

MICROCOPY RESOLUTION TEST CHART

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HEADQUARTERS STRATEGIC AIR COMMAND
Directorate of Aircraft Maintenance
Aircraft Engineering Division

Engineering Report No. P-344

SCAVENGING ENGINE OIL PUMPS FOR OIL SERVICE - J57 AND TF33 SERIES ENGINES

26 JUN 1980

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APPROVED: Specific action by organizations or units will not be taken as a result of this report unless requested by HQ SAC under separate cover.

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1. **PURPOSE:** This report describes a study of the use of a timed starter operation (in lieu of engine operation) to validate engine oil service, an/or to empty a full N2 gearbox.

2. **FOREWORD:** Between 1973 and 1975 approximately 50% of the engine in-flight shutdowns was attributed to oil system problems. HQ SAC/LGME investigations led to improved technical order procedures for servicing and maintaining the oil systems. One major problem was drain down of oil from the oil tank into the engine between the basic post-flight (BPO) check and the next flight. Oil leaked into, and filled the N2 gearbox and subsequently drained overboard, depleting the oil supply available for the next flight. The problem was found to be particularly significant on B-52D and B-52H aircraft. Therefore, preflight cold oil checks were made mandatory on these aircraft if more than 72 hours had elapsed since the BPO oil check. Engine operation is presently required when oil level is below specified minimum on the preflight cold oil check to scavenge oil from the N2 gearbox before servicing. This consumes fuel, adds turbine cycles and requires engine-run qualified personnel to perform the tasks. If timed starter operation can scavenge all oil from the N2 gearbox and sumps considerable savings can be realized. Such a procedure has been developed, and B-52 and -135 tests have demonstrated its effectiveness.

3. **CONCLUSIONS:** Timed starter operation for validating oil service, performing pre-flight cold oil checks or scavenging oil from a full N2 gearbox has been field-tested and shown to be viable and cost effective.

4. **RECOMMENDATIONS:**

a. HQ SAC/LGME recommends that the applicable technical orders be changed to authorize use of the timed starter operation for checking oil service, performing pre-flight cold oil checks or scavenging oil from a full N2 gearbox. (AFTO Form 22 action has been initiated by this office. See Atch 15 for a list of affected technical orders.)

b. Recommend use of a two minute interval for the timed starter operation for B-52D, G,H, and EC/RC/KC-135A aircraft.

c. Recommend other commands consider the use of timed starter operation in lieu of engine operation to validate oil service, and scavenge oil from full gearboxes and sumps on their possessed aircraft.

5. **DISCUSSION:**

a. An adequate quantity of oil in the engine oil tanks at takeoff is essential for successful mission accomplishment. Static oil leakage occurring between the basic postflight and the next flight can fill up the N2 gearbox to a point where it drains overboard onto the ramp. This condition can deplete all or part of the engine oil supply. HQ SAC/LGME previously investigated this problem under test plan P-285, Oil Quantity in Engine Tanks at Takeoff. This test showed that a significant number of in-flight shutdowns occurred as a direct result of oil losses between flights. During the June 77 to Sep 78 test, 25.3% of the B-52D and 15.7% of the B-52H aircraft required oil service prior to takeoff due to static oil leakage. To remedy this situation pre-flight cold oil checks are now required on

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Static oil drain-down occurring between the postflight inspection and next flight can fill the N ₂ oil pump and accessory housing on J57 and TF33 jet engines to a point where it drains overboard on the ramp. This can deplete the oil supply, resulting in launching of aircraft with less than full oil quantity. The purpose of this test was to evaluate a method of turning over an engine with the starter to rotate the gear type oil pumps and scavenge oil back to the tank. For testing the N ₂ gearboxes were filled to their maximum capacity with oil. The engines were then motored with the starter for two minutes and checked for residual oil quantities.			

B-52D and B-52H aircraft if more than 72 hours have elapsed since the last oil service check. Technical data directs that an engine must be operated for an oil service check if more than 30 minutes have elapsed since engine shutdown on -135 and 1 hour on B-52 aircraft. With the ever increasing cost of fuel, the growing manpower shortage and the need to extend engine life, a less costly method to check oil service is needed. While conducting test P-285 a technique of scavenging oil from a full N2 gearbox using a timed starter operation in lieu of operating the engine was developed and demonstrated. Starter RPM proved high enough to operate the scavenge pumps effectively, returning the oil in the gearbox back to the tank. Residual oil levels in the N2 gearbox were minimal, well within acceptable limits. Starter operation times were less than, or equal to the two minute (maximum time limit) allowed by technical orders for each aircraft type (See references below):

1B-52D-2-7-1,	B-52D Aircraft	J57-19W/-29W Engine
1B-52G-2-7JG-1	B-52G Aircraft	J57-43WB Engine
1B-52H-2-7JG-1	B-52H Aircraft	TF33-P3 Engine
1C-135(K)A-2-4-1	KC-135A Aircraft	J57-59W Engine
1C-135B-2-4	RC-135 Aircraft	TF33-P5 Engine
1C-135(E)C-2-4-1	EC-135 Aircraft	TF33-P9 Engine

b. On 6 Feb 1979, HQ SAC/LGME coordinated with OC-ALC/MMSRHA/MMSRKA on conducting a formal test on all -135 and B-52 aircraft engines. OC-ALC noted that as long as the two minute time limit was not exceeded the timed starter technique was acceptable and should not result in any significant degradation in starter reliability. HQ SAC/LGME formally initiated Project P-344-T-1, Scavenging Engine Oil Sumps for Oil Service - J57 and TF33 Series Engines, on 12 Feb 1979.

c. The engine oil scavenge pumping system consists of a #1 bearing scavenge pump, #2 and #3 bearing combination scavenge and main pressure pump, #4 and #5 bearing scavenge pump and a #6 bearing scavenge pump. The pumps are positive displacement gear type pumps which will effectively scavenge oil when engine rotation exceeds 12%. The starter alone turns the engines at RPMs 16-29%. Therefore starter operation is effective in scavenging oil. Engine operation is not necessary.

d. HQ SAC/LGME and OC-ALC/MAEPRG conducted a series of tests on N2 gearboxes at OC-ALC from 25 April through 5 May 1979. The test included N2 gearboxes for all series of -135 and B-52 aircraft engines. Using the BAUER Model BEI 3649 test stand the test was designed to determine the following:

- (1) The volumetric capacity of each type N2 gearbox.
- (2) The oil scavenging characteristics of each type gearbox (amount of oil scavenged during the timed test period).
- (3) Length of starter operating time required to sufficiently scavenge oil from a full N2 gearbox.

e. N2 gearbox oil capacities were determined by filling the N2 gearbox until oil drained overboard from the overboard vent. The oil was then drained and measured. Oil capacities were:

TF33-P3, P5, P9	10.5 quarts
J57-43WB/-59W	11.5 quarts
J57-19W/-29W	*5.5 quarts

*NOTE: The J57-19W/-29W N2 gearbox capacity is only 5.5 quarts but another 6.5 quarts is trapped above the N2 gearbox before draining overboard through the automatic overboard oil drain valve.

Oil scavenging characteristics were varied among the different types of gearboxes. Residual oil levels were dependent on length of operating time, and starter speeds. Overall test results were favorable. (See Atch 1). The TF33 gearboxes required a longer period of starter operation to scavenge oil sufficiently but were within the two minute time limit. The depot tests only involved the N2 gearbox. Therefore, scavenging oil with the complete system on in-service engines could require increased starter operating times plus leave larger residual oil amounts. Field testing was required to validate the concept.

f. HQ SAC/LGME released test plan P-344-T-1 to twenty bases on 11 July 1979. Each base was scheduled to perform a predetermined number of oil scavenging tests depending on the type of engines to be tested. This was based on the results of the OC-ALC tests. See Atch 2. Engines were to be selected from two categories:

(1) An engine located on the flightline with the N2 gearbox full of oil and leaking overboard onto the ramp.

(2) An engine on test cell with the N2 gearbox "force fed" by maintenance personnel until oil drains from the overboard vent. Due to the physical design of each oil system, specific instructions were provided for each engine. See Atch 3 for specific instructions. On 13 Aug 1979 HQ SAC/LGME issued a change to test plan P-344-T-1 listing an improved procedure for accomplishing the test on J57-43WB/-59W engines. See Atch 4. Results from each test were recorded on test forms provided with each test plan. See Atch 5 for sample form. Of particular interest was the type of air start cart used, the unit's air pressure output, the duration of the test, recorded starter RPM's observed at various time intervals and residual oil levels upon completion of the test.

g. 180 engines were scheduled for testing and a total of 150 were completed. Thirty tests were cancelled because testing showed that residual levels on 100% of these engines were within established limits. See Atch 6 for residual oil levels. Data obtained during tests were analyzed to determine the probability values associated with the residual oil levels. Reference Atch 7, part 1, for a summary of the results. In all cases less than two minutes of starter operation were sufficient to scavenge enough oil from a full gearbox to prevent a subsequent over-service oil condition. Pneumatic pressure output from air start carts (M32A-60A/MAIA) provided enough air to rotate the engine oil pumps with sufficient RPM's (minimum 12%) to scavenge oil to desirable residual levels. For all tests, starters reached approximately 80% of their maximum obtainable RPM within the first 30 seconds of operation. See Atch 7 Part 2. The data indicates that starter operation times of 60-90 seconds were sufficient for adequate scavenging. However to minimize possible confusion and to increase confidence that scavenging is complete, two minutes (120 seconds) starter operation was selected for all aircraft.

h. The oil systems for each type of engine although similar in function are considerably different in construction and oil storage capacity. Normally after engine operation or within 30 minutes (-135) and 1 hour (B-52) from engine shutdown, oil is serviced to the lower lip of the filler neck. To adopt the starter operating technique for checking oil service a new simplified procedure was adopted. This new procedure is necessary because the oil would be cold after a timed-starter operation. Therefore additional expansion space is necessary. This procedure involves use of a visual reference point in the oil tank (bottom of the oil tank screen for B-52G, H, KC/RC/EC-135 aircraft and approximately 1/4 inch over tank saddle B-52D), while taking into account the possible residual oil in the N2 gearbox, and thermal expansion of the oil after engine start. A formula was devised to figure the "maximum mission duration obtainable" based on the cold oil servicing technique and the available oil for mission requirements. (see Atch 8). Note that the oil quantity in Block 7 is the amount available to figure the maximum mission duration obtainable when you divide that figure by the oil consumption rate (2.0, 1.5, 1.0, and .5) quarts of oil respectively. See the following attachments for data on the particular oil systems:

Atch	Aircraft
8	Data on all aircraft
9	B-52D
10	B-52G
11	B-52H
12	KC-135A
13	RC-135
14	EC-135

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TESTING RESULTS - N2 GEARBOX OIL SCAVENGING TESTS CONDUCTED AT OC-ALC/MAE PRG
TINKER AFB OK, 29 APR/5 MAY 79.

(Time interval versus remaining residual oil in N2 gearbox)

	J57-19W/-29W (1.0 minute time interval)					
	Test #					
Remaining Residual Oil	1 16 oz	2 10 oz	3 17 oz	4 14 oz		
	J57-19W/-29W (1.5 minute time interval)					
	Test #					
Remaining Residual Oil	1 8 oz	2 6 oz	3 9 oz	4 4 oz		
	J57-43WB/-59W (1.5 minute time interval)					
	Test #					
Remaining Residual Oil	1 9 oz	2 22 oz	3 20 Oz	4 19 oz	5 28 oz	6 25 oz
	J-57-43WB/-59W (2.0 minute time interval)					
	Test#					
Remaining Residual Oil	1 12 oz	2 18 oz	3 19 oz	4 16 oz	5 19 oz	6 160z
	TF-33-P3-P5-P9 (2.0 minute time interval)					
	Test #					
Remaining Residual Oil	1 8 oz	2 11 oz	3 10 oz	4 10 oz	5 10 Oz	6 10 oz
	Test #					
Remaining Residual Oil	7 10 oz	8 10 oz	9 12 oz	10 12 oz	11 12 oz	12 12 oz
	Test #					
Remaining Residual Oil	13 12 oz	14 14 oz	15 14 oz	16 12 oz	17 8 oz	18 6 oz
	Test #					
Remaining Residual Oil	19 6 oz	20 8 oz				

NOTE: DURING TESTING OF TF-33 GEARBOXES SCAVENGE PRESSURE DID NOT "DROP OFF" UNTIL APPROXIMATELY 1 MINUTE, 45 SECONDS, THEREFORE, THE 2 MINUTE TIME LIMIT WAS SELECTED.

PROJECT P-344 N₂ GEARBOX OIL SCAVENGING, (TEST BASES, TEST
 QUANTITIES AND TEST TIME INTERVALS) DESIGNATION

B-52D J57-19W/-29W	<u>Base</u>	<u>Time Interval</u>	<u>Quantity</u>
	Dyess AFB	60 Seconds	10
	Carswell AFB	60 Seconds	10
	March AFB	60 Seconds	10
B-52G J57-43WB	<u>Base</u>	<u>Time Interval</u>	<u>Quantity</u>
	Barksdale AFB	90 Seconds	10
	Griffiss AFB	90 Seconds	8
	Robins AFB	90 Seconds	8
	Wurtsmith AFB	90 Seconds	8
	Fairchild AFB	90 Seconds	8
B-52H TF33-P3	<u>Base</u>	<u>Time Interval</u>	<u>Quantity</u>
	KI Sawyer AFB	105 Seconds	10
	Ellsworth AFB	105 Seconds	10
	Grand Forks AFB	105 Seconds	10
EC/RC-135 TF33-P5, P9	<u>Base</u>	<u>Time Interval</u>	<u>Quantity</u>
	Offutt AFB	105 Seconds	10
KC-135A J57-59W	<u>Base</u>	<u>Time Interval</u>	<u>Quantity</u>
	Altus AFB	90 Seconds	8
	Plattsburgh AFB	90 Seconds	8
	Castle AFB	90 Seconds	10
	Grissom AFB	90 Seconds	8
	Beale AFB	90 Seconds	8
Travis AFB	90 Seconds	8	

SPECIFIC INSTRUCTIONS FOR EACH SERIES ENGINE

J57-19/-29W: Oil system design makes it very difficult to "force fill" the gearbox. Therefore, only select engines that are full of oil and leaking overboard through the Automatic Drain Valve. Record pneumatic pressure output from start cart plus identify what type of start cart was used for starting power. Motor the engine for the time interval designated in Atch 1. NOTE: DO NOT TURN ON IGNITION. Motor engine with the starter only. During the timed starter cycle record starter RPMs at the time intervals (indicated on Atch 2, test form). Drain the gearbox and check for residual oil. Open drain valve assembly P/N 223795, measure the remaining oil quantity and record the amount on the test form. Residual oil should be no more than 2 quarts.

NOTE: If residual oil is greater than 2 quarts, do not reaccomplish the test.

If the first five test engines exceed the residual level, add 15 seconds to the next five test engines starter time interval. Close the drain valve assembly P/N 223795. Service the oil tank to approximately 1/2" over the oil tank saddle.

J57-43WB/-59W: If the engine N₂ gearbox is not already full and leaking overboard, disconnect the anti-siphon hose assembly P/N 316817 at the anti-siphon adapter P/N 323476. "Force fill" the N₂ gearbox through the top of the hose (using a small funnel). Approximately 11 to 12 quarts of oil will fill a gearbox. Watch for oil draining from the overboard breather tube P/N 69-1169 (J57-59W) and oil cooler duct P/N 35-21060-4 (RH) and 35-21060-501 (LH) on J57-43WB engines. Reconnect the anti-siphon hose P/N 316817. Record pneumatic pressure output from start cart plus identify what type of start cart was used for starting power. Motor the engine for the time interval designated in Atch 1. NOTE: DO NOT TURN ON IGNITION. Motor engine with the starter only. During the timed starter cycle record starter RPMs at the time intervals (indicated on test form, Atch 2). Drain the gearbox and check for residual oil. Remove the gearbox oil suction pump screen P/N 287712. Measure the remaining oil quantity and record the amount on the test form. Residual oil should be no more than 2 to 3 quarts for J57-43WB and 1 to 1.5 quarts for the J57-59W.

NOTE: If residual oil is greater than 3 quarts (J57-43WB), 1.5 quarts (J57-59W) repeat the test on the same engine and add 15 seconds to the starter time interval.

If residual oil levels are exceeded on the second test, perform a third test adding another 15 seconds, and record residual oil quantity.

Replace the packing P/N MS9388-214 on the oil suction pump screen P/N 287712 and reinstall in the N₂ gearbox. Service oil tank to a level where the oil is just visible² in the bottom of the perforated screen.

TF33-P3, -P5, -P9: If the engine N₂ gearbox is not already full and leaking overboard, remove the upper left hand gearbox cover pad P/N 389306. USING A SMALL FUNNEL, "force fill" the gearbox through the opening until oil drains from the overboard breather tube P/N 35-32564-1 (TF33-P3) or P/N 69-11100-1 (TF33-P5, -P9).

CAUTION: Use extreme care to prevent contamination of the oil system.

Approximately 10 to 11 quarts of oil will fill a gearbox. Install new gasket P/N 389619 and reinstall the cover pad P/N 389306. Record pneumatic pressure output from start cart plus identify what type of start cart was used for starting power. Motor the engine with the starter only. During the timed starter cycle record starter RPMs at the time intervals (indicated on test form Atch 2). Drain the gearbox and check for residual oil. Remove the oil drain plug P/N MS9015-08 from the 6 o'clock position of the gearbox rear cover plate. Measure the residual oil quantity and record the amount on the test form. Residual oil should be 1 to 1.5 quarts for the TF33-P3, and P9 engine, and 1.5 to 2 quarts for the TF33-P5 engine.

NOTE: If residual oil is greater than 1.5 quarts for the TF33-P3 and P9 and 2.0 quarts for the TF33-P5, reaccomplish the test and add 15 seconds to the starter time interval.

Replace the packing P/N MS9387-08 and reinstall the drain plug P/N MS9015-08. Service the oil tank to a level where the oil is just visible in the bottom of the screen.

SPECIFIC INSTRUCTIONS FOR EACH SERIES ENGINE

J57-19/-29W: Oil system design makes it very difficult to "force fill" the gearbox. Therefore, only select engines that are full of oil and leaking overboard through the Automatic Drain Valve. Record pneumatic pressure output from start cart plus identify what type of start cart was used for starting power. Motor the engine for the time interval designated in Atch 1. NOTE: DO NOT TURN ON IGNITION. Motor engine with the starter only. During the timed starter cycle record starter RPMs at the time intervals (indicated on Atch 2, test form). Drain the gearbox and check for residual oil. Open drain valve assembly P/N 223795, measure the remaining oil quantity and record the amount on the test form. Residual oil should be no more than 2 quarts.

NOTE: If residual oil is greater than 2 quarts, do not reaccomplish the test.

If the first five test engines exceed the residual level, add 15 seconds to the next five test engines starter time interval. Close the drain valve assembly P/N 223795. Service the oil tank to approximately $\frac{1}{2}$ " over the oil tank saddle.

J57-43WB/-59W: If the engine N₂ gearbox is not already full and leaking overboard, remove the full pump garloc seal drain line and install a No. 6 cap on the fuel pump drain fitting (to prevent oil draining overboard through the hole in the full pump shaft). Remove the short breather elbow P/N 265311 (oil tank to intermediate case) and "force fill" the N₂ gearbox through the breather opening in the intermediate case (using a small funnel). Approximately 12 to 13 quarts of oil are required to fill the gearbox system before oil will run overboard. Watch for oil draining from the overboard breather tube P/N 69-1169 (J57-59W) and the oil cooler duct P/N 35-21060-4 (RH) and 35-21060-501 (LH) (F57-43WB).

CAUTION: If the oil tank is full and you "force feed" the gearbox, drain from the oil tank a quantity of oil equal to that "force fed" into the gearbox.

Record the pneumatic pressure output from the start cart plus identify the type of start cart. Motor the engine for the time interval designated in Atch 1. NOTE: DO NOT TURN ON IGNITION. Motor the engine with the starter only. During the timed starter cycle record starter RPMs at the time intervals (indicated on test form, Atch 2). Drain the gearbox by removing the oil suction pump screen, P/N 287712 and check for residual oil. Measure the remaining oil quantity and record the amount on the test form. Residual oil should be no more than 2 to 3 quarts for J57-43WB and 1 to 1.5 quarts for J57-59W.

NOTE: If residual oil is greater than 3 quarts (J57-43WB), 1.5 quarts (J57-59W) repeat the test on the same engine and add 15 seconds to the starter time interval.

If residual oil levels are exceeded on the second test, perform a third test adding another 15 seconds, and record residual oil quantity.

Replace the packing P/N MS9388-214 on the oil suction pump screen P/N 287712 and reinstall in the N₂ gearbox. Replace the packings (4 ea) P/N MS 9388-211 on the breather ferrule P/N 265312, the packing P/N MS 9388-215 on the breather elbow P/N 265311, and reinstall the breather tube assembly. Remove the No. 6 cap from fuel pump fitting and reconnect the fuel pump drain line. Service the oil tank to a level where the oil is just visible in the bottom of the perforated screen.

Atch 4-1

N₂ GEARBOX OIL SCAVENGING TEST

BASE: _____ TEST EVALUATOR: _____ DATE: _____

ENGINE T/M/S: _____ ENGINE SERIAL #: _____ ENGINE HOURS: _____

CHECK ONE: Engine Installed on Aircraft _____. Mounted in test cell _____.

STARTER PNEUMATIC POWER PROVIDED BY: M32A-60A ____ MA1A ____ (check one).

PNEUMATIC PRESSURE OUTPUT OF START CART: M32A-60A ____ psi MA1A ____ psi .

NOTE: To ensure test is valid, N₂ gearbox must be full of oil and dripping overboard.

DURATION OF TEST: 60 - 75 - 90 - 105 - 120 seconds (circle one) (see Atch 1)

STARTER RPMs OBSERVED AT THE FOLLOWING TIME INTERVALS:

_____ 30 _____ 60 _____ 75 _____ 90 _____ 105 _____ 120 seconds

RESIDUAL OIL DRAINED FROM N₂ GEARBOX AT COMPLETION OF TIMED STARTER OPERATION:

_____ QUARTS _____ OUNCES

REMARKS:

N₂ GEARBOX OIL SCAVENGING TEST

BASE: _____ TEST EVALUATOR: _____ DATE: _____

ENGINE T/M/S: _____ ENGINE SERIAL #: _____ ENGINE HOURS: _____

CHECK ONE: Engine Installed on Aircraft _____. Mounted in test cell _____.

STARTER PNEUMATIC POWER PROVIDED BY: M32A-60A ____ MA1A ____ (check one).

PNEUMATIC PRESSURE OUTPUT OF START CART: M32A-60A ____ psi MA1A ____ psi .

NOTE: To ensure test is valid, N₂ gearbox must be full of oil and dripping overboard.

DURATION OF TEST: 60 - 75 - 90 - 105 - 120 seconds (circle one) (see Atch 1)

STARTER RPMs OBSERVED AT THE FOLLOWING TIME INTERVALS:

_____ 30 _____ 60 _____ 75 _____ 90 _____ 105 _____ 120 seconds

RESIDUAL OIL DRAINED FROM N₂ GEARBOX AT COMPLETION OF TIMED STARTER OPERATION:

_____ QUARTS _____ OUNCES

REMARKS:

QUANTITY OF ENGINE OIL SYSTEM SCAVENGING TEST CONDUCTED AT 20 SAC UNITS IAW
SAC/LGME TEST PLAN 344-T-1 (TIME INTERVAL VERSUS REMAINING RESIDUAL OIL)

(QUARTS OF RESIDUAL OIL)

	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
60 sec			1		2	3		1	B-52D
75 sec				3		2			J57-19W/-29
90 sec				5	9	4			*(4 qts)
90 sec	2	15	7	6					B-52G
									J57-43WB
									*(2 qts)
105 sec	2	15	9	4					B-52H
									TF33-P3
									*(2 qts)
90 sec		31	5	4					KC135A
									J57-59W
									*(1.5 qts)
105 sec		3	3						EC135
									TF33-P9
									*(2.0 qts)
105 sec			3	1					RC135
									TF33-P5
									*(2.0 qts)

KEY: * = Allowable residual oil level

NOTE: Approximately 1 qt of the residual oil quantity cannot be scavenged back to the main oil tank. This is the oil level that is between the bottom of the main oil pump gears and the N2 gearbox case drain. Therefore, actual residual oil levels will always be approximately 1 qt lower than than figures shown above.

90% CONFIDENCE STATEMENT FOR STARTER SCAVENGING OPERATION

After "T" seconds of starter operation, the probability is at least "P" percent that the main gearbox will contain no more than "Q" quarts of oil.

<u>AIRCRAFT TYPE</u>	<u>"T" (seconds)</u>	<u>P</u>	<u>Q</u>
B-52D	90	0	1.0
		3	1.5
		14	2.0
		60	2.5
		92	3.0
		98	3.5
B-52G	90	0	0.5
		40	1.0
		64	1.5
		88	2.0
		98	2.5
		99	3.0
B-52H/EC135/RC135	105	1	0.5
		42	1.0
		74	1.5
		97	2.0
		99	2.5
		KC-135	90
64	1.0		
78	1.5		
97	2.0		
99	2.5		

STARTER RPM/VERSES TIME

<u>TYPE ACFT</u>	<u>CLOCK TIME</u>	<u>AVG % RPM</u>	<u>% OF MAX RPM ATTAINABLE BY STARTER</u>
B-52D	30 sec	21	81
	60	25	96
	120	26	100
B-52G	30	15	83
	60	18	100
	120	18	100
B-52H	30	15	79
	60	18	95
	120	19	100
KC-135	30	17	85
	60	20	100
	120	20	100
RC-135	30	22	92
	60	23	96
	120	24	100
EC-135	30	22	96
	60	23	100
	120	23	100

OIL SYSTEM/MAXIMUM MISSION DURATION/OIL CONSUMPTION DATA CHART

ACFT	(1) FULL TANK TOTAL OIL VOLUME	(2) OIL VOLUME BETWEEN HOT & COLD OIL SERVICE	(3) COLD OIL SERVICE VOLUME	(4) COLD OIL SERVICE VOLUME EXPANSION WHEN HEATED	(5) COLD OIL SERVICE VOLUME PLUS EXPANSION VOLUME	(6) 20% MINIMUM OIL VOLUME	(7) OIL LEVEL USED TO FIGURE OIL CONSUMPTION DATA
B2D	64.0 qts	7.0 qts	57.0 qts	2.74 qts (at 120°C)	59.74 qts	11.95 qts	47.79 qts
B2C	35.0 qts	3.0 qts	32.0 qts	1.69 qts (at 132°C)	33.69 qts	6.74 qts	26.95 qts
B2H	40.92 qts	4.0 qts	36.92 qts	1.99 qts (at 135°C)	38.91 qts	7.78 qts	31.13 qts
B-135A	22.0 qts	2.0 qts	20.0 qts	.83 qt (at 104°C)	20.83 qts	4.17 qts	16.66 qts
B-135	23.76 qts	3.0 qts	20.76 qts	.83 qt (at 100°C)	21.59 qts	4.32 qts	17.27 qts
B-135	48.40 qts	4.0 qts	44.4 qts	1.776 qts (at 120°C)	46.176 qts	9.235 qts	36.941 qts

Maximum allowable residual oil levels: B-52D (4.0 qts), B-52G (2.0 qts), B-52H (2.0 qts), KC-135A (1.5 qts), KC-135 (2.0 qts), B-135 (2.0 qts)

2 gearbox oil capacity: *B-52D (12.0 qts), B-52G and KC-135A (11.5 qts), B-52H, RC-135 and EC-135 (10.5 qts). (Key: * = N2 gearbox traps 5.5 qts plus another 6.5 qts can be trapped between the gearbox and the overboard drain located 08:00 position on intermediate case).

DTE: In order to figure columns 3, 4, 5, 6, and 7 use the following formulas:

Column 3 = Col 1 minus col 2

Column 4 = Multiply col 3 times oil temp listed in () in col 4, time the coefficient of expansion for MIL-L-7808 oil (0.0004).

Column 5 = Col 3 plus col 4

Column 6 = Col 5 times 20%

Col 7 = Col 5 minus col 6

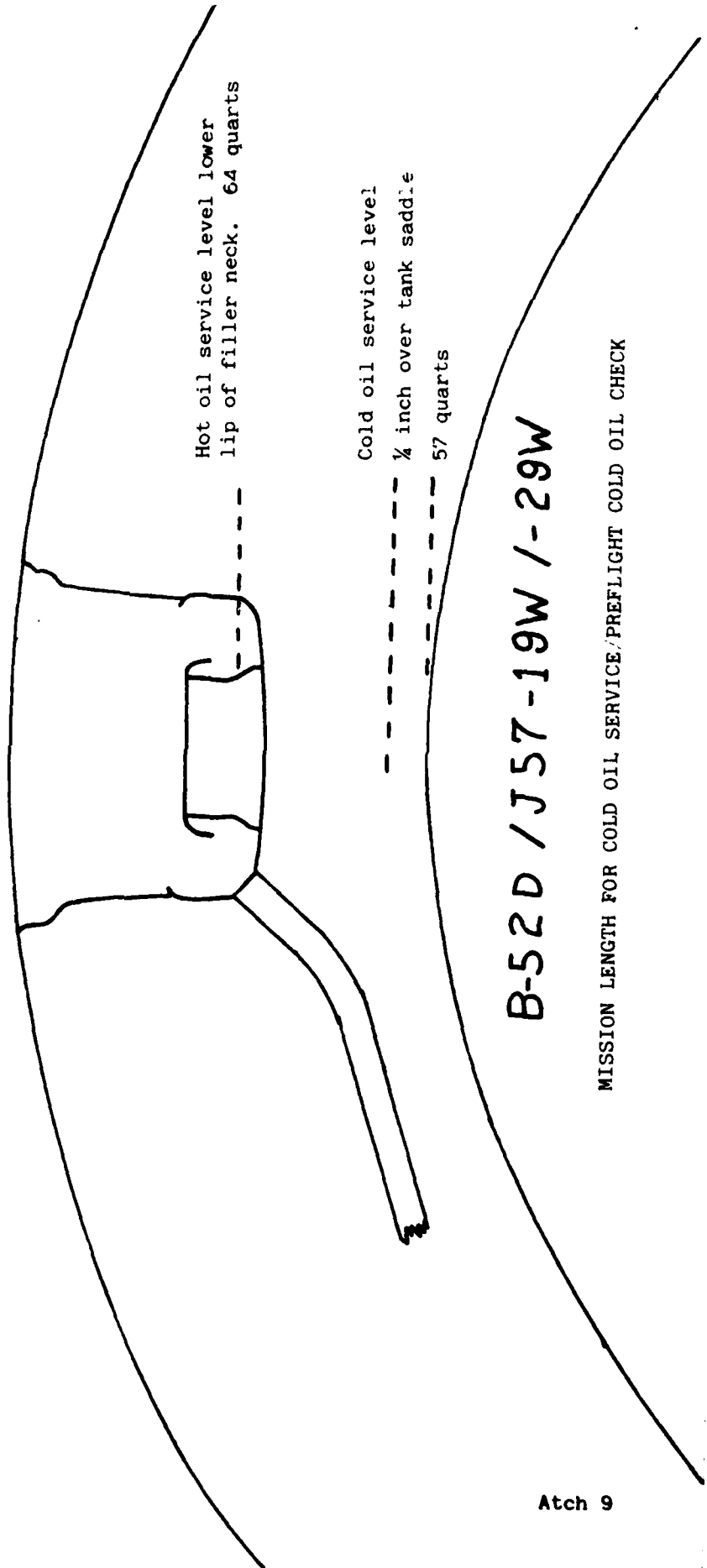
figure oil consumption data/maximum mission duration: Divide the figure in Col 7 by 2.0, 1.5, 1.0, and .5 quarts respectively to figure the mission length in hours.

OIL CONSUMPTION DATA (PREFLIGHT COLD OIL CHECK OR COLD OIL SERVICE)

Consumption Rate	Maximum Mission Duration
2 qts per hour (4 pts)	24 hours
1.5 qts per hour (3 pts)	32 hours
1.0 qt per hour (2 pts)	48 hours
.5 qt per hour (1 pt)	96 hours

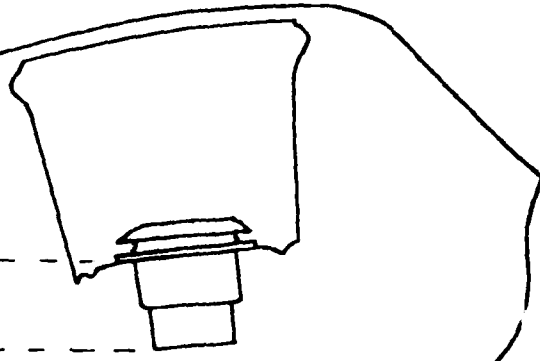
NOTE: Maximum oil consumption rate is 4 pints per hour. This table is based on filling the oil tank to the level (1/4 inch over the oil tank saddle - 7 quarts low - cold oil service) allowing for 2.74 quarts hot oil expansion, plus having 4 quarts of residual oil trapped in the N2 gearbox. while maintaining a minimum of 20% (11 95 quarts) of usable oil at all times

Full oil tank (hot oil service) 64.0 qts
 (cold oil service level) 57.0 qts
 Maximum allowable residual oil quantity remaining in N2 gearbox after starter operation 4.0 qts
 (57.0 qt) oil expansion level 2.74 qts
 Total 63.74 qts



Hot oil service level
 lower lip of filler neck
 35.0 qts

Cold oil service level
 bottom of tank screen
 32.0 qts



OIL CONSUMPTION DATA (COLD OIL SERVICE ONLY)

Consumption Rate	Maximum Mission Duration
2 qts per hour (4 pts)	24 hours
1.5 qts per hour (3 pts)	32 hours
1.0 qt per hour (2 pts)	48 hours
.5 qt per hour (1 pt)	96 hours

NOTE: Maximum oil consumption rate is 4 pints per hour. This table is based on filling the oil tank to the level (bottom of tank screen - 3 quarts low - cold oil service) allowing for 1.69 quarts hot oil expansion, plus having 2 quarts of residual oil trapped in the N2 gearbox, while maintaining a minimum of 20% (6.74 quarts) of usable at all times.

Full oil tank (hot oil service)	35.0 qts
Cold oil service level	32.0 qts
Maximum allowable residual oil quantity in N2 gearbox after starter operation	2.0 qts
(32.0 qt) oil expansion level	<u>1.69 qts</u>
Total	35.69 qts

MISSION LENGTH FOR COLD OIL SERVICE

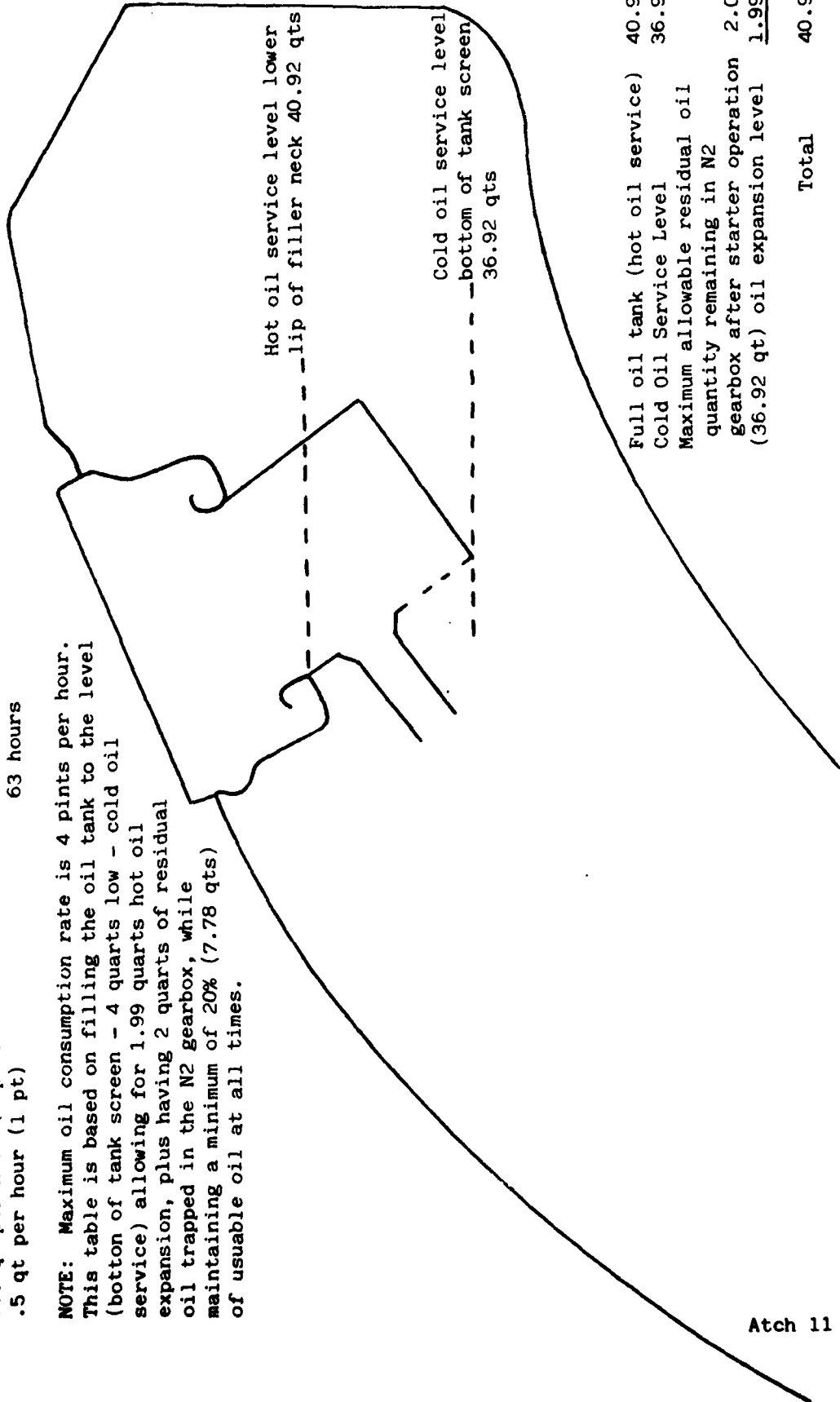
B-52 G / J57-43W

Atch 10

OIL CONSUMPTION DATA (PREFLIGHT COLD OIL CHECK OR COLD OIL SERVICE)

Consumption Rate	Maximum Mission Duration
2 qts per hour (4 pts)	16 hours
1.5 qts per hour (3 pts)	21 hours
1.0 qt per hour (2 pts)	32 hours
.5 qt per hour (1 pt)	63 hours

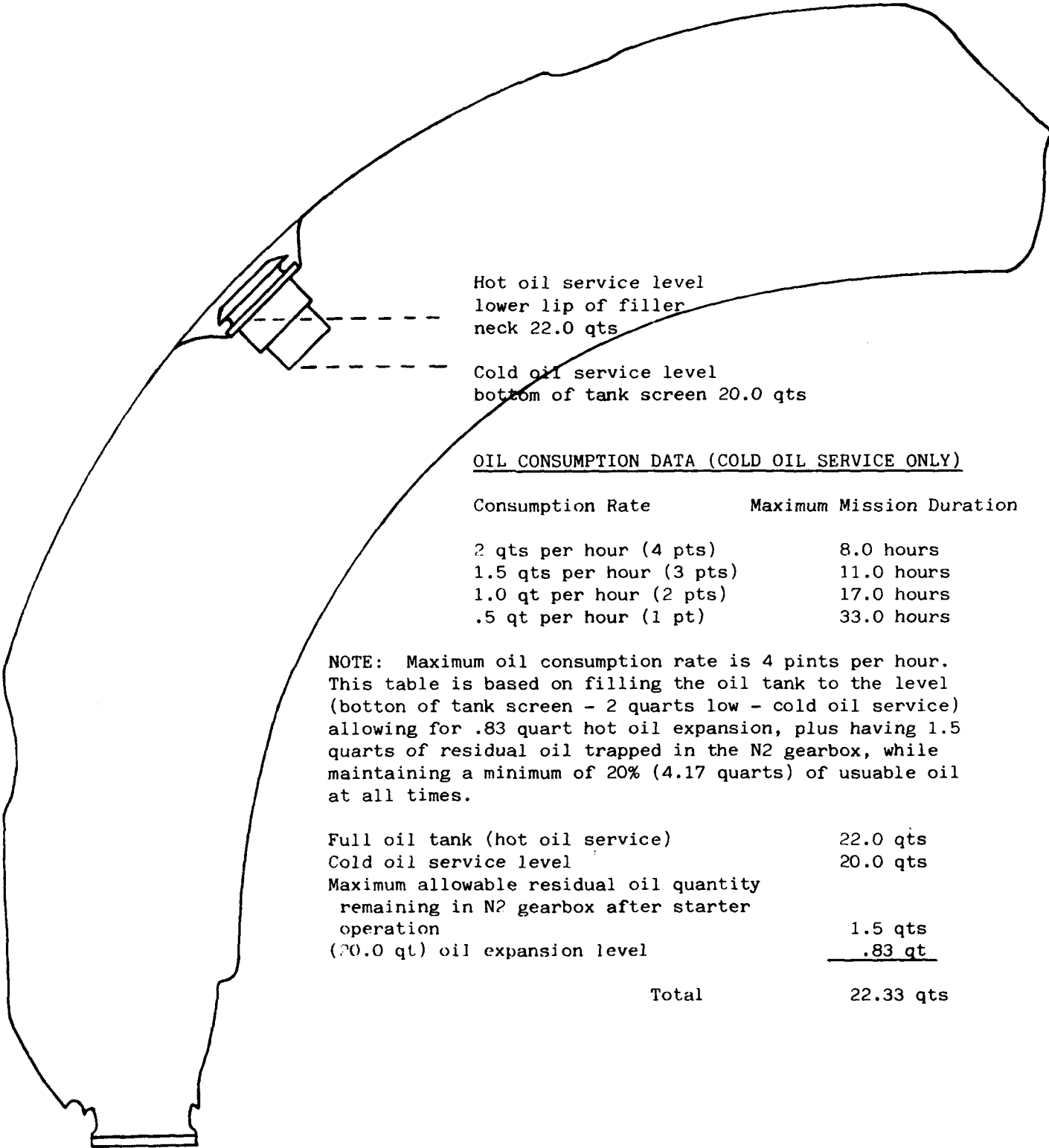
NOTE: Maximum oil consumption rate is 4 pints per hour. This table is based on filling the oil tank to the level (bottom of tank screen - 4 quarts low - cold oil service) allowing for 1.99 quarts of residual expansion, plus having 2 quarts of residual oil trapped in the N2 gearbox, while maintaining a minimum of 20% (7.78 qts) of usable oil at all times.



Full oil tank (hot oil service) 40.92 qts
 Cold Oil Service Level 36.92 qts
 Maximum allowable residual oil quantity remaining in N2 gearbox after starter operation 2.0 qts
 (36.92 qt) oil expansion level 1.99 qts
 Total 40.91 qts

MISSION LENGTH FOR COLD OIL SERVICE/PREFLIGHT COLD OIL CHECK

B-52H / TF 33-P3



Hot oil service level
 lower lip of filler
 neck 22.0 qts

Cold oil service level
 bottom of tank screen 20.0 qts

OIL CONSUMPTION DATA (COLD OIL SERVICE ONLY)

Consumption Rate	Maximum Mission Duration
2 qts per hour (4 pts)	8.0 hours
1.5 qts per hour (3 pts)	11.0 hours
1.0 qt per hour (2 pts)	17.0 hours
.5 qt per hour (1 pt)	33.0 hours

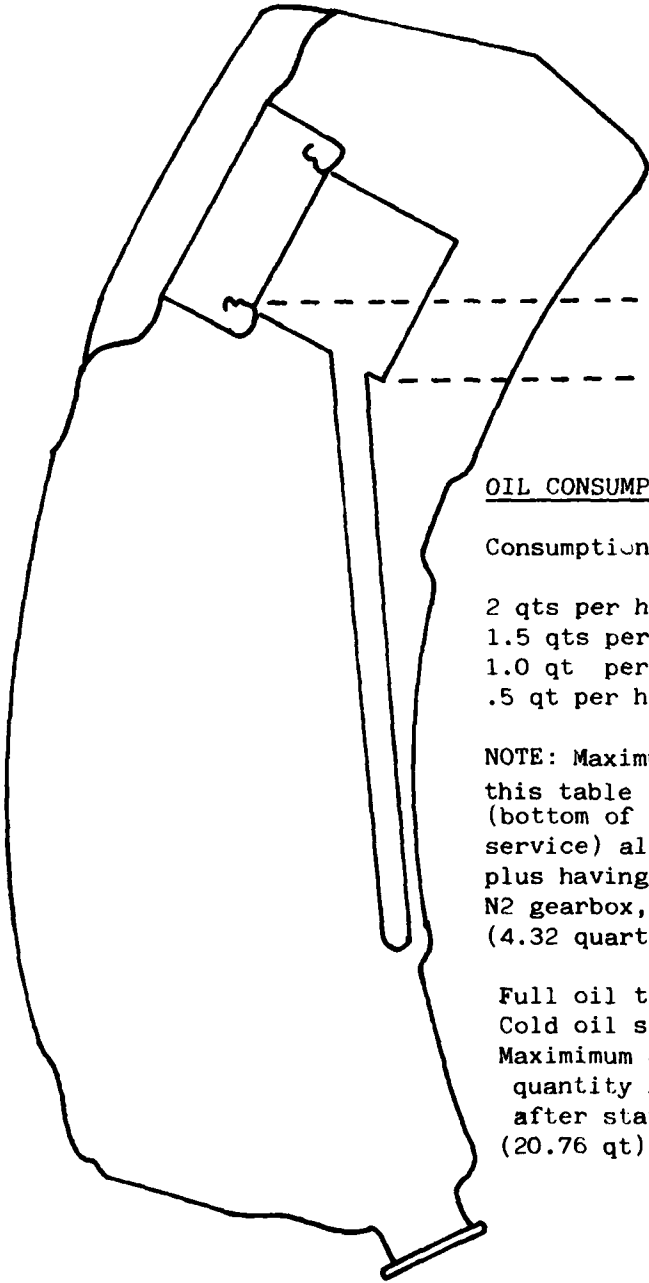
NOTE: Maximum oil consumption rate is 4 pints per hour. This table is based on filling the oil tank to the level (bottom of tank screen - 2 quarts low - cold oil service) allowing for .83 quart hot oil expansion, plus having 1.5 quarts of residual oil trapped in the N2 gearbox, while maintaining a minimum of 20% (4.17 quarts) of usable oil at all times.

Full oil tank (hot oil service)	22.0 qts
Cold oil service level	20.0 qts
Maximum allowable residual oil quantity remaining in N2 gearbox after starter operation	1.5 qts
(20.0 qt) oil expansion level	<u>.83 qt</u>
Total	22.33 qts

MISSION LENGTH FOR COLD OIL SERVICE

KC-135A / J57-59W

Atch 12



Hot oil service level lower lip
of filler neck 23.76 qts

Cold oil service level bottom of
tank screen 20.76 qts

OIL CONSUMPTION DATA (COLD OIL SERVICE ONLY)

Consumption Rate	Maximim Mission Duration
2 qts per hour (4 pts)	9 hours
1.5 qts per hour (3 pts)	12 hours
1.0 qt per hour (2 pts)	17 hours
.5 qt per hour (1 pt)	35 hours

NOTE: Maximum oil consumption rate is 4 pints per hour
this table is based on filling the oil tank to the level
(bottom of tank screen - 3.0 quarts low - cold oil
service) allowing for .83 quart hot oil expansion,
plus having 2.0 quarts of residual oil trapped in the
N2 gearbox, while maintaining a minimum of 20%
(4.32 quarts) of usable oil at all times.

Full oil tank (hot oil service)	23.76 qts
Cold oil service level	20.76 qts
Maximum allowable residual oil quantity remaining in N2 gearbox after starter operation	2.0 qts
(20.76 qt) oil expansion level	<u>.83 qt</u>
Total	23.59 qt

MISSION LENGTH FOR COLD OIL SERVICE

RC-135 / TF 33-P5

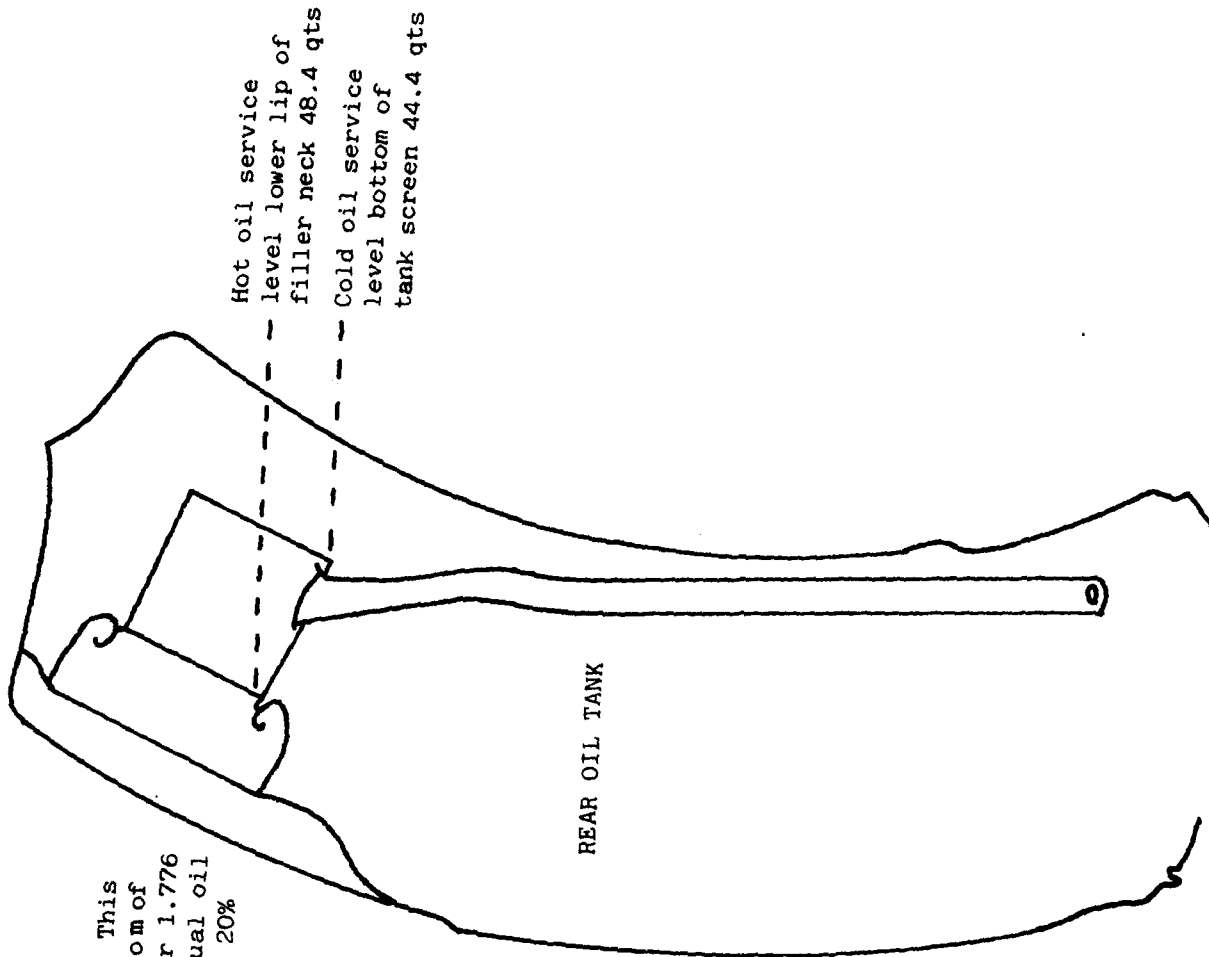
Atch 13

OIL CONSUMPTION DATA/COLD OIL SERVICE ONLY

Consumption Rate	Maximum Mission Duration
2 qts per hour (4 pts)	19 hours
.5 qts per hour (3 pts)	25 hours
1.0 qt per hour (2 pts)	38 hours
.5 qt per hour (1 pt)	76 hours

NOTE: Maximum oil consumption rate is 4 pints per hour. This table is based on filling the oil tank to the level (bottom of tank screen - 4.0 qts low - cold oil service) allowing for 1.776 quarts hot oil expansion, plus having 2.0 quarts of residual oil trapped in the N2 gearbox, while maintaining a minimum of 20% (9.235 quarts) of usable oil at all times.

Full oil tank (hot oil service)	48.4 qts
Cold oil service level	44.4 qts
Maximum allowable residual oil quantity remaining in N2 gearbox after starter operation	2.0 qts
(44.4 qt) oil expansion level	<u>1.776 qts</u>
Total	48.176



MISSION LENGTH FOR COLD OIL SERVICE

EC-135 / TF33-P9

LIST OF TECHNICAL ORDERS CHANGED BY HQ SAC/LGME AFTO 22 ACTION

1B-52D-2-2	Para 4-56	Engine oil tank servicing
1B-52D-2-2	Para 4-56a	Preflight cold oil check
1B-52B-10-1	Para 7-50	Oil supply tank filling
1B-52G-2-2JG-3	Task 3-23-1	Engine oil system filling
1B-52F-10-1	Para 7-51	Oil supply tank - filling
1B-52H-2-2JG-3	Task 3-22a	Preflight cold oil check
1B-52H-2-2JG	Task 3-23	Engine oil system filling
1B-52H-10-1	Para 7-42	Oil supply tank filling
1C-135(K)A-2-2JG-3	Task 3-28	Engine oil filling
1C-135(K)A-10-1	Para 7-59	Engine oil tank filling
1C-135A-2-2	Para 3-42	Engine oil tank - servicing
1C-135B-2-4	Para 7-25	Engine oil tank - filling
1C-135B-10-2	Para 7-48	Engine oil tank - filling
1C-135(K)A-2-2	Para 3-39	Engine oil tank - servicing
1C-135(E)C-2-4	Para 6-25	Engine oil tank - filling
1C-135(E)C-10-1	Para 7-44	Engine oil tank - filling
1C-135(E)C-2-4-1	Para 5-24	Engine oil tank - filling