steve Westbrook at (512) 522-3185 or Sid Lestz at (512) 522-2582.

Very truly yours,

S.J. Lestz, Director

S.R. Westbrook
Senior Research Scientist

SJL/SRW/lap (SRW.L)
Enclosure
cf: U.S. Army Belvoir Research, Development and Engineering Center, Attn: STRBE-VF, Messrs. M.E. LePera, F.W. Schaekel, and T.C. Bowen

Table 1. Properties of Jet A (Simulating JP-8) From TACOM

Property	ASTM Test Method	MIL-T-83133C Requirements	AL-18934-F
Appearance	D 4176	Clear & Bright	Clear & Bright
Color	D 156	Report	+16
Total Acid Number, mg KOH/g	D 3242	0.015, max	0.009
Aromatics, vol%	D 1319	25, max	17.1
Olefins, vol%	D 1319	5.0, max	2.0
Sulfur, total, wt%	XRF (a)	0.30, max	0.13
Mercaptan Sulfur, wt%	D 3227	0.002, max	0.001
Distillation, °C	D 86		
Initial Boiling Point		Report	170
10% recovered		204, max	187
20% recovered		Report	193
50% recovered		Report	210
90% recovered		Report	251
End Point		300, max	291
Residue, vol%		1.5, max	0.5
Loss, vol%		1.5, max	0
Flash Point, °C	D 56	38, min	48
Gravity, API	D 1298	37-51	43.2
Density, kg/L	D 1298	0.775-0.840	0.8096
Freeze Point, °C	D 2386	-47, max	-46
Kin. Viscosity at -20°C, cSt	D 445	8.0, max	5.08
Kin. Viscosity at 40°C, cSt	D 445	NR (b)	1.42
Hydrogen Content, wt%	D 3701	13.4, min	13.7
Net Heat of Combustion, MJ/kg	D 240	42.8, min	42.875
BTU/lb		18,400, min	18,433
Smoke Point, mm	D 1322	25, min	21.7
Copper Corrosion	D 130	1, max	1a
Thermal Stability (JFTOT),	D 3241		
Visual Code		<3	1
Change in Pressure Drop, mm/Hg		25, max	0
Existent Gum, mg/100 mL	D 381	7.0, max	0.9
Particulate Matter, mg/L	D 2276	1.0, max	0.6
Filtration Time, minutes	Appendix A	15, max	ND (c)
Water Reaction, Interface	D 1094		
Rating		lb, max	1
Water Separation Index, MSEP	D 3948	70, min (d)	84
Fuel System Icing Inhibitor	(e)	0.10-0.15	<0.01
Conductivity, pS/m	D 4308	150-600	16
Cetane Index	D 976	Report	46.9
Cetane Number	D 613	NR	47.3

(a) X-Ray Fluorescence
(b) No Requirement
(c) Not Determined
(d) 85 minimum with all additives except corrosion inhibitor/lubricity improver additive and the static dissipator additive.
(e) FED-STD-791, Method 5340

(SRW.L)

TABLE 2. Analyses of Referee Grade Diesel Fuel (MIL-F-46162C) Sample

Properties	ASTM Test Method	MIL-F-46162C Requirements	AL-18935-F
Density, kg/L at 15°C	D 1298	Report	0.8741
Gravity, °API	D 1298	NR (a)	30.3
Flash Point, °C	D 93	Report	78
Distillation, °C	D 86		
Initial Boiling Point		Report	203
10% Recovered		220, min	226
50% Recovered		255 to 305	272
90% Recovered		310 to 360	338
95% Recovered		315 to 365	362
End Point		385, max	386
Residue, vol%		3, max	0.5
Sulfur, wt%	X-Ray Fluorescence	0.95 to 1.05	1.04
Accelerated Stability, Total Insolubles, mg/100 mL	D 2274	1.5, max	2.3
Cetane Index (b)	D 976	37 to 43	40.9
Cetane Number (b)	D 613	37 to 43	45.5
Kinematic Viscosity at 40°C, cSt	D 445	1.9 to 4.1	3.36
Cloud Point, °C	D 2500	-13, max	-23
Pour Point, °C	D 97	-18, max	-29
Particulate Contamination, mg/L (0.8 µm filter)	D 2276, modified, (Appendix A2)	10, max	1.7
Volume filtered, L		1	1
Ash, wt%	D 482	0.02, max	0.002
Carbon Residue, 10% Bottoms, wt%	D 524	0.20, max	0.16
Neutralization No., mg KOH/g	D 974	0.2, max	0.14
Copper Corrosion at 50°C	D 130	1, max	1A
Net Heat of Combustion, MJ/kg	D 240	Report	42.193
Aromatics, vol%	D 1319	Report	42.7
Cetane Improver	Appendix	Report	Neg

(a) NR = No Requirement.
(b) D 613 is the preferred method but either is acceptable, provided fuel does not contain cetane improver.

(SRW.L)

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

BFLRF

File: 02-1955-180
02 August 1989

Commander
U.S. Army Tank-Automotive Command
Attn: AMSTA-RGRD, Mr. Ellsworth C. Adams
Warren, Michigan 48397-5000

Subject: **Analysis of MIL-L-2104 15W-40 Reference Oil**

Dear Sir:

A sample of Army reference oil, MIL-L-2104, grade 15W-40, designated AL-18886-L, was analyzed, and the properties were compared against the blending tolerances for this product.

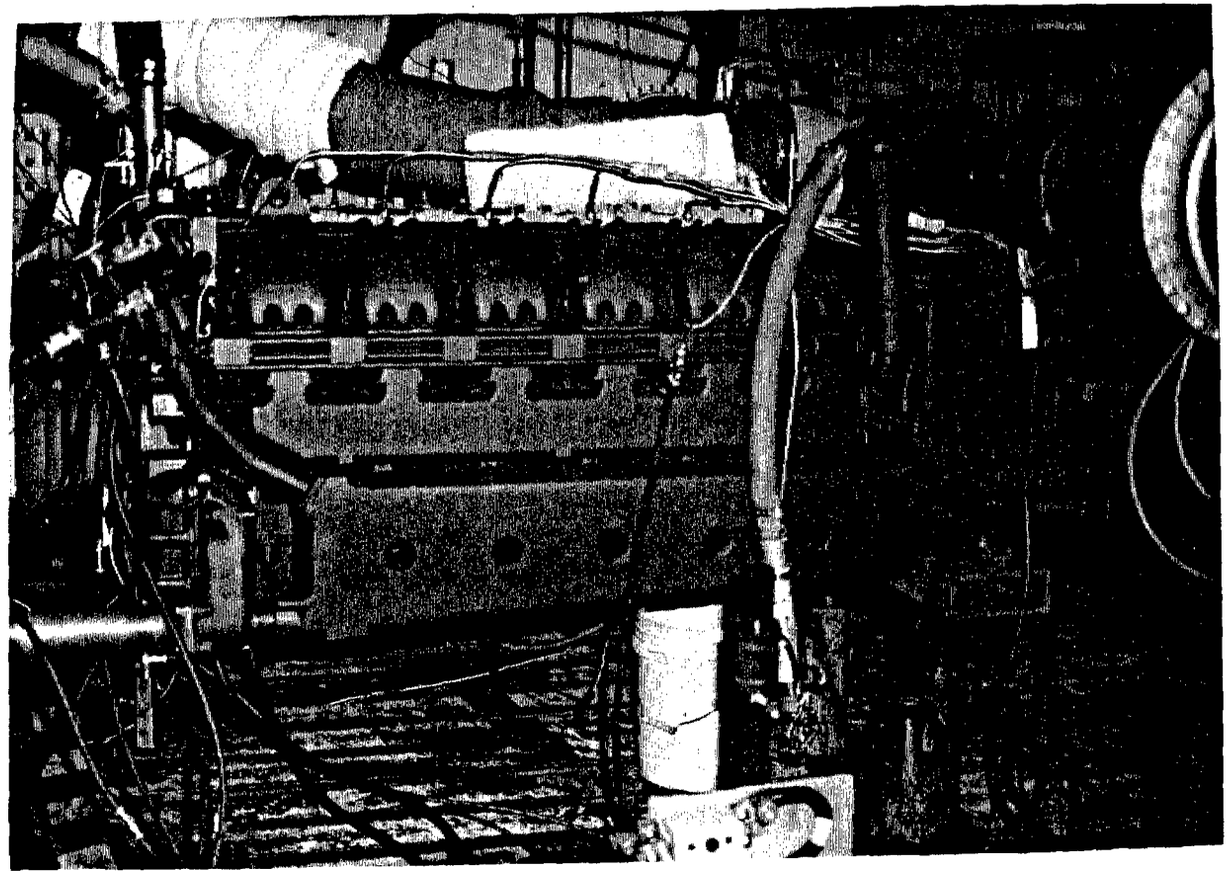
The data are presented in the following table:

Property	AL-18886-L	MC-2777 Tolerances	Comment
Viscosity, 100°C, cSt	13.05	13.25-14.25	Low
Viscosity, 40°C, cSt	101.68	91.0-121.0	OK
Flash Point, °C	237	215 min	OK
Sulfated Ash, wt%	0.79	0.88-1.18	Low
Elements, wt%			
Sulfur	0.78	0.46-0.70	High
Phosphorus	0.08	0.126-0.168	Low
Calcium	0.12	0.15-0.20	Low
Zinc	0.09	0.149-0.192	Low
Nitrogen	0.038	0.059 min	Low
Magnesium	0.042	0.050-0.066	Low
Boron	5 ppm	Trace	OK
Copper	NIL	NIL	OK

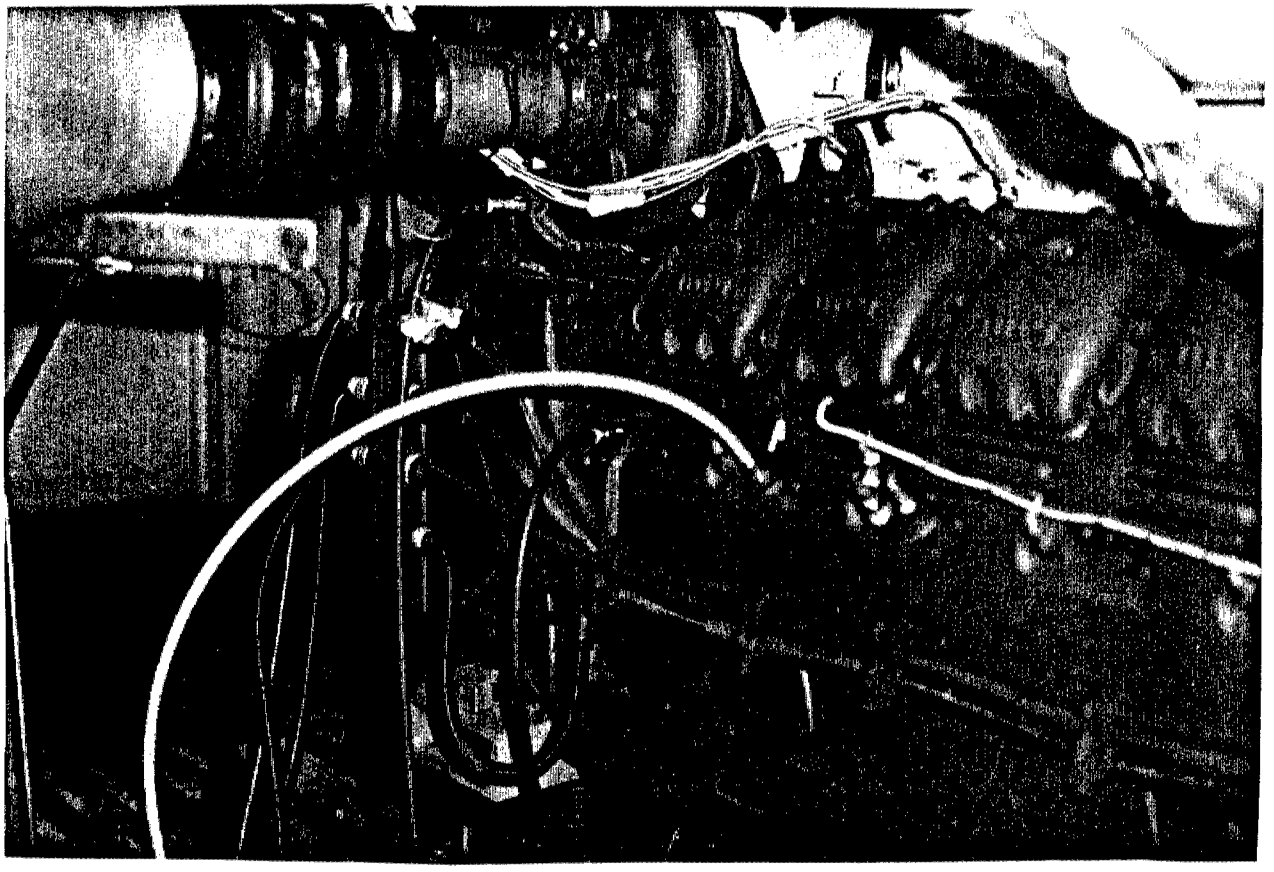
APPENDIX D

PHOTOGRAPHS

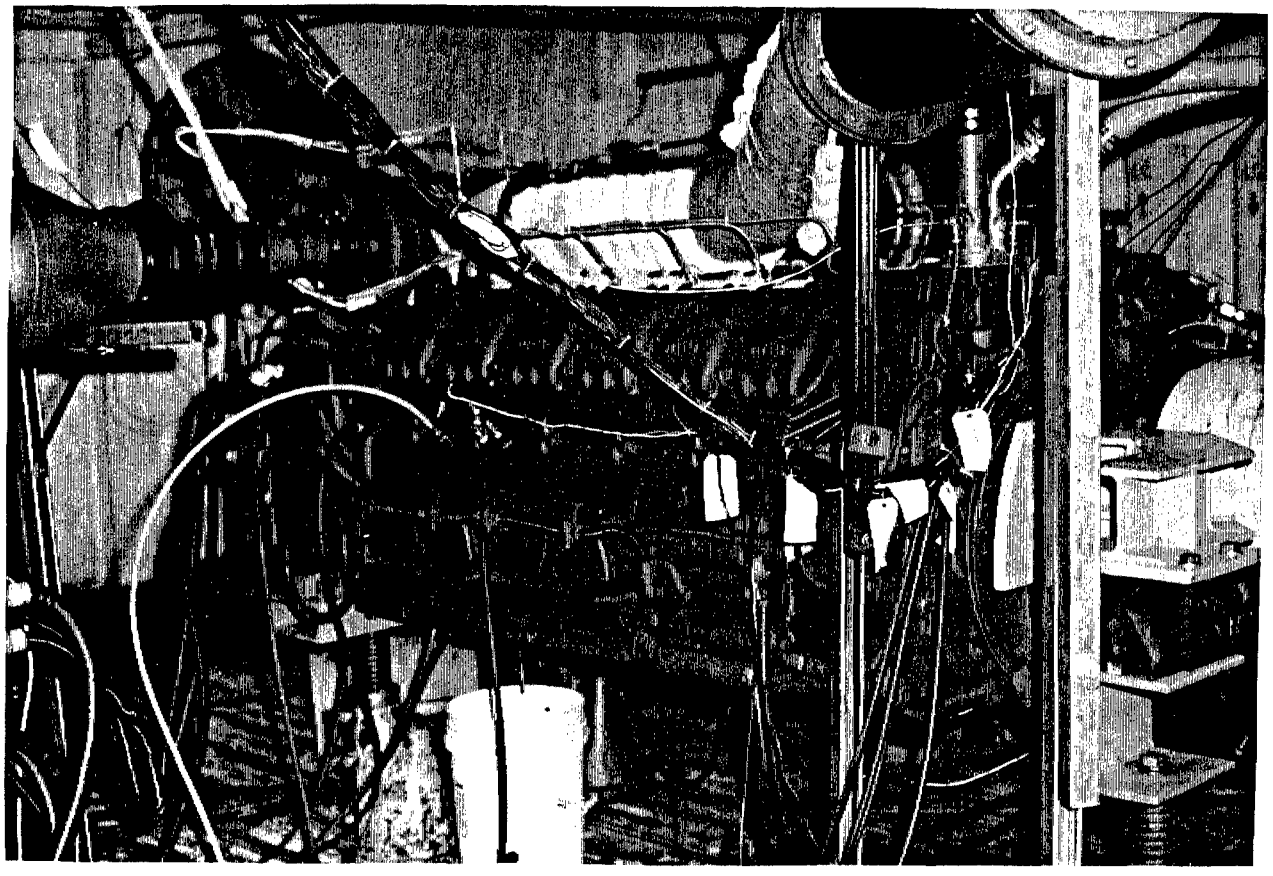
MTU MT883 ENGINE



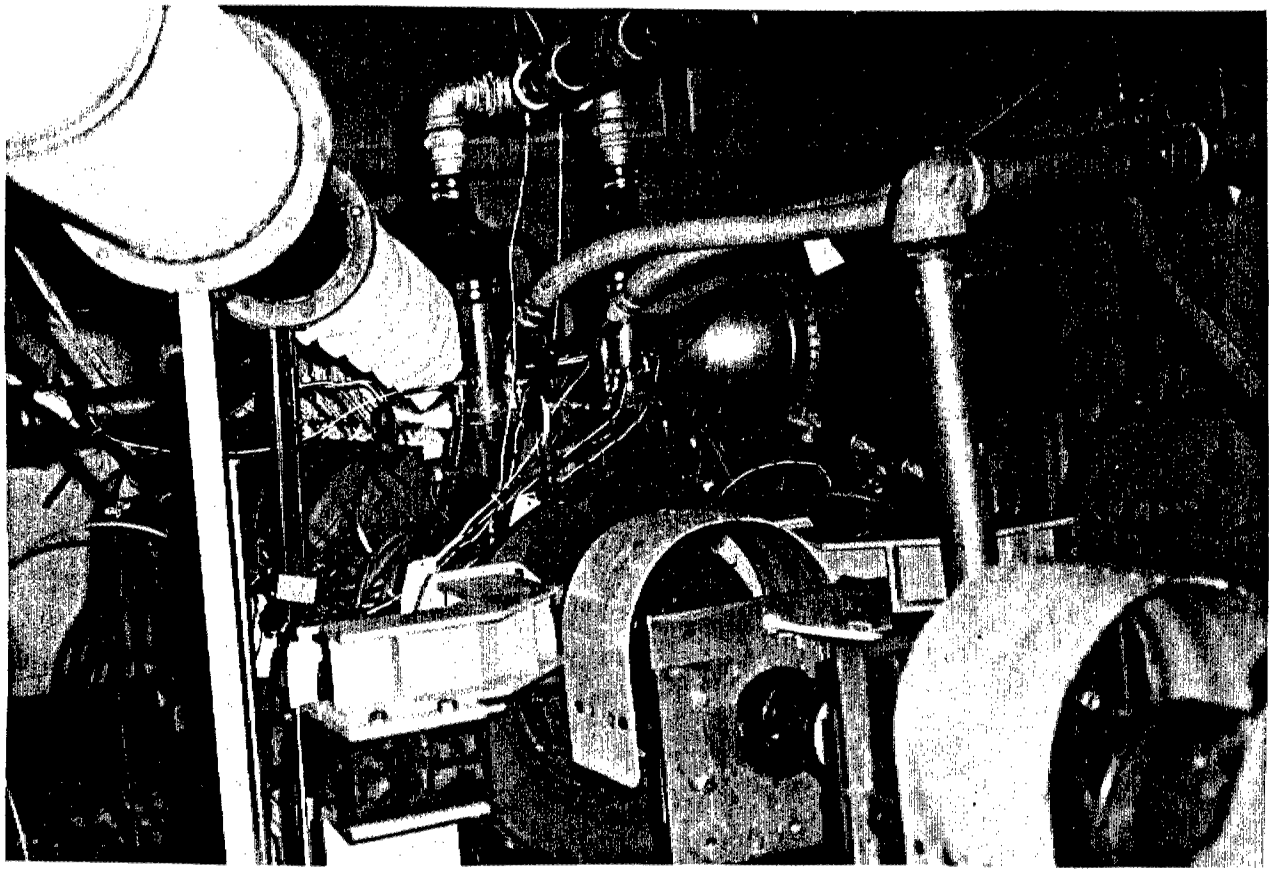
Right (B Side) of MT883 Engine in Test Cell



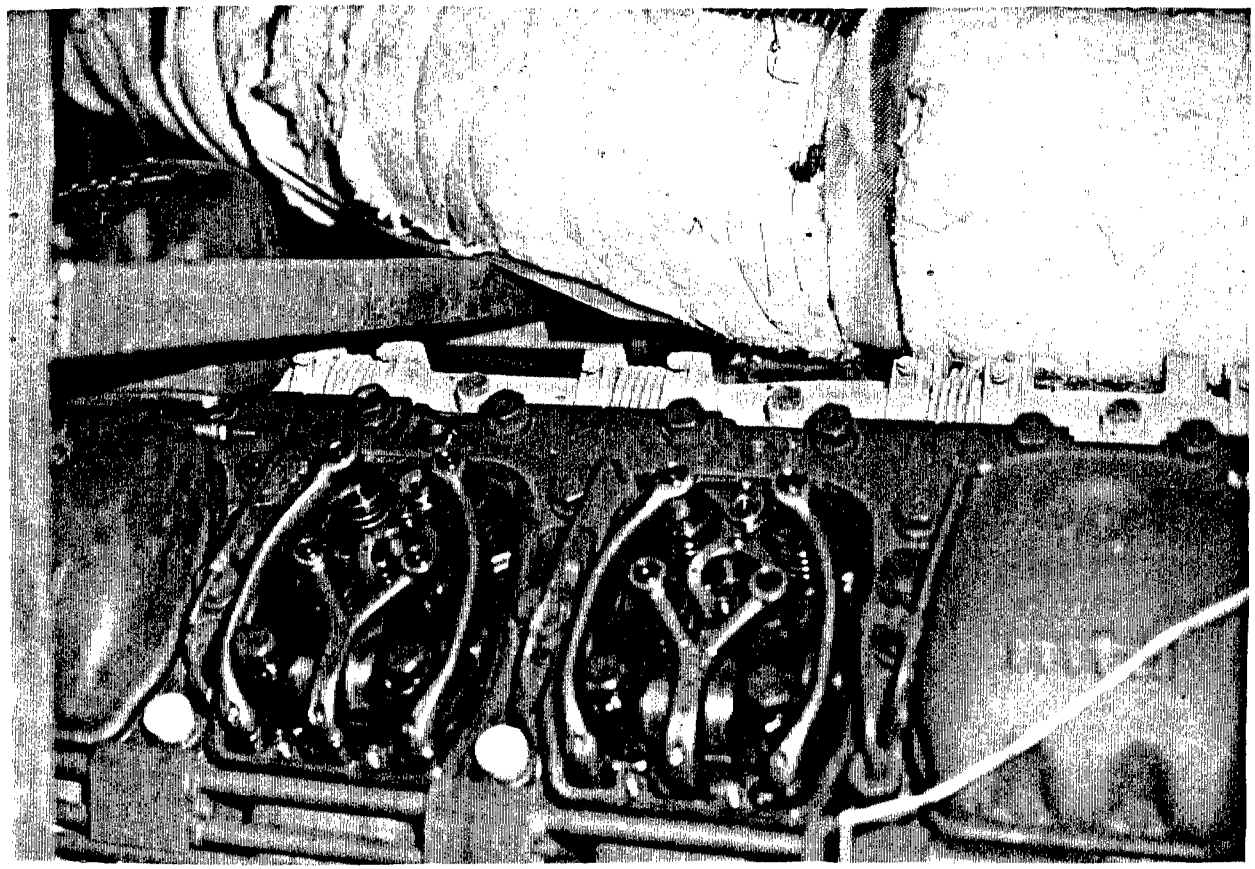
Left (A Side) of MT883 Engine in Test Cell Showing
Air Inlet to Turbocharger



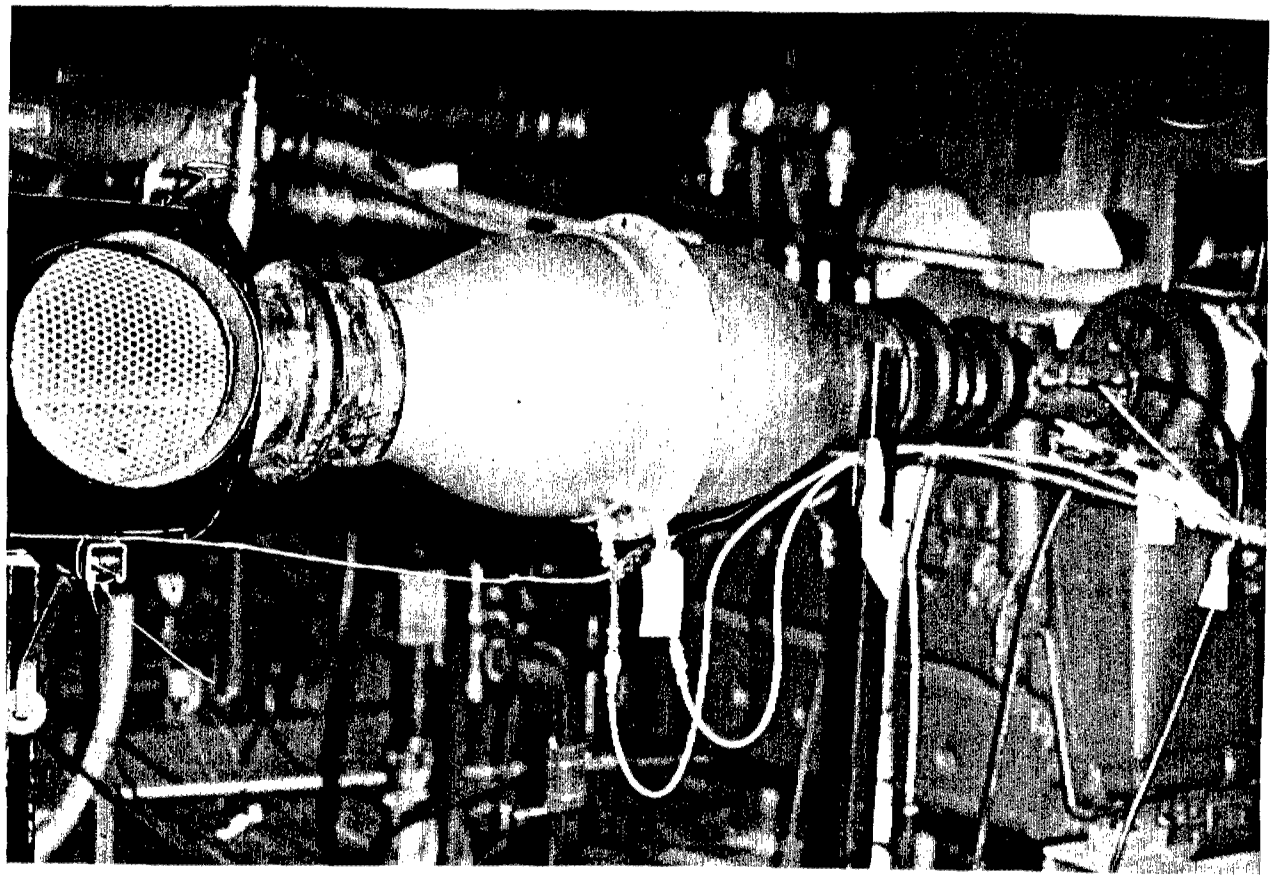
Left (A Side) View of Engine in Test Cell Showing Inlet Air and Exhaust Systems



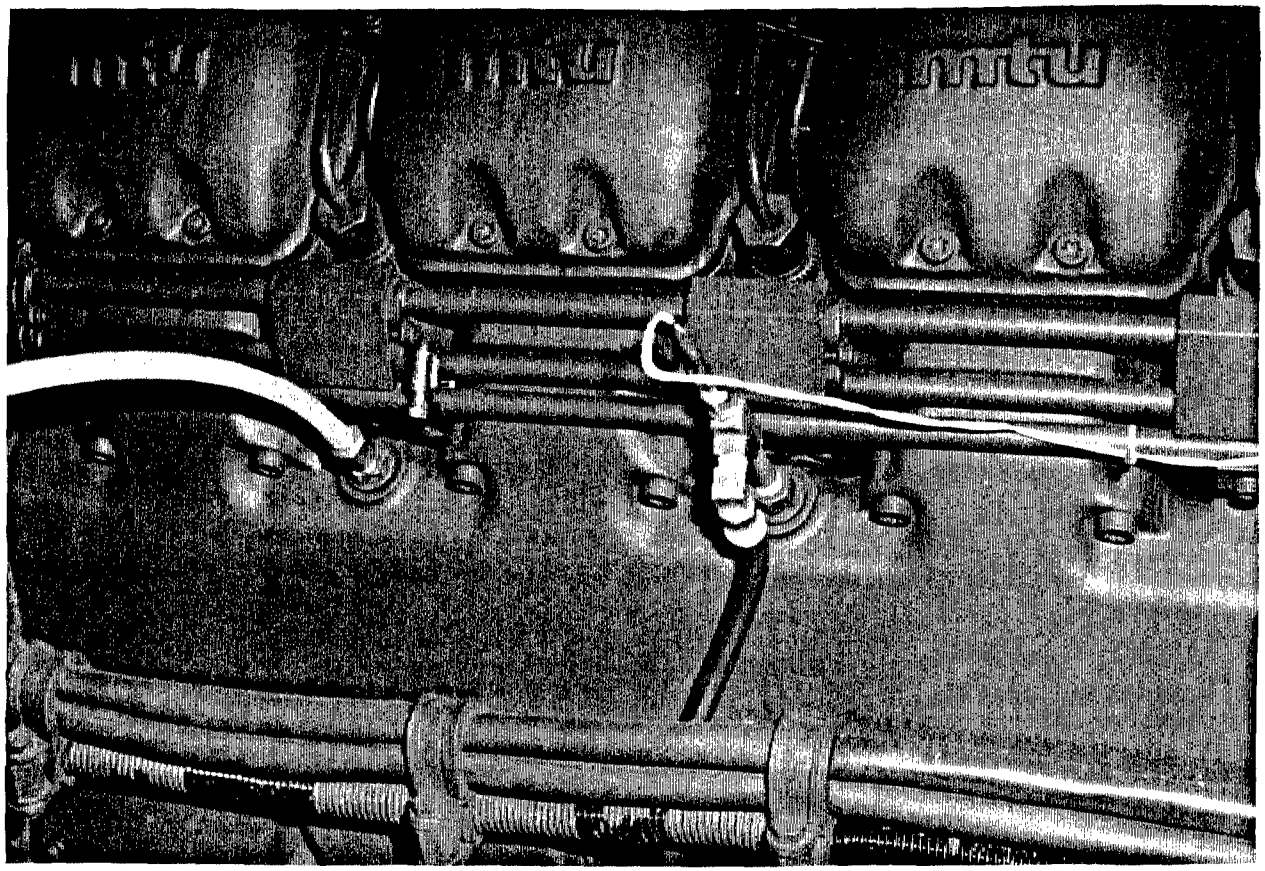
Flywheel End of MT883 Engine Installed in Test Cell



Cylinder Heads (Covers Removed) Showing Intake and Exhaust Rocker Arms



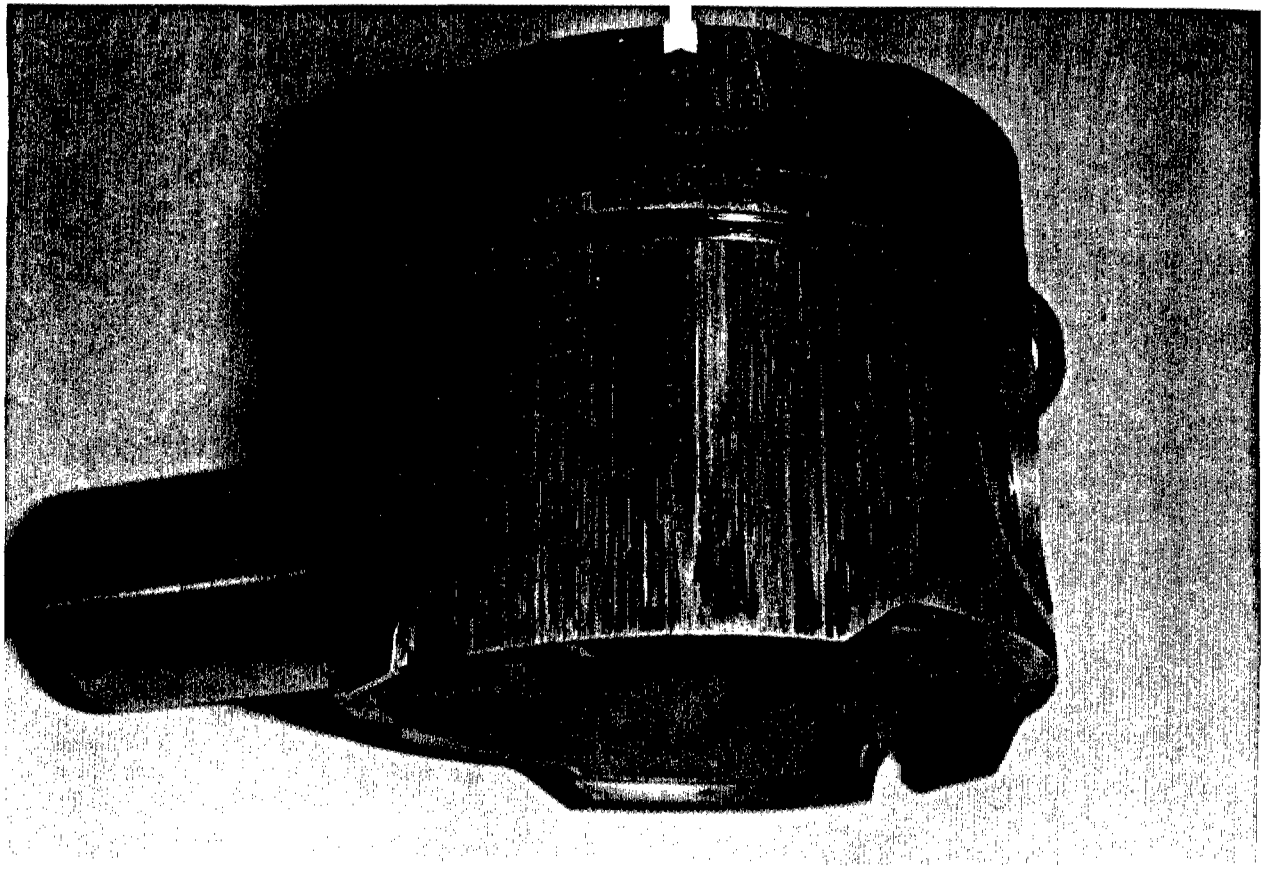
Right (B Side) Showing Air Cleaner and Merriam Laminar Flow
Air Measurement Unit



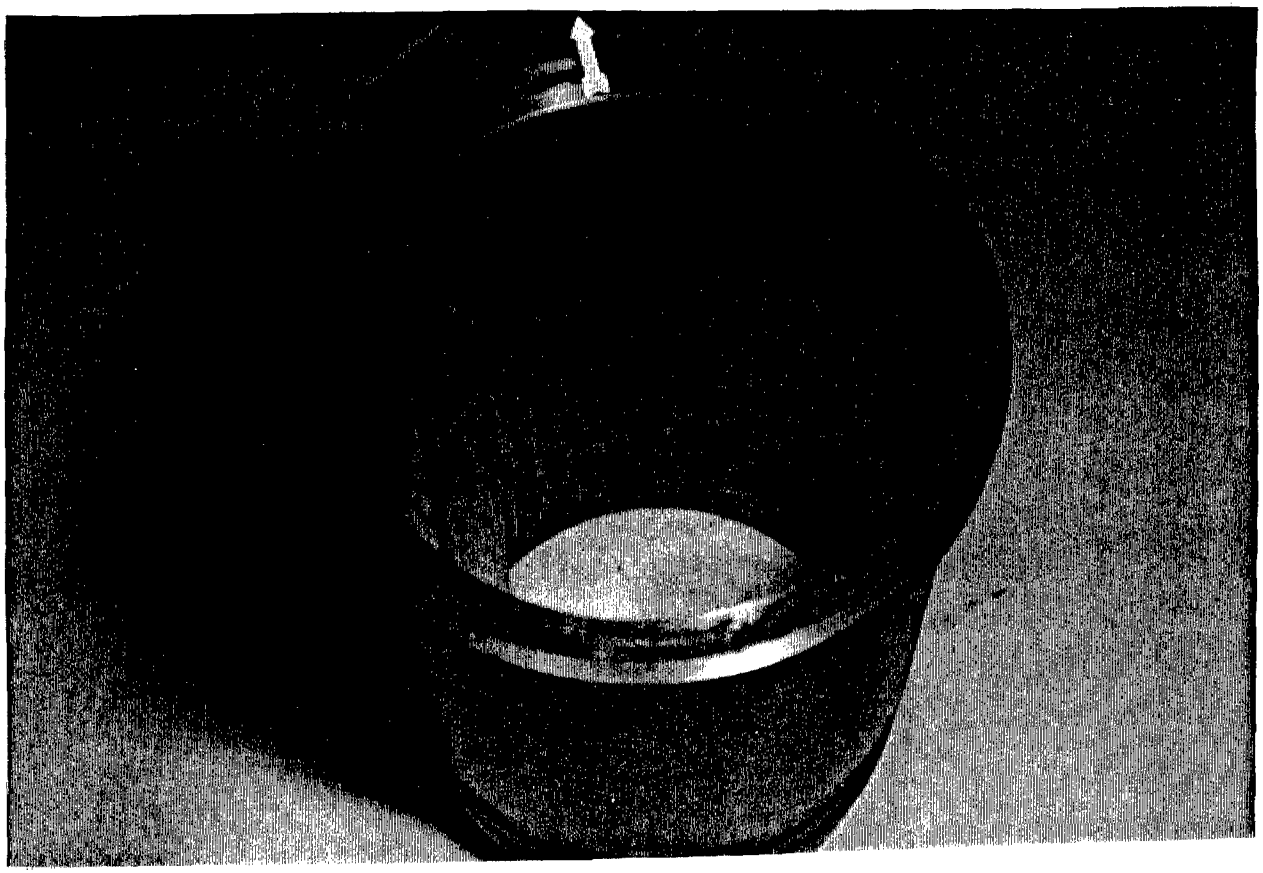
Left (A Side) Showing Intake Manifold Pressure Line to
Engine Control, and Thermocouple & Pressure Tap

MTU (GM-MVO) Engine Instrument/Control Panel

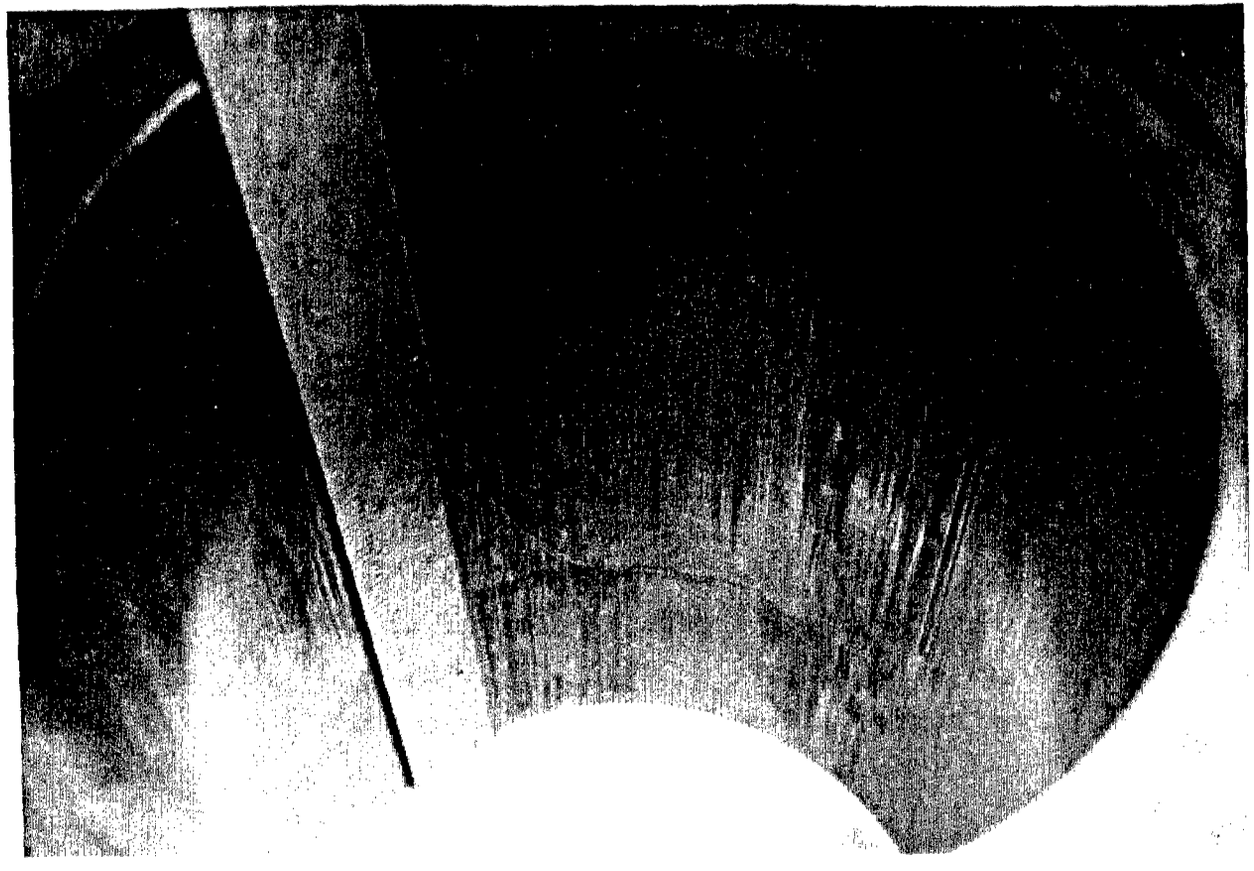
Connecting Rod from Cylinder B-4



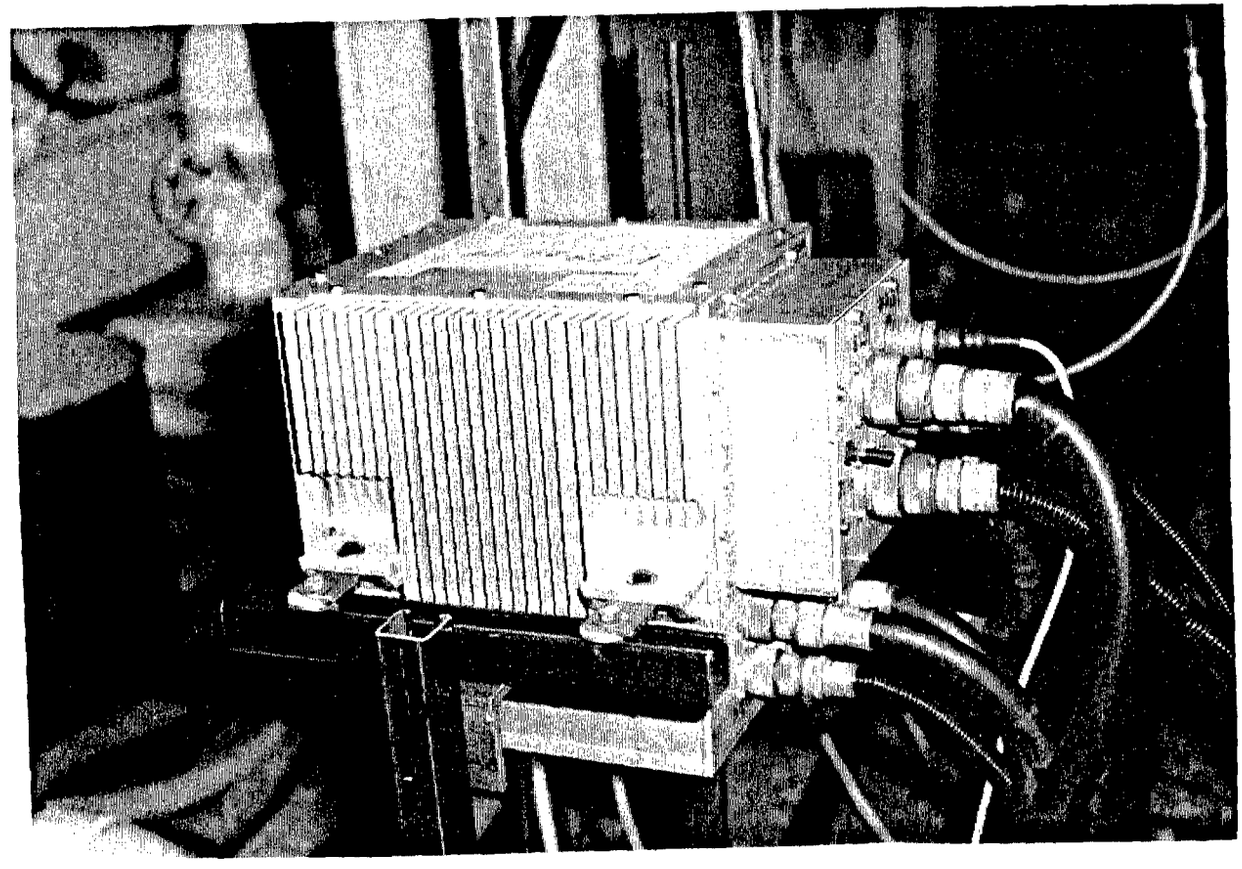
Scuffed Piston from Cylinder B-4 Outboard Side



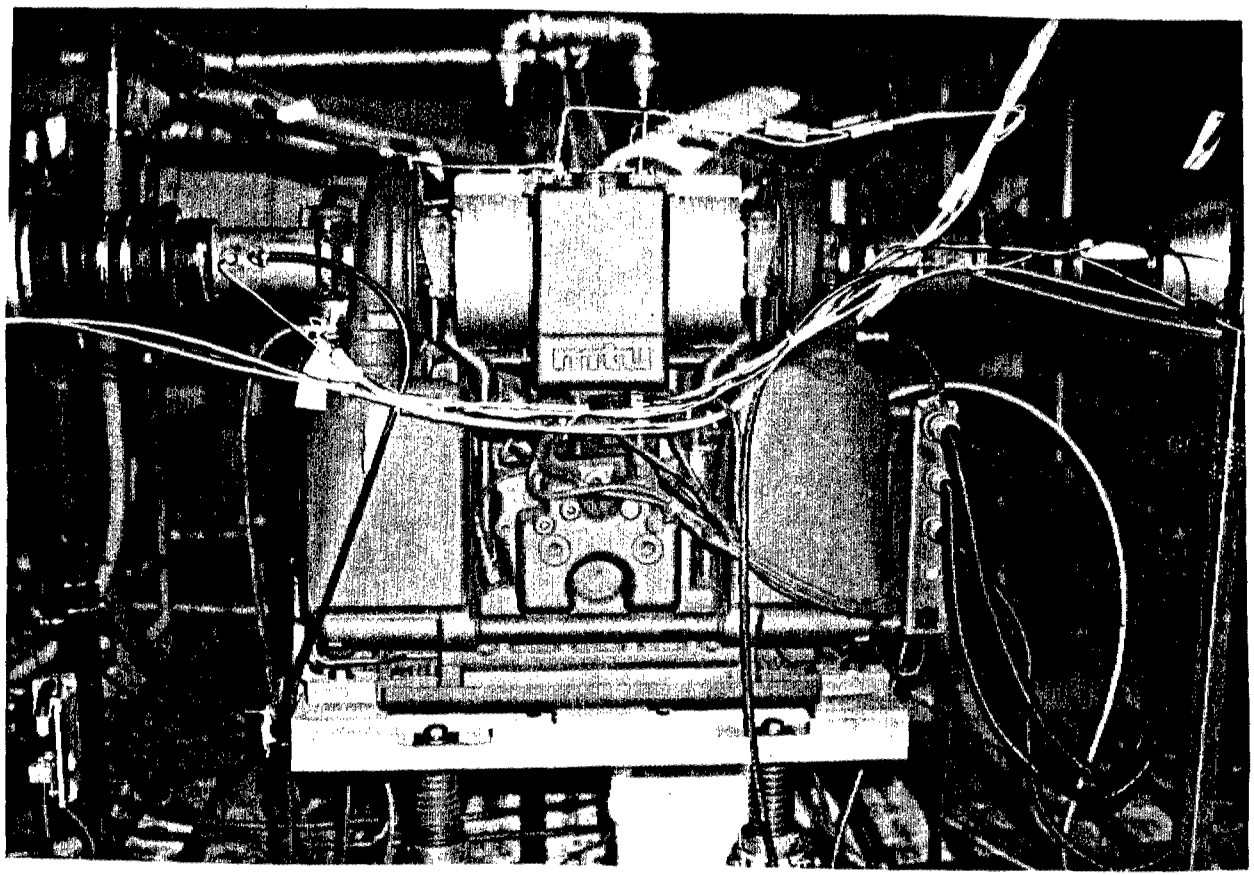
Outboard Side of B-4 Cylinder Liner



Inboard Side of B-4 Cylinder Liner



MT883 Engine Electronic Control Unit



Front (Damper) End of MT883 Engine in Test Cell

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