CT7-2E INCREMENTAL CHANGE Release Notification Date: 12/28/2021

MM 72-00-00
ENGINE - TEST

DISCLAIMER

The Incremental Changes published by GE Aviation are considered Instructions for Continued Airworthiness. These Incremental Changes, along with the current Manual revision and published Temporary Revisions, constitute the latest Instructions for Continued Airworthiness.

HIGHLIGHTS

HIGHLIGHT REFERENCE	DESCRIPTION OF CHANGE
tk72-00-00-760-803	Technical Change: Added engine drain leakage limits for the combustor drain in Table 501.

*** * * FOR CT7-2E1**

TASK 72-00-00-760-803

1. General Information.
   This section provides engine operating limits; instructions for testing the engine during fault isolation; and instructions for testing the engine following repair or replacement of parts, and following replacement of engine.
2. Description of Engine Controls.
   A. Electronic Engine Control Unit.
      The control system is a modern dual-channel Full Authority Digital Engine Control (FADEC) system. The FADEC System includes two major components: an Electronic Engine Control Unit (EECU) and a Fuel Metering Unit (FMU). The EECU modulates fuel flow and schedules the compressor variable geometry and start bleed air. The following controllers are provided to protect engine and aircraft limits:
      * Power turbine speed (Np)
      * Load sharing by means of ITT or Torque (pilot selectable)
      * Maximum physical and corrected gas generator speed
      * Minimum gas generator speed (Ng)
      * Maximum gas generator acceleration rate
      * Maximum gas generator deceleration rate
      * Maximum interturbine temperature (ITT)
      * Minimum fuel flow (to facilitate starting)
      * Maximum fuel flow
      * Maximum engine torque limiting.

B. Fuel System.

The fuel system provides the following features:

* Accessory gearbox mounted components for accessibility and minimum fuel lines
* Suction fuel system capability
* A fuel metering unit (FMU) with an integral main pump and VG actuator
* Error-proof mounting features
* Combined VG and start-bleed valve actuation
* Fail-fixed features on fuel flow and VGs
* Use of a common valve for overspeed and normal shutoff

3. Operating Limits.

A. Scope.

This section provides operating limits during normal engine operation, oil and fuel limitation, and engine performance data.

B. General Operating Limits.

Observe engine operating limits in Table 501 and in Figure 501, Figure 502, and Figure 503, as applicable.

C. Starting Limits.

NOTE: Refer to paragraph 5. for engine starting procedures.

Time-to-idle limits for making a normal start are shown in Figure 501. Start time is measured from initial Ng indication (with PAS control / SIF switch at IDLE) until idle speed is reached. Temperature limits from start to ground idle are shown in Figure 502.

D. Idle Speed Limits.

Observe ground idle speed limits, shown in Figure 503.

E. In-Flight Limits.

The engine will function satisfactorily for one minute under low gravity conditions and for 30 seconds under zero gravity conditions.

F. Shutdown Limits.

NOTE: Refer to paragraph 6.B. for engine shutdown procedures.

G. Oil and Fuel Limitations.

(1) See Table 5, INTRODUCTION, for approved oils to be used in the engine.

(2) See Table 6, INTRODUCTION, for approved fuels to be used in the engine.

TABLE 501. ENGINE OPERATING LIMITS

Item		Limits
NOTE: *100% Ng = 44,700 rpm *100% Np = 21,000 rpm		
Ng	FLAT 30 second/2 min. (OEI)*	105% (46,935 rpm)
	5-min. takeoff (AEO)	102.7% (45,907 rpm)
	Continuous (OEI)*	102.7% (45,907 rpm)
	Maximum continuous (AEO)	102.7% (45,907 rpm)
	12 Second Transient (AEO)	103.2% (46,137 rpm)
	Overspeed trip range	108.5% (48,499.5 rpm)
Np	Continuous with load or with no load	104% (22,000 rpm)
	12-second transient	110% (23,100 rpm)
	Overspeed trip range	25,000 (±250 rpm)
NOTE: Avoid steady-state power turbine operation in the 24-38% (5,000-8,000 rpm) Np and 53-72% (11,000-15,000 rpm) Np ranges.		
*** FOR CT7-2E1 NOT MODIFIED TO SB 74-0004**		
ITT	FLAT 30 Second/2 min. (OEI)*	1078°C (1972°F)
	5-min. takeoff (AEO)	968°C (1775°F)
	Continuous (OEI)*	968°C (1775°F)
	Maximum continuous (AEO)	942°C (1727°F)
	12-second transient (AEO)	974°C (1785°F)
	Starts**	963°C (1766°F)
*** FOR CT7-2E1 MODIFIED TO SB 74-0004**		
ITT	FLAT 30 Second/2 min. (OEI)*	1101°C (2013°F)
	5-min. takeoff (AEO)	983°C (1802°F)
	Continuous (OEI)*	983°C (1802°F)
	Maximum continuous (AEO)	957°C (1755°F)
	12-second transient (AEO)	991°C (1816°F)
	Starts**	963°C (1766°F)

*** * * FOR CT7-2E1**

Output Shaft Torque	FLAT 30 Second/2 min. (OEI)*	575 lb ft (779.6 N.m)
	5-min. takeoff (AEO)	515 lb ft (698.2 N.m)
	Continuous (OEI)*	515 lb ft (698.2 N.m)
	Maximum continuous (AEO)	490 lb ft (664.4 N.m)
	12-second transient (AEO)	545 lb ft (738.9 N.m)
Outside air temperature (OAT) Sea Level		-58° to 140°F** (-50° to 60°C)

NOTE: ** EECU must be powered to warm up for 10 minutes before engine start at temperatures below -40°C (-40°F).

Fuel leakage	Leakage from all drains with engine running.	2 cc per minute maximum (approximately 10 drops per minute)
	Leakage from all drains on shutdown.	50 cc maximum
Starting	Time between ground starts.	30 seconds minimum
	Time from start to idle speed.	See Figure 501.
	Time to lightoff.	30 seconds maximum
	Ignition exciter duty cycle.	2 minutes on 3 minutes off 2 minutes on 23 minutes off
	Starter duty cycle.	Refer to aircraft operating instructions.

NOTE: If engine does not light off, abort start, using instructions in paragraph 5.D. and 5.E.

CAUTION: DO NOT USE TYPE II OILS WHEN RUNNING ENGINE IN OAT BELOW -40°F (-40°C).

Oil Pressure:

NOTE: * Oil pressure limits apply to both Type I and Type II oils. (See Table 5, INTRODUCTION, for list of approved oils.)

* It is normal for oil pressure to be high during first start when oil is cold (ambient temperature). Oil pressure should return to 30-100 psid (207-689 kPa) after 5 minutes of operation at idle speed. The engine may then be accelerated to any desired Ng level. After acceleration, the pressure may rise above 100 psid (689 kPa) for a short time until the oil further warms to normal operating temperature.

Oil Pressure (psid)	Ng
0-20 (0-138 kPa)	No steady-state operation.
20-30 (138-207 kPa)	Caution region, no steady-state operation above ground idle.
30-100 (207-689 kPa)	Engine operation is acceptable for all operation speeds.
100-120 (689-827 kPa)	Restricted to starting and initial operation with cold oil.
120-200 (827-1379 kPa)	No operation above ground idle.

Oil pressure fluctuations	±5 psi (±34 kPa) maximum

CAUTION: * OPERATION OF ENGINE WITH THE OIL QUANTITY LESS THAN 3.5 QUARTS (3.3 LITERS) WILL RESULT IN DAMAGE TO BEARINGS DUE TO OIL FROTHING/STARVATION.

* IF OIL CONSUMPTION EXCEEDS 0.3 LB/HR, ENGINE OPERATION IS NOT ALLOWED UNLESS OVER-SERVICEABLE LIMIT EXTENSIONS (SPECIAL PROCEDURES) REQUIREMENTS ARE MET OR OIL CONSUMPTION IS REDUCED BELOW 0.3 LB/HR.
* ENGINES THAT ARE BEING MONITORED FOR HIGH OIL CONSUMPTION OR FOR KNOWN OIL LEAKAGE MUST HAVE OIL LEVEL CHECKED AT LEAST DAILY UNTIL THE PROBLEM IS CORRECTED.

NOTE: * Operators may elect to establish a program to monitor the oil consumption rate of each engine on a periodic basis. This will permit early identification of engines requiring oil system maintenance, allowing the maintenance to be scheduled at a convenient opportunity.

* To accurately calculate an oil consumption rate, the following information must be recorded for each oil servicing event:
  - Date
  - Time
  - Quantity of Oil Added.

Maximum Oil Consumption Rate:	0.3 lb/hr
Oil Capacity:	To oil level indicator FULL line, 7.3 quarts (6.9 liters)
Maximum Usable Oil Quantity:	3.8 quarts (3.6 liters)

Minimum Oil Quantity Required for Engine Operation:		3.5 quarts (3.3 liters)
Oil temperature		
Engine Power Setting	Normal Temperature Range (All Power Settings)	Max Transient
All	270°F (132°C)	300°F (149°C)

NOTE: * Oil temperature limits apply to both Type I and Type II oils. (See Table 5, INTRODUCTION), for list of approved oils.)

* Oil temperature is measured at the engine oil filter discharge.
* If oil temperature is outside these limits, there is a problem and there should be a post-flight investigation. Do not run engine when oil is above maximum temperature. Refer to FAULT ISOLATION.

Engine Installed in Aircraft		
High-frequency vibration limits	Steady-state	2.5 inch/sec (64 mm/sec) maximum
	Transient (less than 5 sec duration)	3.5 inch/sec (89 mm/sec) maximum
Engine drain leakage from:		
1	Fuel Manifold Drain and Fuel Filter Drain	No leakage allowed
2	Common Drain and Swirl Frame, FMU Vent and Overspeed and Drain Valve (combined)	2 cc/min max (running)
3	Sequence Drain Valve	50 cc max on shutdown
4	Swirl Frame Drain	5 cc/hr (running)
5	FMU Vent	
	* Running * Static (excluding leakage during priming or vapor venting)	50 cc/hr max 50 cc/hr max
6	Common Drain	35 cc/hr max (running or static)
7	Combustor Drain	50 cc max post shutdown

* One Engine Inoperative

** Refer to paragraph 5 (ENGINE STARTING PROCEDURES)

H. Jet Blast Area.

See Figure 504 for estimated jet blast temperature and velocity profiles at engine exhaust for ground idle and for takeoff power conditions.

I. Performance Data.

Engine performance data is provided in Table 502.

TABLE 502. PERFORMANCE RATINGS FOR UNINSTALLED ENGINE AT STATIC, SEA LEVEL, STANDARD DAY CONDITIONS

Rating	**Minimum Power (SHP) (hp)**	**Maximum Gas Generator Speed (Ng) (rpm)**	**Rated Output Shaft Speed (Np) (rpm)**	**Maximum Specific Fuel Consumption (SFC) (lb/hp/hr)**	**Rated Output Shaft Torque (Qp) lb/ft (N.m)**	**Maximum Measured Gas Temp (T4.5)/ITT °C (°F)**
*** **FOR CT7-2E1 NOT MODIFIED TO SB 74-0004**						
FLAT 30 Second/2 Minute (OEI)*	2164	46,935	21,000	- -	575 (779.6)	1078 (1972)
Continuous (OEI)*	1983	45,907	21,000	- -	515 (698.2)	968 (1775)
Takeoff (AEO) (5 min.)	1983	45,907	21,000	- -	515 (698.2)	968 (1775)
12-Second Transient (AEO)	N/A	46,137	- -	- -	545 (738.9)	974 (1785)
Max continuous (AEO)	1870	45,907	21,000	- -	490 (664.4)	942 (1727)
*** **FOR CT7-2E1 MODIFIED TO SB 74-0004**						
FLAT 30 Second/2 Minute (OEI)*	2214	46,935	21,000	- -	575 (779.6)	1101 (2013)
Continuous (OEI)*	1985	45,907	21,000	- -	515 (698.2)	983 (1802)
Takeoff (AEO) (5 min.)	1985	45,907	21,000	- -	515 (698.2)	983 (1802)
12-Second Transient (AEO)	N/A	46,137	- -	- -	545 (738.9)	991 (1816)
Max continuous (AEO)	1871	45,907	21,000	- -	490 (664.4)	957 (1755)
*** **FOR CT7-2E1**						

*One Engine Inoperative

*** * * FOR CT7-2E1**

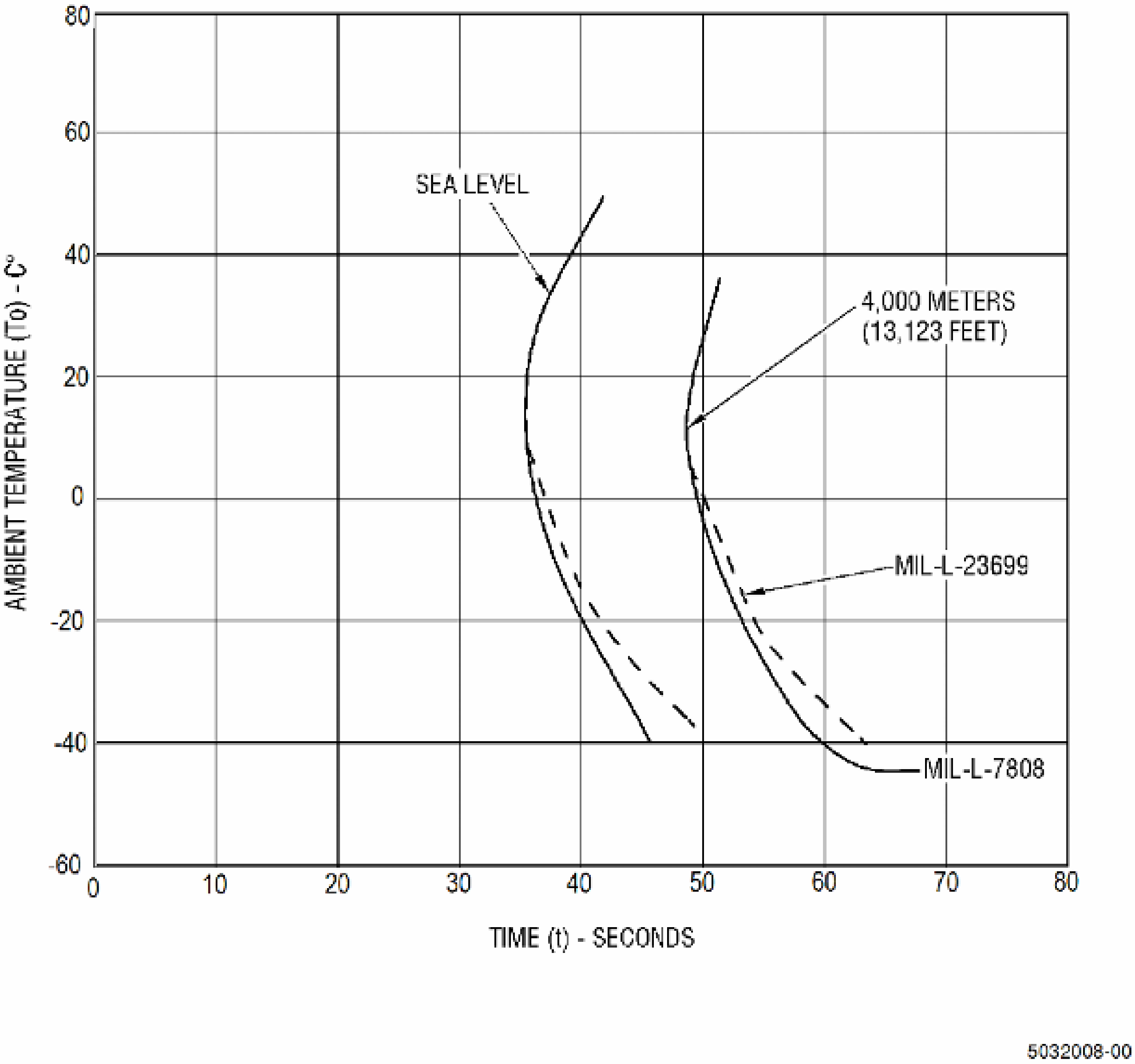

Figure 501 Time-To-Idle Limits

*** * * FOR CT7-2E1 NOT MODIFIED TO SB 74-0004**

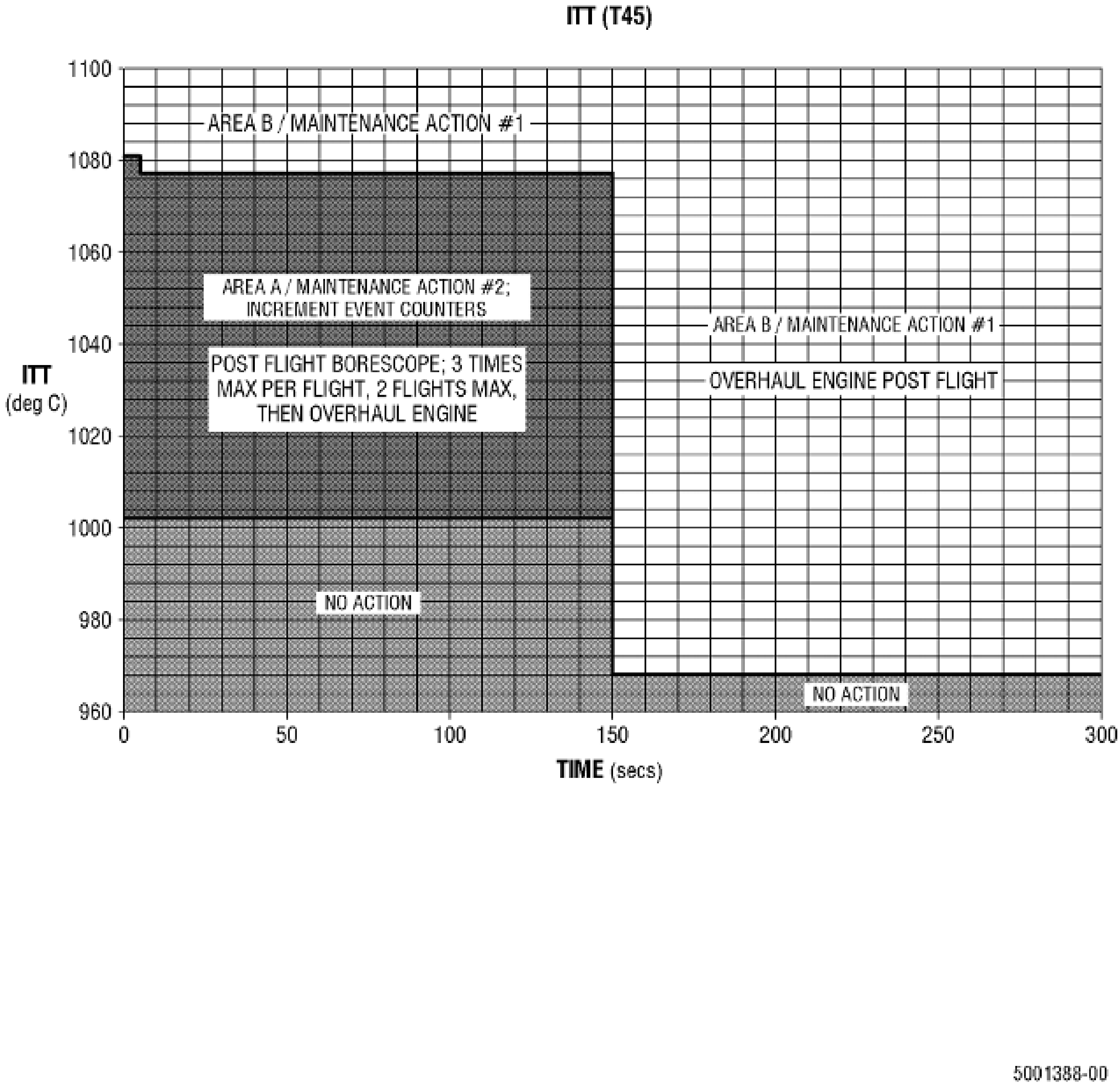

Figure 502 (Sheet 1) Engine Overtemperature Limits

*** * * FOR CT7-2E1 MODIFIED TO SB 74-0004**

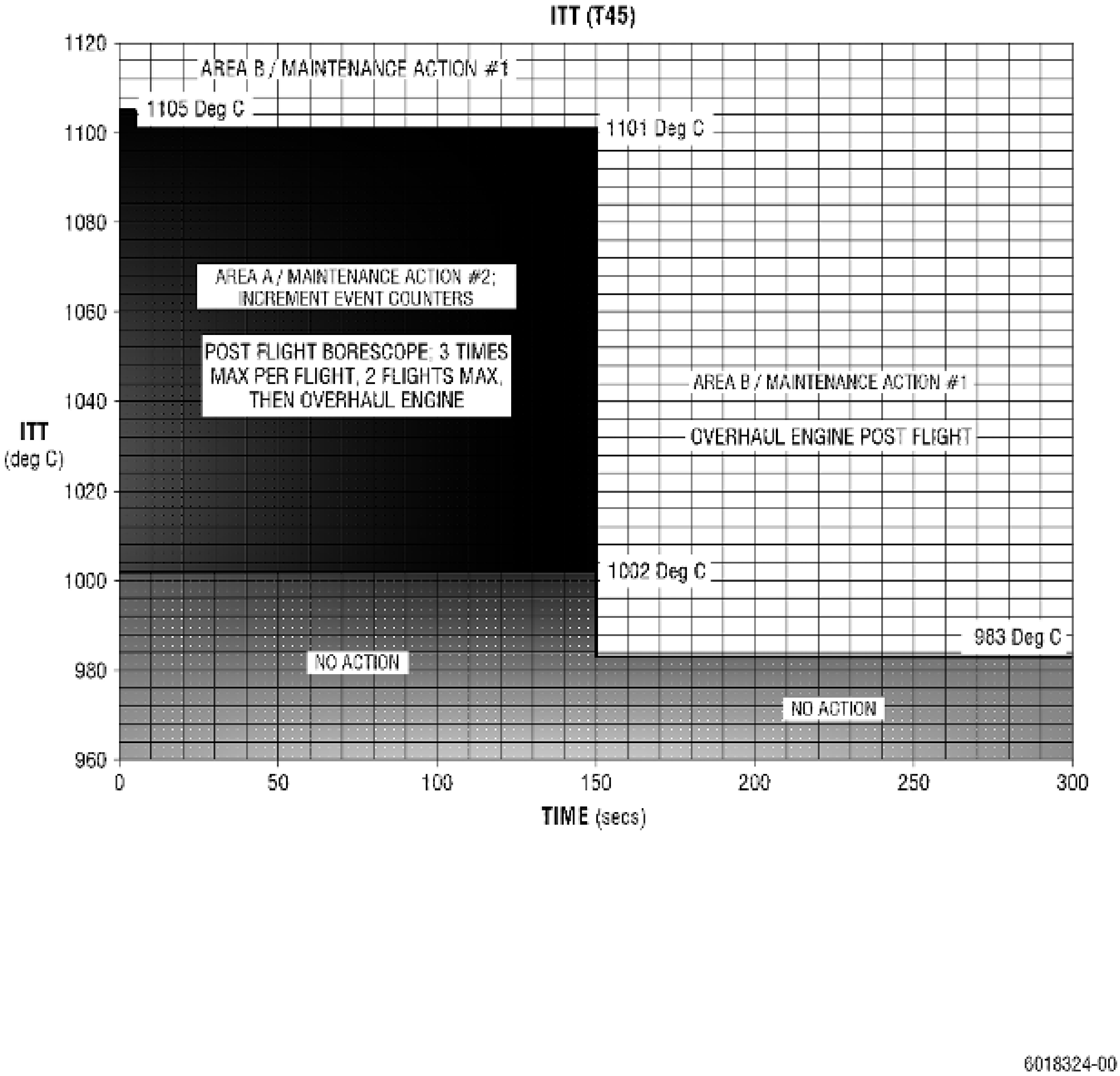

Figure 502 (Sheet 2) Engine Overtemperature Limits

*** * * FOR CT7-2E1**

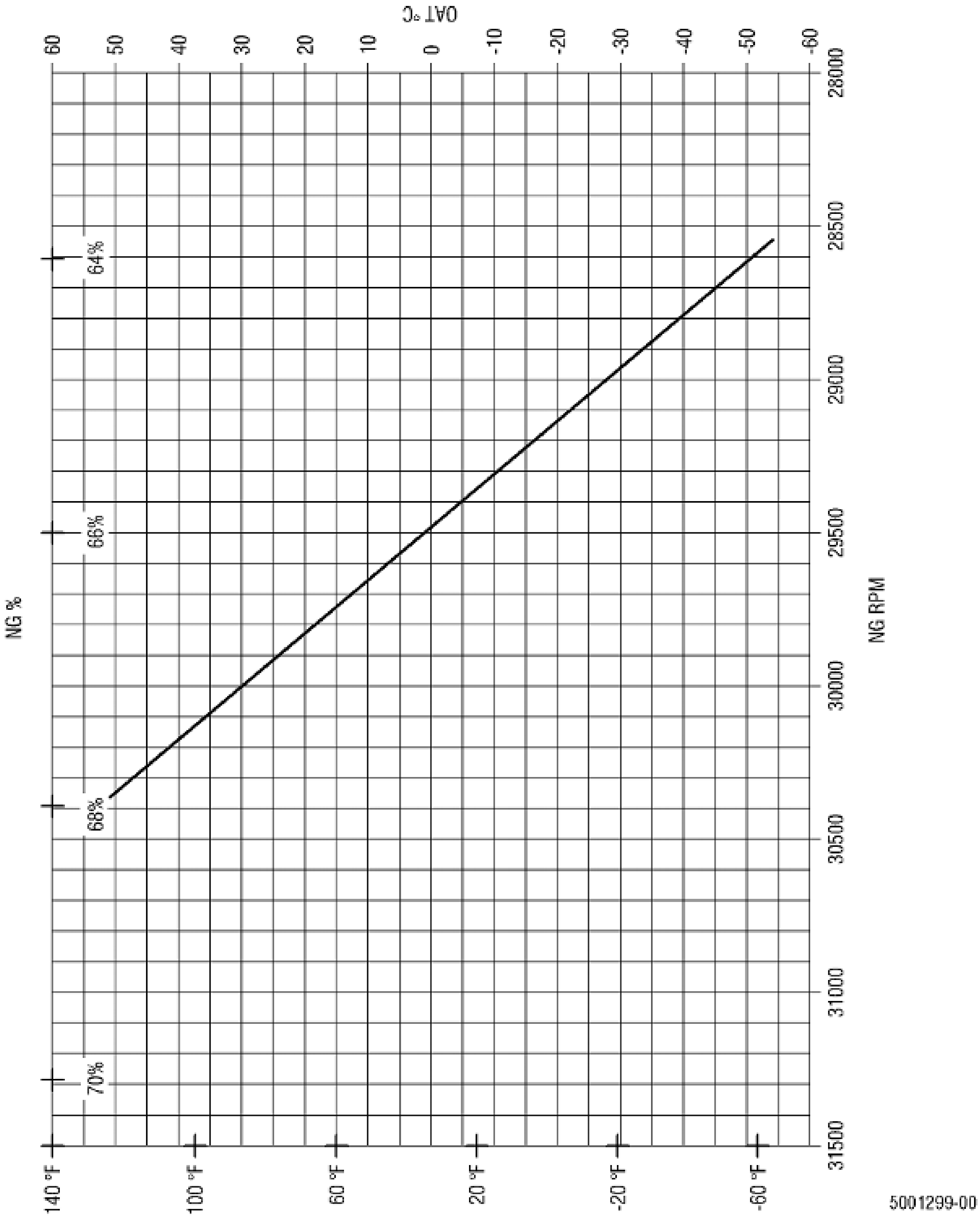

Figure 503 Gas Generator Rotor Speed (Ng) Limits (Startup Only)

*** * * FOR CT7-2E1**

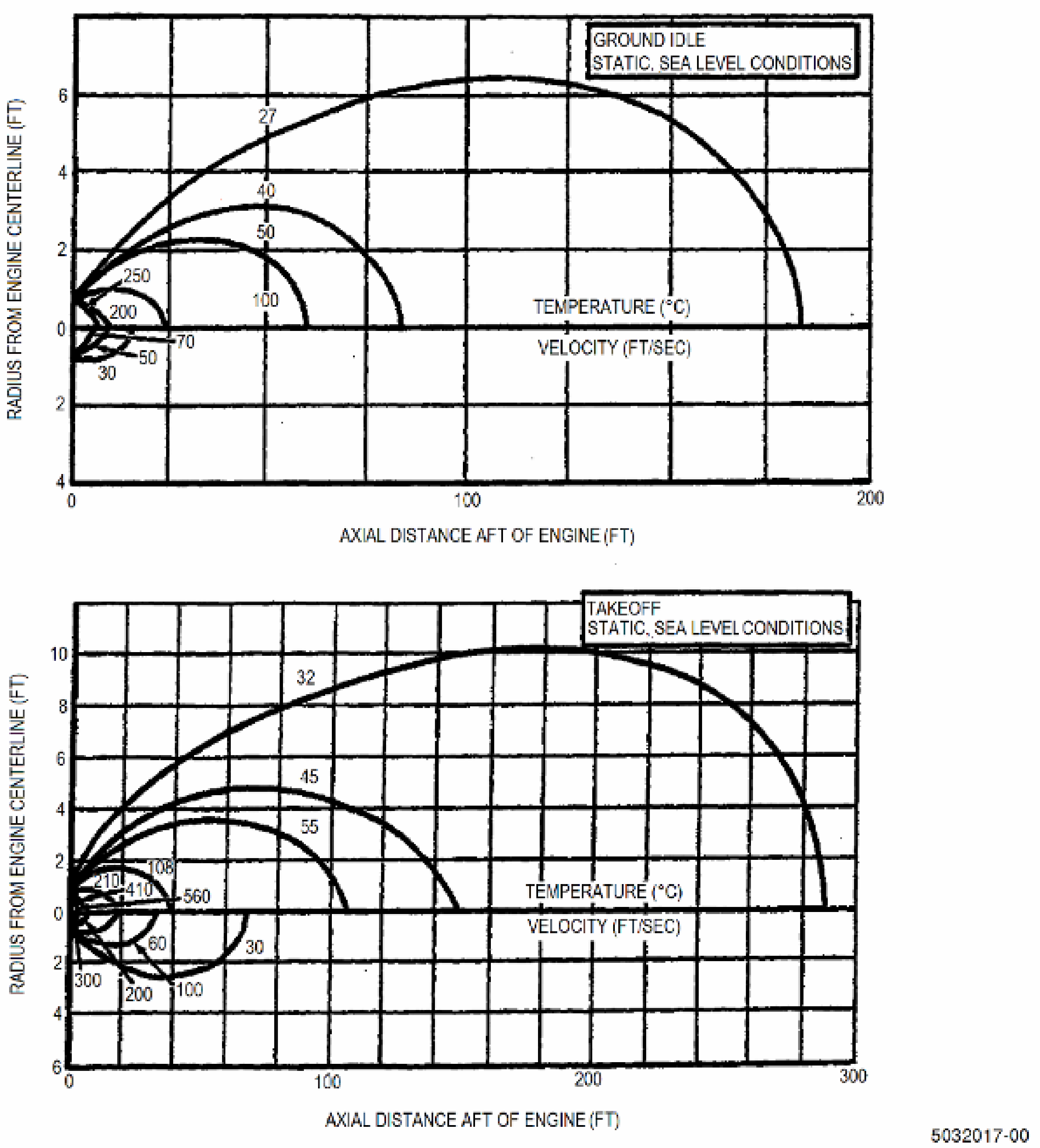

Figure 504 Jet Blast Temperature and Velocity Profiles

4. Checkout Procedure After Replacement of Parts.

A. Table 503 lists the checks that must be made after engine parts have been replaced.

B. If two or more checks are required, they can be done during the same run.

C. Procedures for checks listed in Table 503 are given in paragraph 6.C, 6.D, 6.E, and 6.J.

TABLE 503. CHECKOUT PROCEDURES AFTER REPLACEMENT OF PARTS

Part Replaced	**Overspeed (para 6.E.)**	**Idle Speed Leakage Check (para 6.D.)**	**Break-In Run (para 6.J.)**	**Engine Functional Test (para 6.C.)**
Cold Section Module	X	X		X
* A-Sump Output Shaft Assembly		X		X
* No. 1 Carbon Seal		X		
* Power Takeoff Drive Assembly		X		X

	* Swirl Frame		X		X
	* Inlet Separator Boot		X		X Step (3) only
	* Actuating System Linkage Assembly	X	X		X
	* IGV Actuating Ring and Stages 1 and 2 Vane Actuating Rings	X	X		X
	* Stator Vane Actuating Rings		X		X
Hot Section Module:					
	* Face-type Seal	X	X		X All steps except (4)
	* Stage 1 Nozzle Assembly	X	X		X All steps except (4)
	* Gas Generator Rotor and Stator Assembly	X	X	X	X All steps except (4)
	* Combustion Liner	X	X		X All steps except (4)
Power Turbine Module		X	X		X All steps except (4)
	* C-Sump Cover and C-Sump Heat Shield		X		
Accessory Section Module			X		X
	* Axis-A Cover Assembly		X		
	* Radial Drive Shaft Assembly		X		
	* Particle Separator Blower and V-Band Coupling Assembly		X		
Fuel System Components:					
	* Fuel Filter		X		
	* Fuel Filter Element and Bowl		X		
	* Gearbox-to-FMU Hose Assembly		X		
	* FMU and grooved clamp coupling	X	X	X	X
	* Start Feed Tube	X	X		
	* Main Fuel Manifold and Injectors		X		
	* Fuel Boost Pump		X		
Electrical System Components:					
	* Igniter Plugs				Start Attempt only
	* Electronic Engine Control Unit (EECU)	X			X All steps except (4)
	* Electrical Ignition Leads		X		Start Attempt only
	* Ignition Exciter Assembly		X		Start Attempt only
	* Green Electrical Cable Assembly (W3)				X Steps (3), (4) only
	* Blue Electrical Cable Assembly (W5)	X			X Step (3) only

	* Electrical Chip Detector	X	
*** * * FOR CT7-2E1 NOT MODIFIED TO SB 72-0013**			
	* Fuel Pressure Switch	X	
*** * * FOR CT7-2E1**			
	* Alternator Stator		X Step (3) only
	* Alternator Rotor		X Step (3) only
	* Thermocouple Assembly		X Step (3) only
	* Torque and Overspeed Sensor Assembly		X Step (3) only
	* Power turbine speed / Torque Sensors (Np/Q)		X Step (3) only
	* Np Sensor		X Step (3) only
*** * * FOR CT7-2E1 MODIFIED TO SB 72-0013**			
	* Torque Identification Plug		X Start Attempt only
*** * * FOR CT7-2E1**			
Air System Components:			
	* Anti-Icing Bleed and Start Valve, Anti-Icing Seal Housing, Anti-Icing Seal Retainer, Lanyard and Clip Assembly, Auxiliary Bleed Tube	X	X Step (4) only
	* T2 Sensing Tube and Nonmetallic Temperature Sensing Tube	X	
	* Compressor Leakage Air Tube	X	
	* Forward Seal Pressure Tube	X	
	* Seal Pressure and Scavenge Tube Assembly	X	
	* Anti-Icing Bleed Duct	X	
	* IGV Anti-Icing Duct	X	
	* IGV Anti-Icing Feed Tube	X	
	* P3 Hose and Tube Assembly	X	
Oil System Components:			
	* Oil Cooler	X	X
	* Oil and Scavenge Pump	X	X Step (2) only
	* Scavenge Screens	X	
	* Oil Filter Bypass	X	

Sensor		
* Lube Manifold Tube Assembly	X	X
* Oil Pressure Transmitter	X	
* Oil Filter Bowl	X	
* Oil Filter Element	X	
* Oil Cooler Bypass Relief Valve	X	
* Cold Oil Relief Valve	X	
* C-Sump Forward Scavenge Tube	X	
* Mid C-Sump Scavenge Tube	X	
* Seal Pressure and Scavenge Tube Assembly	X	
* C-Sump Oil Supply Tube	X	
* B-Sump Drain Tube	X	
* Oil Tank Cap and Adapter	X	
* Oil Manifold Assembly	X	
* Oil Temperature Detector	X	
* Oil Inlet and Scavenge Tubes	X	
* Oil Supply Tubes (Left-Hand and Right-Hand)	X	
* B-Sump Oil Inlet Check Valve	X	
* Main Frame Oil Strainer	X	
* Oil Level Indicators	X	
* Oil Transfer Sleeves (From Main Frame-to-Accessory Gearbox)	X	
* Oil Drain Plug	X	
* Oil Drain Insert	X	
* C-Sump Aft Oil Scavenge Tube	X	

5. <u>Engine Starting Procedure.</u>

A. Preliminary Information.

(1) A normal start occurs when the engine lights off and accelerates to idle speed within temperature limits.

(2) Restarting after Normal Shutdown. The engine can be restarted at any time after normal shutdown provided that the ITT is below 150°C (302°F).

CAUTION: DO NOT ENGAGE STARTER ABOVE 15% NG.

(3) The engine starter system should be capable of motoring the engine to at least 26% Ng. Starter cutout is 52% Ng. The start should be monitored using cockpit instrumentation along with visible and audible signs of rotation.

(4) Starter times may be slightly longer and smoke from the exhaust may be observed when starting an engine for the first time after a fuel system component has been replaced or when starting a preserved engine.

B. Prestart Checks.

Set controls and switches as follows:

(1) Stop Idle Flight Switch .... STOP

(2) Anti-Icing .... OFF

(3) Customer Bleed Air .... OFF

(4) Set Collective Flat Pitch on Ground

(5) Aircraft fuel shut off valve ... OPEN

C. Starting.

CAUTION: READ INSTRUCTIONS IN PARAGRAPH F BEFORE RESTARTING AN ENGINE THAT HAS BEEN SHUTDOWN FROM ABOVE 90% NG; OTHERWISE, ENGINE COULD BE DAMAGED.

(1) Activate electrical power to engine FADEC system, mission computers, and starter system on the engine to be started.
(2) Activate aircraft fuel boost pump.
(3) Set the SIF switch to IDLE.
(4) Engine automatically starts and accelerates to ground idle condition.

D. Starting Limits.

NOTE: See limits for starting during cold or hot weather.

Return SIF switch to STOP and abort the start if any of the following conditions are exceeded:

(1) Engine start will be terminated at 1765°F (963°C) by the engine control.
(2) No indication of oil pressure within 30 seconds after the engine starter is activated.
(3) Ng fails to accelerate and hangs before reaching the ground idle Np (55% for one engine and 71% for two) or Ng (if rotor brake is on).
(4) Ignition does not occur within 18 seconds after the initial indication of Ng.

CAUTION: IF STARTING LIMITS IN STEP D ARE EXCEEDED, RETURN PAS CONTROL / SIF SWITCH TO STOP POSITION TO PREVENT OVERTEMPERATURE.

E. Starting Information.

(1) Time limits for making a normal start are shown in Figure 501. Start time is measured from initial Ng indication (with PAS control / SIF switch at IDLE) until idle speed is reached.
(2) Temperature limits are shown in Figure 502.

NOTE: Visual redness or glowing of the power turbine case is normal during engine operation. Visual redness or glowing will not damage the power turbine case.

(3) Ground idle speed limits are shown in Figure 503.
(4) If fuel is sprayed into engine without a start occurring, purge engine of fuel.
(5) It is normal for the oil filter impending bypass caution light to come on when starting an engine if oil temperature are below normal operating temperatures. This happens because of the relatively high oil viscosity and the degree of contamination accumulation in the oil filter. When the engine oil temperature reaches approximately 100°F (38°C) during warmup, the caution light should go out.

F. Starting Notes.

(1) Start time is measured from the initial Ng indication after initiating a start until the ground idle speed is reached.
(2) The engine is equipped with a hot start preventer that will limit ITT to 963°C (1765°F). However, when the SIF switch is moved from the STOP position to the FLIGHT position, the hot start preventer is deactivated.
(3) Idle Ng will vary depending upon rotor brake operation, operating conditions, and single engine operation or dual engine operation when Np governor is operable.
(4) If fuel is introduced to the engine without a start occurring, purge the engine of the fuel by conducting a dry rollover.
(5) In cold weather the oil pressure may exceed 200 psid (1379 kPa) when the engine is started. Before advancing the engine from IDLE to FLIGHT, wait for the oil pressure to drop to 100 psid (689 kPa), (maximum time above 200 psid (1379 kPa) is 2 minutes). Alternatively, in order to reduce the time to reach the normal oil conditions, the pilot is allowed to move the SIF switch to the FLIGHT position instead of staying at IDLE to wait for the oil pressure to drop within the limit. In this case the helicopter shall stay at minimum pitch on ground until the oil pressure is below the limit of 100 psig (689 kPa).
(6) When the oil temperature is below the normal operating temperature, it is normal for the oil filter impending bypass caution indicator to be displayed when the engine is started. This happens because of the relatively high oil viscosity and the degree of contamination accumulation in the oil filter. When the engine oil temperature reaches approximately 38°C (100°F) during warmup, caution indicator should turn off.

G. Restart of Engine After Shutdown.

(1) Refer to descriptions of normal and emergency shutdowns (paragraph 6.B.).
(2) Restart engine after emergency shutdown only as follows:
  * The reason for the shutdown is known and if restarting will not cause engine damage.
  * The engine is motored to cool ITT to 150°C (302°F), Ng is less than 15%, and the restart is initiated within 5 minutes after the shutdown.
  * The engine was allowed to cool for 4 hours, if restart was not initiated within 5 minutes.
(3) In flight there are no time limitations for restart. Restart the engine at a maximum ITT of 150°C (302°F) with Ng below 15%.
(4) The engine is equipped with a hot start preventer that will limit ITT to 963°C (1765°F). However, when you move the SIF switch from the STOP position to the FLIGHT position, the hot start preventer is deactivated.

6. <u>Checkout Procedures When Engine Is Operating.</u>

A. Engine Motoring Procedure.

CAUTION: DO NOT EXCEED STARTER DUTY CYCLE (REFER TO ROTORCRAFT FLIGHT MANUAL).

(1) To motor engine, electrical power must be supplied to the EECU and starting system.
(2) Set SIF switch to STOP.

(3) Turn SIF switch to CRANK.
(4) Release CRANK button to stop rollover.

B. Engine Shutdown (Ground and Flight).

CAUTION: BEFORE YOU MOVE THE SIF SWITCH TO THE STOP POSITION, THE ENGINE SHOULD BE COOLED FOR 2 MINUTES AT IDLE. IF AN ENGINE IS SHUT DOWN FROM A HIGH POWER SETTING WITHOUT BEING COOLED FOR 2 MINUTES, AND IT IS NECESSARY TO RESTART THE ENGINE, THE RESTART SHOULD BE MADE WITHIN 5 MINUTES AFTER SHUTDOWN. IF THE RESTART CANNOT BE DONE WITHIN 5 MINUTES, THE ENGINE MUST BE ALLOWED TO COOL FOR 4 HOURS.

(1) Preliminary Information.
(a) The normal shutdown procedure (step (2)) calls for running the engine(s) at ground idle speed for a minimum of 2 minutes before shutdown. Operating the engine(s) at an Ng of 90% or less for 2 minutes is an alternative method of cooling the engine(s).
(b) The emergency shutdown procedure (step (4)) should be followed when the engine is shutdown from high power (over 90% Ng) without first running for at least 2 minutes with Ng below 90%.

(2) Normal Shutdown.

CAUTION: BEFORE SHUTTING BOTH ENGINES DOWN, ELECTRICAL POWER SHOULD BE AVAILABLE TO PERMIT MOTORING AN ENGINE ON THE STARTER, IF REQUIRED, AFTER ENGINE SHUTDOWN.

(a) Run the engine(s) for a minimum of 2 minutes below 90% Ng.
(b) Set the SIF switch to STOP on one or both engines, as desired. The engines may be shutdown one after another or simultaneously.
(c) Monitor the ITT after shutdown. If the temperature rises above 540°C (1004°F), or if there is evidence of combustion after shutdown, as indicated by a rapidly increasing ITT, motor the engine until the temperature decreases below 540°C (1004°F).

(3) Primary Shutdown Procedure.
(a) Set one engine to IDLE.
(b) Run engines 2 minutes at IDLE.
(c) Set the SIF switch to STOP.
(d) Monitor the ITT for exceedance of limitations.
(e) Repeat steps (a) through (d) for second engine.

(4) Emergency Shutdown (Shutdown from High Power, Over 90% Ng). Refer to paragraph 5.
(a) Set the SIF switch directly from FLIGHT to STOP.
(b) Monitor the ITT after shutdown. If the temperature rises above 540°C (1004°F), or if there is evidence of combustion after shutdown, as indicated by a rapidly increasing ITT, motor the engine until the ITT decreases below 540°C (1004°F),

C. Functional Test Procedures for Newly Installed Engines and Component Replacement.

NOTE: Upon initial installation, new engines may exhibit a pinkish colored fuel drain during shutdown. This is due to the presence of residual dye used during factory fuel system leakage checks. This fuel coloring is normal under these circumstances, is not harmful to the engine fuel system, will cause no operational difficulties, and will disappear as the engine is operated.

(1) Before initial engine start, motor engine (para 6.A) for 20 seconds before advancing PAS control / SIF switch to IDLE.
(2) Do an idle speed leakage check (para 6.D). Verify that engine is operating within limits of paragraph 3, Table 501.
(3) Do a ground power assurance check (para 6.H.).
(4) Do an anti-icing start bleed check (para 6.F).

D. Idle Speed Leakage Check.

(1) Do a visual inspection of the air leakage from the air system components, compressor bleed port and P3 line, and horizontal and vertical split lines while the engine operates at idle speed.

WARNING: KEEP HANDS AWAY FROM HOT SECTIONS.

(a) Leakage is not permitted if observable more than 6 inches (152 mm) from the air system components.
(b) Leakage is not permitted if observable more than 12 inches (305 mm) from the horizontal and vertical split lines and flange joints.
(c) Leakage is not permitted on the P3 air system and connectors. If leakage is suspected, apply a soap and water solution on the location where leakage is suspected. Leakage is not permitted if the solution bubbles.

(2) Visually check for fuel and oil leaks, paying particular attention to the following:
(a) Hose and tube connections that were disconnected and reinstalled during fault isolation or maintenance.
(b) Mating flange joints between accessory drive gearbox assembly and its components.
(c) Area between fuel filter bowl and filter housing.
(d) Overboard drain for excessive oil or fuel leakage.
(e) Fuel manifold.

(3) If any leaks are found, shut down engine by moving PAS control / SIF switch to OFF.
(4) Correct all leaks.
(5) Check oil level indicator. If necessary, add oil (SERVICING).
(6) Restart engine (para 5.F).

E. Overspeed Check.

(1) The EECU is programmed with full capability to self-test the engine overspeed system. The system allows for entirely automatic test of all aspects of the overspeed system during

starts and shutdowns without pilot initiation and without affecting normal engine operation. The automatic overspeed test consists of three parts: starting tests, continuous testing, and a shutdown test. A complete test of all parts of the overspeed system is completed in a sequence of four engine starts and shutdowns.

(2) Failure to pass the overspeed test indicates a loss of full overspeed protection and an overspeed system failure message will be displayed in the cockpit. Takeoff is not authorized if the overspeed test failure indication is displayed. Although failure of the overspeed test requires appropriate maintenance action, the EECU will not prevent further operation of the engine.

(3) Abnormal startup or shutdown procedures can prevent completion of the overspeed test. Although a failure has not been detected, a separate indication that the overspeed check was not completed will be displayed. Maintenance action to troubleshoot and repair the system is required after landing.

(4) Both overspeed test messages will be latched in the EECU until the overspeed check has been passed. After corrective maintenance is performed, it may take up to four engine starts for the messages to clear in the cockpit.

F. Anti-Icing Bleed and Start Valve Check.

NOTE: Anti-icing (A/I) switch must be OFF during start (see Operating Instruction Manual GEK 112766).

(1) With the test engine driving the rotor at 102% Nr, slowly increase collective pitch to obtain 92% Ng minimum.

CAUTION:
* DO NOT CYCLE ANTI-ICING BLEED AND START VALVE MORE THAN ONCE TO DETERMINE PROPER OPERATION.
* VALVE MALFUNCTION CAN CAUSE ENGINE FLAMEOUT AT LOW POWER SETTINGS OR DURING RAPID COLLECTIVE MOVEMENTS.
* IF ANY PART OF THE ANTI-ICING CHECK FAILS, DO NOT FLY THE AIRCRAFT.

(2) Turn on engine anti-icing systems, Ng should increase with an increase of T4.5 / ITT of approximately 54°F (12°C) minimum.

NOTE: Amount of increase in T4.5 / ITT should vary with Ng and ambient temperature.

(3) If recorded T4.5 / ITT is less than the 54°F (12°C) minimum, the valve has failed check. Refer to 75-00-00, INSPECTION.

G. Engine Ground Idle Speed Operation.

(1) Once idle speed is reached, the FADEC will automatically protect the engine from subidle operation. Logic in the FADEC will command a shutdown if any of the following conditions are detected:

(a) Engine rollback during a start attempt due to a malfunction in the starter system or control system.

(b) Uncontrolled deceleration.

(c) Fuel interruptions, FMU malfunction, or other reasons for subidle operation.

(2) Make sure the operating limits in Table 501 are not exceeded during the engine run up and cautions are clear.

(3) Refer to paragraph 5 for the engine check procedures.

H. Ground Power Assurance Check.

(1) The following procedure is used to check engine performance before flight:

CAUTION: OBSERVE ALL ENGINE AND AIRCRAFT OPERATING LIMITS DURING THIS CHECK.

NOTE: The influence of wind may have a significant effect on the result of the check.

(a) Position aircraft into the prevailing wind to minimize hot gas ingestion.

(b) On engine not being checked, set SIF switch to IDLE.

CAUTION: IF ICING CONDITIONS EXIST, DO NOT KEEP ANTI-ICING SYSTEM OFF LONGER THAN NECESSARY TO RUN TEST; OTHERWISE, AN ICING CONDITION COULD CAUSE DAMAGE TO ENGINE.

(c) Set the following conditions on the test engine:
* Customer bleed off
* Anti-icing off
* SIF switch at FLIGHT (Nr and Np at 102%).

(d) With the test engine driving the rotor at 102%, increase collective to set torque at 70%, 75%, or 80%. A higher torque setting will improve the accuracy of the check, but the aircraft must not become excessively light on the wheels. Environmental conditions and aircraft weight will determine the highest torque setting that can be safely tested.

(e) Stabilize engine at this condition for 1 minute, and record the following on ground power assurance worksheet:
* % torque
* ITT
* Pressure altitude
* OAT.

(f) Plot the values from above on the ground power assurance graphs to calculate engine temperature margin:
* If temperature margin is >5°C (41°F), the engine is acceptable
* If temperature margin is <5°C (41°F) but >0°C (32°F), the value should be confirmed with an Inflight Power Assurance Check (para 6.I.).
* If temperature margin is <0°C (32°F), the engine has failed check. Refer to FAULT ISOLATION 000 or applicable Aircraft Flight Manual for corrective action.

I. Inflight Power Assurance Check.

(1) The following procedure is used to check engine performance during flight:

CAUTION: OBSERVE ALL ENGINE AND AIRCRAFT OPERATING LIMITS DURING THIS CHECK.

NOTE: The influence of airspeed may have a significant effect on the result of the check. The check is designed with a nominal airspeed of 120 KTAS.

(a) Set both engine SIF switches to FLIGHT and establish level flight at 70% torque with a rotor speed of 102% Nr.

(b) Check airspeed <140 KTAS. Reduce power if necessary to maintain level flight with airspeed <140 KTAS.

CAUTION: IF ICING CONDITIONS EXIST, DO NOT KEEP ANTI-ICING SYSTEM OFF LONGER THAN NECESSARY TO RUN TEST; OTHERWISE, AN ICING CONDITION COULD CAUSE DAMAGE TO ENGINE.

(c) Set the following conditions on the test engine(s):

- Customer bleed off
- Anti-icing off
- SIF switch at FLIGHT (Nr and Np at 102%).

(d) When required conditions are met, fix power level and ensure that OAT is stable.

(e) Once OAT indication is stable, stabilize engine at this condition for 1 minute, and record the following:

- % torque
- ITT
- Pressure altitude
- OAT.

(f) Plot the values from above on the inflight power assurance graphs to calculate engine temperature margin:

- If temperature margin is >0°C (32°F), the engine is acceptable
- If temperature margin is <0°C (32°F), the engine has failed check. Refer to FAULT ISOLATION 000 or applicable Aircraft Flight Manual for corrective action.

J. Break-In Run Check.

A break-in run is required whenever a gas generator rotor and stator are replaced. When done properly, the break-in ensures that the gas generator section will operate reliably and with the highest efficiency. If the break-in procedure is neglected or is not accomplished properly, the gas generator efficiency may deteriorate resulting in performance loss and an increase in specific fuel consumption. Proceed as follows:

NOTE: Visual redness or glowing of the power turbine case is normal during engine operation. Visual redness or glowing will not damage the power turbine case.

(1) Start non break-in engine using normal start procedure.

(2) Bring Nr to 102%.

(3) Start break-in engine and bring Ng up slowly to 85 ±1% (point 1 on Table 504).

(4) To break-in gas generator do the following:

(a) Set Ng to points as specified in Table 504. Stabilize at each point for 15 to 30 seconds.

(b) Change Ng speeds as slowly as possible, avoid rapid transients.

(c) Continue setting Ng points as specified in the table until the aircraft becomes light on the gear. Note the Ng setting at which this occurs. The remaining points will have to be reached in flight.

NOTE: If the maintenance site has a tiedown area, it is possible to complete the break-in without aircraft flight.

(5) Take off, being careful to keep Ng on break-in engine at or below point reached in step (4).

(6) Attain 2000-3000 feet (609.6-914.4 meters) altitude and stabilize in a hover.

(7) Continue setting Ng points (Table 504) until all eight are completed. Avoid any rapid transients or sudden maneuvers while this flight portion of break-in is being done.

(8) The gas generator can now be considered broken-in and normal engine/aircraft operating conditions may be resumed.

TABLE 504. BREAK-IN Ng SPEEDS

Point	rpm (Ng)	Time at point (in seconds)
1	85 ±1%	15-30 sec.
2	90 ±1%	15-30 sec.
3	85 ±1%	15-30 sec.
4	90 ±1%	15-30 sec.
5	95 ±1%	15-30 sec.
6	100 ±1%	15-30 sec.
7	95 ±1%	15-30 sec.
8	100 ±1%	15-30 sec.

K. Overtemperature Check.

This inspection procedure must be followed when investigating a reported engine overtemperature. This procedure contains information to determine whether an actual overtemperature did exist; it also gives further inspection requirements to determine the extent of possible engine damage, and gives corrective maintenance requirements.

An overtemperature can damage the stage 1 nozzle vanes and turbine blades. The damage may be identified visually, depending upon the extent and duration of the overtemperature. Damage to stage 1 nozzle vanes can vary, from complete vane burn-through to swelling and minor cracking. Damage to turbine blades can vary from complete burnaway of the blade, to blade roughness, to dark discoloration at the blade tip, and to blade CODEP coating changes in the form of flaking, blistering, and wrinkling, with the most notable changes at blade tip area.

(1) Verification of Overtemperature.

(a) Verify reported overtemperature by comparing reported time spent at maximum temperature. Go to Table 501, item T4.5/ITT, and see Figure 502 for limits.

(b) Check aircraft temperature indicating system for calibration error. If indicating system errors are found and the overtemperature cannot be verified, correct indicating system. If indicating system checks OK, it must be assumed that actual overtemperature did take place. In that case, remove hot section module (REMOVAL AND INSTALLATION) and do a detailed inspection (72-40-00, INSPECTION).

7. System and Component Checks.

A. Fuel System Check.

(1) Fuel flow to the engine can be verified. The actuating system, the anti-icing bleed start valve can be checked for faulty operation. It is important to understand the following before doing this check:

(a) Procedure in step (2) is used to verify that fuel is flowing to the engine. Fuel should drain from the FMU and out of the aircraft drain after the SIF switch is returned to STOP position.

(b) A steady stream of fuel should not drain from the FMU and out of the aircraft drain when the SIF switch is at IDLE and when engine is motoring. It is normal to observe some leakage, but there should not be a steady stream of fuel from the drain during initial rollover.

(2) Fuel flow verification.

Fuel is flowing to the engine if mist can be seen coming from the tailpipe during wet motoring or if fuel drains from the FMU and out of the aircraft common drain after the SIF switch is returned to STOP position. Verify fuel flow as follows:

(a) Place the SIF switch at IDLE.

(b) Motor engine to maximum speed (at least 26% Ng).

(c) Look for fuel mist coming from tailpipe.

(d) With engine motoring at maximum speed, wait 30 seconds, and then return SIF switch to STOP position.

(e) If fuel is witnessed emanating from the exhaust, troubleshoot the engine's ignition system. If you do not have fuel mist, change the FMU.

(3) Fuel boost pressure switch check.

(a) Make sure that A/C fuel boost pump delivery system operates correctly. Refer to Airframe Maintenance Manual. If not, troubleshoot fuel boost pump delivery system with procedures from the Airframe Maintenance Manual.

B. Oil Consumption Check.

NOTE: Oil consumption check can be combined with other engine operational checks to reduce total amount of engine test time.

(1) Make sure that the oil level indicator is at the FULL mark. If necessary, add oil (SERVICING).

(2) Start and operate the engine until the oil temperature stabilizes.

CAUTION: DO NOT WAIT MORE THAN 22 MINUTES FROM THE TIME YOU SHUT DOWN THE ENGINE TO THE TIME YOU CHECK THE OIL LEVEL. OTHERWISE, THE OIL SYSTEM CAN BE OVERSERVICED AND THE OIL CONSUMPTION CHECK WILL NOT BE ACCURATE.

(3) Shut down the engine and wait a maximum of 20 minutes before you check the oil level. Do not wait more than 22 minutes; otherwise, the oil consumption check will not be accurate. Check the oil level; if necessary, add oil to bring the oil level indicator to the FULL mark.

(4) Record the reference number that corresponds with the oil level on the installed oil indicator.

(5) Start and operate the engine for a minimum of 60 minutes (this will permit the completion of the oil consumption check and other required operational checks).

CAUTION: DO NOT WAIT MORE THAN 22 MINUTES FROM THE TIME YOU SHUT DOWN THE ENGINE TO THE TIME YOU CHECK THE REFERENCE NUMBER. OTHERWISE, THE OIL CONSUMPTION CHECK WILL NOT BE ACCURATE.

(6) Shut down the engine and wait a maximum of 20 minutes. Do not wait more than 22 minutes; otherwise, the oil consumption check will not be accurate.

(7) Check and record the reference number that corresponds with the oil level on the installed oil indicator.

(8) Subtract the reference number recorded in step (7) from the reference number recorded in step (4); then multiply the result by 40. This is the actual value (cc) of oil used.

NOTE: If the oil consumption is more than 110 cc/hour, notify engineering.

(9) Calculate the oil consumption (cc/hour) as follows:

[data from step (4) - data from step (7)] X 40 = __cc (total oil used)

[total oil used ÷ total engine run time] X 60 min./1 hour = __cc/hr

EXAMPLE:

Total engine run time	90 minutes
data from step (4)	38
data from step (7)	36

[38 - 36] X 40 = 80 cc (total oil used)

[80 cc ÷ 90 minutes] X 60 minutes /1 hour = 53.3 cc/hr

C. Torque Repeatability Check.

(1) This check may be done on the ground or at altitude. If it is done on the ground, aircraft should be headed into the wind to reduce the effects of exhaust gas ingestion. If it is done at altitude, all steps must be done at same altitude. In either case, all steps must be done at the same OAT and at the same Np.

(2) Check the torque system for repeatability as follows:

(a) Slowly increase engine power until T4.5 / ITT reaches 1202°F (650°C). If 1202°F (650°C) is exceeded, reduce power until T4.5 / ITT is below 1112°F (600°C), and then slowly approach 1202°F (650°C) again in an increasing direction.

(b) Stabilize T4.5 / ITT at 1202°F (650°C) for 1 minute, and record torque, Ng, and T4.5/ ITT .

(c) Increase power until T4.5 / ITT is 1292°-1382°F (700°-750°C).

(d) Now slowly reduce power until T4.5 / ITT is 1202°F (650°C). If you go below 1202°F (650°C), increase power until T4.5 / ITT is 1292°-1382°F (700°-750°C), and then slowly approach 1202°F (650°C) again in a decreasing direction.

(e) Stabilize T4.5 / ITT at 1202°F (650°C) for 1 minute, and record torque, Ng, and T4.5/ ITT.

(f) With aircraft on the ground, reduce power quickly to ground idle speed. Record torque, Ng, and T4.5 / ITT with engine stabilized at ground idle speed.

(g) Compare the torque value recorded in step (b) with that recorded in step (e). The difference between the two values in the repeatability error.

(3) The following conditions indicate a torque system repeatability problem:

(a) A repeatability error of more than 10% torque, 360 lb in. (40.7 N.m) when checked as specified in step (2).

(b) Transient torque splits that match up during steady-state operation.

(c) Torque is high at ground idle speed (0-3% is normal).

(d) Torque split of more than 5% during normal steady-state operation.

D. Engine Serviceability Test for No or Low Oil Pressure.

(1) Remove scavenge screens (79-00-00), one at a time, and inspect them for contamination. Place any particles in suitable containers. Record on tag the sump from which particles were found, and attach tag to container. Reinstall scavenge screens (79-00-00).

(2) Remove electrical chip detector (79-00-00). Analyze particles, SERVICING, (if any). Clean chip detector (79-00-00). Place particles that are removed in suitable container. Tag container. Reinstall chip detector (79-00-00).

(3) During engine operation, monitor the following:

(a) Oil pressure and oil temperature illumination.

(b) Chip detector light coming on.

(c) Changes in vibration level.

(d) An uncontrolled deceleration in % Ng and rise in T4.5 / ITT indicating a possible bearing seizure.

(4) Start engine. Run engine at ground idle speed for 2 minutes.

(5) Record oil pressures and oil temperatures versus % Ng for power settings used and compare them with previous engine records.

(6) Advance the PAS control / SIF switch to FLY. Increase collective pitch to a torque value just below that which should lift the helicopter off the ground (single engine). Note torque, and run engine at this condition for 10 minutes.

(7) Decrease collective pitch and return the PAS control / SIF switch to IDLE. Run engine at this condition for 2 minutes.

(8) Advance the PAS control / SIF switch to FLY. Increase collective pitch to the torque noted in step (6). Run engine at this condition for 10 minutes.

(9) Decrease collective pitch and return PAS control / SIF switch to IDLE. Run engine at this condition for 2 minutes.

(10) Repeat steps (8) and (9) three more times to complete a 1-hour engine run.

(11) Shut down engine.

(12) Remove electrical chip detector (79-00-00) and scavenge screens (79-00-00). Inspect detector and screens for contamination.

(13) If contamination is found in chip detector and in scavenge screens, clean them (79-00-00).

(14) If no contamination is found in chip detector or in scavenge screens and if engine has run for 60 minutes with no faults, reinstall chip detector (79-00-00) and scavenge screens (79-00-00). Operation can be continued.

(15) Discard particles found in scavenge screens and chip detector (steps (1) and (2)).

E. Preliminary Ignition Check.

(1) Use a multimeter for this check. Connect multimeter leads to resistance sockets in multimeter. Short the leads together. Adjust indicator to read zero. Set switch at a position that will allow low resistance to be accurately read on scale. Be sure all electrical connectors are tight. The following checks are for testing the circuits in the alternator, green cable, and ignition exciter assembly. These following checks will determine which components should be replaced. Before performing procedure, ensure all other applicable procedures in FADEC FAULT ISOLATION 001 and Non-FADEC FAULT ISOLATION 002, Figure 109 (Table No Start (Fuel Mist Seen Coming from Tailpipe)), have been completed.

(a) Disconnect ignition exciter at P20 and measure connector J20 at pins 1 to 3 looking toward the alternator. Resistance should be between 2 and 6 ohms. Measure resistance between each pin, 3 and 1, to the connector back shell. No short circuits allowed. If resistance is out-of-limits, continue to step (b). Otherwise, replace the ignition exciter.

(b) Disconnect alternator at P30 and measure connector J30 at pins 9 to 10. Resistance should be between 2 and 6 ohms. If resistance is out-of-limits, replace alternator. Otherwise, replace green cable.

F. Electrical Ignition Lead Check.

(1) Remove electrical ignition leads (74-00-00).

(2) Check for continuity from socket on one end of lead to socket on other end of lead. If continuity is not indicated, install new electrical ignition lead (74-00-00).

(3) Check lead for short-to-ground by testing socket at one end of electrical ignition lead for shorts to metal braid. if lead is shorted or if resistance is less than 500k ohms, install a new electrical ignition lead (74-00-00).

(4) Repeat steps (2) and (3) for other electrical ignition lead.

G. Green Cable Oil Pressure Transmitter Circuit Check.

CAUTION: DO NOT USE MULTIMETER CAPABLE OF PRODUCING OUTPUT VOLTAGES GREATER THAN 1.5 VOLTS DC. A VOLTAGE GREATER THAN 1.5 VOLTS DC MAY DAMAGE THE EECU CIRCUITS.

NOTE: A multimeter must be used for this check.

(1) Disconnect electrical connector (W3P2 - green cable) at oil pressure transmitter, and disconnect aircraft cable connector (E3) at electrical connector (W3J1 - green cable) on swirl frame.

(2) Check continuity of green cable from connectors W3P2 to W3J1 as follows (no open circuits allowed):

W3P2 Sockets		W3J1 Pins
1	to	7
2	to	6
3	to	5

(3) Check electrical connector (W3P2) for short circuits between sockets 1, 2, and 3. No short circuits allowed.

(4) Check electrical connector (W3P2) for short circuits to aircraft ground from sockets 1, 2, and 3. No short circuits allowed.

(5) If green cable is faulty, replace cable (74-00-00, REMOVAL AND INSTALLATION).

(6) If green cable is not faulty, reconnect it to oil pressure sensor, and reconnect aircraft cable connector (E3) to electrical connector (W3J1 - green cable) on swirl frame.

H. Igniter Plug Serviceability Check.

(1) Remove both igniter plugs from midframe ports (74-00-00). Be sure that ignition leads have been grounded to engine.

(2) Connect ignition leads to plugs.

(3) Install slave igniter plugs into midframe ports.

WARNING: IGNITER PLUGS

* BEFORE ENERGIZING THE IGNITION CIRCUIT, BE CERTAIN THAT NO FUEL OR OIL PRESENT. HAVE FIRE EXTINGUISHING EQUIPMENT PRESENT.
* HIGH VOLTAGE IS PRESENT. BE CERTAIN THE IGNITION UNIT AND PLUGS ARE GROUNDED BEFORE ENERGIZING THE CIRCUIT.
* NEVER TOUCH OR MAKE CONTACT WITH THE ELECTRICAL OUTPUT CONNECTOR WHEN OPERATING ANY IGNITION COMPONENT.
* NEVER HOLD OR MAKE CONTACT WITH THE IGNITER PLUG WHEN ENERGIZING THE IGNITION COMPONENT.

(4) Ensure the airframe fuel boost pumps are OFF and the fuel shut off valves are CLOSED. Place the SIF switch in the IDLE position to perform roll over with ignition OFF. Observe plugs for sparks. If igniter plugs are providing approximately two sparks per second, igniter plugs are serviceable. Otherwise, replace igniter plug.

(5) Remove slave igniter plugs and install serviceable plugs into midframe ports (74-00-00).