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AD-A202 989

COMPARISON OF SINGLE GRADE AND MULTIVISCOSITY LUBRICANTS IN M60 TANKS UNDER HOT AMBIENT CONDITIONS

INTERIM REPORT
BFLRF No. 240

By

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Under Contract to

U.S. Army Belvoir Research, Development and Engineering Center
Materials, Fuels and Lubricants Laboratory
Fort Belvoir, Virginia

Contract No. DAAK70-87-C-0043

Approved for public release; distribution unlimited

May 1988

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

ADA202989

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Interim Report BFLRF No. 240	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Belvoir Fuels and Lubricants Research Facility (SwRI) 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Southwest Research Institute San Antonio, Texas 78284	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Belvoir Research, Development and Engineering Center 8b. OFFICE SYMBOL (If applicable) STRBE-VF	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAK70-85-C-0007, WD 11; DAAK70-87-C-0043, WD 5
8c. ADDRESS (City, State, and ZIP Code) Fort Belvoir, VA 22060-5606	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 263001 / PROJECT NO. IL26300 ID150 / TASK NO. 07(1) / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Comparison of Single-Grade and Multiviscosity Lubricants in M60 Tanks Under Hot Ambient Conditions (U)

12. PERSONAL AUTHOR(S)
Montemayor, A.F. and Owens, Edwin C.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM Aug 87 TO Aug 88	1988 August	45

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Comparison, Atmospheric Temperature, Lubricating Oils, Lubricants, Tank Engines, Pressure, High Temperature, Engines, Low Pressure.

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

In this program, two MIL-L-2104D lubricants, OE/HDO-15/40 and OE/HDO-40, and one SAE 50-grade lubricant were evaluated in three M60A2 RISE passive tanks. The tanks, with AVDS-1790-2C engines, were used to evaluate these lubricants under high ambient temperature conditions. As a result of this program, no significant differences in engine oil operating temperatures were found between the MIL-L-2104D 15W-40 or 40 grades and the SAE 50-grade lubricants. Although significant differences were noted in operating temperatures among vehicles, these differences were larger than any observed oil differences.

In addition, no difference was noted in idle oil pressure between the OE/HDO-40 and the SAE 50-grade lubricants in fully warm engines. It was noted that the OE/HDO-15/40 oil produced approximately 1-psi lower oil pressure at idle than the SAE 50 grade in fully warm engines. However, engine-to-engine difference in idle oil pressure was larger than the oil viscosity-related differences.

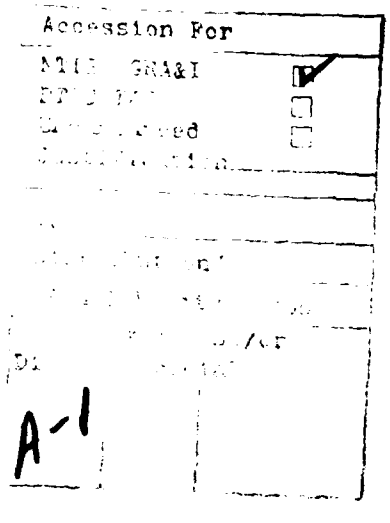
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION	
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Mr. T.C. Bowen	22b. TELEPHONE (Include Area Code) (703) 664-3576	22c. OFFICE SYMBOL STRBE-VF

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

FOREWORD

This work was performed at the Belvoir Fuels and Lubricants Research Facility (BFLRF) located at Southwest Research Institute (SwRI), San Antonio, TX, under Contract Nos. DAAK70-85-C-0007 and DAAK70-87-C-0043, for the period 24 August 1987 through 28 August 1988. Work was funded by the U.S. Army Belvoir Research, Development and Engineering Center (Belvoir RDE Center), Ft. Belvoir, VA. Mr. T.C. Bowen, Belvoir RDE Center (STRBE-VF), was the contracting officer's representative, and Mr. M.E. LePera was the technical monitor.



ACKNOWLEDGEMENTS

The authors wish to express appreciation to the personnel from The Marine Corps Air Ground Combat Training Center at Twenty-Nine Palms, CA, for the excellent cooperation and professionalism displayed during this project. The authors also gratefully acknowledge the conduct and interpretation of the statistical analyses provided by Ms. Janet Buckingham of Southwest Research Institute.

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I. BACKGROUND

Military Specification MIL-L-2104D was recently amended to specify a grade 15W-40 (military symbol OE/HDO-15/40) lubricant for use in combat and tactical equipment.(1)* This multigrade oil would help eliminate seasonal oil changes and simplify logistics. Extensive testing of the multiviscosity lubricants has revealed no significant field problems.(2,3) Along with the other specification revisions, the OE/HDO-50 (grade 50) oil was eliminated. The use of this viscosity grade had fallen to a low level, and it was believed that the 15W-40 or 40 grades were acceptable substitutes. The 40 grade was retained because of a requirement of some stationary engines.

Engine overheating, final drive seal leakage, and short engine life when using OE/HDO-15/40 oil were reported in the M60 battle tanks by the U.S. Marine Corps during the summer of 1986. As a result, the Marine Corps expressed concern about the adequacy of the OE/HDO-15/40 product to protect the AVDS-1790-2C engine used in the M60 tanks, particularly under high-temperature/high-load conditions. A program to investigate these complaints was authorized by the U.S. Army Belvoir Research, Development and Engineering Center (Belvoir RDE Center).

II. OBJECTIVE

The objective of this program was to compare the performance of the MIL-L-2104D OE/HDO-15/40, OE/HDO-40, and a commercially available SAE 50-grade lubricant in M60 tanks under high ambient temperature conditions.

III. SCOPE

Two MIL-L-2104D lubricants, OE/HDO-15/40 and OE/HDO-40, and one SAE 50-grade lubricant were evaluated in this program. Three M60A2 RISE passive tanks with AVDS-1790-2C engines were used to evaluate these lubricants under high ambient temperature conditions during 24 August 1987 through 28 August 1987.

* Underscored numbers in parentheses refer to the list of references at the end of this report.

IV. APPROACH

Belvoir Fuels and Lubricants Research Facility (BFLRF) at Southwest Research Institute (SwRI) procured and shipped two 55-gallon drums each of the OE/HDO-15/40 and OE/HDO-40 lubricants to the Marine Corps Air Ground Combat Center at Twenty-Nine Palms, CA. The 50-grade oil was that currently in use at Twenty-Nine Palms. Analyses of the test oils are given in Appendix A. Fig. 1 illustrates the viscosity of the three oils at both 40° and 100°C.

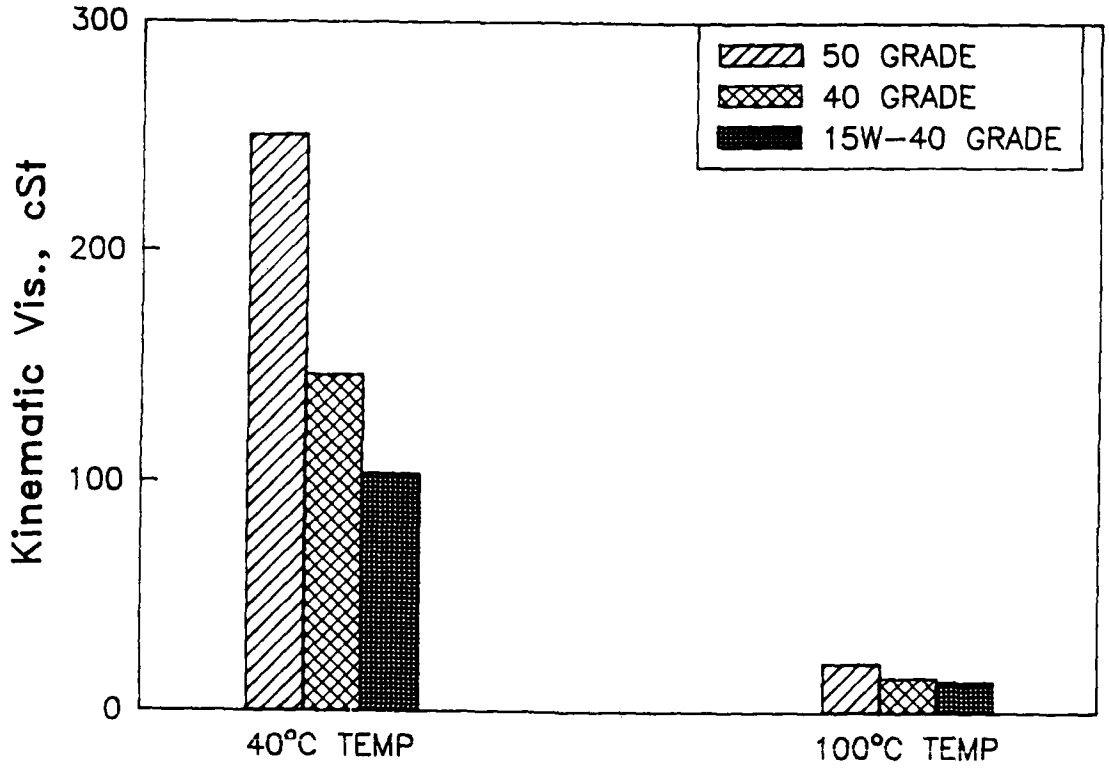

Figure 1. Lubricant viscosity comparison

Three M60A1 RISE passive tanks were chosen for testing. These tanks were C25, C21, and C22 henceforth referred to as vehicle Nos. 1, 2, and 3, respectively. Each tank was equipped with the AVDS-1790-2C RISE engine. The power packs were pulled from each vehicle, the oil coolers pressure cleaned, the oil changed, and the power packs reinstalled. The oil coolers were not drained. A 4-fluid-ounce sample of the lubricant was drained from each vehicle. The engine access panel, located in the rear of the crew compartment, was removed in order to provide access to the engine from the turret area. The panel remained off during the testing.

Each engine was instrumented to record oil sump temperature, oil gallery temperature, ambient air temperature, engine compartment temperature, and oil pressure. The oil sump temperatures were obtained by fastening exposed junction type T thermocouples to the oil dipsticks of each engine with stainless steel tie wire. The oil gallery temperatures were obtained by replacing the 3/4-in. (19.05-mm) pipe plugs (see Fig. 2) with T-fittings for thermocouple and pressure taps. The ungrounded type T thermocouples were inserted until they touched the springs in the oil galleries and then withdrawn 0.25 inch (6.35 mm).

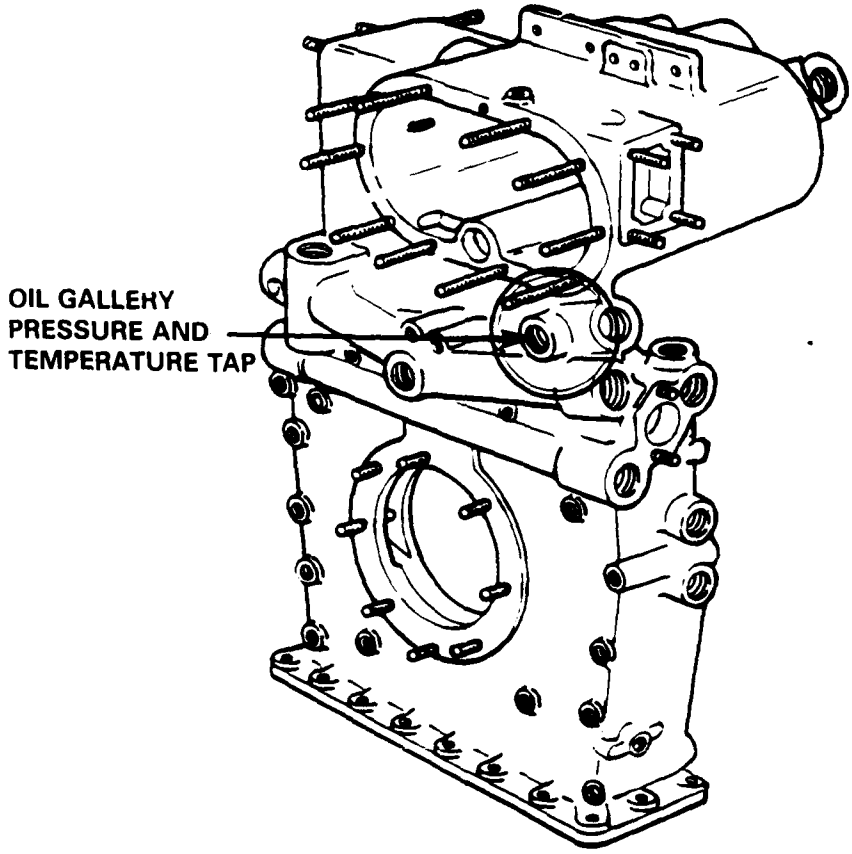

Figure 2. Location of oil gallery pressure and temperature tap

Ambient temperatures were obtained by wiring thermocouples to the outside of the turrets near the gunners' hatchways. To minimize direct solar heat on the thermocouples, they were shielded along their length and on top by a Teflon® tube so that only the lower tips of the thermocouples were exposed. In practice, however, solar impingement on the turrets directly under the thermocouples raised the actual recorded temperatures when the tanks were at rest. The engine compartment thermocouples were tie wrapped

to the right protector bars located just inside the access panel and adjacent to the 3/4-in. (19.05 mm) pipe plugs. It was hoped that this position would indicate the engine compartment temperature. In practice, however, air was pulled into the engine compartments through the open access panels, and the recorded temperatures were more representative of the crew compartments than the normal engine compartment. Oil pressures were obtained from the T-fittings, through 1/4-in. (6.35-mm) hoses, and thence to 0- to 200-psig pressure transducers. All signals were routed to data loggers secured on the oddment racks in the turrets of each vehicle. The data loggers were preprogrammed to log each of the variables once per minute and to record the time of day and internal battery voltages. The thermocouples and pressure transducers were previously checked in conjunction with the data logger for reading accuracy. The thermocouples were accurate to $\pm$ 2.2°F when checked at 212°F (100°C), and the pressure transducers were accurate to $\pm$ 0.7 psig over the range of 0 to 60 psig.

Testing of the vehicles started at approximately 1:00 pm each day in order to obtain the hottest ambient temperatures for the test. The vehicles were run under a variety of conditions, including idling, hill climbing, high-speed road, and slow march. Terrain for the testing was desert sand with low hills. The test course was to have been the same for all three days of testing. In reality, however, the terrain had minor variations, particularly on the first day. At the completion of each run, the oil was drained (in hull), and the next test oil introduced into the engines. Although the oil filters were changed, the oil coolers were not drained. Again, 4-fluid-ounce samples of the drained lubricants were taken. Since the oil coolers were not drained, it was recognized that there would be some undrained lubricant carryover mixed with the test oils. A schedule of the tests performed is shown in TABLE 1.

TABLE 1. Test Matrix

	Vehicle		
	No. 1	No. 2	No. 3
Run No. 1	SAE 50	OE/HDO-40	OE/HDO-15/40
Run No. 2	OE/HDO-40	OE/HDO-15/40	SAE 50
Run No. 3	OE/HDO-15/40	SAE 50	OE/HDO-40

V. DISCUSSION OF RESULTS

During the testing, four notable anomalies occurred. Vehicle No. 1 (SAE 50) incurred a minor problem that forced termination of testing in that vehicle during the first day of testing. The malfunction ended testing with that vehicle before the oil temperatures reached their maximums. The vehicle was towed to the maintenance facility. On day 2, vehicle No. 2 (OE/HDO-15/40), oil pressure maximums were abnormally low. Although idle oil pressures were normal, oil pressure maximums never exceeded 41 psig; 50- to 55-psig oil pressures would be normal. In addition, the oil temperature drop across the coolers was abnormally high for this run. These observations are believed to indicate a low oil sump level, although no mention of a low oil sump level was made by crew members. There was one sensor failure during the testing. The oil sump thermocouple failed on vehicle No. 2, day 3, (SAE 50) after only a few minutes of running. Vehicle No. 1, day 3, also had 4 minutes of ambient air temperature not being recorded. A connector, which had separated, was simply reconnected, and the data recording continued.

Edited data are shown in Appendix A. In the appendix, pre- and post-test data have been eliminated, and missing values have been replaced with question marks. The first column indicates the number of minutes past noon. The raw data show that ambient air temperatures rose significantly during idle periods. This increase in temperature is probably caused by radiant and convective heating from the stationary turrets, producing a higher reading on the thermocouple than the actual air temperature. When the vehicle began moving, the temperatures decreased to actual air temperatures. Recorded temperatures remained high briefly after idles as the vehicles began to accelerate. In order to compensate for this aberration, ambient air temperatures at idle and for 1 minute after idles were changed to missing values. All analyses were done using the edited data.

Average ambient air temperatures were 98.2° (36.8°) to 102.9°F (39.4°C) during the testing. Average ambient air temperatures for each test run are shown in TABLE 2. These temperatures exclude pre- and post-test data and idle data as previously described.

TABLE 2. Average Ambient Air Temperature for Each Test Run, °F (°C)

	Vehicle		
	No. 1	No. 2	No. 3
Run No. 1	101.0 (38.0)	99.6 (37.6)	100.2 (37.9)
Run No. 2	98.2 (36.8)	99.4 (37.4)	100.9 (38.3)
Run No. 3	100.7 (38.2)	100.3 (37.9)	102.9 (39.4)

Oil sump temperature versus time relationships for vehicle Nos. 1 and 3 are shown in Figs. 3 and 4. Note that in Fig. 3 (vehicle No. 1), the curve for the SAE-50 oil is abbreviated due to the mechanical failure of the vehicle. A similar comparison for vehicle No. 2 is given in Fig. 5, although without the SAE-50 data due to the previously noted sensor failure. Comparison of the oil sump temperatures for vehicle No. 1 using the three grades of oil seems to indicate that the OE/HDO-15/40 lubricant produced slightly higher temperatures than the OE/HDO-40 or SAE-50 products. This conclusion is difficult to support, however, since vehicle No. 1 never reached peak operating temperatures with the SAE-50 lubricant. The OE/HDO-15/40 lubricant produced the same or lower sump temperatures in vehicle Nos. 2 and 3. Oil gallery temperature comparisons also showed this same pattern.

Engine oil pressure is a function of engine speed, engine wear (both in the bearings and pump), and oil viscosity. Maximum oil pressures are limited by either relief valves or the ability of the pump to deliver oil. Minimum oil pressures are limited by the ability of the pump to deliver oil and the viscosity of the oil. The engine oil pressure at idle then should be directly related to the oil viscosity and the sump oil temperature. It would be expected that higher viscosity grade oils would produce higher idle oil pressures, since the temperature data had shown no differences in oil temperatures. The primary question to be answered is how much difference is there between grades, and is this difference likely to impact vehicle durability?

Note that all the test vehicles had idle oil pressures below the 15-psi minimum level recommended by the engine manufacturer, except for vehicle No. 1 on day 1 when the engine failed before reaching fully warmed conditions. No engine warning lights were noted by the crews.

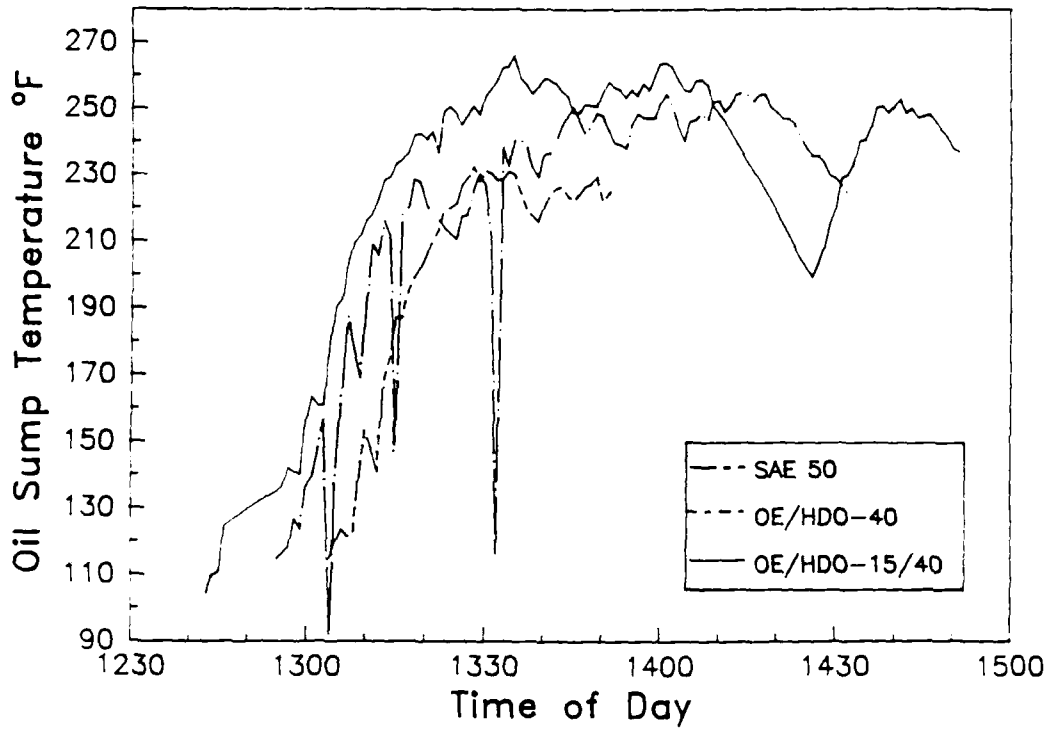

Figure 3. Oil sump temperature versus time relationships for vehicle No. 1

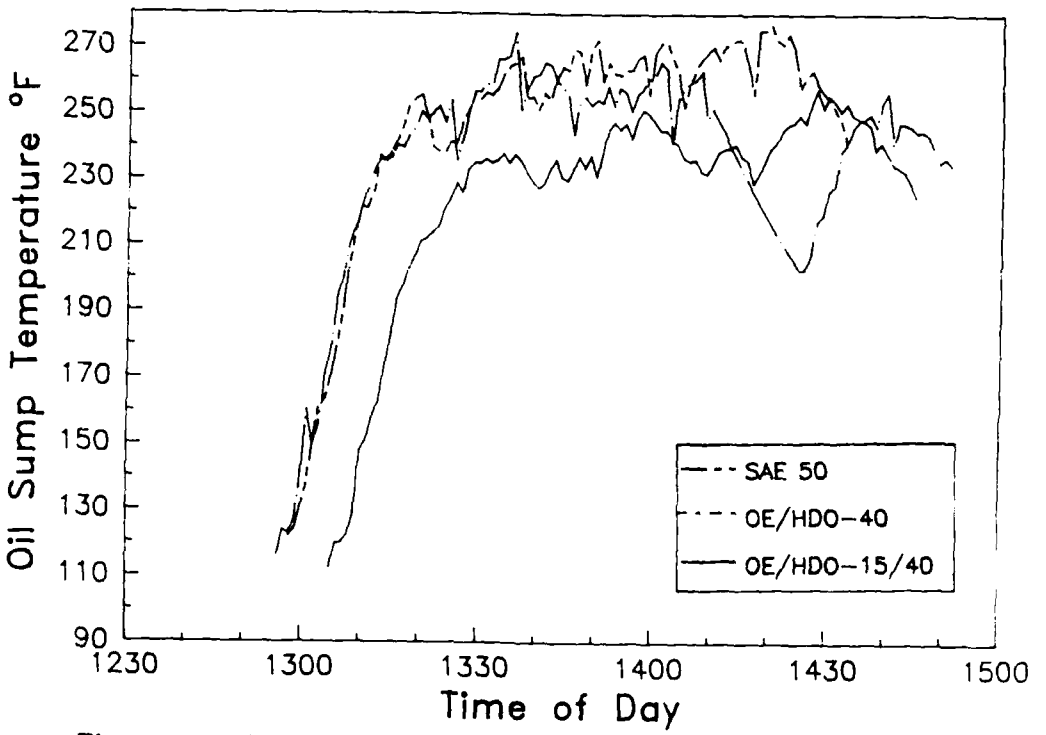

Figure 4. Oil sump temperature versus time relationships for vehicle No. 3

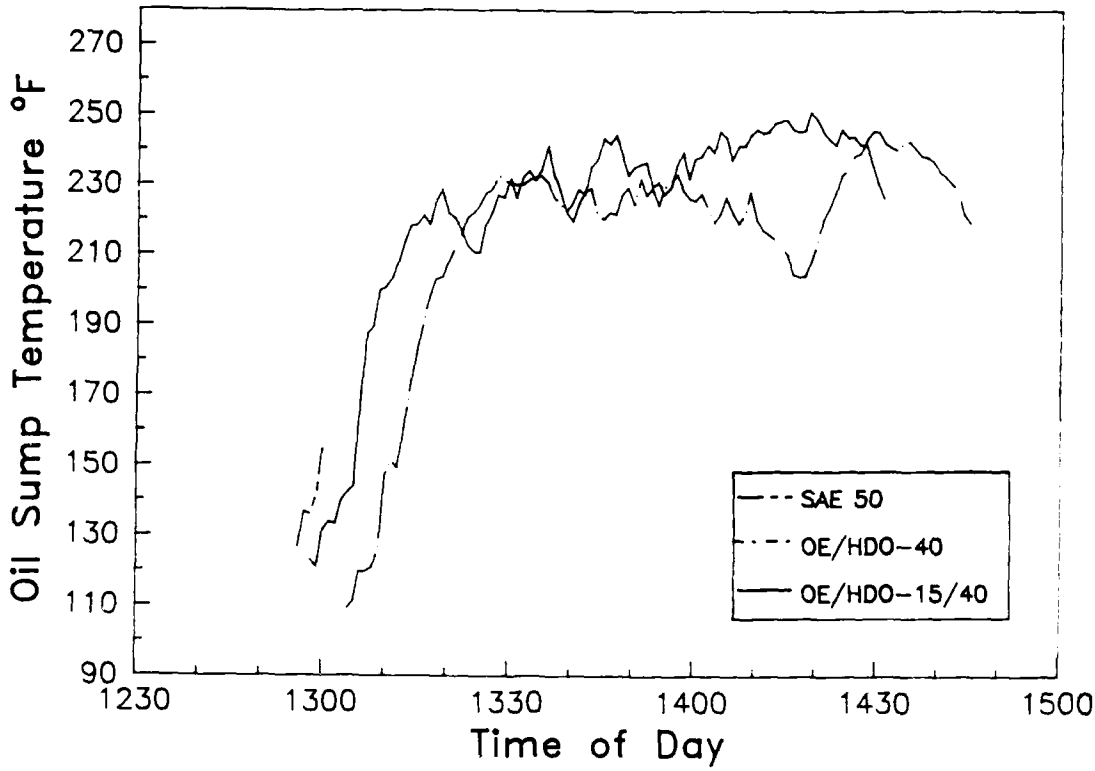

Figure 5. Oil sump temperature versus time relationships for vehicle No. 2

Data from periods in which the engines were at idle were extracted from the oil pressure and sump oil temperature data sets. As expected, as the oil temperature increased, the idle oil pressure fell. This decrease is illustrated in Fig. 6 in the data from vehicle No. 1. At sufficiently high temperatures, the idle pressure with each of the different viscosity grades became very close.

In order to compare the idle oil pressures across the vehicles and viscosity grades, the temperatures above 190°F (88°C) were selected. These pressures were assumed to most closely represent fully warmed engine conditions. Figs. 6 and 7 show 95-percent Tukey intervals for the means of the idle oil pressure by both oil type and by vehicle. This statistical approach attempts to account for day-to-day differences. The lubricants are ranked in the expected order of increasing oil pressure from 15W-40 to 50 grade.

Overlapping of the bands between the lubricants indicates that there may be no statistical difference between the OE/HDO-15/40 and the OE/HDO-40 nor between the OE/HDO-40 and the OE/HDO-50 products. There appears to be a statistical difference between the OE/HDO-15/40 and the OE/HDO-50 lubricants. The difference between the

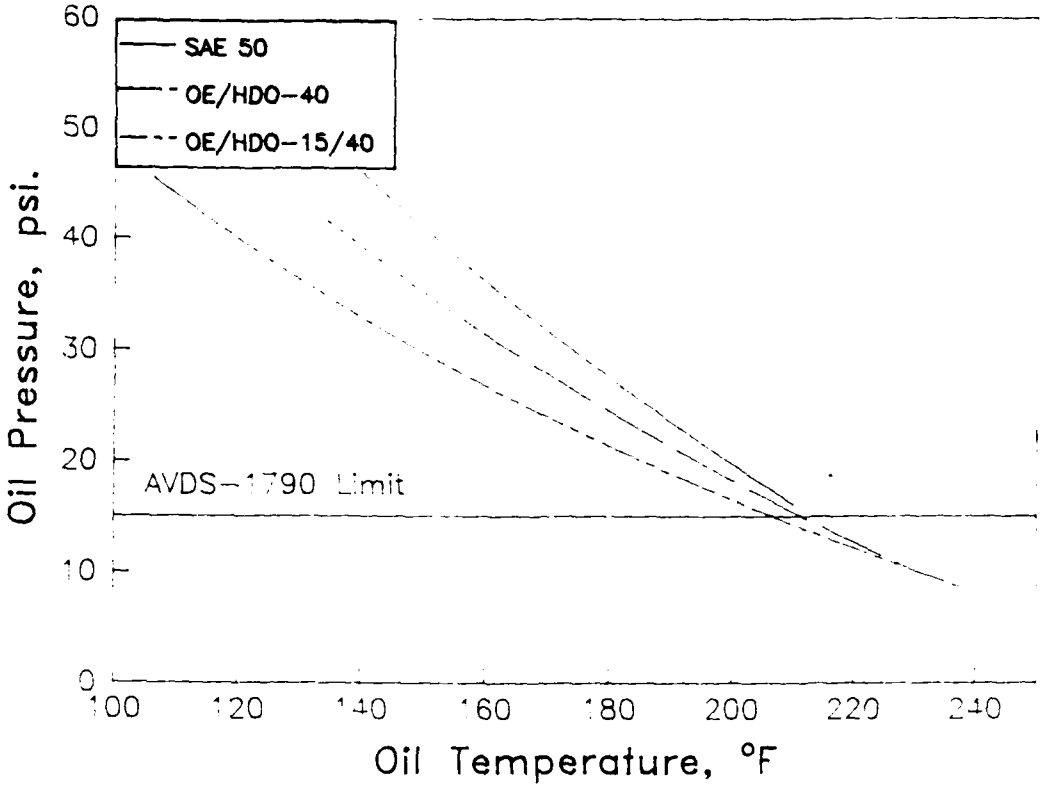

Figure 6. Idle oil pressure
(Vehicle No. 1)

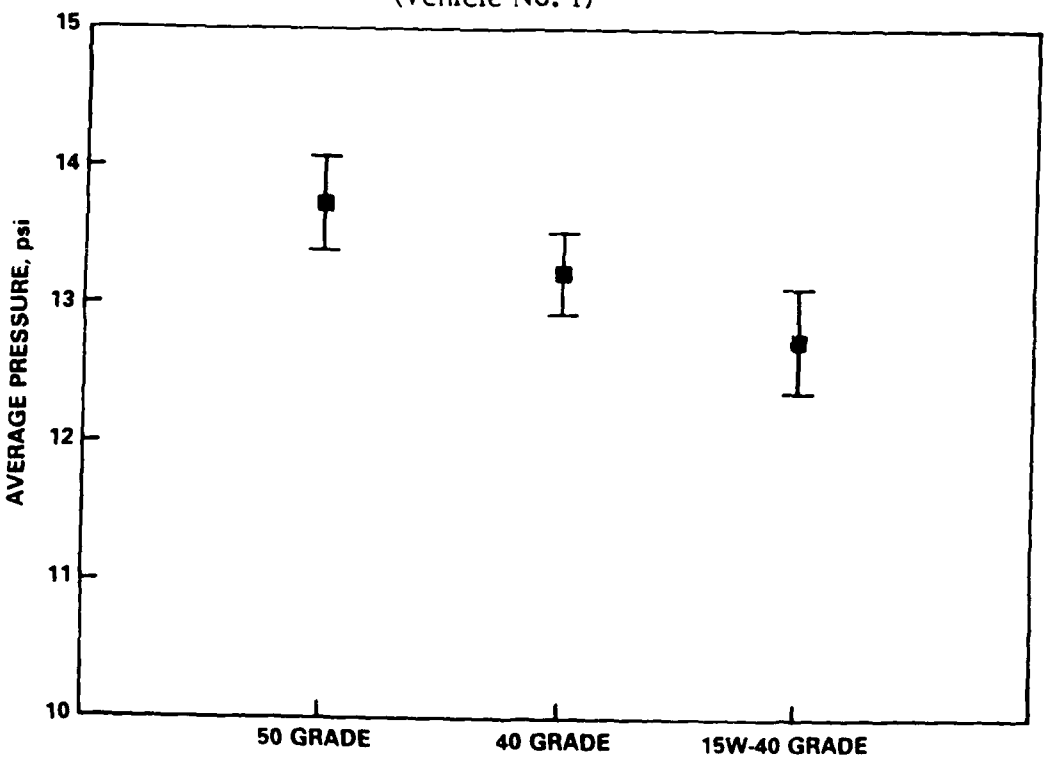

Figure 7. Idle oil pressure
(190° to 240°F)

two lubricants is approximately 1 psig. The vehicle-to-vehicle differences were larger, with the range between the vehicle Nos. 1 and 3 being about 3 psig.

These data indicate that under fully warmed conditions, there are small differences in idle oil pressure between any of the oils tested. The vehicle-to-vehicle differences (build clearances, wear, etc.) caused larger differences in idle oil pressure. Under some types of operations, however, there may be larger differences in idle oil pressure between the various oil grades. As shown in Fig. 8, as the vehicle begins to cool down at idle, the oil pressure begins to rise as the oil viscosity increases. Under this condition, both the straight grade oils recover oil pressure faster than the multiviscosity OE/HDO-15/40 (assuming equal cooling rates). There may be some types of operations where this faster recovery could have an impact on bearing wear.

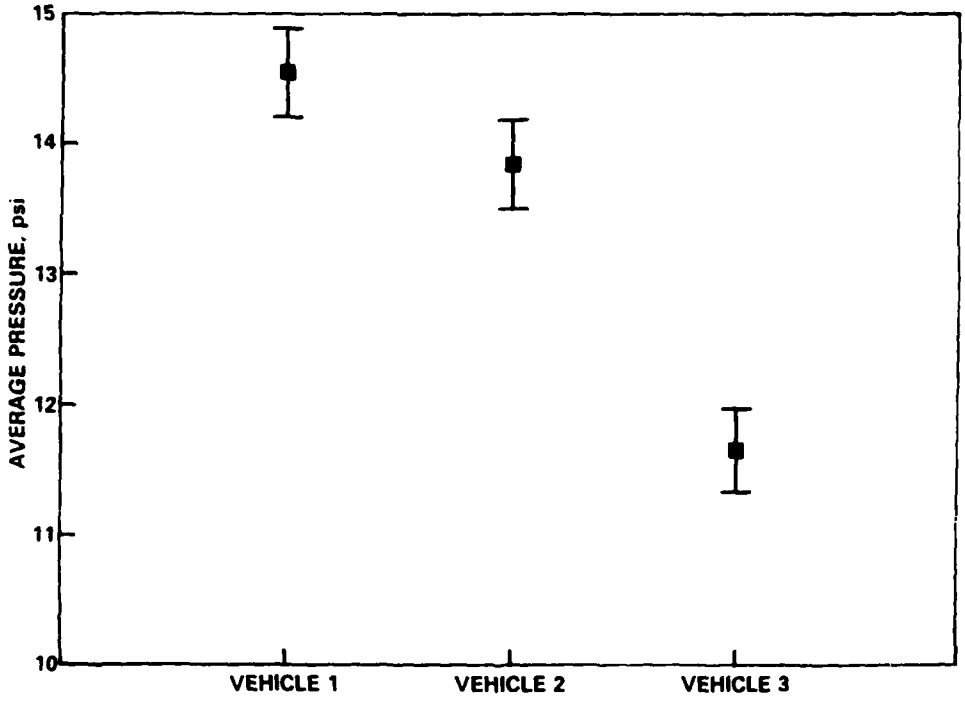

Figure 8. Idle oil pressure by vehicle
(All oils)

Appendix B shows selected properties on the existent, new, and used oils. Based on the iron content of the used oils, and assuming that the new oil had no iron in it, the quantity of unchanged oil remaining in the coolers averages 36 percent of the total oil capacity. This residue was undesirable, but unavoidable since draining the coolers required removal

of the engines. Using the 36-percent residue figure, and averaging the XRF and ICP iron analyses, the amount of iron generated during each test is shown in TABLE 3.

TABLE 3. Engine Oil Iron Generated During Each Test

	Vehicle		
	No. 1	No. 2	No. 3
Run No. 1	-1 ppm (50 gr.)	16 ppm (40 gr.)	3 ppm (15W-40 gr.)
Run No. 2	20 ppm (40 gr.)	9 ppm (15W-40 gr.)	19 ppm (50 gr.)
Run No. 3	6 ppm (15W-40 gr.)	10 ppm (50 gr.)	13 ppm (40 gr.)

The -1 value for vehicle No. 1, run No. 1, indicates that iron content decreased during the test and resulted from minor inaccuracies in the measurement or sampling technique. The SAE-50 product averaged a 13-ppm increase, the OE/HDO-40 product averaged a 16-ppm increase, and the OE/HDO-15/40 product averaged a 6-ppm increase.

The used oil analyses show that vehicle No. 3 initially had higher iron, lead, copper, and silicon levels than the other vehicles. These higher levels indicate that vehicle No. 3 had either more miles of operation since oil change than the other vehicles, or was wearing at a more rapid rate than the others or both. Vehicle No. 3 consistently maintained higher iron, lead, and copper levels than the other vehicles, indicating accelerated wear in this vehicle. This accelerated wear in vehicle No. 3 may have been caused by the consistently higher temperatures exhibited by the vehicle.

VI. CONCLUSIONS

- There were no significant differences in engine oil operating temperatures between the MIL-L-2104D 15W-40 or 40 grades and the SAE 50-grade lubricants.

- There were significant differences in operating temperatures among vehicles. These differences were larger than any observed oil differences.

- There was no difference in idle oil pressure between the OE/HDO-40 and the SAE 50-grade lubricants in fully warm engines.

- The OE/HDO-15/40 oil produced approximately 1-psi lower oil pressure at idle than the SAE 50 grade in full warm engines.

- The engine-to-engine difference in idle oil pressure was larger than the oil viscosity-related differences.

- Although idle oil pressures as low as 9 psi were recorded during the testing, no oil pressure warning lights were activated, indicating the activation levels for these warning lights are set considerably below the 15-psi levels called for in the technical manuals.

VII. RECOMMENDATIONS

- Data should be developed on engine oil pressure versus wear. This information would be of value in current and future lubricant development programs.

- The possibility of increased bearing wear during high-temperature operations should be investigated further. In particular, testing needs to be conducted in operations where the vehicles are brought to high temperatures, then idled repeatedly. This type of run-hide-run cycle is common under some combat scenarios.

- This program did not address engine wear directly, and does not provide any significant data on wear. Although laboratory testing has not shown any wear problems with the 15W-40 grade in the AVDS-1790-2C engine, if further testing is undertaken, this aspect should be included.

VIII. LIST OF REFERENCES

1. U.S. Military Specification MIL-L-2104E, "Lubricating Oil, Internal Combustion Engine, Tactical Service," 1 August 1988.

2. Butler, Jr., W.E.; Owens, E.C.; Frame, E.A.; and Bowen, T.C., "Pilot Field Tests of Multiviscosity/Synthetic Engine Oil in Army Combat Tactical Vehicles at Ft. Bliss, TX," Interim Report AFLRL No. 160, AD A134703, prepared by U.S. Army Fuels and Lubricants Research Laboratory, San Antonio, TX, July 1982.

3. Butler, Jr., W.E.; Alvarez, R.A.; Frame, E.A.; Buckingham, J.P.; and Owens, E.C., "Field Evaluation of All-Season Tactical Engine Oil OE/HDO 15W-40 at Ft. Knox, KY and Ft. Bliss, TX," Interim Report BFLRF No. 217, prepared by Belvoir Fuels and Lubricants Research Facility (SwRI), San Antonio, TX, July 1986.

APPENDIX A

Edited Data

(NOTE: Question mark in tables indicates a faulty or missing measurement.)

Day 1
M60 Tank No. 1, SAE-50 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
64	1304.	115.1	117.6	?	95.0	56.78
65	1305.	119.9	124.4	101.2	93.4	55.44
66	1306.	123.5	131.4	102.0	93.5	53.34
67	1307.	121.4	132.9	102.5	93.8	52.16
68	1308.	122.2	134.1	102.9	93.8	51.32
69	1309.	139.3	138.7	101.6	93.5	68.32
70	1310.	153.3	144.0	100.0	93.5	65.69
71	1311.	147.7	147.4	101.0	92.9	62.12
72	1312.	140.8	147.2	101.7	93.4	38.34
73	1313.	168.6	151.9	100.1	93.1	67.08
74	1314.	174.6	158.0	99.3	93.3	65.84
75	1315.	187.2	164.9	98.4	93.4	66.41
76	1316.	187.1	171.0	98.8	93.7	63.23
77	1317.	195.3	176.5	100.0	94.1	62.83
78	1318.	199.0	181.3	100.9	94.4	62.50
79	1319.	201.6	184.5	101.3	93.9	49.49
80	1320.	205.5	187.8	101.2	93.8	56.93
81	1321.	210.0	191.4	101.9	94.1	59.28
82	1322.	213.1	195.0	101.3	93.3	58.20
83	1323.	219.0	198.5	101.7	93.7	57.89
84	1324.	219.9	201.6	102.6	94.8	58.28
85	1325.	221.2	203.1	103.0	95.4	59.90
86	1326.	226.7	205.6	101.7	95.1	59.16
87	1327.	229.0	208.8	101.5	94.8	58.75
88	1328.	232.4	211.4	101.9	95.4	48.25
89	1329.	228.0	213.6	102.0	95.1	45.61
90	1330.	231.1	213.0	102.8	96.2	49.41
91	1331.	230.4	212.7	102.2	95.7	53.41
92	1332.	228.4	211.7	102.0	95.9	38.15
93	1333.	228.6	212.3	100.4	95.0	55.78
94	1334.	230.9	212.7	100.3	94.8	44.42
95	1335.	229.8	212.0	100.2	94.9	53.23
96	1336.	224.6	209.9	?	95.5	15.46
97	1337.	219.1	209.9	?	98.9	16.46
98	1338.	217.7	208.8	?	99.3	16.76
99	1339.	215.5	207.0	?	99.0	17.51
100	1340.	220.3	202.4	?	97.7	59.21
101	1341.	224.2	204.2	101.7	95.5	58.81
102	1342.	225.8	207.3	101.3	95.3	61.99
103	1343.	226.4	209.6	101.1	95.9	56.98

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 1
M60 Tank No. 1, SAE-50 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
104	1344.	223.5	208.9	?	95.4	16.00
105	1345.	222.1	206.7	?	95.8	16.36
106	1346.	224.2	205.3	?	95.3	50.19
107	1347.	226.5	207.4	98.8	94.8	59.65
108	1348.	227.2	210.5	97.7	94.9	46.36
109	1349.	229.4	210.1	99.1	95.9	54.89
110	1350.	221.7	210.2	?	95.9	17.89
111	1351.	224.0	207.0	?	95.6	52.24
112	1352.	226.8	208.7	99.9	95.7	59.08

Day 1
M60 Tank No. 2, OE/HDO-40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
64	1304.	109.0	108.0	?	97.3	56.05
65	1305.	111.1	116.6	102.7	93.6	54.13
66	1306.	119.7	123.1	102.2	94.2	51.66
67	1307.	119.8	126.2	101.9	93.4	49.21
68	1308.	120.9	128.0	101.5	93.6	47.83
69	1309.	126.2	133.5	101.1	93.4	66.25
70	1310.	147.0	142.4	99.4	93.8	62.21
71	1311.	151.4	144.2	100.3	93.8	52.15
72	1312.	149.3	145.5	100.9	93.8	31.30
73	1313.	160.4	147.9	99.9	93.8	62.61
74	1314.	172.1	155.3	98.7	93.7	62.73
75	1315.	181.9	162.0	98.3	93.3	61.03
76	1316.	190.3	169.3	98.4	93.5	60.17
77	1317.	198.0	174.5	98.7	94.0	58.30
78	1318.	203.2	179.7	99.3	94.1	57.11
79	1319.	203.8	183.3	100.0	94.3	54.83
80	1320.	208.1	185.1	100.1	93.5	50.64
81	1321.	212.2	188.6	100.1	93.9	51.73
82	1322.	215.3	191.7	100.5	93.8	55.10
83	1323.	220.5	194.9	100.6	93.4	55.01
84	1324.	221.9	197.7	101.4	94.8	45.50
85	1325.	224.3	199.6	101.7	95.1	50.87
86	1326.	227.6	202.0	101.6	95.9	54.38
87	1327.	228.7	205.1	101.2	95.4	51.89
88	1328.	232.8	207.3	101.1	95.6	47.10
89	1329.	231.0	208.4	101.5	96.4	46.62
90	1130.	230.4	208.9	101.5	95.4	45.55
91	1331.	230.2	210.1	101.7	96.5	41.13
92	1332.	230.2	209.6	101.1	95.9	44.28
93	1333.	231.6	208.9	99.5	95.2	42.27
94	1334.	232.2	210.2	99.1	95.3	45.43
95	1335.	232.6	209.8	98.6	95.8	22.72
96	1336.	230.6	208.6	98.8	95.7	36.98
97	1337.	226.6	20..7	?	98.5	13.41
98	1338.	224.6	205.6	?	99.2	13.74
99	1339.	222.2	202.7	?	99.3	14.09
100	1340.	219.5	199.3	?	98.6	51.95
101	1341.	224.6	199.8	101.2	96.3	52.74
102	1342.	228.1	202.6	99.5	96.3	49.51
103	1343.	229.1	205.2	98.8	95.6	46.75

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 1
M60 Tank No. 2, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
104	1344.	221.1	205.8	?	94.9	13.03
105	1345.	220.3	204.3	?	94.6	13.36
106	1346.	222.1	202.6	?	95.4	13.60
107	1347.	221.6	198.9	?	95.6	48.0
108	1348.	227.1	202.5	98.3	95.3	55.59
109	1349.	229.2	205.1	97.5	94.8	40.63
110	1350.	224.6	206.1	99.5	96.9	56.71
111	1351.	231.9	205.8	99.7	96.0	55.05
112	1352.	227.1	208.3	100.3	96.3	21.70
113	1353.	229.2	206.0	99.4	95.3	52.23
114	1354.	224.1	205.6	100.2	96.4	54.25
115	1355.	229.4	205.6	100.1	95.7	45.22
116	1356.	231.0	207.7	99.7	95.3	37.62
117	1357.	233.2	207.9	98.5	95.4	37.84
118	1358.	228.6	206.4	?	95.9	14.12
119	1359.	226.2	206.2	?	95.5	46.91
120	1400.	225.4	205.1	98.4	95.9	42.70
121	1401.	227.5	206.8	?	95.9	19.11
122	1402.	223.2	204.0	?	96.1	39.55
123	1403.	219.3	201.4	?	96.2	13.16
124	1404.	221.6	202.7	?	97.8	53.94
125	1405.	226.6	200.9	99.4	95.5	26.31
126	1406.	222.3	201.6	99.1	95.7	50.46
127	1407.	218.9	200.1	98.5	95.5	52.00
128	1408.	221.5	198.7	99.1	95.0	56.40
129	1409.	228.2	201.7	98.2	95.1	53.88
130	1410.	220.0	201.7	?	96.9	13.96
131	1411.	217.2	199.5	?	97.2	14.35
132	1412.	215.9	198.1	?	97.3	14.57
133	1413.	214.4	195.8	?	97.4	14.93
134	1414.	212.5	192.2	?	97.2	15.34
135	1415.	210.2	189.4	?	97.6	15.88
136	1416.	204.6	186.8	?	97.2	28.17
137	1417.	203.9	186.8	99.6	96.1	40.09
138	1418.	204.1	186.3	99.4	96.3	55.64
139	1419.	208.4	187.2	98.8	96.3	56.97
140	1420.	213.6	192.4	97.8	96.1	55.27
141	1421.	220.4	197.5	97.9	95.9	51.57
142	1422.	223.7	201.8	97.9	95.7	46.41
143	1423.	227.7	205.9	98.5	96.3	46.96
144	1424.	232.9	209.3	98.1	95.7	48.03
145	1425.	234.5	212.6	98.5	96.0	41.44
146	1426.	238.3	214.8	98.6	96.3	40.11
147	1427.	239.1	216.2	98.2	96.0	33.21
148	1428.	243.0	219.0	98.5	96.5	42.33

Day 1
M60 Tank No. 2, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
149	1429.	245.4	220.9	98.3	96.2	42.62
150	1430.	245.3	221.8	?	95.9	11.19
151	1431.	242.0	219.5	?	96.4	42.29
152	1432.	240.7	217.7	99.0	97.1	43.09
153	1433.	239.8	217.6	98.9	96.6	35.89
154	1434.	242.2	217.2	98.9	96.7	39.29
155	1435.	242.4	216.9	98.2	96.7	44.61
156	1436.	240.2	217.9	98.0	96.6	22.39
157	1437.	238.3	216.0	99.4	97.5	33.08
158	1438.	237.9	215.5	99.0	97.0	32.94
159	1439.	236.7	215.7	?	97.5	11.34
160	1440.	233.9	213.9	?	98.6	21.56
161	1441.	232.4	211.7	100.8	97.9	44.90
162	1442.	230.4	208.6	?	97.3	13.08
163	1443.	228.7	205.2	?	98.2	45.92
164	1444.	221.7	201.5	?	98.8	13.89
165	1445.	219.1	198.3	?	99.3	14.59

Day 1
M60 Tank No. 3, OE/HDO-15/40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
65	1305.	112.2	113.3	?	93.4	36.63
66	1306.	119.6	120.3	105.2	92.6	47.54
67	1307.	119.9	122.9	105.4	93.4	45.69
68	1308.	122.2	125.0	105.8	93.4	45.20
69	1309.	128.3	129.8	105.7	92.6	51.05
70	1310.	147.7	143.1	102.8	93.1	52.21
71	1311.	150.9	150.2	100.2	93.2	32.26
72	1312.	157.8	154.3	99.0	93.3	29.97
73	1313.	163.1	155.4	97.6	93.6	50.54
74	1314.	173.1	163.8	96.2	93.4	53.07
75	1315.	182.2	170.9	95.2	92.8	50.66
76	1316.	193.6	176.5	94.8	93.3	52.17
77	1317.	197.4	181.5	95.1	94.3	50.34
78	1318.	202.6	184.2	95.2	94.4	37.23
79	1319.	206.6	187.4	95.1	93.8	43.49
80	1320.	211.0	190.5	94.9	94.0	28.15
81	1321.	211.9	194.5	94.8	94.4	51.58
82	1322.	213.5	196.2	95.3	94.1	52.35
83	1323.	215.7	199.6	97.3	93.6	49.42
84	1324.	221.0	202.8	98.3	93.1	50.71
85	1325.	223.7	205.0	99.0	93.8	45.67
86	1326.	228.7	207.2	99.5	93.9	23.07
87	1327.	225.8	210.0	100.5	93.9	28.87
88	1328.	232.9	212.2	100.7	95.0	44.74
89	1329.	235.1	213.8	99.9	95.2	48.71
90	1330.	234.9	215.0	101.4	95.4	32.01
91	1331.	236.1	215.3	101.8	95.5	26.02
92	1332.	234.8	216.7	102.2	95.9	27.01
93	1333.	235.8	217.4	102.7	95.7	26.15
94	1334.	237.7	216.4	102.7	94.7	32.88
95	1335.	235.0	218.7	102.7	95.1	46.41
96	1336.	237.5	218.2	102.8	94.9	39.90
97	1337.	235.3	219.8	?	97.1	11.90
98	1338.	232.3	217.1	?	97.8	12.35
99	1339.	229.3	215.1	?	97.3	12.66
100	1340.	227.2	208.3	?	96.4	14.38
101	1341.	228.9	207.8	?	95.4	46.08
102	1342.	232.9	210.7	104.7	95.8	41.51
103	1343.	236.1	213.2	104.4	95.2	45.39
104	1344.	230.8	215.9	?	96.0	11.94

Notes: Min in column 1 indicates minutes past noon on the day of each test.
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Oil pressure is in psig.

Day 1
M60 Tank No. 3, OE/HDO-15/40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
105	1345.	229.6	216.6	?	95.4	12.28
106	1346.	233.0	210.6	?	95.1	36.40
107	1347.	236.9	213.6	102.7	95.3	38.10
108	1348.	233.3	217.4	102.0	95.3	27.23
109	1349.	237.3	220.2	?	95.2	15.17
110	1350.	230.8	217.8	?	95.4	38.12
111	1351.	237.7	216.6	99.8	95.2	46.09
112	1352.	245.0	218.7	101.1	96.8	37.84
113	1353.	247.2	222.8	101.8	95.7	49.27
114	1354.	245.2	225.3	101.6	95.3	32.13
115	1355.	247.0	225.8	98.4	95.7	28.97
116	1356.	242.4	224.3	97.5	95.7	47.45
117	1357.	248.0	225.0	98.8	95.4	47.84
118	1358.	250.8	226.6	99.9	95.5	40.04
119	1359.	250.0	229.0	100.9	95.9	38.91
120	1400.	247.5	232.9	?	97.4	9.76
121	1401.	244.8	230.6	?	98.1	10.08
122	1402.	244.8	227.6	?	98.5	12.42
123	1403.	241.9	223.4	?	97.1	44.49
124	1404.	240.6	220.8	100.0	96.1	52.04
125	1405.	236.7	219.1	?	96.3	11.18
126	1406.	235.5	218.3	?	96.5	26.55
127	1407.	236.2	219.4	98.4	96.6	45.25
128	1408.	232.6	219.1	?	97.3	11.86
129	1409.	231.7	213.5	?	97.3	39.51
130	1410.	235.1	214.0	101.5	96.4	42.71
131	1411.	238.4	217.1	102.5	96.7	44.57
132	1412.	239.4	219.0	103.4	97.2	47.81
133	1413.	239.7	223.3	?	96.3	11.48
134	1414.	240.5	222.8	?	97.1	11.32
135	1415.	237.2	221.0	?	97.4	11.01
136	1416.	235.9	217.2	?	97.7	44.09
137	1417.	229.0	215.6	98.1	96.4	49.77
138	1418.	231.9	214.6	96.8	95.9	42.45
139	1419.	235.7	215.6	96.8	96.5	50.09
140	1420.	239.4	218.2	96.9	95.8	39.72
141	1421.	241.3	220.6	98.1	96.1	49.67
142	1422.	245.0	224.2	99.5	96.2	44.52
143	1423.	246.7	225.4	100.1	96.3	48.32
144	1424.	247.3	227.4	100.6	96.3	33.89
145	1425.	249.4	228.4	100.9	96.3	38.15
146	1426.	247.2	231.1	100.7	95.6	40.90
147	1427.	253.0	232.1	101.0	96.4	41.51
148	1428.	257.3	233.6	101.5	96.3	40.40
149	1429.	251.5	234.7	101.5	95.6	32.49

Day 2
M60 Tank No. 1, OE/HDO-40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
55	1255.	114.6	132.6	?	94.9	46.25
56	1256.	116.5	133.4	103.3	93.8	45.35
57	1257.	118.2	133.7	103.6	93.8	45.00
58	1258.	126.6	135.7	102.6	94.7	58.00
59	1259.	123.5	136.5	102.7	95.2	62.16
60	1300.	136.0	137.5	102.7	94.8	40.00
61	1301.	139.3	140.7	101.9	95.4	52.91
62	1302.	146.4	147.1	100.2	95.3	60.40
63	1303.	156.3	150.3	100.8	95.2	30.38
64	1304.	91.4	149.2	102.1	95.2	28.59
65	1305.	138.7	149.3	101.2	97.4	55.37
66	1306.	164.6	157.4	98.2	98.6	53.69
67	1307.	187.6	165.2	96.9	99.2	38.85
68	1308.	177.7	169.3	97.9	99.6	47.65
69	1309.	168.8	175.7	99.0	98.4	36.90
70	1310.	190.0	179.7	97.2	98.6	33.18
71	1311.	208.9	182.7	97.6	98.8	36.04
72	1312.	205.7	185.2	97.9	99.1	43.54
73	1313.	216.0	189.2	99.2	98.7	54.35
74	1314.	210.7	193.6	100.5	99.4	58.82
75	1315.	146.8	196.3	100.2	98.6	29.42
76	1316.	217.8	201.2	99.8	99.1	38.05
77	1317.	219.9	200.6	97.5	99.8	44.88
78	1318.	228.4	203.7	97.0	100.8	50.92
79	1319.	227.5	206.5	97.4	99.8	23.37
80	1320.	220.7	209.4	?	98.7	15.22
81	1321.	218.4	207.6	?	99.2	15.78
82	1322.	216.3	205.0	?	99.3	16.13
83	1323.	213.9	201.8	?	98.4	16.63
84	1324.	211.9	199.7	?	99.8	17.34
85	1325.	210.3	199.1	?	100.4	17.77
86	1326.	217.3	193.2	?	99.9	47.17
87	1327.	217.8	199.4	99.7	99.7	40.64
88	1328.	225.5	199.6	97.4	100.4	31.44
89	1329.	230.3	201.9	97.5	99.8	56.08
90	1330.	226.7	206.0	?	99.0	15.62
91	1331.	209.8	209.6	?	98.9	29.42
92	1332.	115.9	207.8	96.1	97.3	46.82
93	1333.	238.2	207.5	96.4	98.4	49.79
94	1334.	232.4	211.1	96.5	97.8	47.75

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 2
M60 Tank No. 1, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
95	1335.	240.5	213.0	96.2	98.1	47.01
96	1336.	240.4	215.5	95.9	98.0	39.66
97	1337.	238.7	219.6	?	97.7	13.43
98	1338.	232.1	220.1	?	98.8	13.65
99	1339.	229.1	216.4	?	99.4	14.18
100	1340.	235.7	213.2	?	98.2	42.72
101	1341.	236.7	210.5	98.0	98.6	43.21
102	1342.	240.3	212.9	98.0	99.4	46.33
103	1343.	244.5	215.9	97.6	97.8	41.71
104	1344.	247.6	218.7	97.0	98.4	47.88
105	1345.	250.4	221.1	96.7	97.8	45.13
106	1346.	246.3	220.7	96.6	97.8	31.66
107	1347.	242.4	221.0	?	97.7	12.81
108	1348.	244.7	219.7	?	98.6	31.69
109	1349.	248.5	220.3	95.3	99.0	44.29
110	1350.	247.7	223.1	95.6	97.4	41.32
111	1351.	243.5	224.8	95.8	98.0	21.91
112	1352.	239.7	223.3	98.6	100.3	41.90
113	1353.	239.2	220.4	98.3	98.8	35.88
114	1354.	237.9	219.3	99.4	99.5	45.96
115	1355.	244.8	216.6	98.3	101.3	44.66
116	1356.	248.3	220.9	99.3	100.8	41.56
117	1357.	247.3	222.5	97.9	100.1	45.84
118	1358.	247.0	223.6	98.3	101.6	40.05
119	1359.	247.1	227.4	99.2	101.9	37.58
120	1400.	251.6	223.8	98.6	102.4	38.59
121	1401.	254.3	223.9	98.2	100.3	50.55
122	1402.	250.8	225.6	97.6	99.3	26.55
123	1403.	244.8	228.5	?	99.0	12.35
124	1404.	240.0	226.3	?	98.4	12.62
125	1405.	246.1	220.4	?	98.5	43.42
126	1406.	246.6	222.1	97.0	97.8	38.86
127	1407.	248.4	221.8	96.7	97.9	41.97
128	1408.	246.1	225.7	96.6	97.3	37.05
129	1409.	251.9	223.3	97.0	99.8	43.57
130	1410.	252.5	225.1	96.3	101.0	39.22
131	1411.	249.0	225.3	97.2	98.5	39.79
132	1412.	250.8	226.9	97.2	98.6	46.51
133	1413.	254.5	227.4	96.8	98.6	36.32
134	1414.	254.7	231.3	96.7	98.6	30.00
135	1415.	253.9	228.8	96.8	98.1	43.48
136	1416.	252.2	228.1	97.2	99.0	32.92
137	1417.	254.0	227.0	96.5	99.0	36.85
138	1418.	254.3	227.8	96.2	98.4	28.84
139	1419.	250.4	227.7	96.4	98.4	47.20

Day 2
M60 Tank No. 1, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
140	1420.	248.8	228.0	97.1	98.4	43.64
141	1421.	246.7	227.4	97.1	98.0	37.68
142	1422.	246.7	224.7	97.7	98.1	43.37
143	1423.	245.1	220.3	96.9	98.7	34.22
144	1424.	241.3	222.4	?	98.7	13.09
145	1425.	237.9	221.7	?	99.2	26.40
146	1426.	235.5	218.8	100.2	99.7	23.48
147	1427.	235.5	216.3	?	98.6	19.31
148	1428.	233.8	214.5	?	99.0	13.78
149	1429.	229.7	214.6	?	100.1	22.94
150	1430.	228.8	214.2	?	100.3	17.47
151	1431.	226.1	212.6	?	100.4	23.22
152	1432.	224.1	207.4	?	99.8	39.96

Day 2
M60 Tank No. 2, OE/HDO-15/40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
58	1258.	122.9	122.6	?	96.9	19.39
59	1259.	120.9	127.6	?	95.3	23.29
60	1300.	131.6	130.7	?	94.6	17.82
61	1301.	133.9	132.9	?	94.5	24.43
62	1302.	133.1	141.0	100.0	93.8	23.82
63	1303.	139.6	146.9	99.8	93.8	24.09
64	1304.	142.2	149.0	100.7	95.1	20.56
65	1305.	143.9	148.2	100.3	94.9	24.32
66	1306.	167.9	152.1	98.4	94.7	23.44
67	1307.	187.6	157.1	97.4	93.8	23.41
68	1308.	189.7	160.5	97.4	93.4	23.73
69	1309.	200.0	158.6	?	93.7	19.87
70	1310.	200.9	156.8	?	94.4	25.34
71	1311.	203.5	162.7	95.7	94.1	25.04
72	1312.	208.3	165.5	96.4	94.1	26.64
73	1313.	213.8	164.1	97.2	93.8	22.53
74	1314.	218.3	166.9	?	93.6	11.70
75	1315.	218.7	170.4	?	93.5	21.24
76	1316.	221.2	179.5	99.6	94.2	22.85
77	1317.	218.5	172.4	100.2	94.9	23.54
78	1318.	225.4	172.8	99.0	95.0	24.92
79	1319.	228.8	174.8	97.7	94.6	25.37
80	1320.	221.9	184.0	?	94.4	14.20
81	1321.	220.5	195.6	?	97.4	14.61
82	1322.	217.3	193.1	?	96.3	14.78
83	1323.	212.5	192.3	?	99.8	.545
84	1324.	210.6	191.8	?	120.3	.578
85	1325.	210.7	191.1	?	126.7	14.32
86	1326.	218.6	177.5	?	101.7	25.40
87	1327.	222.1	174.5	102.8	96.7	22.88
88	1328.	227.0	175.4	100.3	95.8	22.74
89	1329.	226.3	176.7	?	95.4	18.39
90	1330.	231.6	181.6	?	94.5	26.28
91	1331.	226.4	181.7	98.4	94.9	33.50
92	1332.	232.3	180.3	?	94.4	19.99
93	1333.	234.2	182.7	?	94.6	25.26
94	1334.	231.3	178.8	97.2	95.0	24.19
95	1335.	234.3	183.0	97.2	95.1	26.01
96	1336.	241.1	186.3	96.9	95.2	26.77
97	1337.	233.1	194.2	96.5	94.6	27.60

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 2
M60 Tank No. 2, OE/HDO-15/40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
98	1338.	228.9	204.6	?	98.9	13.31
99	1339.	222.4	202.5	?	97.9	13.54
100	1340.	224.8	188.7	?	96.7	40.43
101	1341.	228.8	186.0	100.5	95.7	24.02
102	1342.	227.3	181.4	99.0	95.3	15.70
103	1343.	235.2	185.2	98.2	94.5	25.43
104	1344.	237.3	187.4	97.9	94.6	25.13
105	1345.	243.5	189.5	98.0	94.5	25.51
106	1346.	241.7	190.3	98.0	94.6	26.85
107	1347.	244.3	189.1	97.5	94.3	23.67
108	1348.	238.9	197.0	?	94.5	12.07
109	1349.	232.8	205.7	?	95.4	12.94
110	1350.	235.3	185.6	?	94.3	20.82
111	1351.	236.1	187.4	?	93.8	18.24
112	1352.	236.7	184.9	?	94.0	14.55
113	1353.	229.6	197.7	?	94.5	22.88
114	1354.	231.0	198.4	?	95.7	12.16
115	1355.	227.3	189.6	?	95.8	20.42
116	1356.	229.4	183.9	98.1	95.5	22.43
117	1357.	235.8	184.7	98.4	95.9	22.13
118	1358.	239.6	188.9	98.2	95.8	24.66
119	1359.	231.9	191.3	97.8	95.3	23.94
120	1400.	237.6	186.6	97.8	95.7	24.66
121	1401.	238.3	188.0	98.1	95.7	26.63
122	1402.	241.6	191.0	98.2	95.7	26.70
123	1403.	239.4	200.5	99.1	96.4	34.76
124	1404.	245.4	194.1	99.9	96.7	26.20
125	1405.	243.8	196.8	99.8	96.8	24.94
126	1406.	237.2	204.5	99.3	96.2	24.38
127	1407.	241.3	196.9	99.0	95.9	22.20
128	1408.	241.3	203.7	98.4	95.8	23.98
129	1409.	244.5	192.0	97.8	96.0	23.92
130	1410.	246.2	195.8	97.6	96.0	24.83
131	1411.	245.1	199.8	97.6	96.0	22.70
132	1412.	245.5	196.0	97.6	95.8	22.32
133	1413.	247.9	197.0	98.0	95.8	22.60
134	1414.	248.4	199.9	97.6	95.7	22.40
135	1415.	249.0	198.4	97.6	95.8	23.88
136	1416.	246.2	204.9	98.0	96.1	22.92
137	1417.	245.4	198.6	98.4	96.4	20.06
138	1418.	245.8	197.1	98.0	96.1	23.35
139	1419.	251.0	198.7	?	96.1	15.97
140	1420.	249.0	196.4	?	95.9	22.81
141	1421.	245.3	200.6	?	95.8	9.100
142	1422.	243.1	205.9	?	95.8	25.29

Day 2
M60 Tank No. 2, OE/HDO-15/40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
143	1423.	241.6	199.4	97.8	95.8	30.41
144	1424.	246.1	199.4	97.9	96.1	23.13
145	1425.	243.8	197.7	?	96.4	10.06
146	1426.	243.9	198.8	?	96.5	24.34
147	1427.	241.5	204.2	?	96.3	12.13
148	1428.	241.8	209.9	?	96.9	12.15
149	1429.	236.7	208.6	?	97.2	12.29
150	1430.	230.7	205.7	?	97.7	16.82
151	1431.	226.4	204.3	?	97.9	12.93

Day 2
M60 Tank No. 3, SAE-50 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
58	1258.	121.8	123.5	?	97.2	30.65
59	1259.	123.9	129.8	106.2	96.4	36.38
60	1300.	130.4	135.1	105.7	95.6	24.67
61	1301.	137.7	137.6	105.7	95.8	48.34
62	1302.	150.3	148.3	104.0	95.2	47.94
63	1303.	161.3	160.4	102.1	95.2	32.90
64	1304.	163.5	165.8	101.1	95.6	26.01
65	1305.	170.3	168.2	99.8	96.1	36.67
66	1306.	179.4	175.6	97.8	95.5	36.44
67	1307.	190.8	182.2	97.0	95.0	35.29
68	1308.	203.1	192.1	96.5	94.8	27.89
69	1309.	213.2	197.5	96.4	94.7	23.43
70	1310.	221.3	201.9	96.1	94.8	27.41
71	1311.	221.0	205.5	96.5	95.4	38.42
72	1312.	225.8	210.6	95.9	95.1	37.20
73	1313.	237.1	209.9	96.8	95.6	36.93
74	1314.	235.8	211.7	98.2	95.2	33.39
75	1315.	238.3	213.9	98.5	95.3	29.25
76	1316.	241.8	216.5	100.1	95.6	21.48
77	1317.	246.7	218.7	100.6	95.6	31.02
78	1318.	252.7	221.3	101.3	95.9	34.36
79	1319.	254.4	224.1	101.1	95.2	36.05
80	1320.	255.4	225.8	100.8	95.0	19.06
81	1321.	248.6	225.9	?	96.1	12.61
82	1322.	239.6	228.0	?	101.7	-.626
83	1323.	238.3	229.6	?	107.4	-.623
84	1324.	237.8	223.4	?	126.0	-.607
85	1325.	241.2	224.9	?	122.2	12.69
86	1326.	240.5	220.6	?	102.8	26.29
87	1327.	247.6	221.0	106.0	97.5	35.09
88	1328.	250.7	223.5	104.5	96.5	31.98
89	1329.	255.6	225.4	103.2	96.5	36.52
90	1330.	254.0	229.4	102.9	96.2	24.52
91	1331.	256.0	227.1	?	96.3	19.73
92	1332.	255.2	229.1	?	96.3	15.62
93	1333.	257.3	228.6	?	95.7	20.23
94	1334.	261.6	229.8	100.7	95.4	38.36
95	1335.	264.2	232.2	100.6	95.4	37.32
96	1336.	265.1	233.5	100.5	95.6	35.62
97	1337.	266.6	235.7	100.3	95.5	37.77

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (^{o}F) - 32 by 5/9.
Oil pressure is in psig.

Day 2
M60 Tank No. 3, SAE-50 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
98	1338.	254.5	239.8	?	97.4	10.62
99	1339.	255.0	236.9	?	97.5	16.66
100	1340.	250.8	231.2	?	98.2	15.14
101	1341.	256.0	227.4	?	97.0	24.24
102	1342.	253.8	229.1	102.2	96.5	27.53
103	1343.	260.2	230.3	101.7	96.1	29.88
104	1344.	264.1	231.6	101.4	96.2	27.23
105	1345.	263.0	235.4	?	95.8	17.94
106	1346.	269.5	237.9	?	96.2	32.05
107	1347.	268.5	237.5	101.1	95.4	31.03
108	1348.	258.5	237.8	101.2	95.6	28.08
109	1349.	269.3	236.9	99.8	95.5	32.87
110	1350.	272.1	240.4	99.2	95.2	25.22
111	1351.	259.8	241.7	99.9	95.8	27.52
112	1352.	265.4	240.3	?	97.5	8.580
113	1353.	262.0	236.3	?	97.2	30.64
114	1354.	261.6	235.7	100.5	97.1	21.54
115	1355.	263.1	234.6	101.5	97.9	31.79
116	1356.	263.2	235.2	101.3	96.5	33.12
117	1357.	266.6	236.3	101.8	97.1	34.93
118	1358.	267.7	236.6	101.0	96.7	33.70
119	1359.	255.9	241.5	?	97.4	11.21
120	1400.	268.3	237.3	?	97.8	32.49
121	1401.	271.4	239.0	101.4	96.6	22.10
122	1402.	271.7	239.2	101.8	96.6	30.84
123	1403.	266.8	245.3	?	97.2	9.950
124	1404.	261.9	240.8	?	97.5	10.59
125	1405.	251.9	237.6	?	97.6	29.21
126	1406.	258.6	232.5	101.7	96.4	30.39
127	1407.	264.2	233.2	101.2	96.6	38.98
128	1408.	266.5	234.8	100.9	96.2	37.26
129	1409.	268.3	237.6	101.1	97.1	32.21
130	1410.	270.4	238.2	100.9	96.7	29.17
131	1411.	266.5	239.0	100.9	96.6	33.18
132	1412.	270.5	239.9	100.8	96.5	33.23
133	1413.	271.4	240.2	100.9	96.4	27.75
134	1414.	272.2	241.0	101.1	96.7	34.24
135	1415.	272.2	242.0	101.2	96.6	26.89
136	1416.	264.7	242.3	101.4	97.1	25.09
137	1417.	255.9	242.9	101.5	97.1	34.88
138	1418.	275.0	245.2	101.3	96.8	30.54
139	1419.	275.2	244.1	?	96.4	19.79
140	1420.	276.8	245.2	?	96.5	31.39
141	1421.	272.3	246.0	100.7	96.4	25.97
142	1422.	270.9	244.6	100.7	96.6	24.65

Day 2
M60 Tank No. 3, SAE-50 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
143	1423.	274.0	245.3	100.8	96.8	22.30
144	1424.	269.3	245.3	101.6	97.7	23.25
145	1425.	257.2	244.8	?	98.2	10.10
146	1426.	261.5	238.6	?	98.4	25.37
147	1427.	262.9	236.6	102.5	97.4	32.12
148	1428.	258.9	239.0	?	98.7	9.940
149	1429.	256.1	238.5	?	98.8	10.10
150	1430.	254.0	235.2	?	98.4	9.130
151	1431.	251.1	230.8	?	98.9	24.16
152	1432.	247.8	225.3	104.2	98.2	33.71
153	1433.	240.8	226.4	?	98.7	12.16

Day 3
M60 Tank No. 1, OE/HDO-15/40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
43	1243.	104.1	106.2	?	92.9	30.19
44	1244.	109.5	112.4	96.4	91.5	46.12
45	1245.	110.6	118.8	98.0	92.3	56.96
46	1246.	124.6	124.1	99.2	91.2	42.75
47	1247.	125.8	125.4	100.0	91.8	42.18
48	1248.	127.2	126.6	99.7	92.0	41.30
49	1249.	128.4	127.7	98.8	92.3	40.85
50	1250.	129.7	128.7	99.8	92.3	40.07
51	1251.	130.9	129.7	100.4	92.4	39.41
52	1252.	132.0	130.5	101.2	92.7	38.69
53	1253.	133.0	131.1	101.8	92.4	38.18
54	1254.	134.0	131.7	102.0	92.8	37.82
55	1255.	134.8	132.1	102.0	92.4	37.54
56	1256.	136.3	134.6	101.7	92.1	32.89
57	1257.	142.0	135.7	101.3	92.6	28.31
58	1258.	140.6	136.5	102.0	92.8	33.44
59	1259.	140.1	136.6	102.4	93.3	33.80
60	1300.	156.3	141.5	102.4	94.0	51.23
61	1301.	163.3	150.0	102.2	95.3	54.93
62	1302.	160.7	150.3	102.0	94.5	39.36
63	1303.	160.8	153.1	102.3	94.6	25.41
64	1304.	179.8	156.6	101.3	94.6	56.86
65	1305.	190.5	165.6	101.2	96.1	54.12
66	1306.	192.9	173.3	102.0	95.9	49.81
67	1307.	204.2	178.8	101.8	97.2	37.07
68	1308.	209.4	184.5	101.8	97.5	39.84
69	1309.	211.6	189.6	101.0	96.6	40.68
70	1310.	216.1	192.7	100.4	96.7	48.20
71	1311.	218.0	195.1	100.9	97.1	54.52
72	1312.	223.2	199.5	101.7	97.6	50.63
73	1313.	228.3	202.1	102.3	97.5	40.99
74	1314.	229.3	206.4	101.8	97.8	27.27
75	1315.	233.3	208.3	101.5	97.3	36.93
76	1316.	234.6	210.5	101.2	96.7	46.97
77	1317.	236.7	211.8	100.6	98.5	25.83
78	1318.	241.9	216.2	100.9	98.2	48.16
79	1319.	242.2	216.8	100.4	97.1	32.45
80	1320.	240.5	217.7	101.2	97.7	50.92
81	1321.	243.2	217.4	101.6	99.1	46.35
82	1322.	236.6	219.4	102.2	99.1	19.30

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 3
M60 Tank No. 1, OE/HDO-15/40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
83	1323.	249.1	222.3	102.6	99.1	45.15
84	1324.	250.5	223.8	102.1	98.4	42.78
85	1325.	248.5	225.3	102.2	97.6	22.98
86	1326.	244.9	226.0	?	98.3	11.13
87	1327.	247.8	223.0	?	98.6	43.72
88	1328.	250.9	225.5	100.1	98.4	47.42
89	1329.	248.1	224.8	100.1	97.7	44.03
90	1330.	253.5	225.2	99.6	97.6	45.92
91	1331.	255.9	228.6	99.8	98.0	39.39
92	1332.	258.5	231.3	99.9	97.6	42.50
93	1333.	262.3	231.4	100.4	98.8	31.37
94	1334.	262.6	233.4	99.5	99.9	41.12
95	1335.	265.8	234.7	99.9	99.0	43.45
96	1336.	259.2	236.6	?	98.6	10.00
97	1337.	257.2	238.0	?	98.6	10.06
98	1338.	254.4	235.4	?	98.1	10.44
99	1339.	256.4	230.2	?	97.2	42.21
100	1340.	258.9	232.5	99.3	97.7	43.08
101	1341.	258.5	233.6	98.4	98.0	42.80
102	1342.	257.5	239.7	98.6	97.6	26.49
103	1343.	255.2	238.7	100.1	98.7	22.45
104	1344.	253.7	236.5	101.6	100.2	28.65
105	1345.	248.8	232.1	100.4	99.3	33.51
106	1346.	248.6	229.7	100.7	99.2	40.00
107	1347.	251.4	227.0	100.4	98.5	33.85
108	1348.	251.0	228.7	?	99.4	10.53
109	1349.	250.6	226.3	?	100.9	39.49
110	1350.	254.5	228.5	103.1	99.3	40.75
111	1351.	257.9	231.3	103.0	100.5	38.26
112	1352.	256.6	232.5	102.1	100.1	34.57
113	1353.	255.8	236.0	100.5	99.5	35.33
114	1354.	253.3	231.4	99.8	98.6	41.10
115	1355.	255.7	232.1	?	98.9	19.72
116	1356.	253.8	234.0	?	101.7	30.09
117	1357.	257.7	232.1	101.7	101.2	39.92
118	1358.	255.6	232.8	102.1	101.0	39.30
119	1359.	259.6	234.8	?	99.9	19.45
120	1400.	263.7	236.2	?	100.3	43.05
121	1401.	263.9	238.9	102.2	99.9	37.25
122	1402.	262.5	238.1	102.6	99.8	31.55
123	1403.	258.8	238.8	?	101.0	10.00
124	1404.	255.6	236.7	?	100.3	29.09
125	1405.	255.2	232.9	100.7	99.6	46.81
126	1406.	258.3	233.0	100.3	99.5	39.93
127	1407.	258.5	234.4	99.3	99.0	40.95

Day 3
M60 Tank No. 1, OE/HDO-15/40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
128	1408.	257.2	236.6	99.8	99.8	18.30
129	1409.	251.1	233.3	?	100.9	10.59
130	1410.	248.5	231.2	?	100.8	10.82
131	1411.	246.0	228.4	?	102.0	11.22
132	1412.	243.0	225.4	?	102.2	11.52
133	1413.	239.9	222.1	?	102.1	11.93
134	1414.	236.8	218.9	?	101.8	12.40
135	1415.	233.6	215.4	?	100.3	12.78
136	1416.	230.9	211.9	?	99.5	13.22
137	1417.	228.3	208.7	?	99.6	13.68
138	1418.	225.4	205.5	?	99.7	14.17
139	1419.	222.2	202.4	?	99.1	14.63
140	1420.	218.6	199.5	?	99.3	15.09
141	1421.	215.1	196.7	?	99.6	15.60
142	1422.	211.6	193.9	?	99.5	16.13
143	1423.	208.2	191.4	99.2	99.8	16.56
144	1424.	204.9	188.7	99.0	99.9	17.14
145	1425.	202.0	186.3	98.8	99.4	17.42
146	1426.	199.1	184.1	98.6	99.7	17.98
147	1427.	202.8	182.7	99.7	99.6	49.02
148	1428.	207.7	190.0	100.7	99.6	49.59
149	1429.	214.6	192.9	99.5	98.5	50.80
150	1430.	219.9	196.7	100.0	98.3	41.53
151	1431.	228.7	202.2	99.9	98.5	44.88
152	1432.	229.8	207.1	?	98.9	39.68
153	1433.	232.6	213.2	?	98.7	16.69
154	1434.	240.0	214.7	?	99.2	45.69
155	1435.	240.4	217.6	?	99.1	37.81
156	1436.	244.1	220.3	99.6	99.3	36.45
157	1437.	250.0	222.9	99.8	99.5	41.81
158	1438.	250.4	230.5	99.8	99.8	37.77
159	1439.	248.4	231.5	100.0	99.8	36.75
160	1440.	250.4	228.9	100.1	100.1	29.19
161	1441.	252.7	229.6	101.2	100.2	23.53
162	1442.	248.3	231.0	100.8	99.8	34.87
163	1443.	249.7	229.8	100.8	99.8	41.97
164	1444.	247.0	230.7	102.3	100.4	29.57
165	1445.	247.5	227.3	?	101.1	15.64
166	1446.	248.1	227.8	?	101.2	10.67
167	1447.	245.7	224.8	?	101.8	12.66
168	1448.	243.2	227.1	?	104.8	17.53
169	1449.	241.4	223.6	?	102.1	11.55
170	1450.	237.8	221.8	?	102.0	11.96
171	1451.	236.6	215.9	?	100.5	38.31

Day 3
M60 Tank No. 2, SAE-50 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
56	1256.	126.7	135.3	?	95.5	39.80
57	1257.	136.7	137.1	101.9	94.4	39.15
58	1258.	135.9	139.7	101.0	94.7	38.41
59	1259.	141.0	140.5	101.2	94.8	37.50
60	1300.	154.6	145.2	101.5	95.1	57.77
61	1301.	?	149.8	101.0	94.9	58.85
62	1302.	?	152.8	101.3	95.1	60.17
63	1303.	?	153.8	101.3	94.6	27.70
64	1304.	?	156.2	101.5	94.3	57.29
65	1305.	?	160.9	100.8	94.4	57.60
66	1306.	?	167.2	100.4	94.3	56.87
67	1307.	?	173.7	101.0	95.3	59.33
68	1308.	?	177.4	100.8	94.5	24.45
69	1309.	?	182.4	100.1	94.5	56.76
70	1310.	?	187.7	99.2	94.6	51.41
71	1311.	?	188.6	98.8	94.7	55.67
72	1312.	?	190.8	98.6	94.4	56.22
73	1313.	?	195.3	98.5	94.2	55.43
74	1314.	?	198.9	99.2	94.8	44.13
75	1315.	?	199.3	99.7	94.8	46.45
76	1316.	?	198.4	99.3	94.7	47.82
77	1317.	?	200.4	99.7	95.3	52.64
78	1318.	?	202.2	99.7	95.0	51.15
79	1319.	?	204.0	99.3	94.6	53.29
80	1320.	?	205.1	99.2	94.9	45.80
81	1321.	?	208.3	99.8	95.6	45.12
82	1322.	?	208.7	101.1	96.8	46.84
83	1323.	?	212.1	102.0	97.2	51.62
84	1324.	?	212.8	102.3	96.6	51.09
85	1325.	?	214.5	102.4	96.8	46.40
86	1326.	?	216.3	102.5	97.1	45.79
87	1327.	?	216.0	?	98.3	12.16
88	1328.	?	215.2	?	96.6	34.17
89	1329.	?	218.5	99.8	96.8	53.28
90	1330.	?	217.8	99.1	96.0	48.86
91	1331.	?	217.0	98.9	96.1	48.59
92	1332.	?	220.9	99.3	96.4	44.56
93	1333.	?	222.1	99.6	96.8	43.89
94	1334.	?	222.5	100.1	97.0	50.36
95	1335.	?	222.7	100.4	96.4	50.13

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (^{o}F) - 32 by 5/9.
Oil pressure is in psig.

Day 3
M60 Tank No. 2, SAE-50 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
96	1336.	?	222.9	99.1	96.1	45.73
97	1337.	?	222.8	98.7	96.2	44.23
98	1338.	?	224.8	?	95.9	14.76
99	1339.	?	225.5	?	96.6	45.37
100	1340.	?	225.6	99.2	96.4	42.81
101	1341.	?	224.9	98.6	96.5	48.99
102	1342.	?	227.0	98.5	96.5	44.00
103	1343.	?	227.2	?	96.9	10.66
104	1344.	?	226.1	?	97.1	28.36
105	1345.	?	224.5	101.1	97.4	38.73
106	1346.	?	216.5	99.7	97.5	51.88
107	1347.	?	218.3	101.1	98.1	44.21
108	1348.	?	217.3	99.8	97.5	42.50
109	1349.	?	217.8	?	98.0	12.07
110	1350.	?	216.6	?	98.6	12.42
111	1351.	?	216.4	?	98.2	49.88
112	1352.	?	218.1	101.1	97.7	47.71
113	1353.	?	221.1	101.3	98.3	44.94
114	1354.	?	220.9	100.4	97.8	46.21
115	1355.	?	222.8	99.3	97.4	43.87
116	1356.	?	224.3	99.5	97.6	43.11
117	1357.	?	224.5	101.2	98.4	35.59
118	1358.	?	222.2	101.7	97.9	45.98
119	1359.	?	222.5	100.7	97.8	45.00
120	1400.	?	224.9	101.1	98.1	42.87
121	1401.	?	226.7	101.8	98.6	43.61
122	1402.	?	229.8	102.6	99.4	46.18
123	1403.	?	229.4	102.1	98.1	39.71
124	1404.	?	231.0	102.0	98.6	39.17
125	1405.	?	230.9	100.6	98.0	21.17
126	1406.	?	229.1	100.2	98.1	39.93
127	1407.	?	230.7	99.7	98.0	35.37
128	1408.	?	230.2	99.7	97.9	40.52
129	1409.	?	227.9	100.3	98.6	33.01
130	1410.	?	228.3	?	98.9	10.94
131	1411.	?	225.3	?	99.4	11.37
132	1412.	?	222.3	?	99.9	11.72
133	1413.	?	218.8	?	100.3	12.11
134	1414.	?	215.4	?	100.3	12.51
135	1415.	?	211.9	?	100.3	13.07
136	1416.	?	208.4	?	100.5	13.62
137	1417.	?	204.9	?	100.3	14.17
138	1418.	?	201.4	?	100.4	14.78
139	1419.	?	198.1	?	100.3	15.34
140	1420.	?	195.0	?	100.4	16.01

Day 3
M60 Tank No. 2, SAE-50 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
141	1421.	?	191.5	?	100.0	16.64
142	1422.	?	189.0	?	100.6	17.22
143	1423.	?	186.1	?	100.7	17.86
144	1424.	?	183.5	?	100.6	18.54
145	1425.	?	180.8	?	100.2	19.17
146	1426.	?	179.0	?	100.3	49.55
147	1427.	?	179.0	100.6	98.8	57.46
148	1428.	?	185.7	99.9	98.2	50.64
149	1429.	?	189.1	99.5	97.8	47.07
150	1430.	?	193.6	99.9	98.2	53.54
151	1431.	?	198.4	100.6	98.6	44.02
152	1432.	?	203.6	100.8	98.7	46.30
153	1433.	?	203.9	100.4	98.4	24.58
154	1434.	?	207.7	100.3	98.7	48.46
155	1435.	?	210.1	99.4	98.2	49.20
156	1436.	?	213.4	99.5	98.2	48.75
157	1437.	?	216.1	99.8	98.4	48.61
158	1438.	?	217.6	99.3	98.3	30.51
159	1439.	?	218.8	99.2	98.2	48.40
160	1440.	?	219.9	99.1	98.2	45.39
161	1441.	?	220.7	?	98 9	13.49
162	1442.	?	219.1	?	99.9	12.13
163	1443.	?	216.4	?	99.9	12.51
164	1444.	?	209.7	?	99.9	12.99
165	1445.	?	211.3	?	99.8	48.89
166	1446.	?	210.3	?	99.1	11.61
167	1447.	?	206.7	?	100.5	49.97
168	1448.	?	208.2	103.9	101.9	35.88
169	1449.	?	205.7	?	100.3	14.11
170	1450.	?	203.0	?	100.3	29.84
171	1451.	?	200.4	?	101.1	15.05
172	1452.	?	197.9	?	101.3	15.52
173	1453.	?	195.6	?	103.8	16.02
174	1454.	?	193.4	?	102.8	16.45
175	1455.	?	190.3	?	102.7	16.95

Day 3
M60 Tank No. 3, OE/HDO-40 Lubricant

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
56	1256.	116.1	121.4	?	92.0	25.45
57	1257.	123.8	128.8	101.2	90.6	29.75
58	1258.	122.6	132.5	100.5	91.1	30.86
59	1259.	127.1	134.9	101.7	91.5	24.52
60	1300.	140.8	142.6	102.6	92.1	37.70
61	1301.	160.1	154.7	103.1	93.2	28.68
62	1302.	149.4	160.9	102.9	92.9	25.37
63	1303.	155.7	165.5	103.1	92.2	25.70
64	1304.	171.3	169.2	103.1	91.7	30.86
65	1305.	179.0	175.2	103.3	93.3	32.03
66	1306.	194.0	184.0	103.3	92.8	35.88
67	1307.	199.8	191.1	103.3	92.8	38.59
68	1308.	210.0	195.5	?	92.3	18.78
69	1309.	214.8	199.5	?	93.5	45.20
70	1310.	221.2	202.2	102.0	93.6	27.54
71	1311.	226.8	205.0	101.2	94.1	29.37
72	1312.	232.0	208.5	101.2	93.9	28.50
73	1313.	236.0	211.7	101.1	94.0	30.52
74	1314.	235.4	213.8	101.4	94.6	29.57
75	1315.	236.5	216.0	101.3	94.5	33.13
76	1316.	240.1	215.3	101.2	92.7	29.91
77	1317.	239.3	218.7	101.1	93.8	36.58
78	1318.	243.5	218.0	101.1	93.4	31.38
79	1319.	245.7	221.0	101.0	93.8	24.75
80	1320.	250.3	222.5	101.7	93.7	35.93
81	1321.	247.9	222.4	102.4	94.5	33.48
82	1322.	249.9	224.4	103.0	94.4	33.15
83	1323.	252.1	226.0	103.5	95.4	33.09
84	1324.	247.0	228.0	103.8	94.6	27.60
85	1325.	253.6	228.4	103.5	94.5	31.08
86	1326.	235.6	234.4	?	94.9	10.41
87	1327.	241.6	234.2	?	95.0	9.76
88	1328.	249.9	227.2	?	94.3	33.13
89	1329.	256.5	227.7	102.9	94.7	39.10
90	1330.	256.4	229.0	102.8	94.6	34.90
91	1331.	258.8	230.7	102.8	94.2	21.41
92	1332.	258.1	231.0	102.8	94.3	21.70
93	1333.	266.2	233.9	102.9	95.3	23.13
94	1334.	266.2	236.4	103.1	94.9	29.08
95	1335.	267.3	238.6	102.7	95.0	24.19

Notes: Min in column 1 indicates minutes past noon on the day of each test.
Time is in military format.
All temperatures are degrees Fahrenheit. To convert to degrees Centrigrade, multiply temperature (°F) - 32 by 5/9.
Oil pressure is in psig.

Day 3
M60 Tank No. 3, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
96	1336.	274.3	241.1	101.9	94.7	36.06
97	1337.	250.7	245.5	?	96.1	8.72
98	1338.	257.2	243.3	?	96.6	8.38
99	1339.	261.0	237.1	?	96.5	25.23
100	1340.	261.8	234.4	102.6	95.0	31.69
101	1341.	265.2	236.5	102.4	95.2	21.63
102	1342.	264.3	237.3	102.3	95.1	31.19
103	1343.	260.1	238.8	103.0	95.7	24.40
104	1344.	257.8	234.3	?	96.6	10.52
105	1345.	256.2	233.2	?	96.1	28.80
106	1346.	243.5	231.9	102.4	96.3	20.09
107	1347.	253.2	231.4	103.4	97.0	30.75
108	1348.	254.7	231.4	103.4	96.2	26.44
109	1349.	252.3	231.6	104.1	98.1	29.23
110	1350.	253.9	229.6	104.9	97.4	32.43
111	1351.	253.2	231.2	105.3	97.1	35.57
112	1352.	258.1	234.9	105.2	97.1	28.06
113	1353.	251.9	232.8	103.6	97.2	28.43
114	1354.	257.8	233.9	103.3	96.5	30.72
115	1355.	256.4	234.4	103.2	96.1	29.89
116	1356.	250.6	238.2	?	98.6	9.75
117	1357.	255.6	232.2	?	98.3	32.09
118	1358.	257.3	233.8	105.1	98.6	30.77
119	1359.	260.5	235.0	104.7	97.8	31.46
120	1400.	261.8	236.2	104.8	97.8	29.16
121	1401.	265.6	237.4	104.9	98.1	36.10
122	1402.	263.3	237.8	105.1	97.3	26.83
123	1403.	241.2	244.4	?	99.8	8.78
124	1404.	254.2	242.3	?	100.4	8.10
125	1405.	257.8	235.7	?	98.2	25.70
126	1406.	259.2	234.8	104.6	97.7	29.18
127	1407.	260.3	234.5	104.0	97.4	32.73
128	1408.	262.8	234.5	103.2	97.3	33.89
129	1409.	248.4	240.0	?	98.9	9.75
130	1410.	251.4	237.6	?	99.1	10.02
131	1411.	247.7	235.1	?	99.2	10.10
132	1412.	244.4	232.0	?	99.1	10.40
133	1413.	240.4	228.9	?	99.9	10.78
134	1414.	236.8	225.5	?	99.4	11.20
135	1415.	233.2	222.3	?	99.9	11.57
136	1416.	230.0	219.1	?	99.5	11.93
137	1417.	226.3	216.0	?	99.1	12.30
138	1418.	223.1	213.0	?	99.0	12.78
139	1419.	219.8	210.0	?	98.5	13.33
140	1420.	216.7	207.3	?	99.2	13.68

Day 3
M60 Tank No. 3, OE/HDO-40 Lubricant (Cont'd)

Min	Time	Sump Temp	Gallery Temp	Amb. Temp	Compart-ment Temp	Oil Pressure
141	1421.	213.9	204.7	?	98.9	14.15
142	1422.	210.9	202.2	?	99.0	14.65
143	1423.	208.2	199.7	?	98.8	15.14
144	1424.	205.4	197.4	?	99.0	15.66
145	1425.	202.8	195.2	?	99.3	16.20
146	1426.	202.8	191.9	?	100.3	34.66
147	1427.	207.5	193.3	99.5	98.3	34.86
148	1428.	217.3	199.7	101.5	99.0	28.45
149	1429.	219.1	204.1	102.1	97.5	30.55
150	1430.	226.3	207.4	102.6	97.5	32.23
151	1431.	228.5	211.5	102.9	97.5	32.64
152	1432.	238.4	214.9	103.1	97.4	22.15
153	1433.	240.7	217.4	103.4	97.6	21.18
154	1434.	245.6	220.7	103.3	97.2	30.67
155	1435.	247.6	224.1	103.2	97.2	32.87
156	1436.	248.5	226.7	103.3	97.3	26.55
157	1437.	249.7	229.7	103.5	97.3	30.22
158	1438.	245.9	229.8	103.6	97.7	21.04
159	1439.	253.3	231.4	104.1	98.4	20.01
160	1440.	256.2	231.6	103.9	97.5	29.36
161	1441.	240.5	236.0	?	98.2	9.88
162	1442.	247.1	236.3	?	99.1	9.86
163	1443.	246.8	234.3	?	99.6	10.08
164	1444.	245.9	231.5	?	98.5	10.35
165	1445.	244.1	224.6	?	98.6	18.77
166	1446.	244.5	222.9	?	98.7	27.69
167	1447.	243.3	223.2	104.7	101.1	22.71
168	1448.	239.7	224.3	?	103.2	13.80
169	1449.	235.3	224.3	?	100.6	10.27
170	1450.	236.6	220.5	?	100.1	12.92
171	1451.	234.5	216.5	?	99.7	29.50

APPENDIX B

Lubricant Analyses

Lubricant Analyses

AL-No.	Description	XRF Fe, ppm	XRF Ca, %	XRF P, %	XRF Zn, %	XRF S, %	D 445 K. Vis., 100°C, cSt	ICP Analyses, ppm Fe	Cr	Pb	Cu	Sn	Al	Ni	Si	B	Mo	Mg	P	Zn	Ca
16544-L	OE/HDO-15/40 New	<10	0.12	0.12	0.13	0.65	13.43	3	1	<1	<1	<1	<1	<1	9	95	<1	549	1201	1425	1425
16545-L	OE/HDO-40 New	<10	ND	0.11	0.10	0.72	15.04	4	1	8	1	1	<1	<1	5	168	<1	1823	1044	1202	22
16546-L	SAE-50 New	<10	0.14	0.14	0.14	0.48	21.12	3	<1	1	<1	<1	<1	<1	8	<1	11	409	1260	1359	1409
16547-L	SAE-50 Existent V1D0*	47	<0.01	0.12	0.11	0.55	19.84	50	2	12	13	<1	5	3	29	6	<1	1261	1015	1177	115
16548-L	SAE-50 Existent V2D0	37	0.01	0.11	0.12	0.51	18.79	39	2	10	8	2	3	2	9	5	1	1140	1019	1197	234
16549-L	SAE-50 Existent V3D0	90	0.01	0.01	0.11	0.55	21.21	100	4	24	18	<1	18	8	32	7	4	1197	1036	1266	227
16550-L	SAE-50 Warm Up V1D1	25	0.09	0.13	0.13	0.46	20.43	17	<1	8	3	<1	<1	3	17	1	6	655	1170	1315	1007
16551-L	OE/HDO-40 Warm Up V2D1	12	<0.01	0.10	0.11	0.62	15.68	14	<1	1	3	<1	<1	2	9	116	<1	1553	1023	1204	101
16552-L	OE/HDO-15/40 Warm Up V3D1	30	0.01	0.11	0.13	0.59	15.00	28	<1	9	4	<1	4	3	18	71	<1	670	1140	1351	1139
16553-L	SAE-50 Drain V1D1	19	0.09	0.11	0.13	0.49	20.92	21	<1	3	4	<1	1	2	11	1	7	641	1174	1334	1031
16554-L	OE/HDO-40 Drain V2D1	35	<0.01	0.10	0.11	0.61	16.15	23	<1	7	4	<1	2	3	11	108	<1	1518	1031	1166	131
16555-L	OE/HDO-15/40 Drain V3D1	30	0.10	0.11	0.12	0.60	15.05	34	1	14	5	<1	3	1	21	69	<1	702	1173	1360	1114
16556-L	OE/HDO-40 Drain V1D2	33	0.02	0.10	0.11	0.60	16.96	22	<1	<1	3	<1	<1	1	26	96	3	1281	1088	1240	427
16557-L	OE/HDO-15/40 Drain V2D2	20	0.08	0.12	0.13	0.66	14.11	19	<1	2	2	2	1	<1	10	97	<1	930	1115	1327	895
16558-L	SAE-50 Drain V3D2	30	0.11	0.12	0.13	0.55	17.14	30	1	<1	4	<1	4	<1	14	39	5	580	1208	1367	1212
16559-L	OE/HDO-15/40 Drain V1D3	20	0.11	0.12	0.13	0.64	14.30	12	<1	<1	2	<1	2	<1	13	93	<1	764	1146	1363	1106
16560-L	SAE-50 Drain V2D3	19	0.11	0.13	0.13	0.57	16.96	15	<1	<1	2	<1	<1	<1	9	49	6	667	1182	1329	1149
16561-L	OE/HDO-40 Drain V3D3	27	0.06	0.08	0.13	0.60	17.06	21	<1	9	3	<1	1	<1	10	75	2	985	1160	1267	801

* V indicates vehicle number and D indicates day of test sequence.

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